8.1 DEFINITIONS

Below some of the terms used for describing fixed port and terminal facilities are defined:

Berth—a facility where one vessel may be safely moored and load/unload cargo or let passengers or vehicles embark or disembark.

Quay—one or more berths continuously bordering on and in contact with a land or dock area. The quay apron reaches the quay front over the entire length of the berth(s). Often a quay is described as one or more berths which are parallel to the shore although the shore may not be well defined.

Wharf—same as quay, although there seems to be a tendency to use this term for open structures on piles, only.

Pier or Jetty—a structure projecting into the water. Often piers and jetties will have berths on two sides and abut land over their full width. They may also be able to accommodate one or more vessels at the end. Piers and jetties may also be more or less parallel to the shore and connected to land by a trestle and/or a causeway.

The terms quay and wharf on the one side and the terms pier and jetty on the other side are mainly used to characterize berthing facilities with respect to their general arrangement relative to the shore line or adjacent land areas.

A berth which does not require an apron over its entire length but only a platform at midship usually consists of a system of mooring and breasting dolphins. The individual dolphins will normally be interconnected by catwalks and a trestle bridge will connect the platform to land. Such a facility is usually also called a jetty.

Terminal—one or more berths for a limited purpose (such as oil, grain in bulk, containers) and/or limited to one or a few users.

F. Quays and jetties

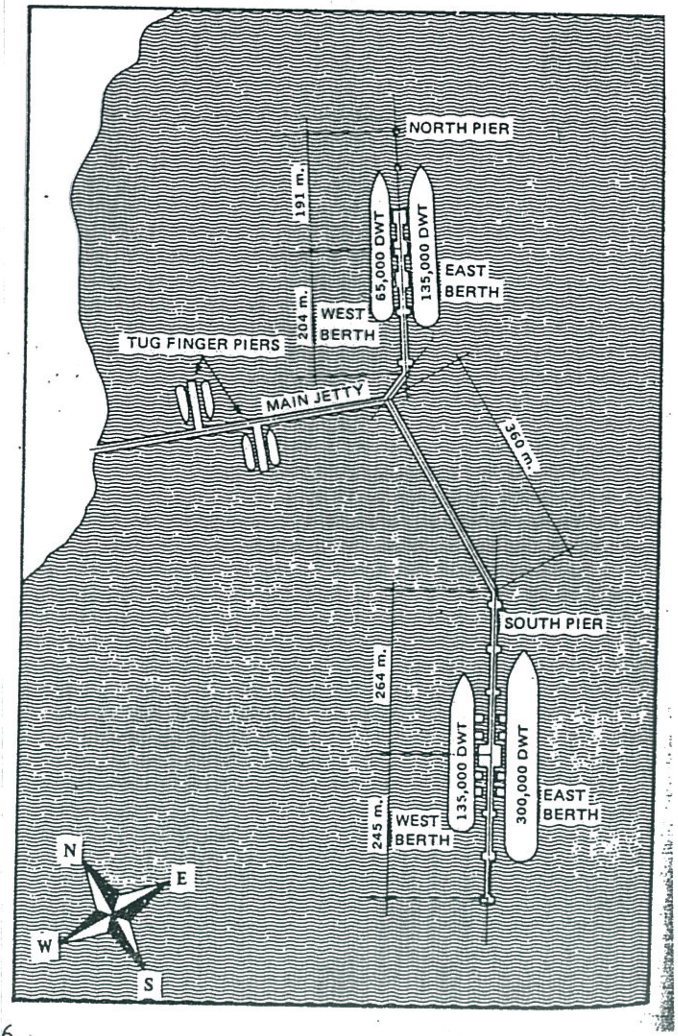
1. Introduction

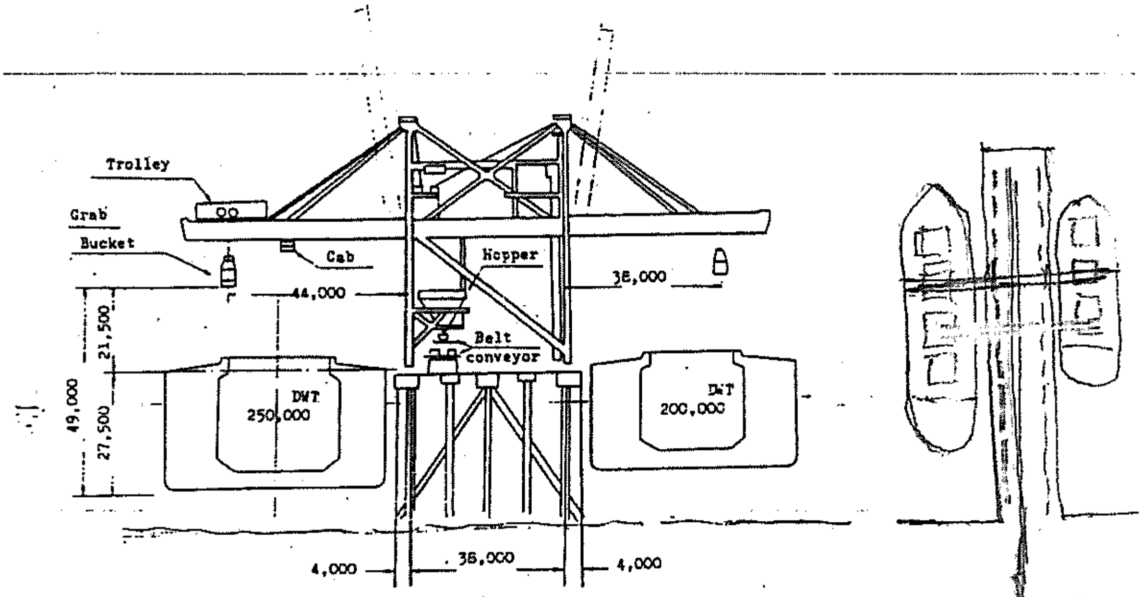
483. A distinction must be made between heavy structures on which cranes and large vehicles can operate, and light structures which can only support pipelines, conveyors and light vehicles. The heavy structures—interchangeably called quays and wharves—can be either marginal (i.e. parallel to the shoreline) or in the form of piers which project from the shore. The light structures, which also project out to deeper water, are called jetties.

484. A jetty is economical where the depth of water available for the ships calling is available only some distance offshore. It is suitable for bulk cargoes—dry or liquid—where the jetty head in deep water accommodates the specialized loading or unloading equipment and the cargo is conveyed ashore by pipeline or moving belt along the jetty approach. A jetty is unsuitable for general cargo, where storage area near the ship is important, unless a high tidal range makes it the only economical solution.

Figure 62

Typical jetty arrangement for tanker terminal





Pontile a sezione continua

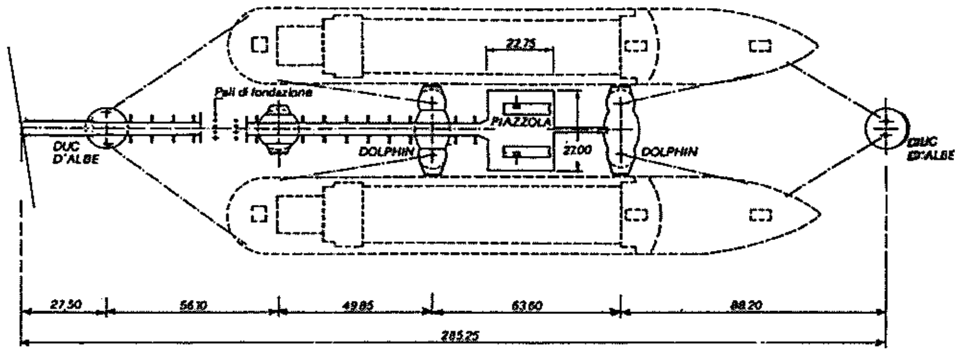


Fig. 97 - Porto di La Spezia. Pontile per petroli.

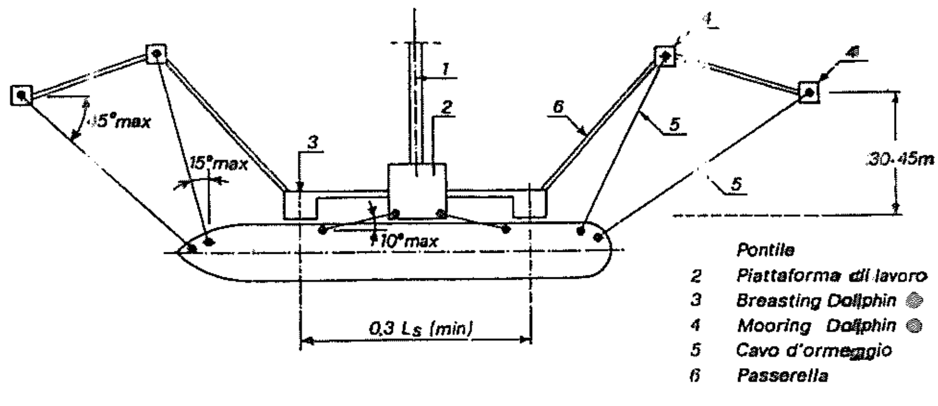


Fig. 98 - Attracco per navi cisterna (tankers).

PIERS

8.5.2 Piled piers

Piled piers may be chosen rather than massive piers because of cost, e.g. if the pier is located at considerable water depth, because the massive pier may develop unacceptable settlements or because a nonreflecting structure is preferred for wave disturbance reasons.

Piled piers simply consist of a deck supported on piles, but the pattern of piling, the type of piles and the particular design of the deck may be varied and combined almost indefinitely. Piles may be of steel, reinforced or prestressed concrete or timber.

When steel piles are used, the fundamental choice is between an H-pile or a pile with a hollow section (tubular pile). The H-pile is usually less costly but offers less column bearing capacity for same weight due to the smaller moment of inertia, in particular if the pile is long. Further, the pile with the hollow section is more corrosion resistant because corrosion will take place almost only on the outside surface. Hollow steel piles are often concrete filled. If this is done for the purpose of completely avoiding corrosion from inside, it is probably an expensive measure compared to allowing for some extra steel in the pile itself.

The deck will normally be of reinforced or posttensioned concrete either with a plain slab or with girders in one or two directions. Cast *in situ* concrete is widely used but also precast deck slabs or combinations of precast and *in-situ* concrete are often used.

The most economic choice in a particular case depends mainly on type of live load, water depth, soil conditions, availability of plant and materials, experience of potential contractors and whether the new pier is located in a sheltered or nonsheltered area. The static principle of a pier is illustrated in Fig. 8.5(a). Structural weight and vertical live loads are carried by the deck and distributed to the piles. Horizontal loads from ships' impact and mooring forces are normally very decisive for piled piers. These loads have to

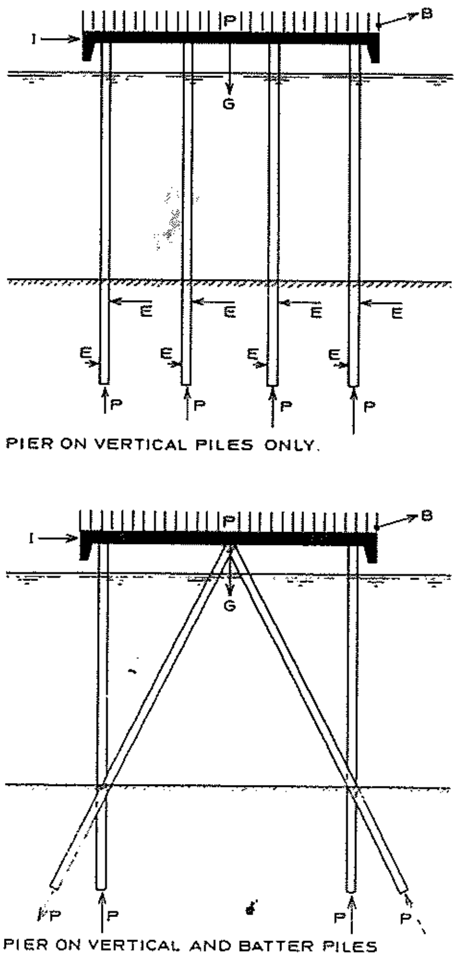


Fig. 8.5 (a) Pier on Piles

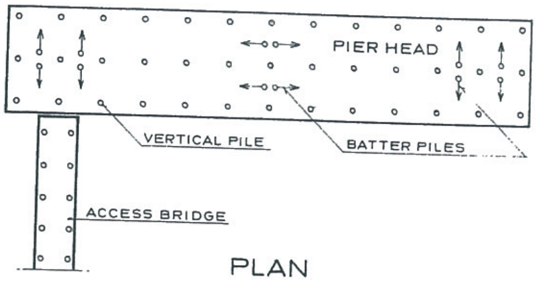


Fig. 8.5 (b) Location of Batter Piles

be transmitted to the ground via the piles. Depending on the number, stiffness, capacity and fixity in the ground of the piles this may be possible with only vertical piles if the corresponding deflections are acceptable. More frequently, however, batter piles are used to transmit horizontal loads. If sufficient pulling resistance cannot be obtained due to the ground conditions, it may be necessary to introduce extra weight in the deck either by concrete or by sand fill.

Because of the importance of the horizontal loads on piled piers, one should realize that mooring forces resulting from wind pressures on vessels cannot be reduced once the maximum profile of vessel is established, whereas the berthing impact forces are functions of the type and characteristics of the fendering chosen for the pier and other parameters related to the vessels and their approach manoeuvres.

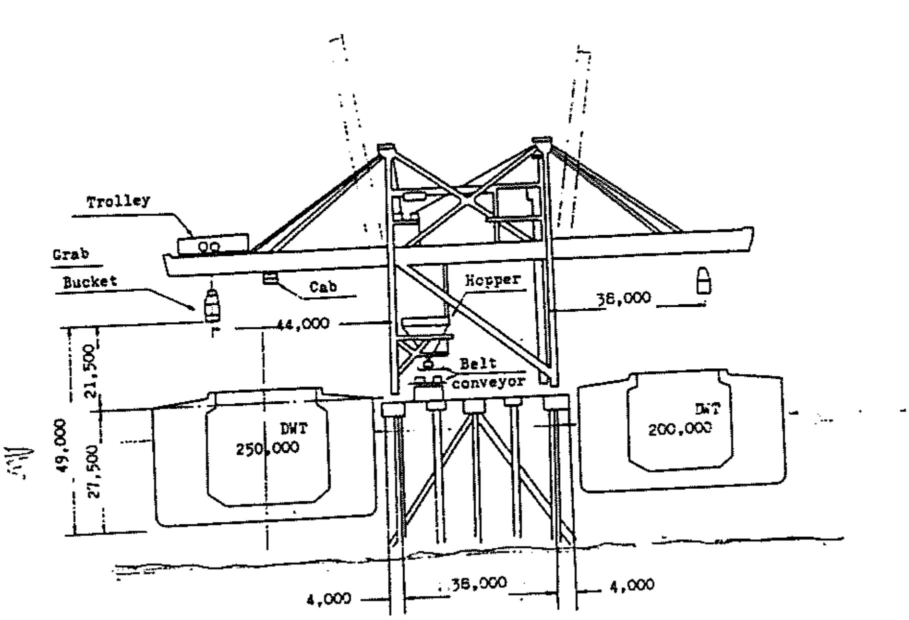
Thus, for piled piers the fendering becomes an important integral part of the structure. This is contrary to the quay structures where berthing impacts could fairly easily be transferred to the ground behind the structure.

The resilience of piers on vertical piles has in a number of cases been utilized to absorb impacts from berthing vessels. Deflections of the pier of up to 15 cm have been allowed and proper fendering has either been omitted or greatly reduced. It is necessary to ensure that pipe lines leading to the pier are sufficiently flexible and that a flexible joint is provided between access bridge and pier. Further, it should be realized that the piles are subject to maximum utilization (axial load and bending) at the soffit of the deck, which is a region with a harsh environment because of alternating wetting and drying. Finally, the ability of a pier to absorb berthing impacts by elastic deformation of the structure itself is considerable lower at the ends than in the central section, whereas normally the ends of piers, in particular, are exposed to impacts.

In a rigid pier it is preferable to have transverse batter piles at the ends to absorb berthing impacts, which would otherwise cause torsion of the entire pier structure. Batter piles in the longitudinal direction may be located near the centre of the pier (see Fig. 8.5(b)).

Whether the pier is rigid or resilient the deck will act as a beam deflecting in a horizontal plane and will distribute horizontal loads to the piles.

Often it is necessary to provide the edge of the deck with a curtain or take other measures which will ensure that small vessels with low freeboard are not trapped underneath the deck at low water.



Item	Specification	Item	Specification	
Nominal Capacity	2,500 T/H	Grab Bucket	$17.2m^3$	Ore
Type	Bridge Type Crab Trolley		$53m^3$	Coal
Max. Vessel	250,000 DWT	Motion	Velocity	Motor
Rail Span	38 m	Hoist	140m/min	1,000KW
Outreach	44m Sea Side	Close	140m/min	1,000KW
	38m Land Sid	Traverse	200m/min	220KWx2
Lift	49m { 21.5 Over Rail	Travel	30m/min	128KWx2
	27.5 Under Rail	Derrick	6min	220KWx2
Lifting Load	81T { 43 Rated Load	Hoist (Bulldozer)	20m/min	150KW
	38 Bucket Weight	Wind Velocity	20m/min: at work	
Lifting Load for Bulldozer	30T	for Design	60m/min: at storm	
Rail for Travel	73kg/m double	Power Supply	6,600V	60 Hz

Fig. 16 General View of 2,500 T/H Unloader

all other troubles, such as chute clogging and snaking and slip of the belt, and then interlocking the results of such detection with the operation of the equipment.

RECLAIMER

The reclaimer is used for collecting the raw material from the yard for the subsequent process. Reclaimer capacity varies with the capacity of equipment located behind the reclaimer. Recently, reclaimers with a capacity of 1000 to 1500 t/h have been widely employed. Reclaimers of the continuous, constant-weighing type utilizing the rotation of a bucket wheel are widely used.

An example of reclaimer specifications is shown in Table 5, and a general view of a reclaimer is shown in Fig. 18.

To control the amount of material collected by the reclaimer, the depth of the cut, i.e. inching distance must be very accurate. The travelling ability of yard equipment varies greatly with the wind or the slope of the rails. With modern reclaimers, a stopping accuracy of ± 50 mm is ensured through the adoption of hydraulic drive. The slewing speed and bucket wheel speed are made infinitely variable through the adoption of a hydraulic drive system. Constant collection is ensured and overload is prevented by various interlocks, such as the interlock between the drive pressure of the bucket wheel and the slewing speed.

Studies on the unattended operation of loaders have been under way for several years. However,

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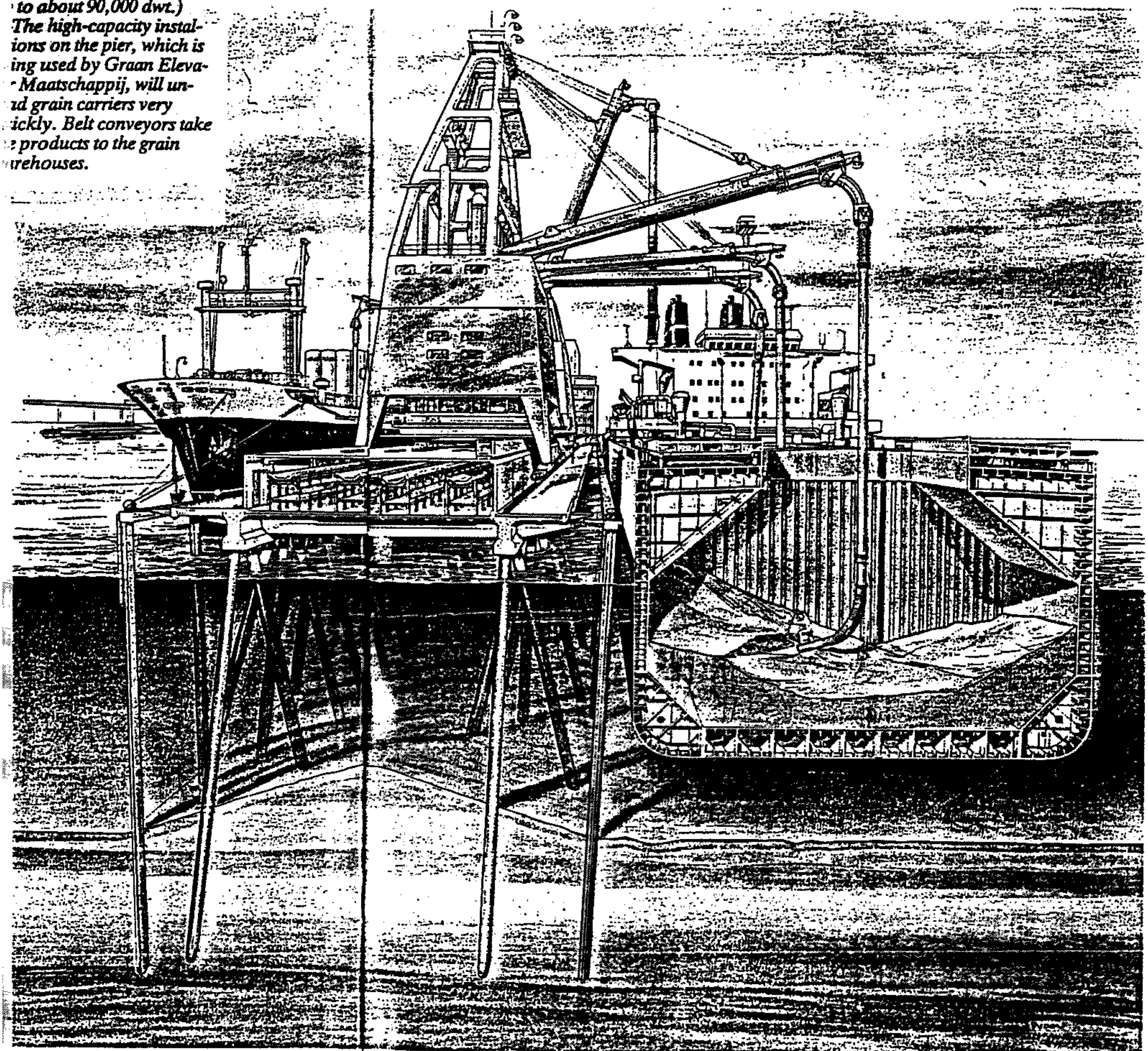
This unloading pier in
ıtlek dates from 1963. The
ncrete construction is 3.45
above ordnance datum.
ıe bottom of the port is
.65 m. below ordnance
tum (suitable for ships of
to about 90,000 dwt.)
The high-capacity instal-
ions on the pier, which is
ing used by Graan Eleva-
Maatschappij, will un-
ıd grain carriers very
ickly. Belt conveyors take
products to the grain
ırehouses.



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2.4. Pontili

Sono opere di accosto con struttura a giorno che si sviluppano essenzialmente in direzione trasversale rispetto alla linea di riva, e assumono configurazione diversa a seconda che siano destinate a traffici di merci solide o liquide. Nel primo caso sono costituite essenzialmente da un'ampia e robusta piattaforma di attracco che può proseguire a piena larghezza fino alla riva, oppure ridursi ad una semplice passerella carrabile portanastri. Rientrano in questa categoria i primi esempi di pontili realizzati in Italia intorno ai primi decenni del secolo (Bagnoli, Genova-Cornigliano, ecc.). Nel secondo caso, invece, sono costituite da una o più piazzole di limitate dimensioni a cui è associato un sistema di briccole di accosto e di ormeggio, collegate a terra da una passerella portatubi.

In questo paragrafo vengono considerati solo i pontili « interni », cioè quelli situati all'interno di porti o entro baie sufficientemente riparate nei riguardi del moto ondoso.

Il pontile solidi SINCAT nella rada di Augusta (1957-58) è formato da una piattaforma di dimensioni 30,6 × 132,5 m per l'accosto di bulk-carriers fino a 10.000 dwt, collegata a terra da una passerella portanastri (figg. 47-48-49).

L'intero pontile è fondato su colonne costituite da una camicia cilindrica in c.a. prefabbricata, poste in opera mediante pontone. Esse sono parte a fondazione diretta con monconi di cucitura e parte fondate su pali trivellati che penetrano nella roccia per circa 3 m. Le camicie sono state successivamente riempite con calcestruzzo eseguito con speciale attrezzatura per getto subacqueo.

La piattaforma poggia, con sopraelevazione sul livello del mare di 4 m, su 56 colonne controventate mediante diagonali prefabbricate, in modo da realizzare la rigidità necessaria all'assorbimento delle elevate sollecitazioni orizzontali sviluppate dalle navi in accosto e ad ormeggio. L'impalcato è stato eseguito in c.a. con le travi longitudinali prefabbricate, mentre i traversi colleganti le colonne e la soletta di calpestio sono stati eseguiti in opera.

or liquid cargo. In the first case they consist essentially of a large, robust berthing platform which can continue at its full width to the shore, or be a mere vehicular catwalk with belt conveyor. The first jetties built in Italy about the first decades of the century come into this category (Bagnoli, Genoa-Cornigliano, etc.). In the second case, however, they consist of one or more platforms of limited size with which a system of berthing and mooring dolphins is associated, connected to the land by a catwalk carrying pipes.

Here will be considered only internal jetties that is the ones situated inside harbours or in bays which are sufficiently sheltered against wave motion.

The SINCAT jetty in the Augusta Bay *(1957-58) consists of a platform measuring 30,6 m × 132,5 m, for the berthing of bulk carriers of up to 10.000 DWT, connected with land by a deck carrying a conveyor belt (Figs. 47-48-49).*

The whole jetty is founded on columns constituted by a precast cylindrical r.c. jacket, placed by means of a pontoon. Part of the columns have direct foundations with seamed ends and part founded on drilled piles which are driven into the rock for some 3 m. The jackets were subsequently filled with concrete using special equipment for underwater pouring.

The platform, standing at an elevation of 4 m above sea level, rests on 56 columns shored by precast diagonal elements, in order to achieve the rigidity necessary to absorb the high horizontal stresses developed by ships approaching and at their mooring. The deck is of reinforced concrete with precast longitudinal beams, while the cross pieces connecting the columns and the floor slab were cast in place.

47

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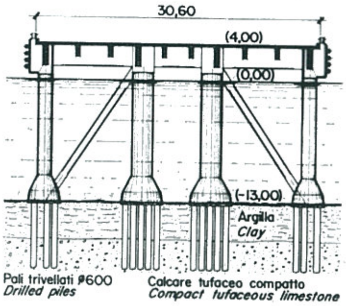

PONTILE SOLIDI SINCAT A PRIOLO NELLA RADA DI AUGUSTA (Impresa Mantelli): 47 - Trasporto di una colonna prefabbricata di fondazione; 48 - Sezione trasversale tipo della piattaforma di attracco; 49 - Vista della piattaforma di attracco.

THE SINCAT BULK GOODS JETTY AT PRIOLO IN THE AUGUSTA BAY (Impresa Mantelli): 47 - Transportation of a precast foundation column; 48 - Typical cross section of the berthing platform; 49 - View of the berthing platform.

8.6 JETTIES

The characteristics of a jetty as defined in 8.1 are that it consists of a number of individual structures each of which support a special type of loads. The mooring dolphins pick up the pull from the hawsers, the breasting dolphins support fenders which absorb berthing impacts and on shore wind loads on the moored vessel and loading platforms support special loading or unloading equipment but normally no horizontal forces apart from wind loads on the equipment.

A typical layout of a jetty with one berth, only, is shown in Fig. 8.6(a). Catwalks which connect the various dolphins and platforms are indicated.

The location of the mooring and breasting dolphins relative to each other is an important issue in the design of jetties. Parameters are the dimensions of the maximum and the minimum size of vessels to be served. The breasting dolphins should be placed as wide apart as possible but the distance should neither exceed the length of the straight side of the smallest vessel nor be less than approximately one-third of the maximum length of vessel, assuming that the vessels do not have to be shifted while loading or unloading. In addition to providing support for fenders, the breasting dolphins may also support bollards for spring lines.

Mooring dolphins for breast lines shall be located at bow and stern at a distance (about the beam of a ship) from the berth line, which will not make the moorings too steep. If the jetty shall serve vessels of different lengths, the location has to be a compromise, unless a double set is provided.

It is common and in accordance with many captains' wishes also to provide mooring dolphins for bow and stern lines because 'this is the way it has always been' and because they provide extra safety in case one of the other lines should burst. However, vessels can be safely moored with only breast lines and springs if the mooring points are properly located and if each mooring point allows for several hawsers. Further, under

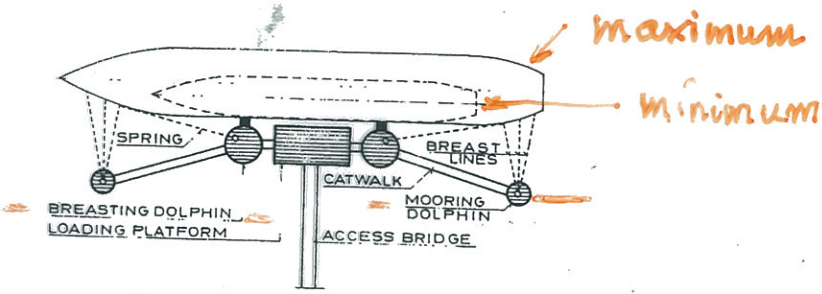

Fig. 8.6 (a) Typical Single Berth Jetty

unfavourable conditions, bow and stern lines could introduce undesirable transverse forces in combination with surge.

That breast lines and springs are sufficient for safe mooring, at jetties where breast lines can be fixed well behind the berth line, has been confirmed at several jetties which do, in fact, serve vessels of considerably greater length than intended. In these cases, the dolphins meant for bow and stern lines are actually used for breast lines.

Unless the loading or unloading platform by purpose is combined with the two breasting dolphins, it is normally located at some distance behind the berthing line in order to avoid horizontal forces on the platform as a result of direct contact with the vessel.

If the jetty is arranged with two berths, one on either side as shown in Fig. 8.6(b), it may be an advantage to combine the two sets of breasting islands into one set which then could be used from both sides. Mooring dolphins then have to be placed (in the centreline) between the two berth lines and to avoid excessively wide breasting islands, it may be necessary to compromise on the distance from berth line to mooring point.

Mooring and breasting dolphins are almost entirely exposed to horizontal forces. If constructed with piles (vertical and batter), several of these will have to take pull because of the lack of downward, vertical loads which could neutralize the pull. Sufficient pulling resistance may be obtained in clayey soils, but only with difficulty, if at all, in granular soils. Also gravity structures, e.g. in the form of caissons or individual, sand-filled sheet pile cells are widely used for dolphins in jetties. As for the gravity quay walls, the principle is that the dolphin is given a weight and the base is given width so that the resultant force intersects the base so far from the edge that the pressure under the dolphin will not exceed the bearing capacity of the subsoil.

It is often economical to give an individual caisson a circular, cylindrical shape. The hoop tension in the shell will make inside diaphragm walls redundant but a deck which distributes the concentrated horizontal load to the walls is required. The cylindrical shape compared with square or rectangular shapes will also reduce current forces and bed erosion effects.

Because the governing loads on a breasting dolphin are impacts from berthing ships, the fenders become integral elements in the design and they cannot be considered just items to be fitted at the end. The loading platform and its access way, if independent of the breasting dolphins, may be considered a pier and reference is made to 8.5.

Jetties are frequently located in open water outside actual harbours. If this is the case in regions where drift ice occurs from time to time, then the designer should realize that impact of drifting ice floes could exceed that of berthing vessels or could result in loads on the exposed mooring dolphins which may exceed the mooring forces. In areas with

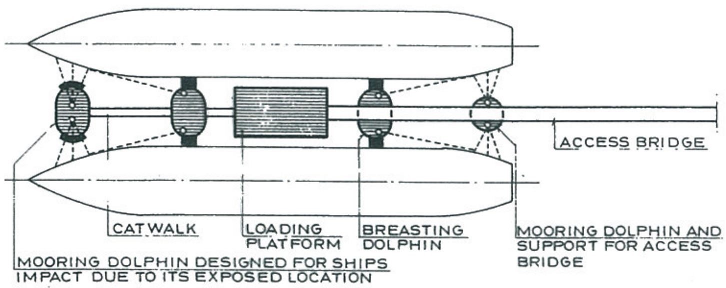

Fig. 8.6 (b) Typical Two-Berth Jetty

drift ice of more than insignificant magnitude, piled structures should be avoided unless they are effectively sheltered by massive structures. Further, it may be necessary to stiffen thin-wall caissons and sheet pile cells with inside concrete slabs buried in the fill at water level.

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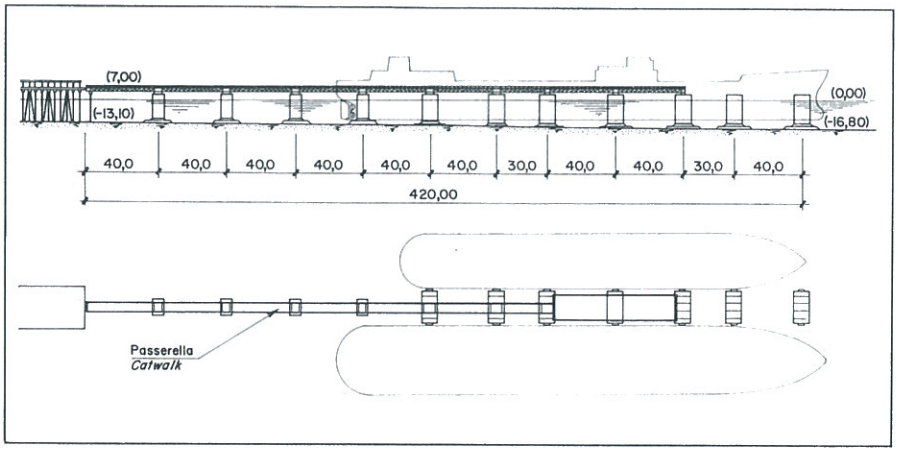

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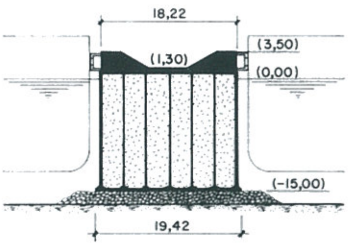

PONTILE SIR A PORTO TORRES (Impresa Fincosit): 50 - Sezione longitudinale e pianta; 51 - Sezione trasversale di un pilone.

THE SIR JETTY AT PORTO TORRES (Impresa Fincosit): 50 - Longitudinal section and plan; 51 - Cross section of a pile.

La passerella portanastri è sostenuta da strutture intelaiate, di cui le più esterne sono formate da due colonne ciascuna, opportunamente sbadacchiate tra loro e alla piazzola, e quelle intermedie da quattro colonne ciascuna con opportune diagonali subacquee di irrigidimento.

Il *pontile SIR a Porto Torres* (1968-69) è costituito da una passerella carrabile portatubi e da una piattaforma di servizio — realizzate con travate in acciaio assiemate su banchina e collocate in opera con pontone — sostenute da piloni poggianti su fondali rocciosi (figg. 50-51).

I piloni sono formati da cassoni cellulari in c.a., che sono stati costruiti a Genova e poi completati in sito con le sovrastrutture in getto armato massiccio. Anche in questo caso la notevole rigidità garantita dalla presenza dei cassoni di infrastruttura ha reso superfluo il ricorso ad opere accessorie indipendenti (briccole di accosto e di ormeggio) per l'assorbimento delle sollecitazioni dovute alle navi.

L'opera, ultimata qualche anno prima dell'inizio della costruzione della diga di difesa del nuovo porto industriale, costituisce un prolungamento fino a fondali di circa 17 m di un preesistente pontile metallico ed è accessibile a navi-cisterna fino a 80.000 dwt.

Il *pontile consortile nella rada di Augusta* (1977-78) è costituito da una passerella carrabile portatubi su pali in acciaio a grande diametro, di collegamento tra la terraferma e tre piazzole di accosto per navi-cisterna fino a 50.000 dwt (figg. 52-53-54-55-56).

La passerella è realizzata con due soli elementi prefabbricati per campata: uno per il traversone su due pali metallici di sostegno per le tubazioni di maggior diametro, ed uno in c.a.p. per la campata di 18 m, costituente la passerella carrabile e il supporto per gli appoggi intermedi delle tubazioni

The catwalk with conveyor belt is supported by trellis structures, the outermost ones of which are formed by two columns each, duly propped, while the intermediate ones are formed by four columns each with opportune underwater stiffening diagonal struts.

The SIR Jetty at Porto Torres *(1968-69) consists of a vehicular deck carrying pipes and a service platform, made of steel girders assembled on the jetty and placed by means of a pontoon, the whole supported by piers standing on the rocky seabed (Figs. 50-51).*

The piers are formed of reinforced concrete multicell caissons, constructed in Genoa and then completed on site with a super-structure of mass reinforced concrete. In this case, too, the considerable stiffness guaranteed by the caissons of the substructure made it unnecessary to have any independent accessory structures (berthing and mooring dolphins) to absorb the stresses caused by the ships.

This work, completed a few years prior to the starting of the construction of the breakwater for the new industrial port, is an extension to water depths of about 17 m of a pre-existing iron jetty, and can be used by tankers of up to 80.000 DWT.

The Consortium Jetty in the Augusta Bay *(1977-78) consists of a vehicular deck carrying pipelines on large-diameter steel piles, acting as a link between terra-firma and three berthing platforms for tankers of up to 50.000 DWT (Figs. 52-53-54-55-56).*

The deck is built with just two prefabricated elements per span: one for the transversal beam on two steel support piles for the larger-diameter pipes, and one of precast r.c. for the 18 m span, forming the vehicular lane and the bearing for the intermediate supports of the smaller pipes. In each pier the structural continuity of the

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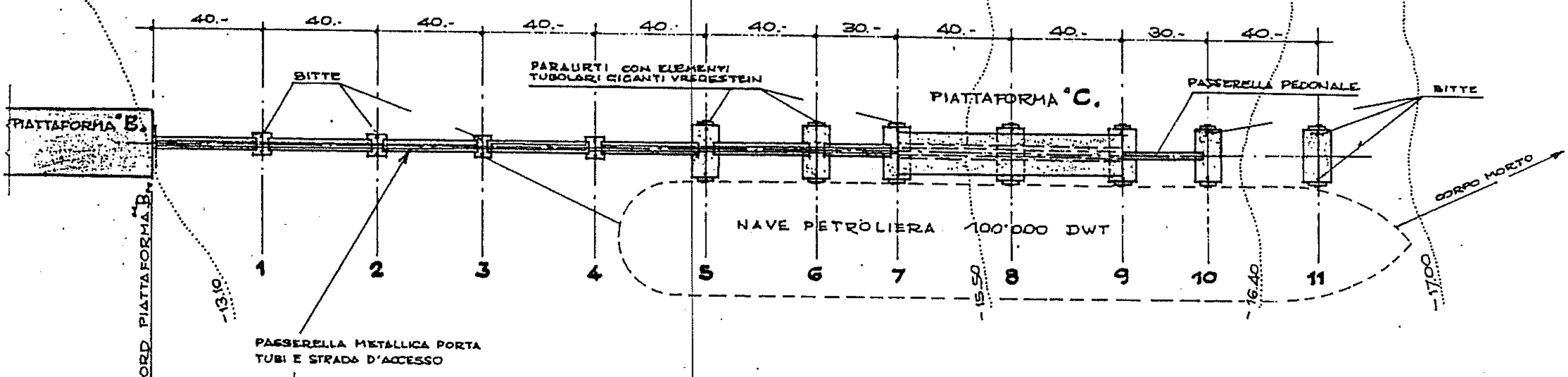
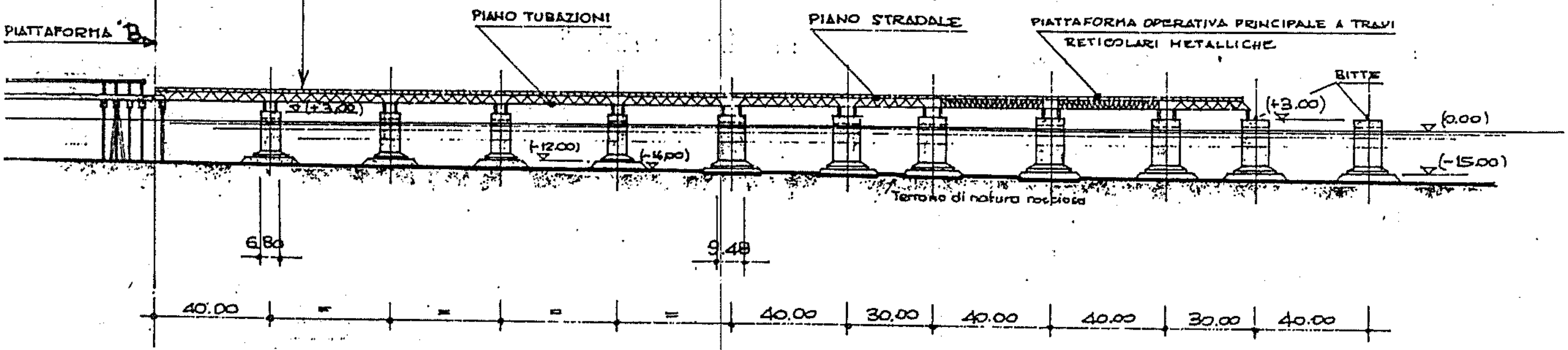
PIANTA DEL PONTILE



PILE 1·2·3·4 – Cassoni cellulari in c.a. – Sezione al fusto: 9,38 x 6,80

PILE 5·6·7·8·9·10 e 11 – Cassoni cellulari in c.a. – Sezione al fusto: 18,42 x 9,48

PROFILO DEL PONTILE

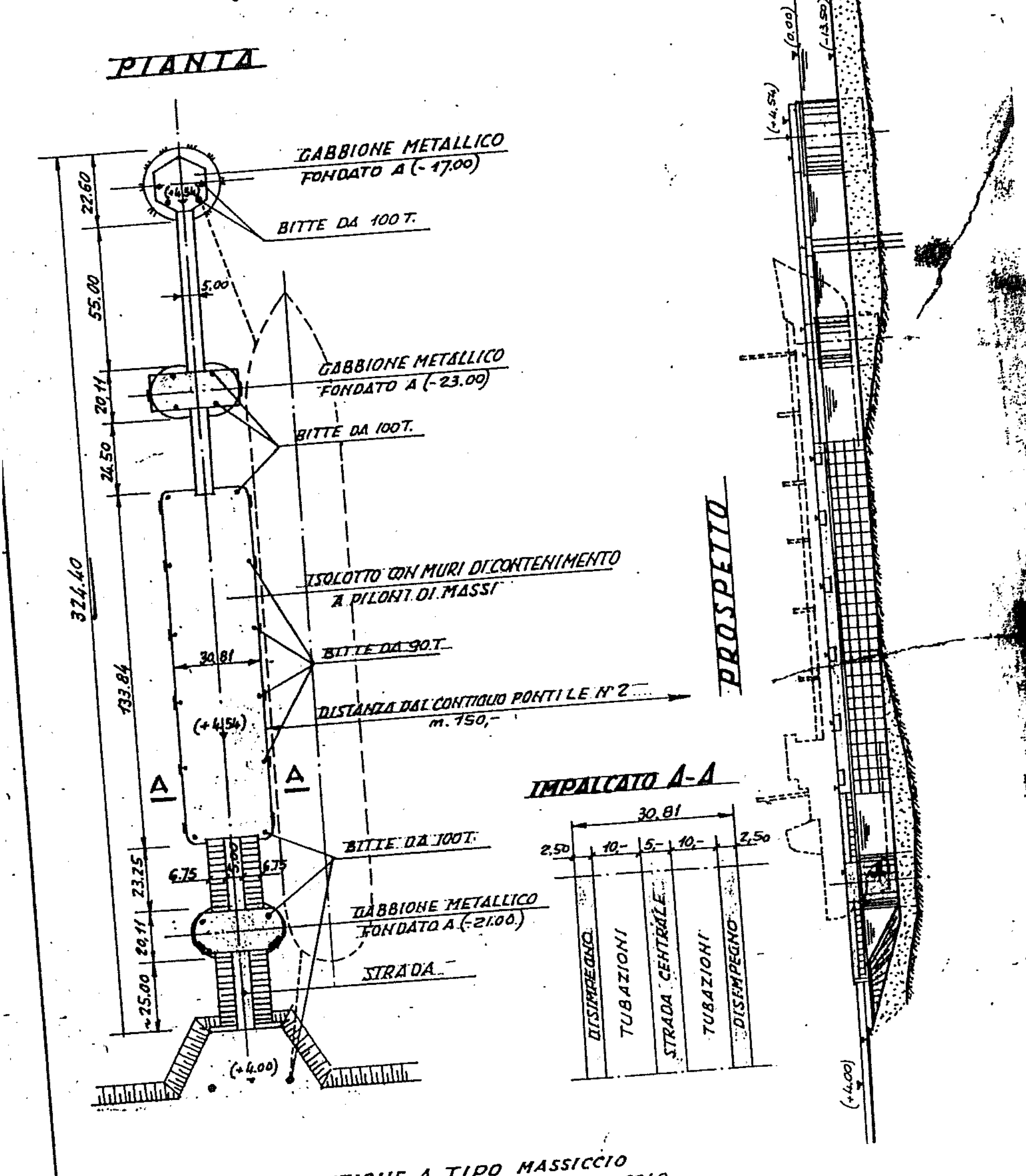


Uegato VI/N

PORTO PETROLI DI LAVERA - MARSIGLIA-

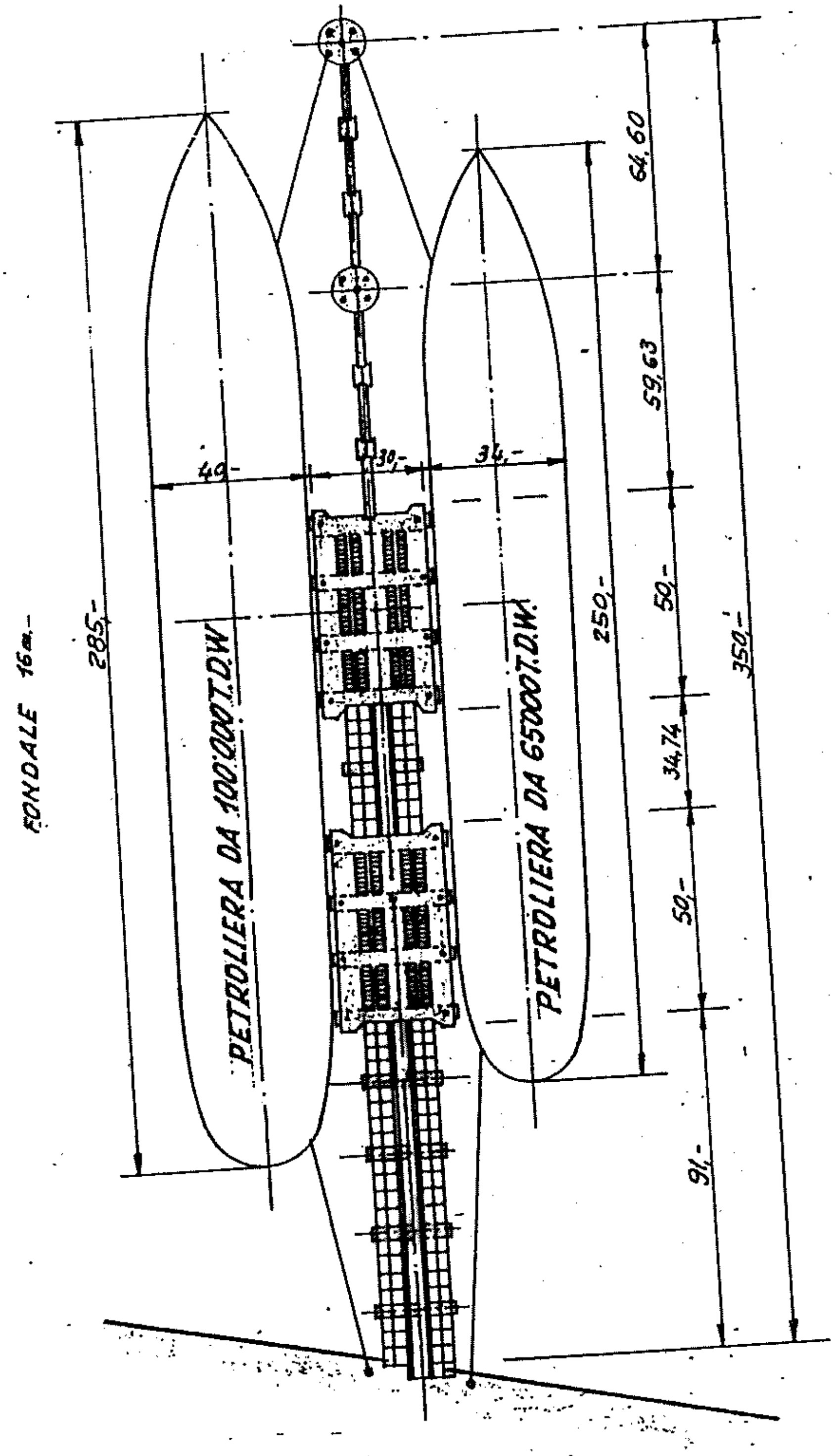
PONTILE N°3 PER PETROLIERE DA 65 000 ÷ 70'000 T.D.W.

(VEDERE "CONSTRUCTION" 1961)



SOLUZIONE A TIPO MASSICCIO
LE DIFESE ELASTICHE DEVONO SOLO
CONCORRERE A RIDURRE EFFETTO D'URTO

PORTO PETROLI DI MULTEDO - PONTILE "D"

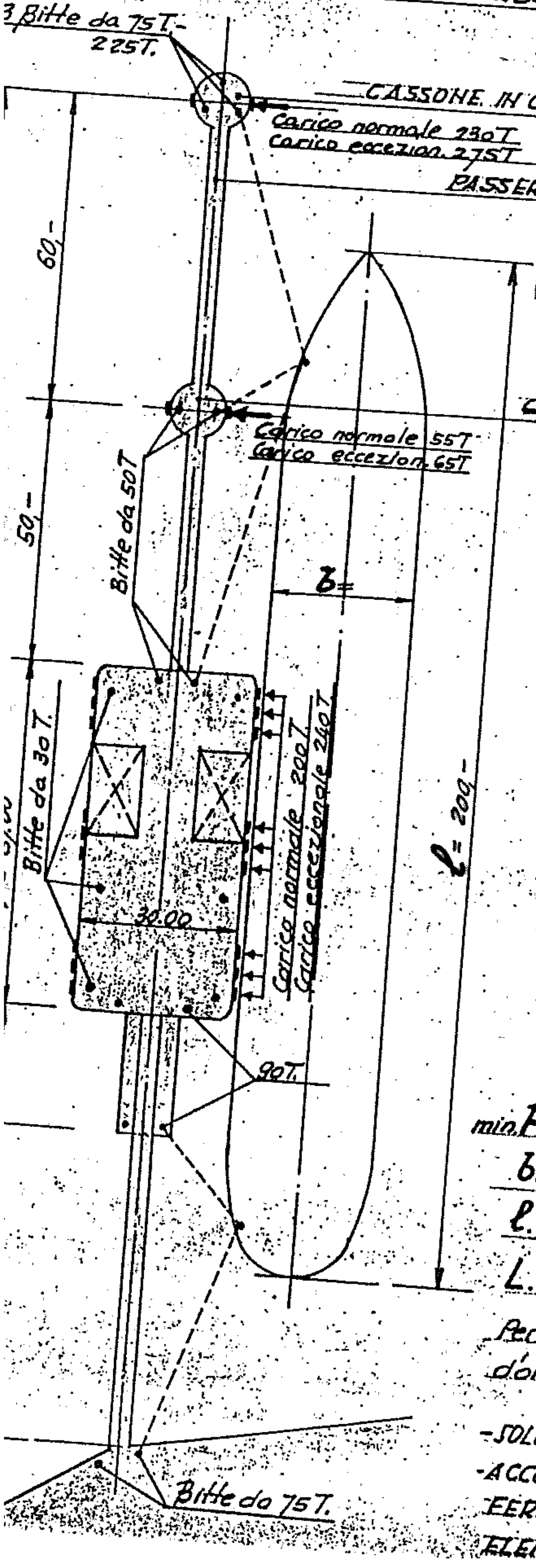


SCALA 1:2000

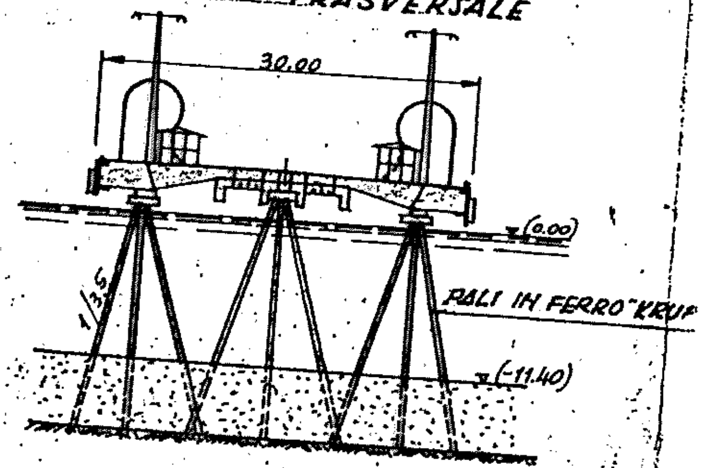
PONTILE PORTO DI STOCCOLMA

PER PETROLIERE DA 32.000 T. D.W (1953)

(VEDERE DOCK E HARBOUR AUTHORITY - MAGGIO 1957)



ATTRACCO PRINCIPALE
SEZIONE TRASVERSALE



CRITERI STABILITI NELLO STUDIO PONTILE DI STOCCOLMA

min. $P = \frac{1}{3} \times l$. (max lunghezza della nave)

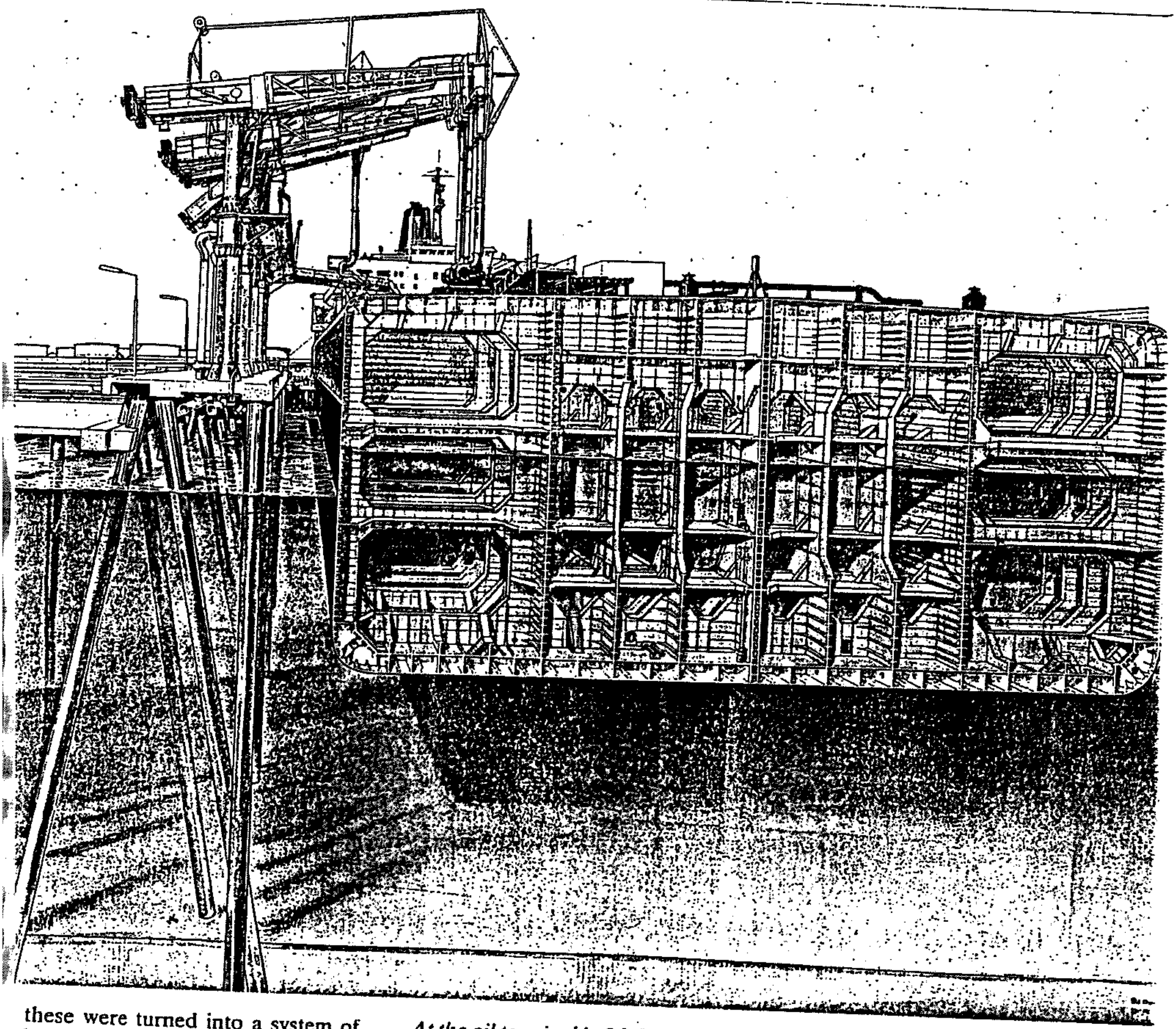
$b. = 3 \times P.$ (pescaggio a pieno carico)

$l. = 18 \times P.$

$L. = \sim 1.25\, l.$ (a Stoccolma $200 \times 1.3 = 260$

Per un buon ancoraggio (minimo per i cavi d'ormeggio $\frac{1}{5}$ lunghezza nave)

- SOLUZIONE PREVALENTEMENTE ELASTICA.
- ACCOSTO PRINCIPALE SU PALI "KRUPP" IN FERRO CON IMPALCATO COSTITUITO DA ELEMENTI PREFABBR



these were turned into a system of
ds to serve as berths for large ships.
he first few years of this century a ma-
eakthrough was made when a method
eveloped to get rid of the soft sub-soil.
a deep trench was dug at the place
the quay-wall was to be erected. Ini-
his trench was not as deep as the thick
of sand, but later it was made even
r. Then large numbers of fascine mat-
weighted with stones were lowered
e trench, after which the surfaces of
ttresses were levelled with a layer of
and.

At the oil terminal in 8th Petroleumhaven this unloader, accessible to very large vess was built in 1974. The pier is 7 m. above ordnance datum, the bottom of the harbour is 23 m. below ordnance datum. The ship in this picture, which measures about 250,000 dwt equipped for bulk transports of inflammable liquids.

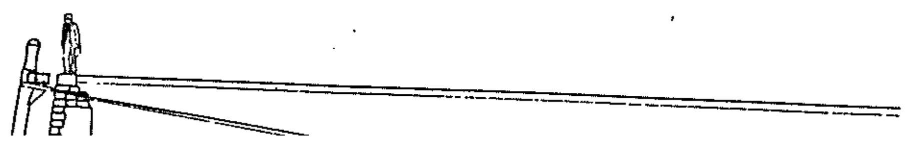
The pier is equipped with several pumping installations which can be connected to th ship's loading and unloading system.

By piling up one layer of mattresses after another along the whole length of the trench, a dyke was made, which was strong enough to keep the masses of soil behind it in place (picture 2).

The next step was to drive a great many wooden poles (this time pitch-pine used instead of fir) into the botto which a strong wooden floor was laid quay was built on this floor and the which had to be dumped behind the wall also rested on it.

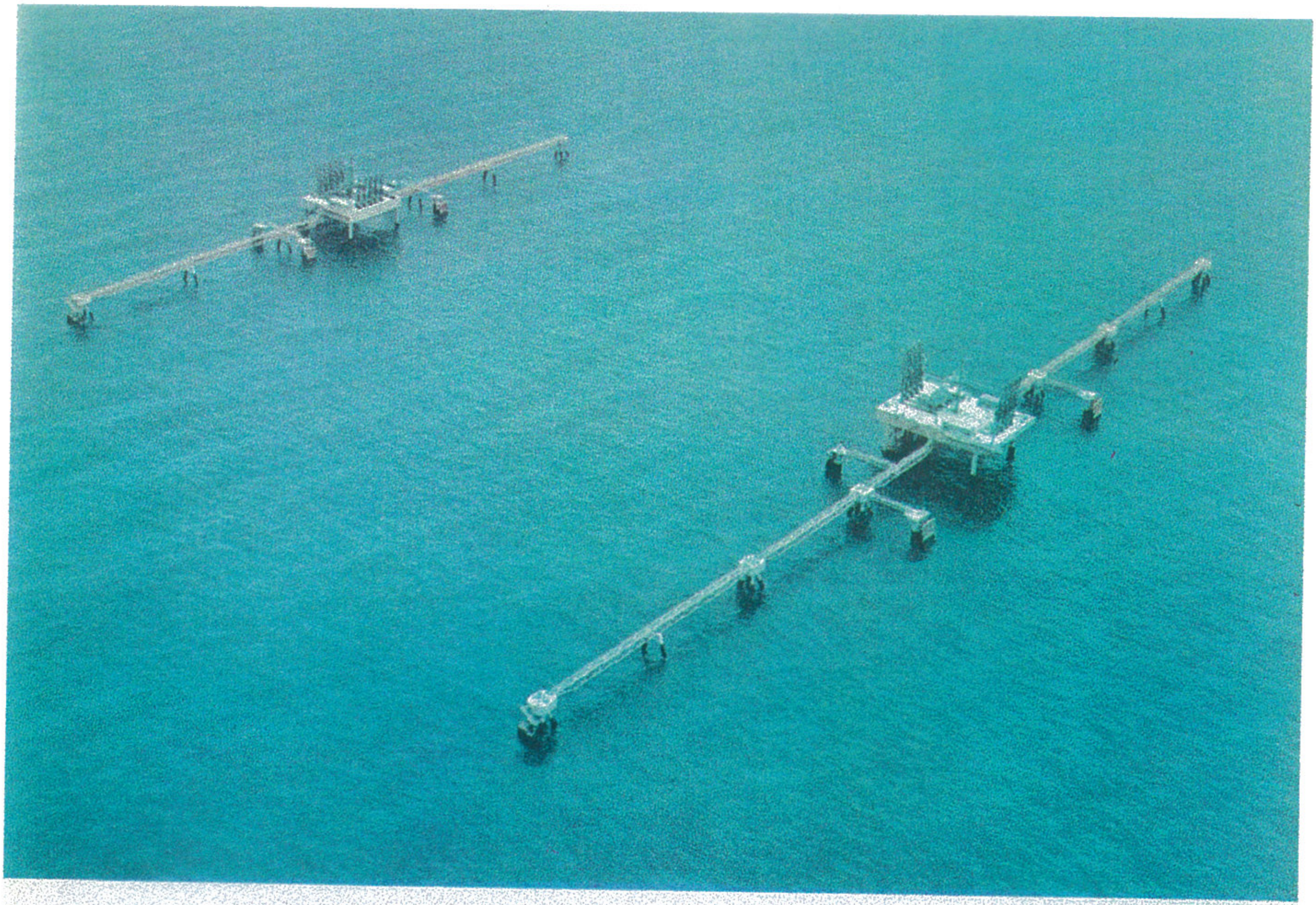
The advantage of this constructio that only this layer of sand exerted pre on the quay.

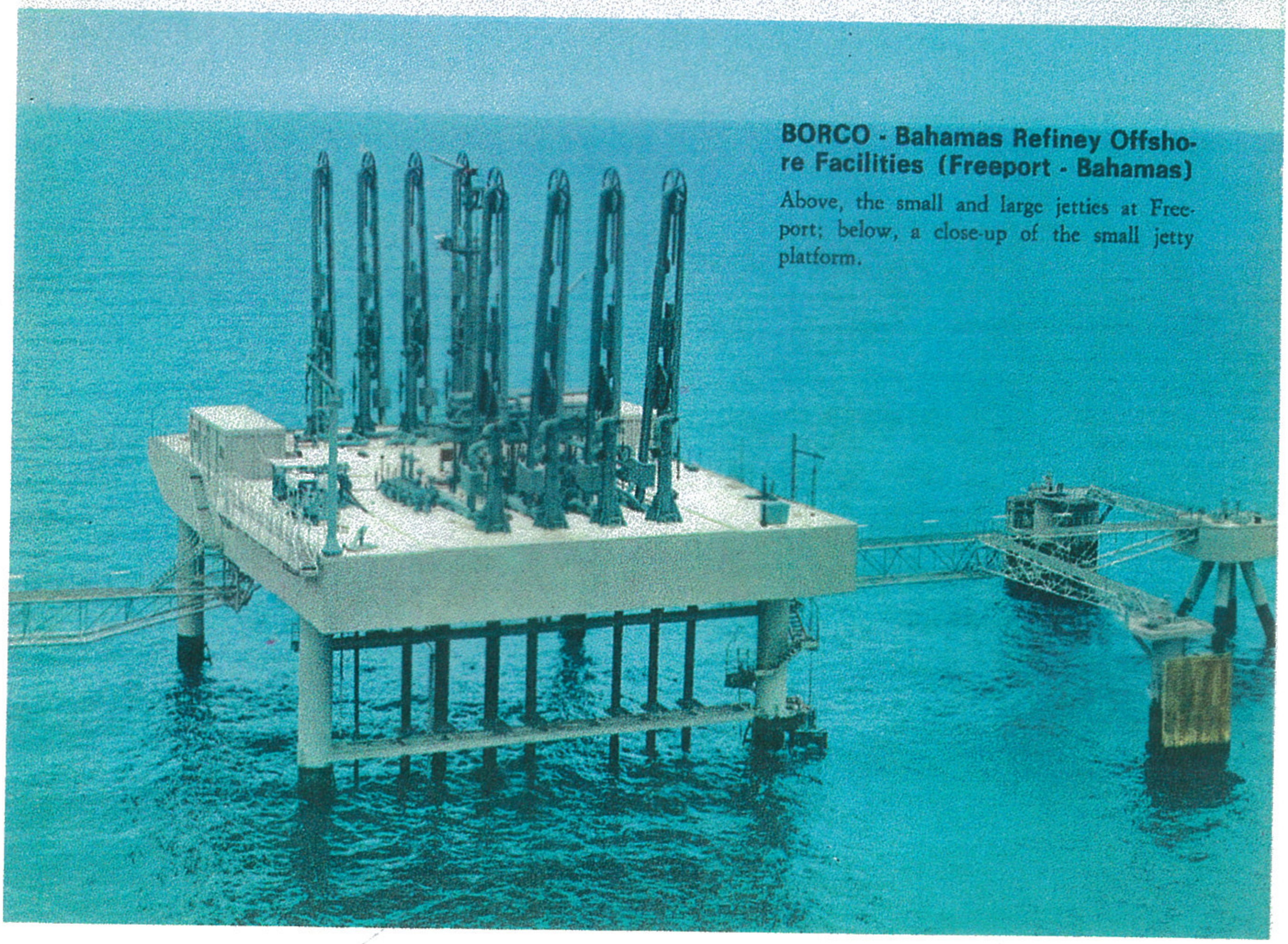
A close look at our drawing will clear that in this case



T.A.L. (Transalpine Line)

Oil marine facilities at Trieste, Italy, for unloading crude oil and supplying the pipeline from Trieste to Ingolstadt.
Total pier length 5600'.
Two berths for simultaneous operations of tanker ships of 100.000 DWT and two berths for 160.000 DWT tankers; design wind velocity 170 km/h.
Sixteen flexible breasting dolphins and 18 rigid mooring dolphins connected to the pier by means of steel walkways.
Pier and platform structures in prestressed and reinforced concrete supported on steel piles.



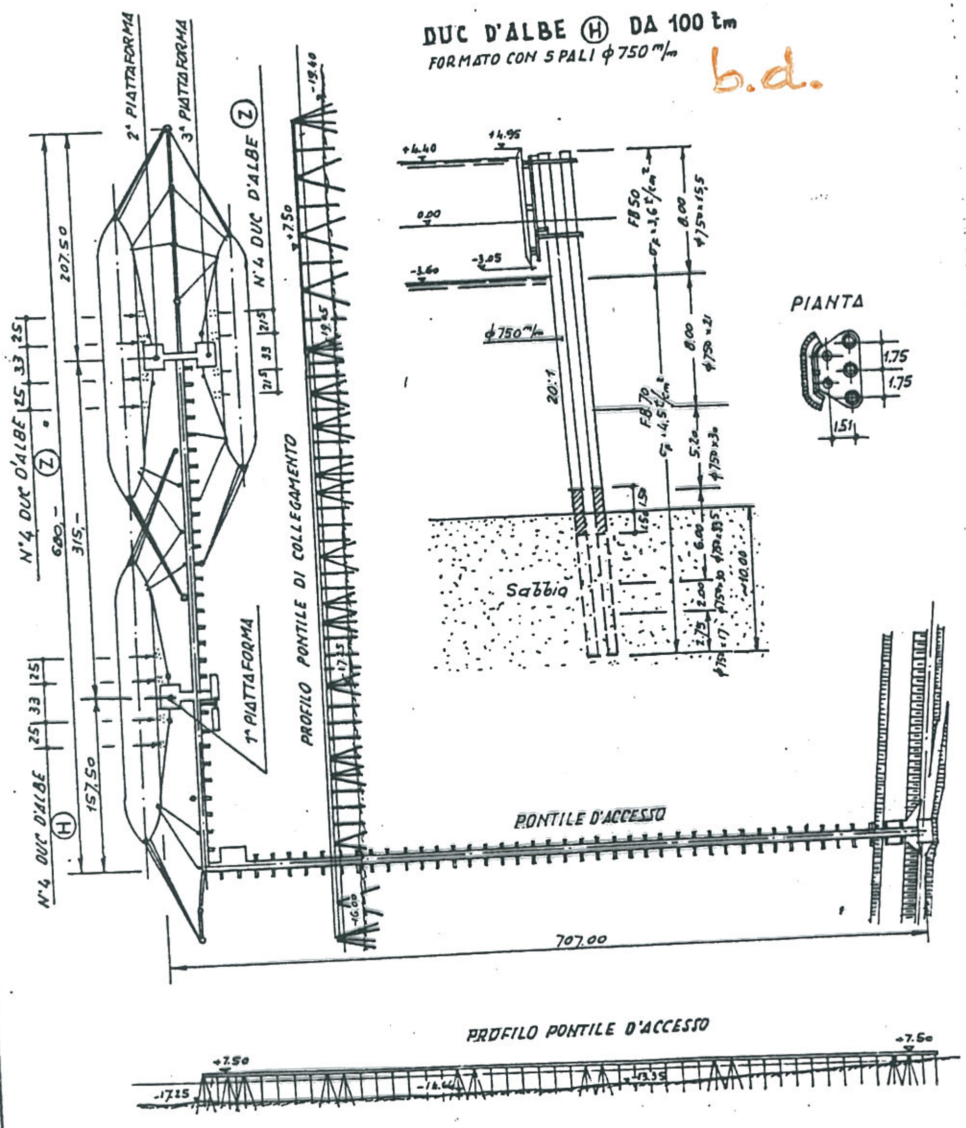


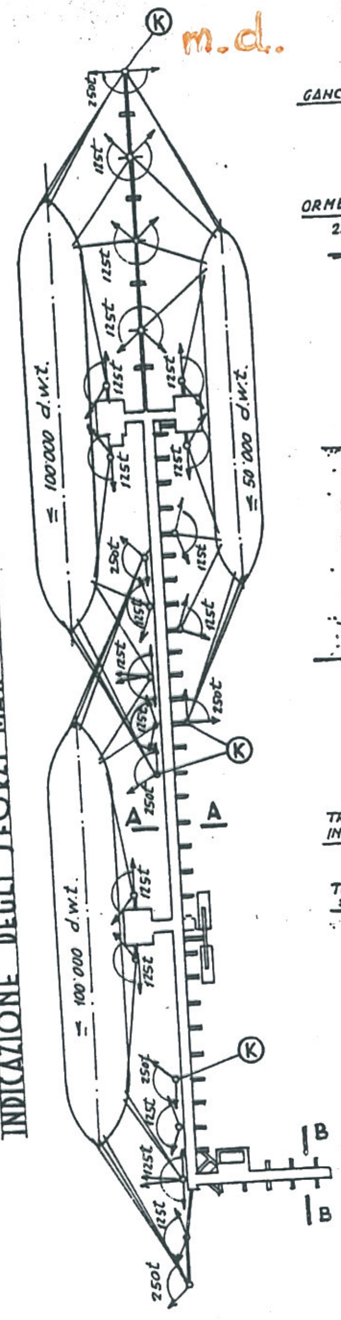
BORCO - Bahamas Refiney Offshore Facilities (Freeport - Bahamas)

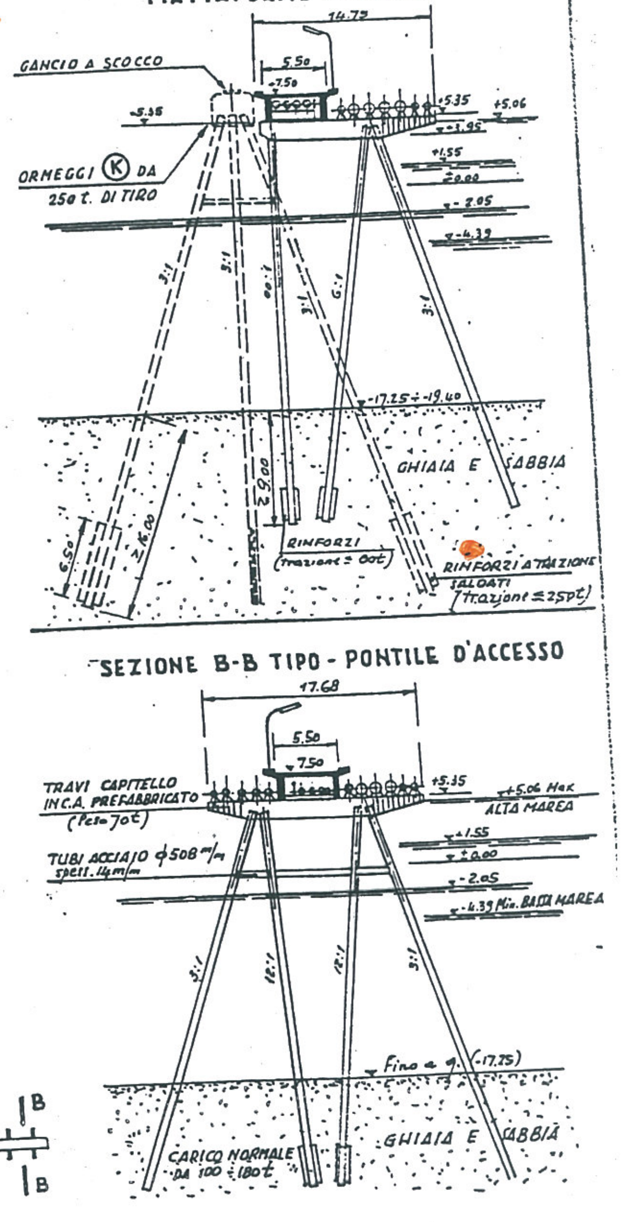
Above, the small and large jetties at Freeport; below, a close-up of the small jetty platform.

IMPIANTO DI SCARICO DI WILHELMSHAVEN (1958)

TERMINALE DELL'OLEODOTTO WILHELMSHAVEN (COLONIA)







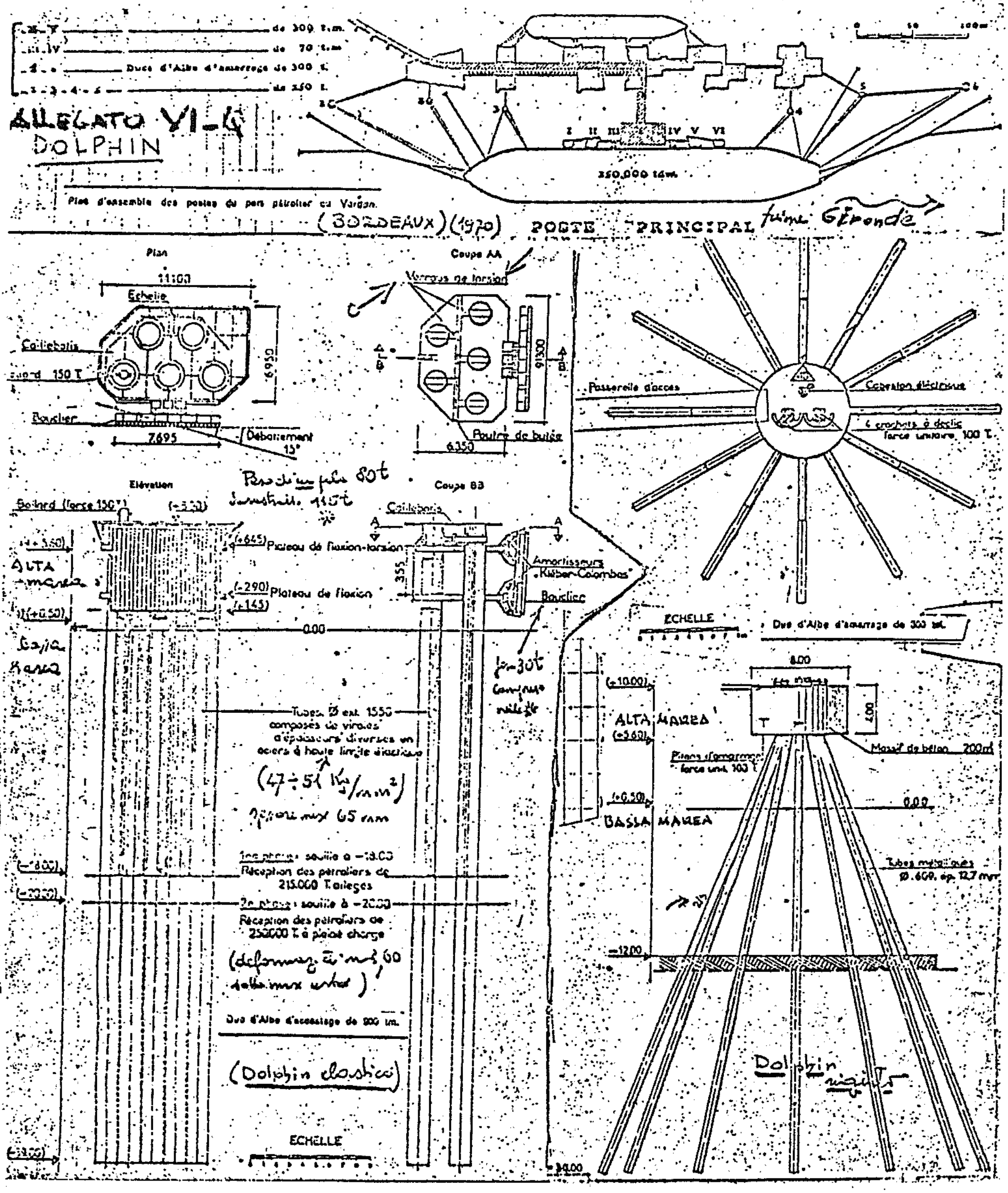
PALI TUBOLARI IN ACCIAIO ϕ546 m/m st.50
spessori: 13,5 ÷ 15,5 m/m RISERVA PER CORROSIONE

DUC D'ALBE (Z) DA 60 tm. SONO FORMATI CON 4 PALI : RINFORZATI A 100 tm CON AGGIUNTA EVENTUALE DI UN PALO INTERMEDIO

D 1221

ALLEGATO VI-4

DOLPHIN



13.1 Design of Resilient Single and Parallel Multi-Pile Dolphins in Non-Cohesive Soils (R 69)

13.1.1 Design Principles and Methods

The design calculation for resilient dolphins is such, that with the existing subsoil properties, the allowable maximum impact and operationally practicable deflection are given, the required embedment and cross-section have to be determined to achieve the required energy absorption. Moreover, contingent loading by hawser pull must be considered. The problem is statically indeterminate and it is important to solve it in such a manner, that best results are achieved consistent with economy, as well as with operational and technical requirements.

Resilient dolphins can be calculated for example, according to the method of Blum [101], taking the dolphin width b into account, whereby b is the width of the dolphin or the single-pile measured at right angles to the direction of force. The following assumptions are recommended for the determination of the passive earth pressures in a detailed calculation.

13.1.2 Density

The submerged density γ' of the soil is assumed as effective density, both for impact loading, as well as for hawser pull loading.

13.1.3 Angle of Wall Friction

The angle of wall friction for the passive earth pressure up to $\delta_p = -{}^2/_3\,\varphi'$, may be used in calculating all dolphin stresses when utilizing plane sliding surfaces, if the condition $\Sigma V = 0$ is fulfilled (Fig. R 69-1). Otherwise, the passive earth pressure should be assumed as acting nearer the horizontal.

The vertical load acting from top to bottom, taking uplift into consideration, can be taken into account as consisting of the weight of the dolphin, the mass of earth within the perimeter of the dolphin, the ultimate vertical skin friction on the sides $(a \cdot D)$ and the vertical component of the equivalent force C as determined by the embedment calculation.

13.1.4 Allowable Stresses

The following stresses are allowable:

Loading through:	
Impact by vessel:	Yield point β_s,
Line pull, wind load, current pressure:	Allowable stresses according to R 18, section 5.4.2 for loading class 2, i.e., applying a safety factor of 1.5 to yield point β_s.

13.1.5 Equivalent Force C

The equivalent force C can be calculated as shown in Fig. R 69-1, from the condition $\Sigma H = 0$, by the formula:

$$C = \gamma' \cdot K_p \cdot \cos\delta_p \cdot D_0^2 \cdot (3\,b + D_0)\,/\,6 - P$$

neglecting the active earth pressure influences as is usual in dolphin calculations, or it can be taken from the vector polygon for the moment diagram.

It can be assumed for the condition $\Sigma V = 0$ that it is inclined to the normal to the axis of the dolphin by as much as $\delta_p' = +{}^2/_3\,\varphi'$.

13.1.6 Embedment

The additional embedment ΔD (Fig. R 69-1) required for the absorption of equivalent force C, can be calculated by the following formula,

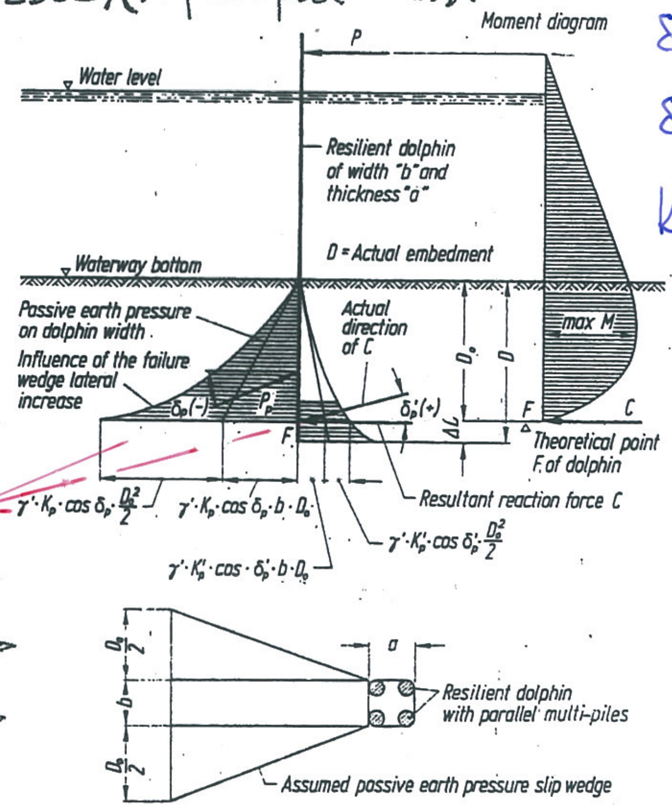
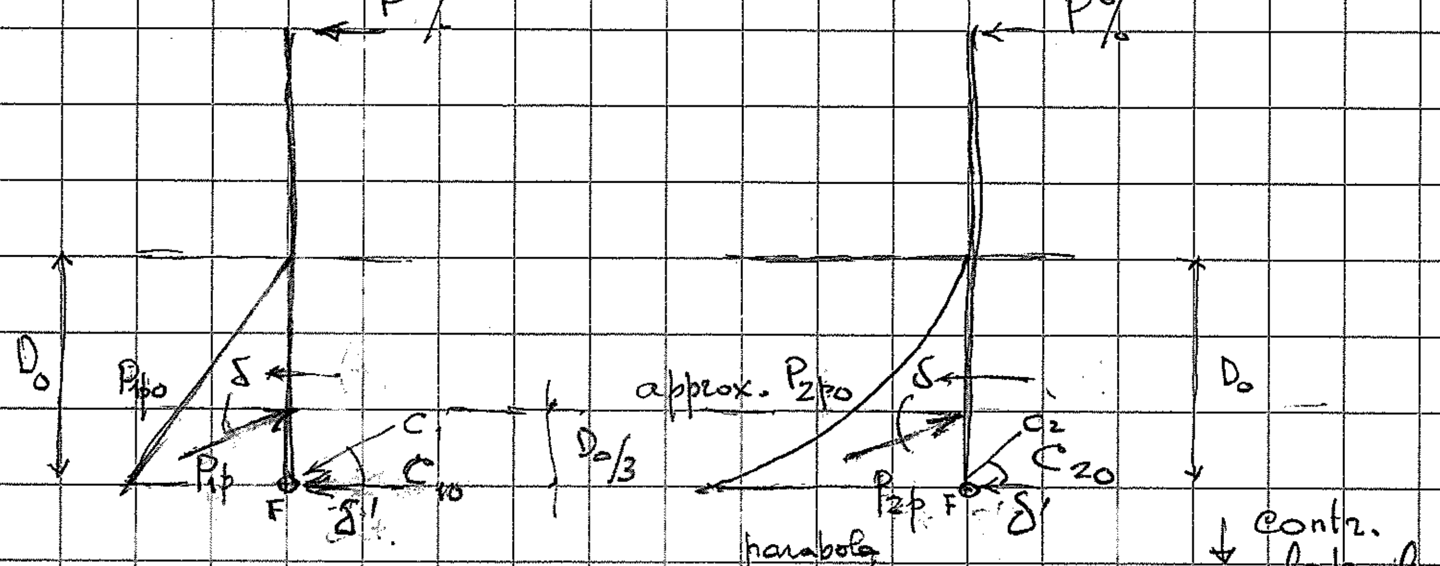


Fig. R 69-1. Passive earth pressure assumption for the calculation of resilient dolphins with parallel multi-piles in non-cohesive soil

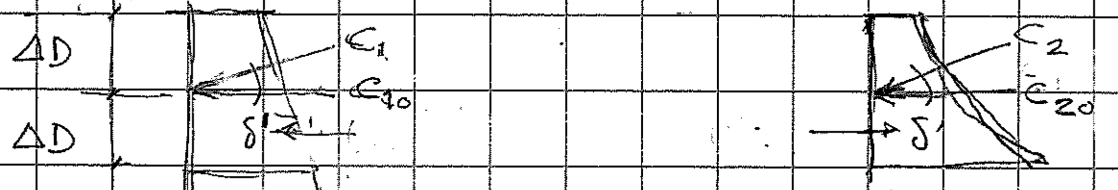
$$* \quad C - P = \frac{1}{2}\gamma' K_p D_o^2 \left(b + \frac{D_o}{3}\right)\cos\delta$$



$$P_{1p_o} = P_{1p}\cos\delta = \frac{1}{2}\gamma' K_p \cos\delta\, D_o^2\, b \;;\; P_{2p_o} = P_{2p}\cos\delta = \left[\frac{1}{3}\gamma' K_p \cos\delta\, D_o^2\, 2\frac{D_o}{4}\right]$$

con Eq. mom rispetto a F

$$P_{p_o} = P_{1p_o} + P_{2p_o} = \frac{1}{2}\gamma' K_p \cos\delta\, D_o^2 \left(b + \frac{D_o}{3}\right)$$ ok si valuta D_o



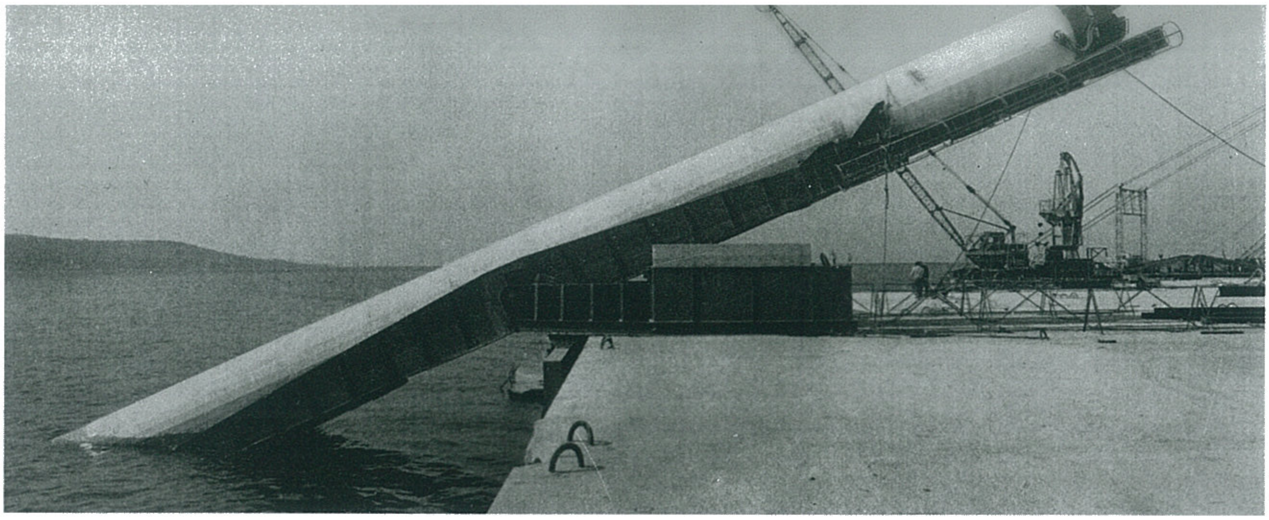
$$C_{10} = C_1\cos\delta' = 2\Delta D\, \gamma' K'_p \cos\delta\, D_o\, b \qquad C_{20} = C_2\cos\delta = 2\Delta D\, \gamma' K'_p \cos\delta\, D_o\, 2\frac{D_o}{4}$$ (contr. lat)

$$C_o = C_{10} + C_{20} = 2\Delta D\, \gamma' K'_p \cos\delta\, D_o \left(b + 2\frac{D_o}{4}\right)$$ ok si valuta ΔD

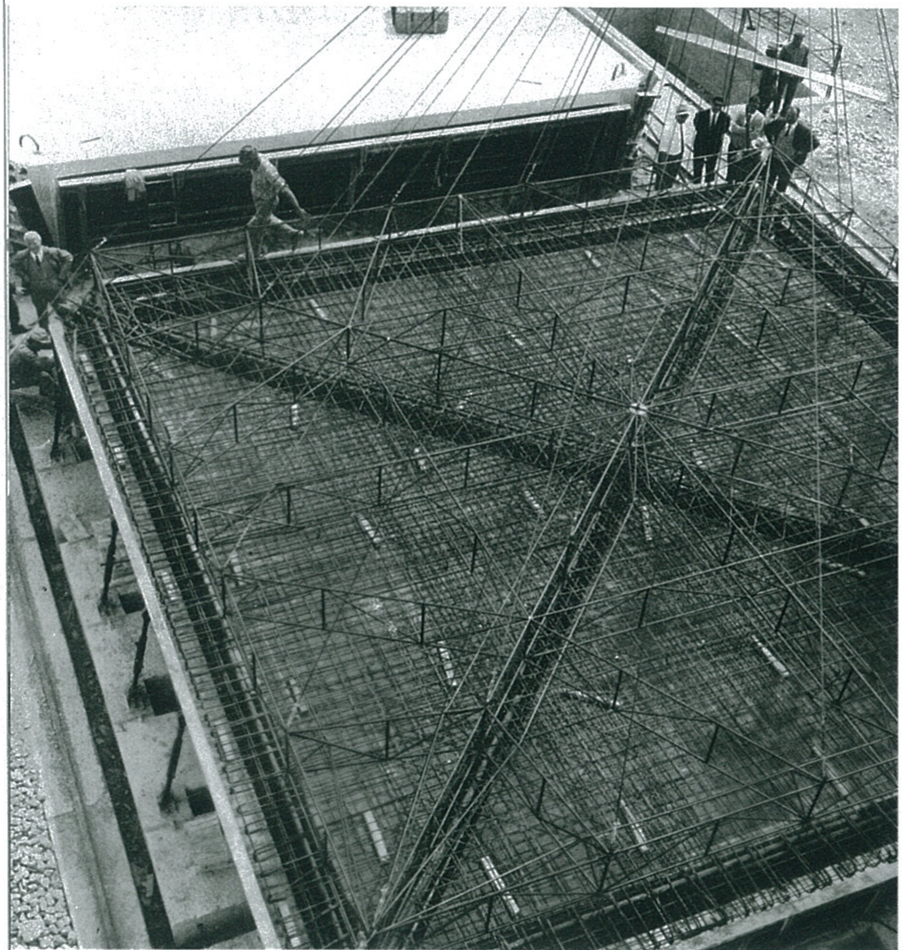
NB Le scomposizioni hanno lo scopo di valutare il contr. lat., δ e δ' possono essere diversi tra loro ordinariamente cioè anche K_p e K'_p : $K_p = \cos^2\varphi \Big/ \left[\cos\delta\left(1 - \sqrt{\frac{\sin(\varphi+\delta)\sin\varphi}{\cos\delta}}\right)^2\right]$

(+ per K_a)

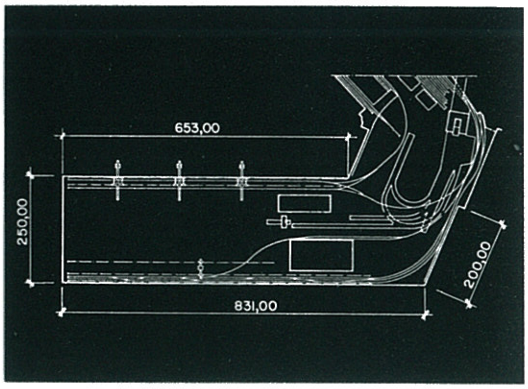
φ°	δ°	K_p	$K_p\cos\delta$	$K_{p\,\delta=0}$	K_a	$K_{a\,\delta=0}$
30	20	6.1	5.3	3	0.3	0.33
36	24	11	10	3.85	0.235	0.26



57
59
60



58



dello spessore di 18 cm esteso a tutte le superfici delle piazzole.

Il *molo 7° del porto di Trieste* (1965-68) è uno sporgente di circa 23 ha, utilizzato per il traffico dei containers, ed è costituito da un impalcato formato da piastre prefabbricate sostenute da pali in c.a. di grande diametro (figg. 57-58-59-60-61-62-63).

I pali hanno un diametro esterno di 1800 mm e sono stati eseguiti costruendo dapprima una camicia dello spessore di 15 cm in c.a. centrifugato, di

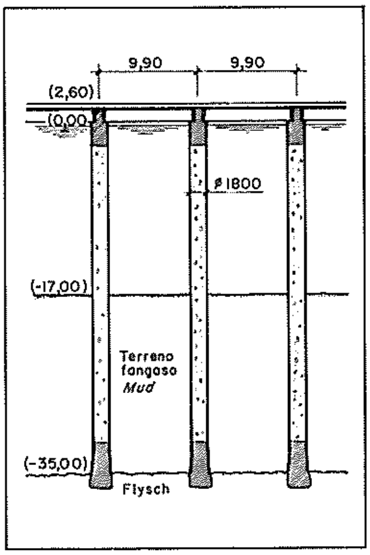
covering all the surfaces of the platforms.

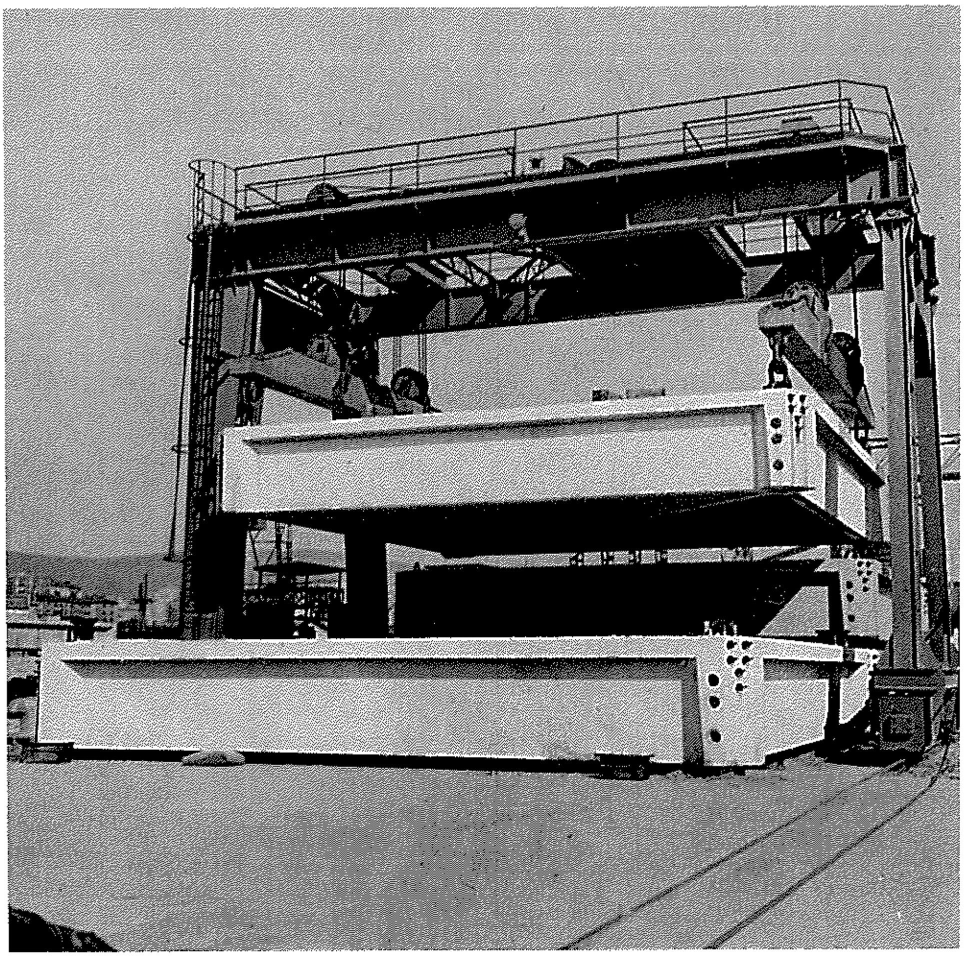
Mole No. 7 of the port of Trieste *(1965-68) covers some 23 ha and is used for container traffic; it consists of a deck formed by precast slabs supported by r.c. piles of large diameter (Figs. 57-58-59-60-61-62-63).*

These piles have an external diameter of 1800 mm and have been constructed by first making a jacket of centrifuged reinforced concrete, 15 cm

62
63

61





MOLO 7° DEL PORTO DI TRIESTE (Impresa Farsura): 57 - Ribaltamento di un palo di fondazione dalla posizione orizzontale a quella verticale; 58 - Posizionamento di una gabbia d'armatura ordinaria e di precompressione, entro una cassaforma per il getto di una piastra nervata; 59-62-63 - Il cantiere di prefabbricazione, lo stoccaggio ed il posizionamento in opera delle piastre in c.a.p.; 60 - Planimetria del molo; 61 - Sezione tipo.

MOLE No. 7 OF THE PORT OF TRIESTE (Impresa Farsura): 57 - Capsizing of a foundation pile from vertical to horizontal position; 58 - Positioning of an ordinary and prestressing reinforcement cage inside the formwork for the casting of a ribbed slab; 59-62-63 - The precasting yard, stockpiling and assembly of the prestressed concrete slabs; 60 - Masterplan of the jetty; 61 - Typical section.

lunghezza variabile da 25 a 37 m. La camicia così costruita è stata messa in opera mediante l'ausilio di adeguata attrezzatura e affondata fino a raggiungere la roccia sana mediante l'uso di attrezzature « Rotary »; ne è seguito il riempimento della camicia con calcestruzzo magro. Il peso dei pali è dell'ordine di 80 t.

Le piastre standard sono di forma quadrata con lato di 9,90 m e sono costituite da sei nervature, quattro perimetrali e due diagonali, in c.a.p. con

thick, of variable length between 25 and 37 m. The jacket thus constructed was placed by suitable equipment and sunk until it reached sound rock through the use of rotary equipment; it was then filled with concrete of lean type. The weight of the piles is in the order of 80 t.

The standard slabs are square in shape with sides of 9,90 m and consist of six ribs, four of them perimetral and two diagonal, of prestressed con-

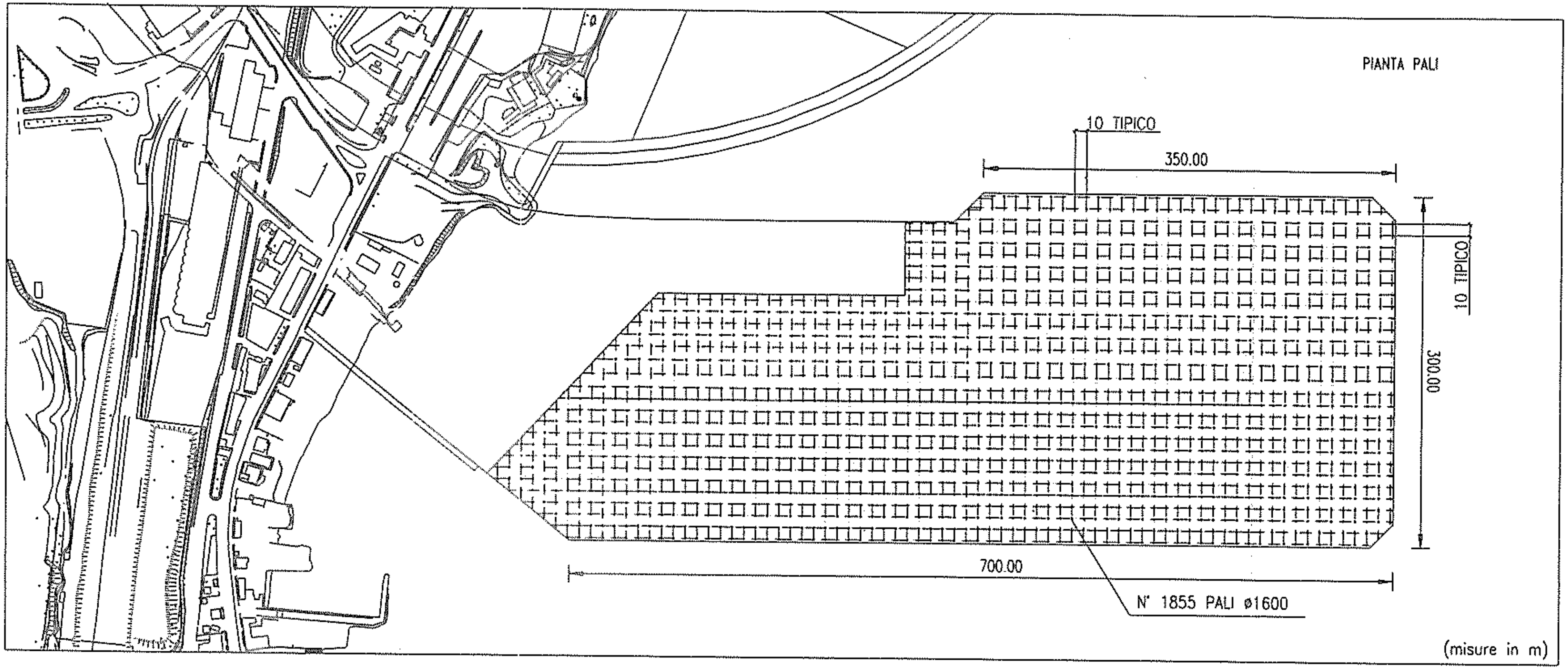
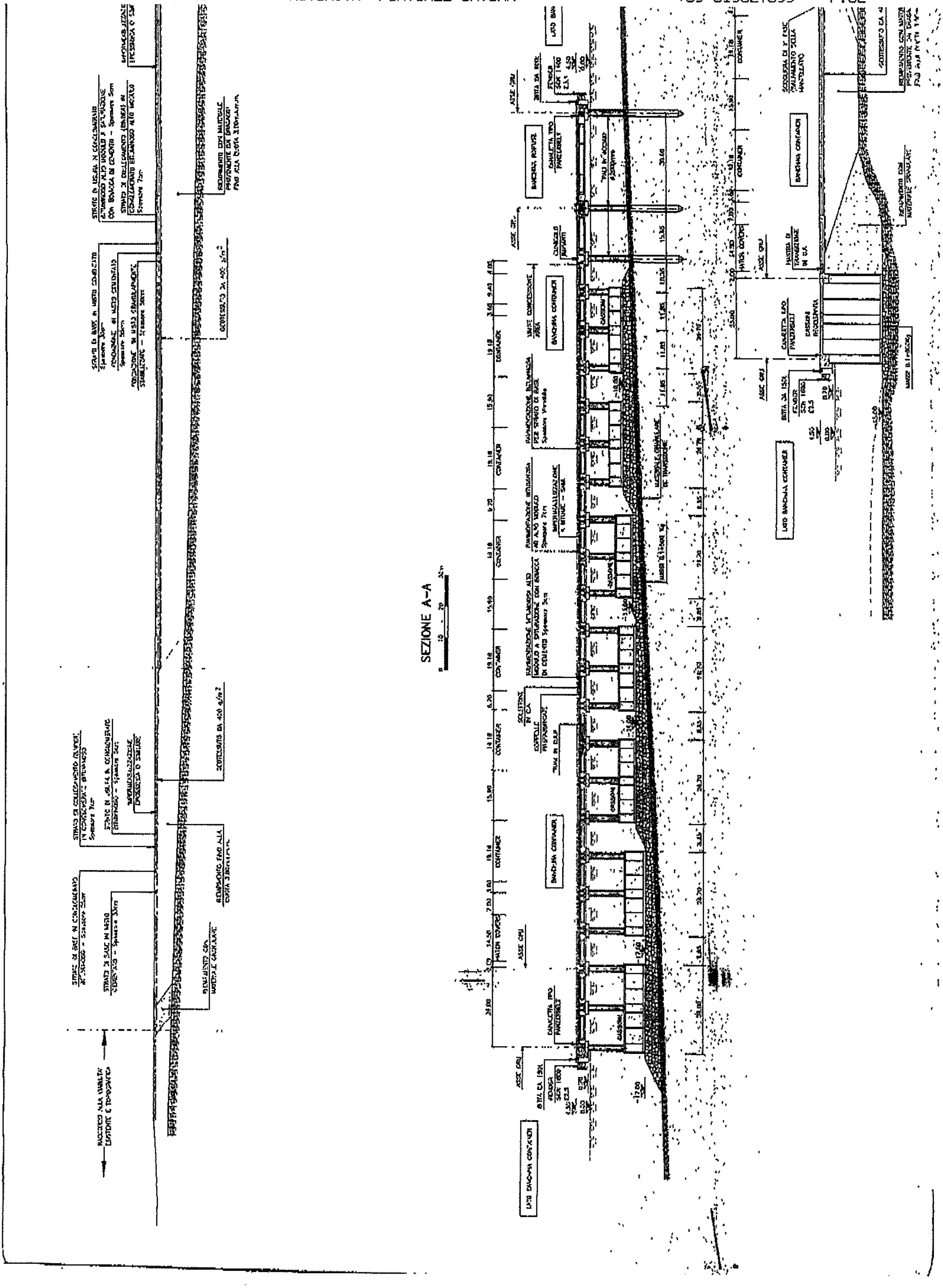
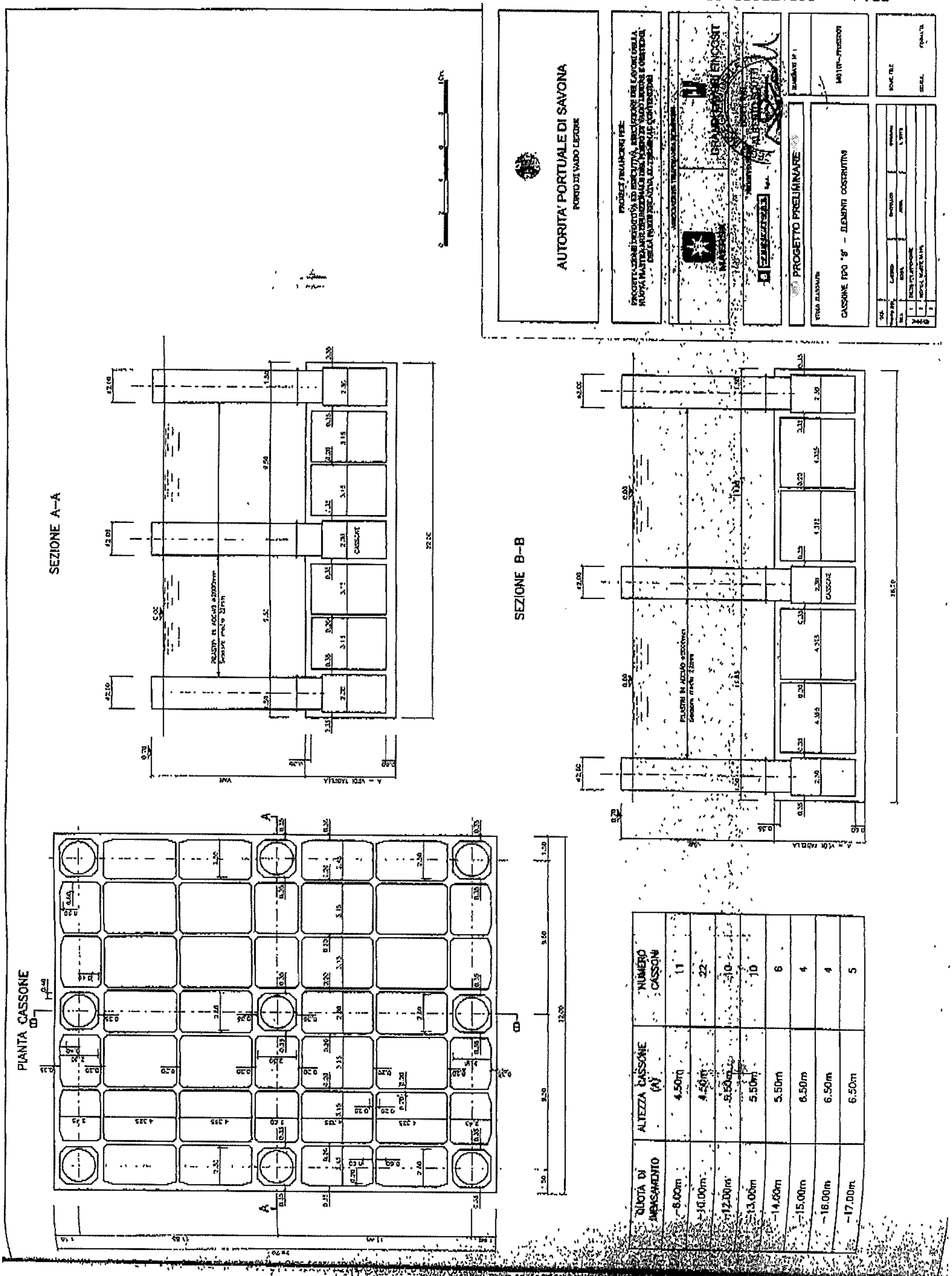


Figura 2 – Pianta della piattaforma con indicazione della disposizione dei pali (maglia 10m x 10m)


SEZIONE A-A



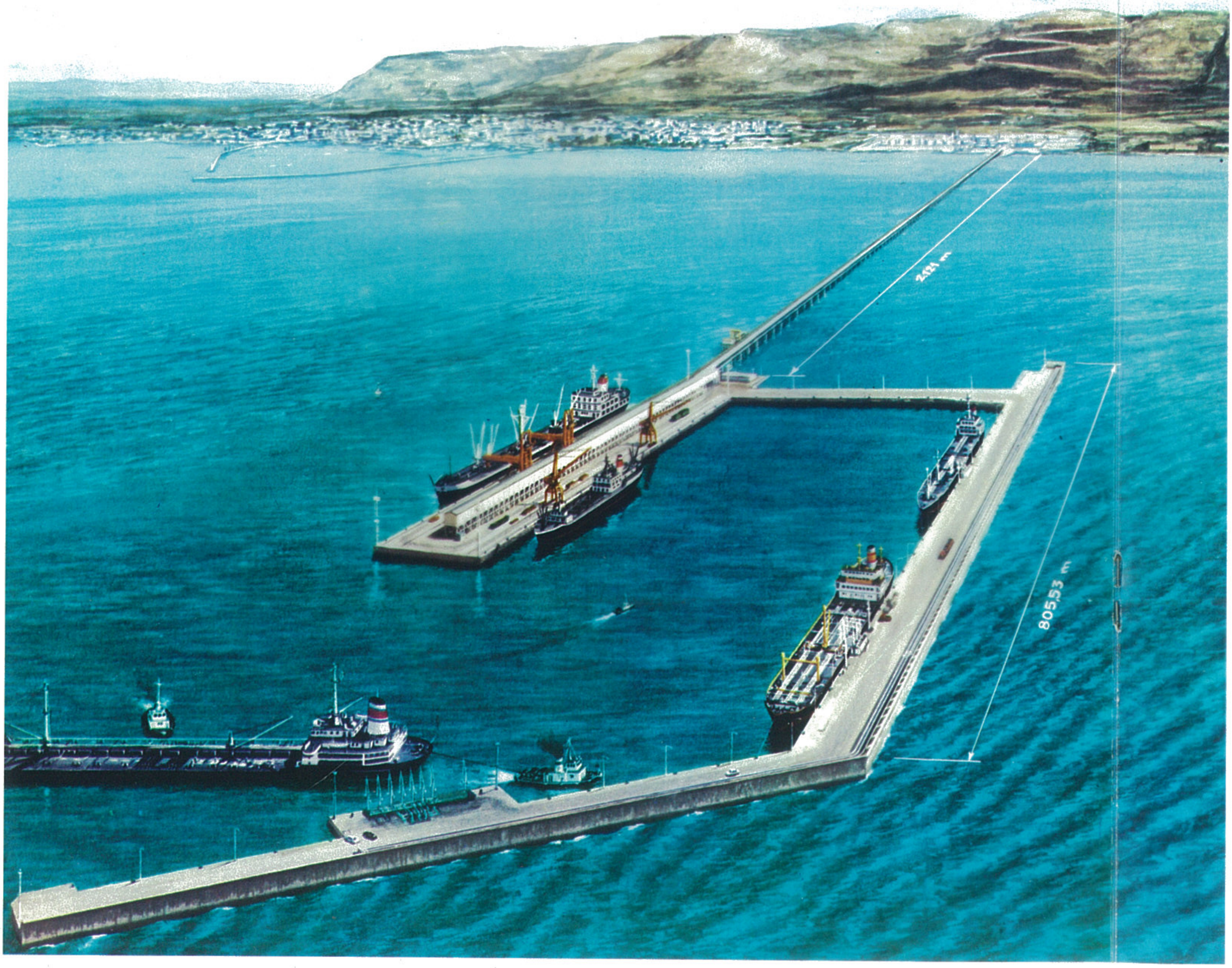
QUOTA DI IMBASAMENTO	ALTEZZA CASSONE (A)	NUMERO CASSONI
-8.00m	4.50m	11
-10.00m	4.50m	22
-12.00m	5.50m	10
-13.00m	5.50m	10
-14.60m	5.50m	6
-15.00m	6.50m	4
-16.00m	6.50m	4
-17.00m	6.50m	5

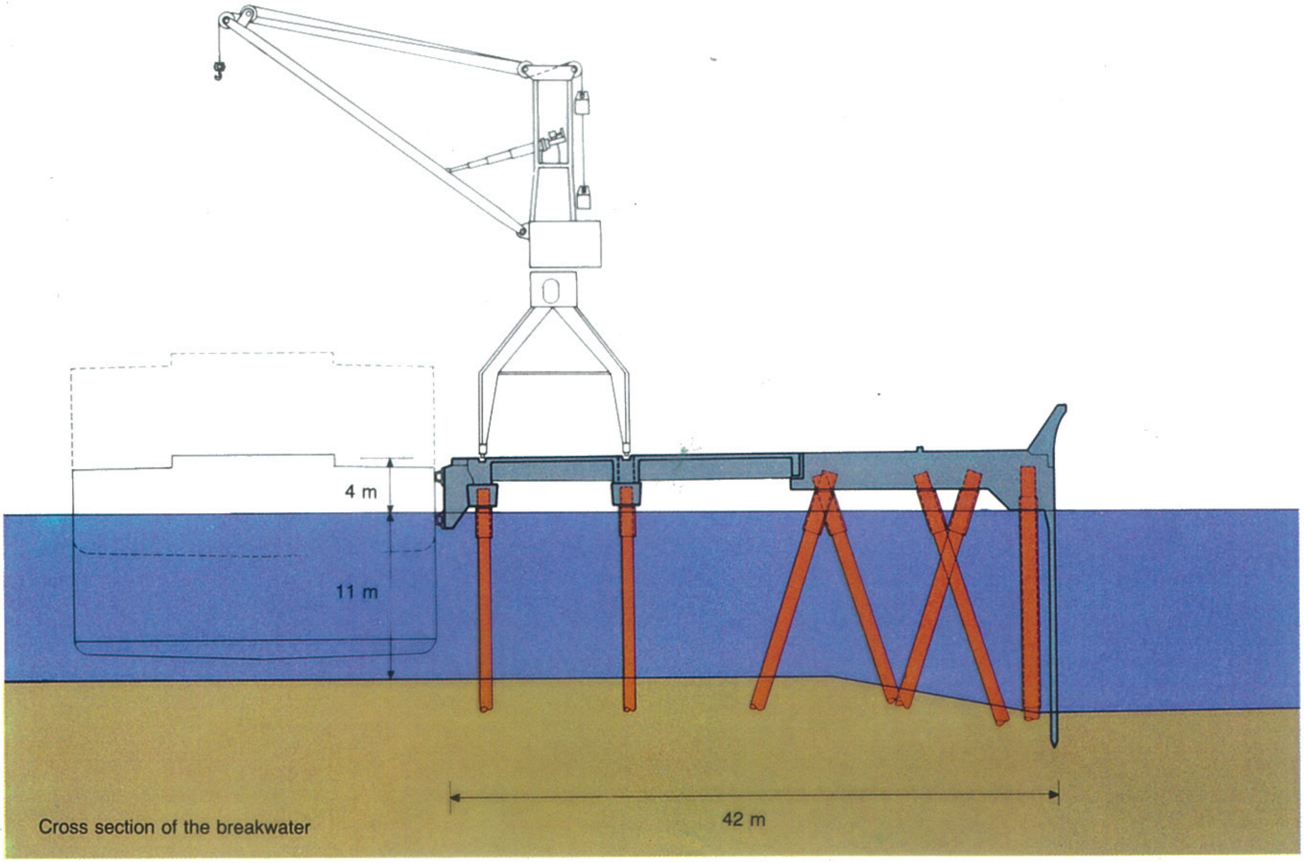
TOTALE P.03

Breakwaters and wharves

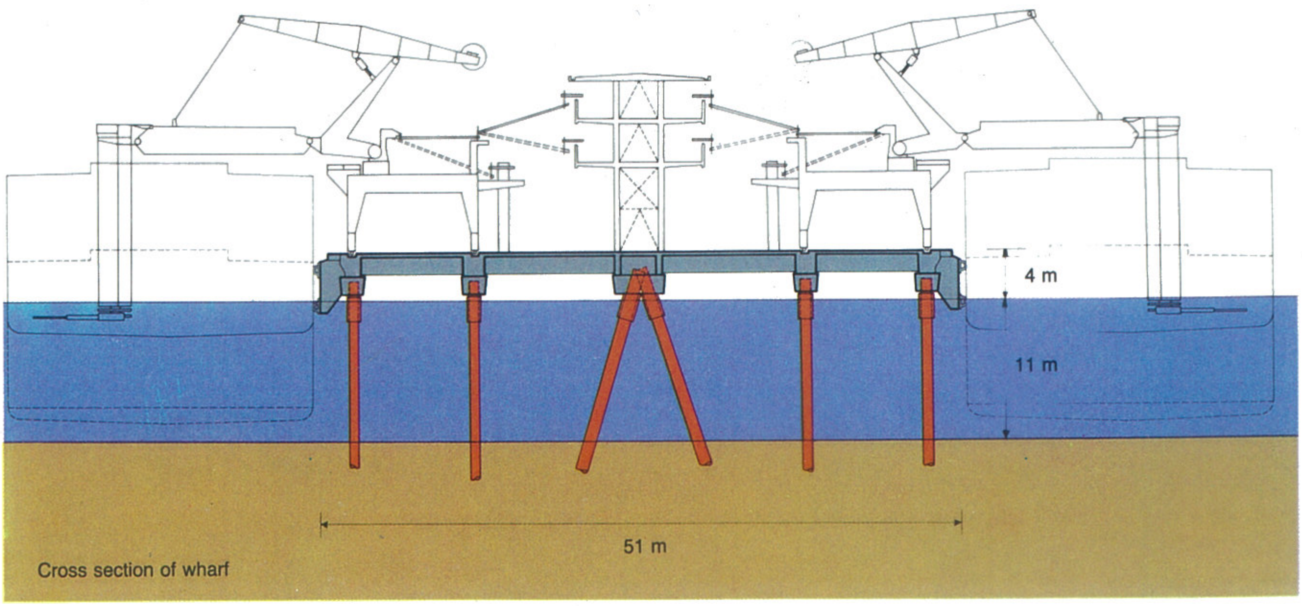
Wharves usually provide ship mooring along a continuous waterfront that is sufficiently long and backed up by an area with enough space to allow efficient handling of goods. When naturally sheltered waters, such as those of bays or river estuaries, are not available, artificial protection from wave action must be obtained from breakwaters.

Sheet piling is the most common and traditional steel product used for building wharves. Recently, wharves consisting of a reinforced concrete platform supported by steel piles have been introduced.





Cross section of the breakwater



Cross section of wharf

6. Drivinç

7. The cc
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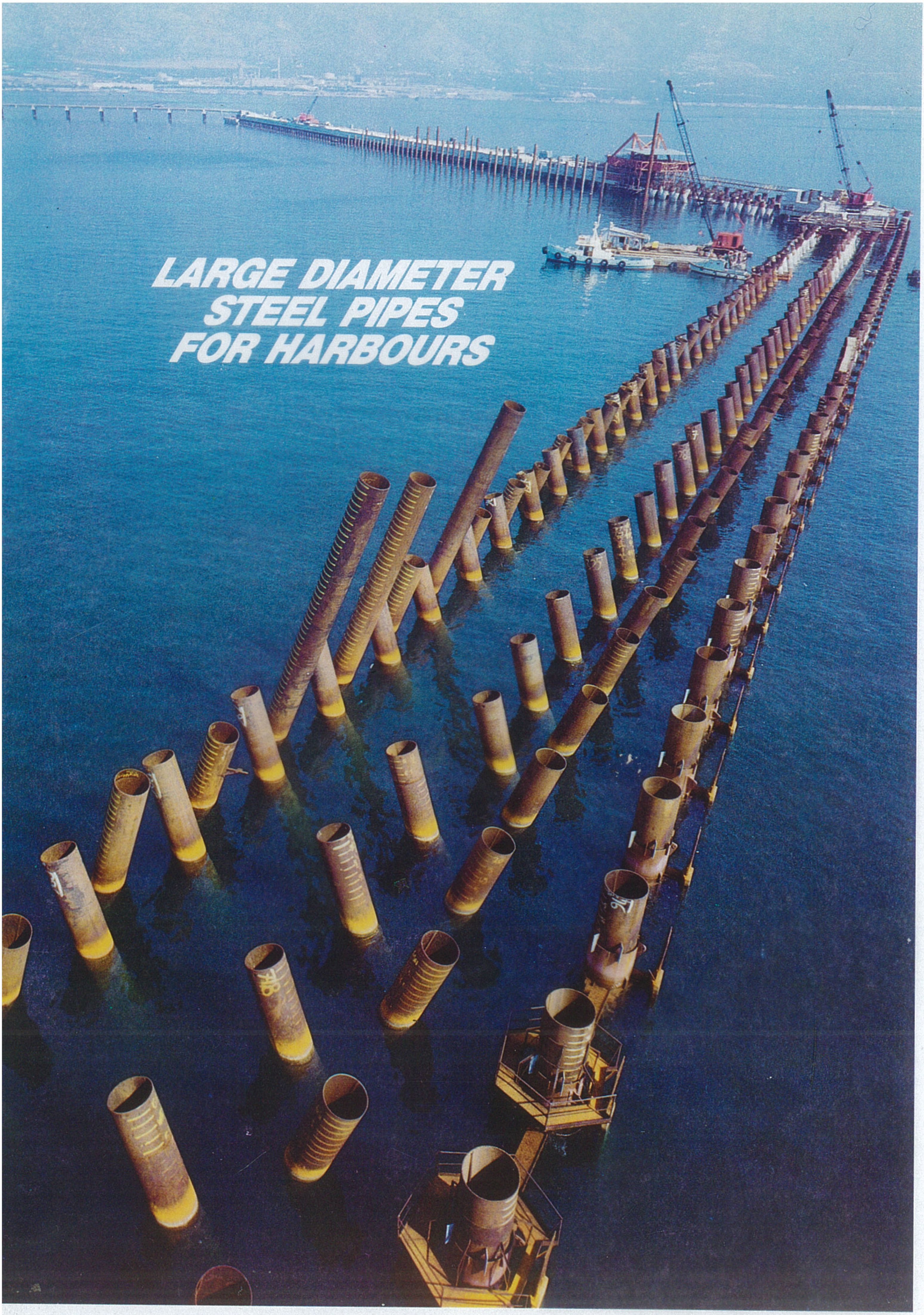
LARGE DIAMETER STEEL PIPES FOR HARBOURS



received or shipped, whereas for only dedicated tanks, the required capacity is three to four times the largest shipload received or shipped for each type of cargo. Rational determination of the required storage capacity is outlined in 2.1.3.

7.6.4 Conventional terminals for refrigerated and/or compressed liquid gases

Hydrocarbons, which are gases at normal temperature and pressure, present special transportation problems. They have to be transported in liquid state in specially built vessels. The liquid state is achieved either by compressing the gas at natural temperature or by cooling the gas to below its boiling temperature at atmospheric pressure. In some cases, a combination of the two methods is used and the gas is transported at moderate pressure and below the corresponding boiling temperature. Table 7.6(b) shows the boiling temperature and the critical temperature (temperature above which the gas cannot be liquefied, irrespective of pressure) for various gases. It may be noted from the table that it is not possible to liquefy methane (principal component in natural gas), ethylene and ethane at natural temperature. Hence, these cargoes can only be transported as liquids by means of cooling. They are usually transported at atmospheric pressure. Other gases are transported by all of the methods mentioned. However, for propane and butane the usual practice is to employ the cooled state for long voyages in large vessels and to use the pressurized state at natural temperature for short voyages in small vessels.

The cargo is transferred in much the same way as described for liquid bulk in 7.6.2. The lower the transfer temperature the higher is the required degree of insulation for pipelines. Due to the difficulty of insulating the end of the loading arm it is common that large lumps of ice form here during transfer operations. Hoses made from rubber are not suitable for low temperatures, hence articulated loading arms are usually used.

There is, however, one important difference from ordinary liquid bulk. When filling the vessel excess vapour is formed due to boiling of the liquid. This vapour has to be transferred back to shore by means of a separate piping system called the vapour-return system. It is burned at the flare of the facility, or reliquefied and reinjected into the pipe lines. In either case significant expenses are incurred. Another solution is to deliver the liquid to the berth slightly below the boiling temperature and apply an ejector to suck the vapour back into the pipe line and utilize the available energy of the subcooled liquid for liquefying the vapour. However, a vapour-return system with a flare will always be required for emergency conditions.

The berths are usually constructed in the same manner as for petroleum bulk. The

Table 7.6(b) Boiling Point and Critical Temperature in Centigrades for Gases

Type of Gas	Boiling Point	Critical Temperature
Methane	−161	−83
Ethylene	−104	+9
Ethane	−89	+32
Propylene	−48	+92
Propane	−42	+97
Ammonia	−33	+132
Butadiene	−4	+152
n-Butane	−1	+152

requirements to distance from population centres and in regard to operations, to safety devices and access limitations during operations are usually more stringent for liquid-gas berths.

Certain ships for the transport of liquefied natural gas (LNG) are not designed for sloshing of the LNG in partly full tanks. Sloshing may result in damage to the insulation with potential catastrophic consequences. For this reason, these vessels require very calm conditions at berth during loading and discharge. Further, they cannot leave the port under any circumstances before the tanks are either full or empty. This may add considerably to breakwater expenditures, and combined with the requirement of distance to other facilities may cause very difficult terminal siting problems.

7.6.5 Storage facilities for liquid gases

Liquefied gases require special low-temperature and/or high-pressure tanks. Both capital and operating costs for such tanks are much higher than for ordinary storage tanks. The tanks which maintain gases in liquid form through low temperature have to be insulated and must have an associated refrigeration plant for reliquefying vapours. Large tanks which maintain gases in liquid form through high pressure should be spherical. The rule of thumb for required storage capacity is two to three times the maximum shipload. For rational determination of the required storage capacity see 2.1.3.

7.6.6 Offshore terminals

Due to the facility with which liquids are transported in pipe lines special types of offshore facilities have been developed for these cargoes.

(a) *Conventional buoy moorings* This is the oldest type of offshore mooring. The vessel ties up at a fixed position by means of multiple chain-anchor moorings. These moorings are so arranged that the vessel maintains a fixed position and orientation. In many, but not all cases, one or two of the moorings are made up by the bow anchors with

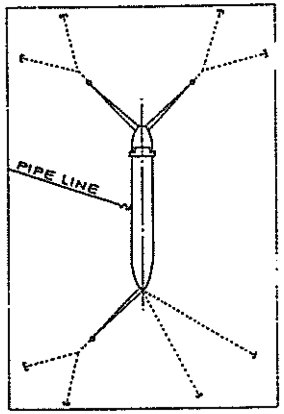


Fig. 7.6 (d) Conventional Multi-Buoy Terminal

which all vessels are fitted. A typical arrangement is shown on Fig. 7.6(d). A major drawback of conventional buoy moorings is the difficulty of navigating into the mooring. Figure 7.6(d) represents the best layout in this regard. Most existing moorings are laid out in a manner which makes occasional collision between the ships and one or more mooring buoys highly probable.

The cargo is transfered through a flexible rubber hose connecting the midships manifold on the vessel with a subsea manifold, which in turn is connected to land facilities by submarine pipe lines. When no vessel is present the hoses are left on the seabed but attached to a marker buoy on the surface.

In most cases this is the lowest capital cost liquid-bulk terminal. However, even moderate wave conditions prevent mooring of tankers and operation of the terminal, which is also prone to high maintenance costs. In principle, there is no limitation to the size of vessel which may be accommodated at a properly designed conventional buoy mooring. However, it is not common to consider this type for vessels larger than 100,000 DWT. This type of berth makes it possible to pump the cargo ashore through floating hoses and thus avoid a submarine pipe line, which may be the preferred solution in cases where very few ships are handled per year.

(b) *Single-point moorings*. At this type of berth the vessel ties up with a bowline only. Consequently, the vessel is free to weathervane around the point to which the bowline is attached, and will tend to align itself in the direction of least resistance. The vessel may stay moored under even very severe conditions. The cargo is transferred by means of rubber hoses floating on the surface connecting the vessel's midships manifold to a swivel on the single-point mooring. Most liquid-bulk vessels only have midships manifolds. Technically it would be advantageous to have the manifold located at the bow of ships which tie up to single-point moorings, and this is done at some terminals which are used only by a small number of vessels modified especially for bow transfer.

Three different types of single-point moorings are in common use:

(a) catenary anchor leg mooring (CALM);
(b) single-anchor leg mooring (SALM); and
(c) tower moorings.

CALM consists of a buoy floating on the surface moored by a number of (usually 5 to 8) conventional chain-anchor legs. The cargo is conveyed between the submarine pipe line and the buoy by means of submarine hoses. The mooring line is connected to the cargo swivel by a lever arm. This device is used to rotate the swivel with the mooring line. Floating hoses connect the cargo swivel on the buoy at the surface to the midships manifold. Figure 7.6(e) showes a CALM.

CALM is the most common single-point mooring. Its maintenance costs are fairly high. However, it is competitive with other types in relatively shallow water (30 m or less).

SALM is a buoy moored by means of one vertical chain or pipe fastened to a single anchor as shown in Fig. 7.6(f). The buoy must be so proportioned that even under extreme conditions the chain always remains taut, otherwise failure results due to impact loads. The cargo is conveyed from a submerged cargo swivel to the midships manifold by means of hoses floating on the surface except for their rise from the cargo swivel to the surface. The swivel is turned by the hoses and not by the mooring line. This puts a

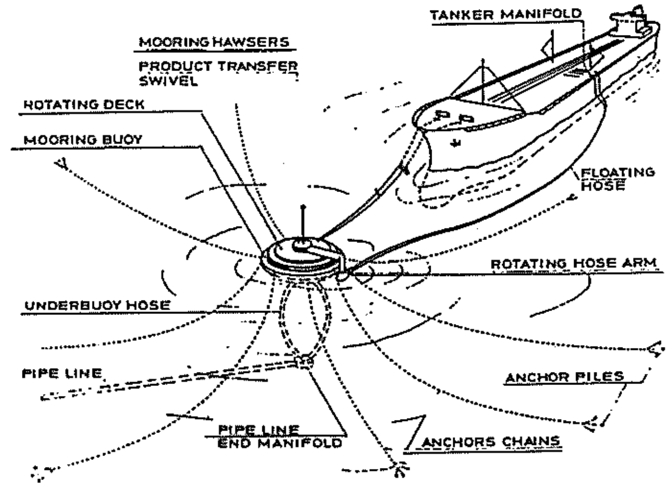


Fig. 7.6 (e) Single-Point CALM

relatively low limit on the permissible torque resistance of the swivel. This type of single-point mooring is especially cost effective in deeper water. It requires slightly larger minimum water depths than CALM due to the reduction of water depth above the anchor-cargo swivel combination.

The tower mooring consists of either a single flexible pipe pile driven into the sea bed or a trussed tower. The cargo swivel is usually above the water surface. This type of installation is especially well suited for vessels equipped with bow manifolds in which case floating hoses can be avoided entirely. The principal drawback is that they are more prone to collision damage and the required repairs are likely to be very costly.

It is claimed that vessels can remain at single-point moorings during extreme wave conditions (up to $H_s = 4$ m or more depending on the specific installation). However, due to problems associated with maintaining the floating hose securely attached to the midships manifold, transfer is usually limited to conditions with $H_s \leqq 2$ m.

Even when a port provides suitable locations and water depths for conventional berths it may be worthwhile to consider a single-point mooring in the open sea outside the port. While the risk of small oil spills is somewhat larger at a single-point mooring the risk of a catastrophy is significantly reduced due to the fact that vessels do not have to navigate in the confines of the port among other vessels or near grounding depths. The required water depth in the port may perhaps be reduced, if tankers are accommodated elsewhere.

The utilization of single-point moorings for the transfer of liquefied gas has been considered, but appears to be feasible only for gases with relatively high-boiling points such as propane. The principal difficulties are the use of rubber hoses which may not remain flexible at low temperatures, thermal insulation and the restriction on the motion of certain LNG tankers, when the tanks are only partly filled (see 7.6.4).

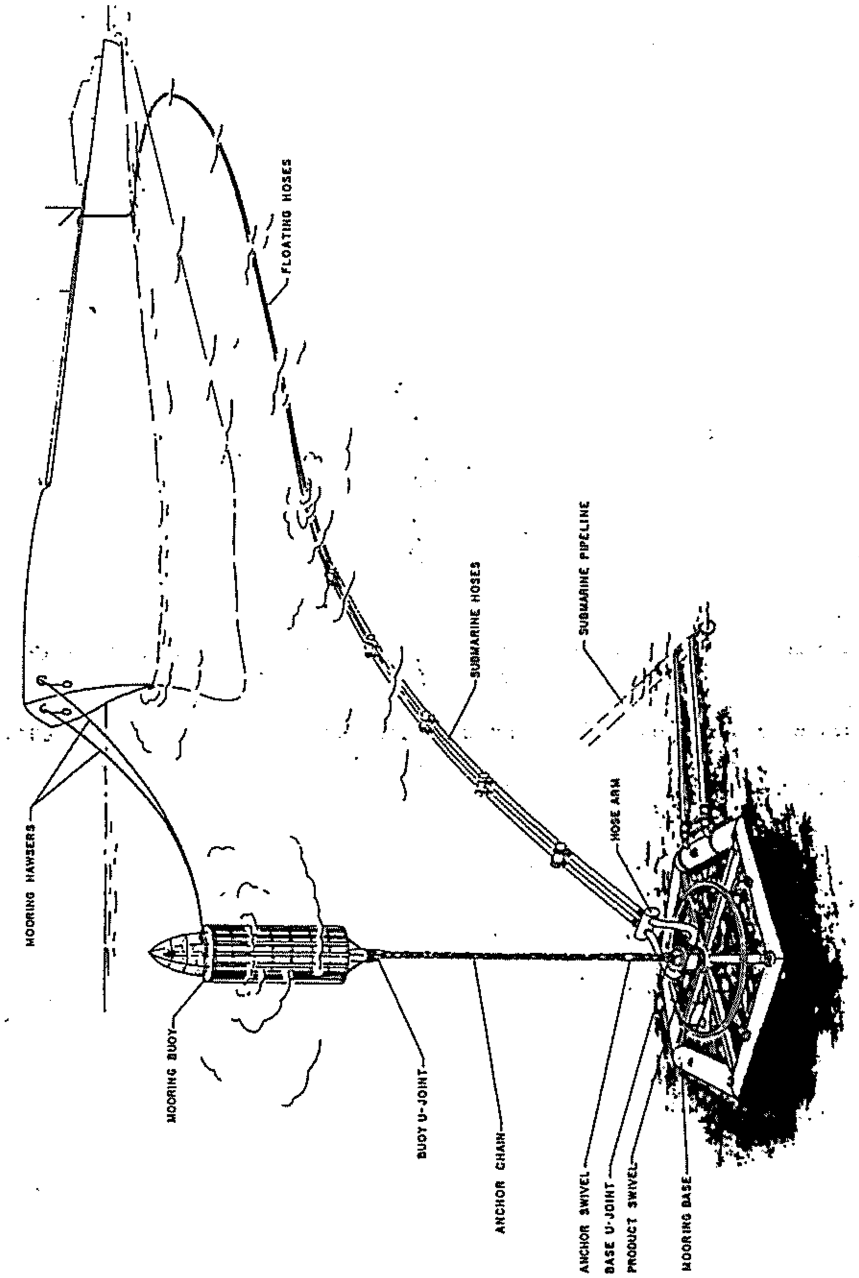


Fig. 7.6 (f) Single-Point SALM. Reproduced by permission of SOFEC Inc. Tanker Terminals

7.7 DRY BULK TERMINALS

7.7.1 General considerations

A large variety of goods is carried by ships as dry bulk. These goods can be divided roughly into four main categories:

(a) minerals such as iron ore;
(b) coal;
(c) food stuffs such as grain; and
(d) other commodities such as cement.

During recent years iron ore accounted for about 45 percent of major dry-bulk commodity shipments, coal and grain for about 20 percent each, and bauxite/alumina and phosphate rock for about 7 percent each.

Depending on the volume being transferred at a particular port, one or more berths may be dedicated exclusively to dry bulk or perhaps even reserved for one particular commodity. The decision whether to have berths exclusively dedicated to dry bulk is an economic one which involves a variety of factors, the most important of which is the forecast annual or seasonal volume. However, the location of storage facilities, contamination, exposure to the elements and safety hazards to the community may also play significant roles in making this decision. In general, when a berth is dedicated exclusively to dry bulk, it is possible to employ high-capacity transfer devices to effect quick turnaround of the vessels. Whereas, when the berth is used for a variety of purposes, it is usually only possible to use mobile transfer equipment of low capacity.

Dry bulk is frequently transferred between the loading or discharge device and the storage by means of belt conveyors. While these conveyors are usually not located at quay level, the supporting structures do obstruct horizontal handling of general cargo, vehicle traffic, etc. In general, it is desirable that dry bulk storage takes place fairly close to the berths. However, stockpiles may cause special geotechnical problems because of the high unit loads they exert on surfaces close to berths.

Depending on the type of commodity, the storage usually is one of four basic types:

(a) open storage yard, which is normally used for commodities which do not suffer serious degradation by being exposed to the elements;
(b) shed, which is normally used for commodities which would suffer degradation if exposed to rain;
(c) silo, which is used for storage of grain, cement and other commodities which must be protected from the elements. Silos are normally equipped with efficient materials handling equipment; and
(d) slurry pond, which is, of course, only feasible for materials, which are not damaged by water.

The choice between covered sheds or silos is usually based on economics. Silos would normally be preferred when the storage time is short, and for commodities which are fine powders for dust-control reasons.

Bulk cargoes vary widely in regard to stowage factor, angle of repose, generation of dust, resistance to degradation by mechanical handling and hazardous properties such as toxicity, susceptibility to fire and spontaneous ignition. For stowage factors and angles of repose see Table 7.7(a). In addition, there are large differences in regard to their

un nuovo monormeggio per superpetroliere nel porto di genova

I 35 milioni di tonnellate di petrolio sbarcate al porto petroli di Genova-Multedo non solo contribuiscono per quasi un terzo al fabbisogno totale italiano, ma sono anche destinati in quantità elevata alle raffinerie svizzere e tedesche.

Nel contempo il gigantismo navale ha fatto sì che all'attuale piattaforma monormeggio per navi fino a 500.000 tpl sia ormai sbarcato il 50% dell'intero greggio genovese, ponendo così problemi operativi. Poiché si prevede che tale situazione sia destinata a perdurare, ne consegue la necessità di provvedere con soluzioni a breve termine.

A tal fine è stata prevista la costruzione di un nuovo monormeggio a 1740 metri dalla diga dell'aeroporto, collegato con gli impianti a terra mediante una tubazione sotterranea, utile anche a far fronte alle eventuali interruzioni della attuale isola, giunta al suo ottavo anno di vita. (Cfr. Porto e Aeroporto di Genova nn. 2, 1971; 4, 1972; 9, 1974).

Alla progettazione ha collaborato la Snam-Progetti, come già era avvenuto nel 1963 per il porto petroli.

Ogni decisione è stata assunta dal Consorzio del porto con l'assenso unanime di Regione, Provincia e Comune, ed il Consiglio Superiore dei Lavori Pubblici ha espresso parere favorevole al progetto.

Il costo dell'opera è di 23,6 miliardi ed il finanziamento prevede la partecipazione di diversi soggetti, con un sistema analogo a quello adottato per altri impianti portuali. Sarà infatti finanziato da Società del Gruppo Eni ed il rimborso avverrà attraverso il gettito di un'apposita addizionale tariffaria per le petroliere di portata lorda superiore fino a 270.000 tpl.

Il sistema di ormeggio è stato progettato tenendo presenti le fondamentali esigenze di:

- garantire una assoluta assenza di inquinamenti;
- garantire la sicurezza dell'impianto e delle navi in caso di impatto;
- offrire un approdo poco sensibile alle condizioni meteoceanografiche avverse.

Per determinare le coordinate geografiche del nuovo punto ottimale di ormeggio nello specchio di mare antistante il porto petroli si è tenuto presente: la presenza nelle stesse acque dell'attuale piattaforma; la rotta di accesso e di rilascio degli ormeggi; la necessità di non intralciare il traffico di naviglio minore per il porto petroli e per il costruendo porto di Voltri; la vicinanza dell'aeroporto; la lunghezza minima possibile della condotta sottomarina per contenere i costi di installazione e manutenzione; la profondità del fondale; la consistenza del terreno del fondale per definire il tipo di ancoraggio; le correnti marine; i venti; le norme generali di sicurezza; le servitù aeree.

Il punto prescelto per l'installazione del nuovo sistema di ormeggio è ad una distanza di 1740 metri dalla diga dell'aeroporto, su un fondale di circa 65 metri, a 2250 metri dall'attuale piattaforma e proprio di fronte all'Italcantieri.

Come detto, vi potranno attraccare navi da 270.000 tpl, con una lunghezza massima di 350 metri, una larghezza di 52 metri ed un pescaggio a pieno carico di 20 metri. A queste dimensioni si è giunti tenuto conto che la composizione della flotta in arrivo all'attuale isola è costituita per l'80% da navi di tonnellaggio fino a 270.000 tpl e che l'impianto esistente è già in grado di ricevere super petroliere fino a 500.000 tpl.

Il concetto principale su cui si basa la configurazione del monormeggio è costituito dalla separazione della funzione di ormeggio da quella di trasferimento del greggio.

Il monormeggio si compone fondamentalmente di:

☐ un corpo boa costituito da un elemento cilindrico (5) nella parte superiore e da una struttura reticolare (4) nella parte inferiore.

Il corpo cilindrico è compartimentato in modo da assicurare la necessaria riserva di spinta anche in caso di falla in uno dei compartimenti.

Nella parte superiore del corpo cilindrico sono sistemate le attrezzature di superficie (7) composte essenzialmente da un giunto girevole e da un ponte rotante che sostiene il sistema di processo di superficie (9).

Questi componenti consentono il collegamento fra le tubazioni fisse entro il corpo boa e le manichette galleggianti (8), qualunque sia la posizione assunta da quest'ultime.

Sul ponte rotante sono anche allestiti gli accessori di tipo marinaresco (fanali di segnalazione, corno da nebbia, riflettore radar).

Nella camera superiore della boa, cui si accede da passo d'uomo a tenuta stagna, è sistemato il manifold delle linee del greggio.

I montanti principali della struttura a traliccio (4) sono adibiti anche al trasferimento del greggio e si raccordano al manifold della camera superiore

☐ una base di ancoraggio al fondo (1) costituita da una struttura reticolare di forma esagonale ai cui vertici si trovano le sedi dei pali di fondazione (2) in cui questi vengono cementati dopo l'operazione di battitura.

Sulla base è sistemato il manifold sottomarino che si collega da un lato alla condotta sottomarina (11) e dall'altro alle linee provenienti dal corpo boa.

Nella parte superiore sono sistemati i supporti per l'alloggiamento ed il bloccaggio del sistema di ormeggio (16);

☐ un sistema di ormeggio costituito da un braccio rigido (13) in grado di ruotare, attraverso una ralla girevole (12), su dodici rulli (16), sul piano orizzontale e su due cerniere nel piano verticale.

I rulli sono montati su una struttura ad anello smontabile che vincola globalmente il sistema di ormeggio alla base di ancoraggio.

Il braccio rigido di ormeggio (13), che collega la ralla girevole (12) alla fune elastica (14) di ormeggio della petroliera, consente alla petroliera stessa di assumere qualsiasi posizione rispetto alla boa, mantenendo la fune di ormeggio ad una distanza di sicurezza dalla boa stessa.

Inoltre, durante i periodi di inattività del monormeggio, il braccio rigido mantiene la fune di ormeggio in posizione tale da impedire ogni interferenza fra corpo boa e fune.

La dimensione trasversale massima del corpo boa è inferiore al diametro minimo della struttura di supporto dei rulli, in modo tale che è possibile portare in superficie per interventi di manutenzione tutto il blocco struttura di supporto-rulli-ralla-braccio girevole, sfilando senza dover smontare il corpo boa dalla base d'ancoraggio.

Le scatole dei cuscinetti su cui ruotano i rulli sono riempite di olio lubrificante pressurizzato dalla superficie così da equilibrare la pressione esterna dell'acqua e la pressione interna dell'olio.

È inoltre possibile la circolazione forzata dalla superficie dell'olio lubrificante, mediante una linea di mandata e una di ritorno.

Tale sistema consente anche di individuare eventuali infiltrazioni d'acqua nel circuito di lubrificazione;

☐ un giunto cardanico di forza (3) che collega il corpo boa alla base di ancoraggio.

Detto giunto è collegato mediante flange sia al corpo boa che alla base sul fondo.

Le normali operazioni di connessione/sconnessione prevedono di operare solo sul lato base dove è stato previsto un apposito sistema di centraggio e collegamento/scollegamento rapido;

☐ un sistema di raccordo per il deflusso del greggio da inviare alle condotte sottomarine costituito da:

- due manichette galleggianti (8) di collegamento alla nave
- due tubazioni e valvole di superficie (9) sul ponte rotante
- un giunto girevole (7)
- quattro tubazioni e valvole all'interno del corpo cilindrico della boa
- quattro tubazioni rigide integrate nella struttura reticolare della boa
- quattro manichette flessibili di collegamento tra la boa e la sua base sul fondo
- tubazioni e valvole sulla base al fondo
- collettore e collegamento alle condotte sottomarine.

Il sistema di ormeggio della nave è costituito da:

- un cavo di nylon
- un braccio metallico con ralla girevole
- un sistema di rulli di scorrimento connessi alla base della struttura.

In assenza di navi all'ormeggio il braccio metallico assume una posizione orizzontale e mantiene in verticale, sott'acqua il cavo di ormeggio, la cui estremità libera connessa ad una piccola boa emerge in superficie.

Il giunto rotante permette il passaggio dell'olio e la rotazione delle tubazioni attorno all'asse della boa.

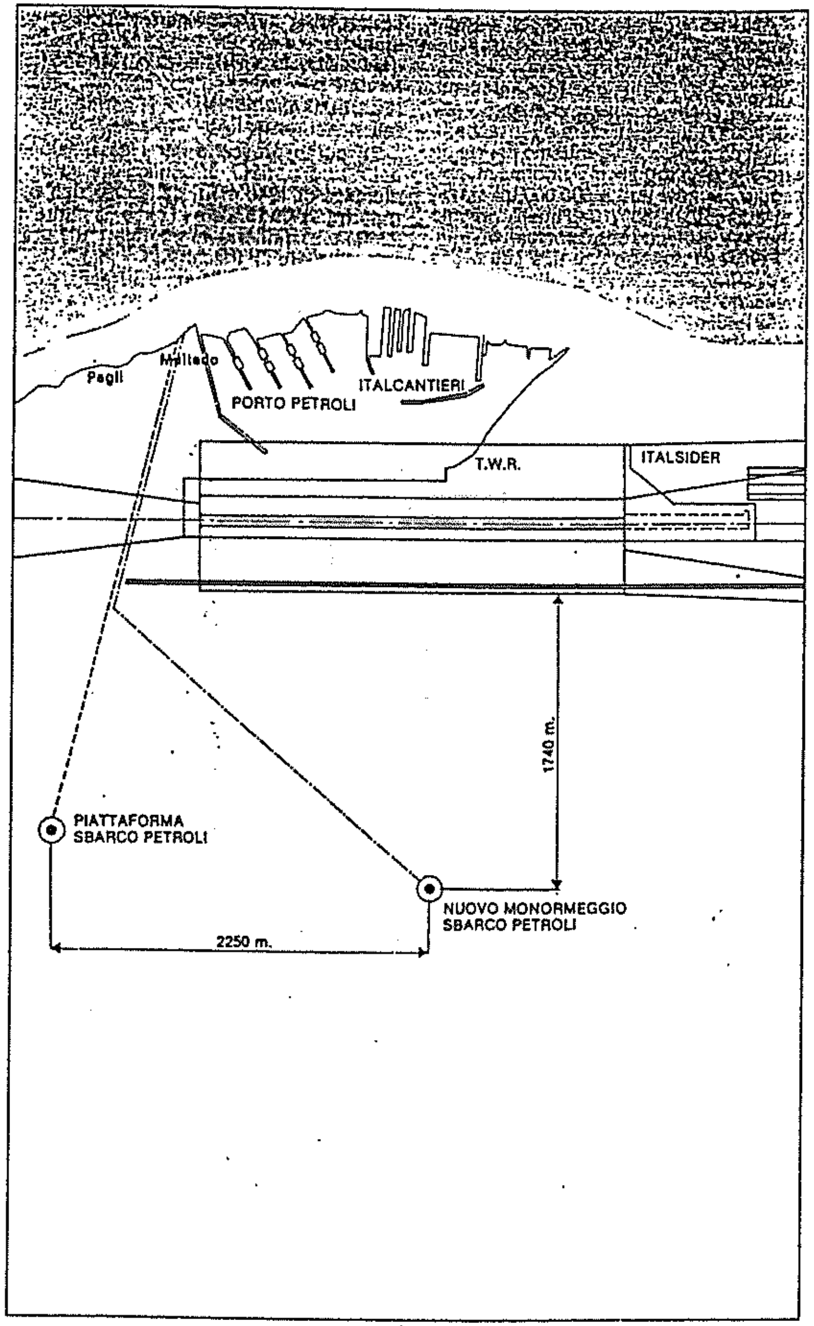
Serve inoltre da collettore delle due linee provenienti dalle manichette galleggianti.

È costituito da due parti, una solidale con il corpo cilindrico della boa e l'altra collegata alla tavola rotante, connesse attraverso due cuscinetti di spinta obliqua.

La manichette che collegano la boa ai manifolds della petroliera sono di tipo standard e il tipo di rivestimento interno è stato scelto tenendo conto della presenza di aromatici nel greggio da scaricare.

Le linee sono due della lunghezza di circa 320 m. ciascuna e del diametro di 24".

Ognuna di esse è composta da un primo gruppo di 5 manichette che partono dal giunto rotante della boa e sono di tipo rinforzato e peso limitato ma non di tipo autogalleggiante, un secondo gruppo di 24 manichette autogalleggianti con riserva di spinta del 25% ed infine un ultimo



gruppo con diametro di 16" e di tipo rinforzato che viene recuperato a bordo della nave.

Al braccio metallico d'ormeggio è collegato un cavo di ormeggio di nylon della lunghezza di circa 95 m., alla cui estremità libera è attaccata una boa di recupero ed a questa uno spezzone di catena lungo circa 9 m. ed un'altro spezzone di cavo in polipropilene di circa 10 m.

Il cavo di nylón oltre alla caratteristica di una alta resistenza alla trazione conferisce pure una grande elasticità al sistema di ormeggio consentendo di ridurre i picchi dovuti alla dinamica della nave.

La boa avrà tutte le segnalazioni per poter essere facilmente individuata e consentire agli altri mezzi di manovrare opportunamente secondo il «Regolamento Internazionale per prevenire gli Abbordi in Mare».

Il sistema di segnalazione luminoso è attivato automaticamente da fotocellule all'imbrunire o in condizioni di scarsa visibilità.

La boa sarà inoltre munita, per il caso di nebbia, di un autofono attivato automaticamente per la presenza di foschia o nebbia.

Le manichette ed i gavitelli vengono segnalati con luce fissa rossa della portata di 2 miglia.

La boa sarà inoltre identificata da pannelli sul quali si legge il nominativo scritto in nero su fondo giallo.

Il sistema è stato progettato in modo da permettere un altro grado di prefabbricazione con conseguente facilità delle operazioni di costruzione ed installazione e riduzione dei tempi.

La tipologia strutturale si presta molto bene ad una costruzione di tipo modulare di cui si possono elencare i seguenti blocchi prefabbricabili che possono essere costruiti in parallelo anche in officine a cantieri diversi.

Le condizioni di operatività possono essere stabilite come segue:

Condizioni limite per la presa dell'ormeggio

Altezza d'onda	2.0 m ÷ 2.5 m
Velocità del vento fino a	40 km/h
Velocità della corrente di superficie	0.25 m/s

Condizioni limite per la discarica

Altezza d'onda	3.0 m ÷ 4.0 m
Velocità del vento fino a	60 km/h
Velocità della corrente di superficie	0.25 m/s

Condizioni limite per il rilascio dell'ormeggio

Altezza d'onda	3.5 m ÷ 4.5 m
Velocità del vento fino a	80 km/h
Velocità della corrente di superficie	0.25 m/s

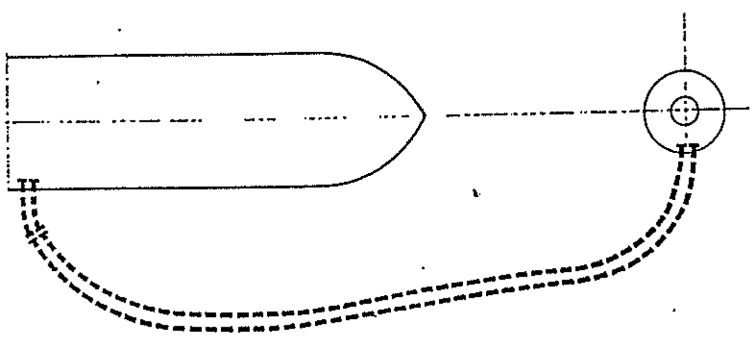
In fase di ormeggio alla boa è richiesta l'assistenza di un mezzo navale («line boat») per il trasferimento a bordo del cavo e delle manichette.

Inoltre è prevista anche l'assistenza di un rimorchiatore che eviti in caso di cambio improvviso di vento, che la nave venga spinta contro la boa in fase di operazione di discarica. Il rilascio dell'ormeggio può invece avvenire senza assistenza alcuna.

Sulla base di tali considerazioni e delle condizioni meteoceanografiche limite per le varie operazioni i relativi tempi di occupazione del terminale si possono prevedere in:

- Tempo necessario all'ormeggio 2 ÷ 3 h (dall'arrivo della petroliera all'inizio del pompaggio)
- Tempo di scarica 20 h (tanker da 270.000 DWT e rata di scarico da 9000 m³/h)
- Tempo per il rilascio dell'ormeggio 0.5 ÷ 1h

SCHEMA DISPOSIZIONE E LUNGHEZZA MANICHETTE

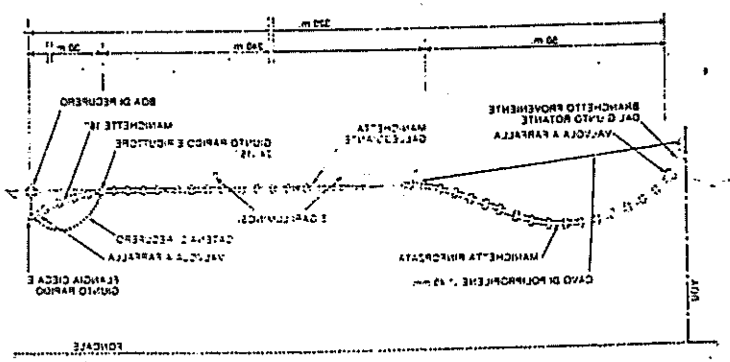


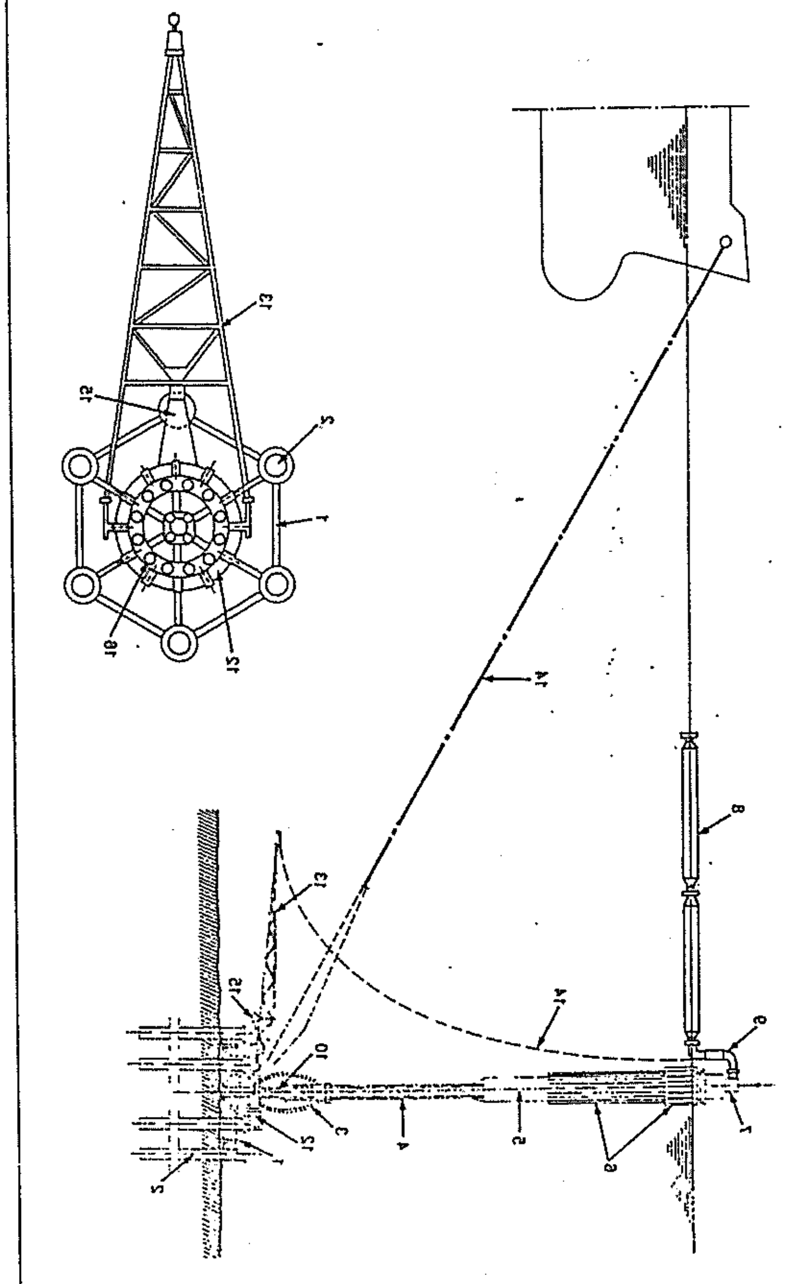
A	=	Distanza boa/prova di nave a pieno carico	= 111 m.
A'	=	Distanza boa/prova di nave in zavorra	= 103 m.
B	=	Distanza manifold da prova	= 170 m.
C	=	Bordo libero a nave in zavorra	= 20 m.
D	=	Distanza manifold da murata	= 5 m.
E	=	Altezza manifold da coperta	= 2 m.
F	=	3 volte raggio curvatura linea da 16"	= 7 m.

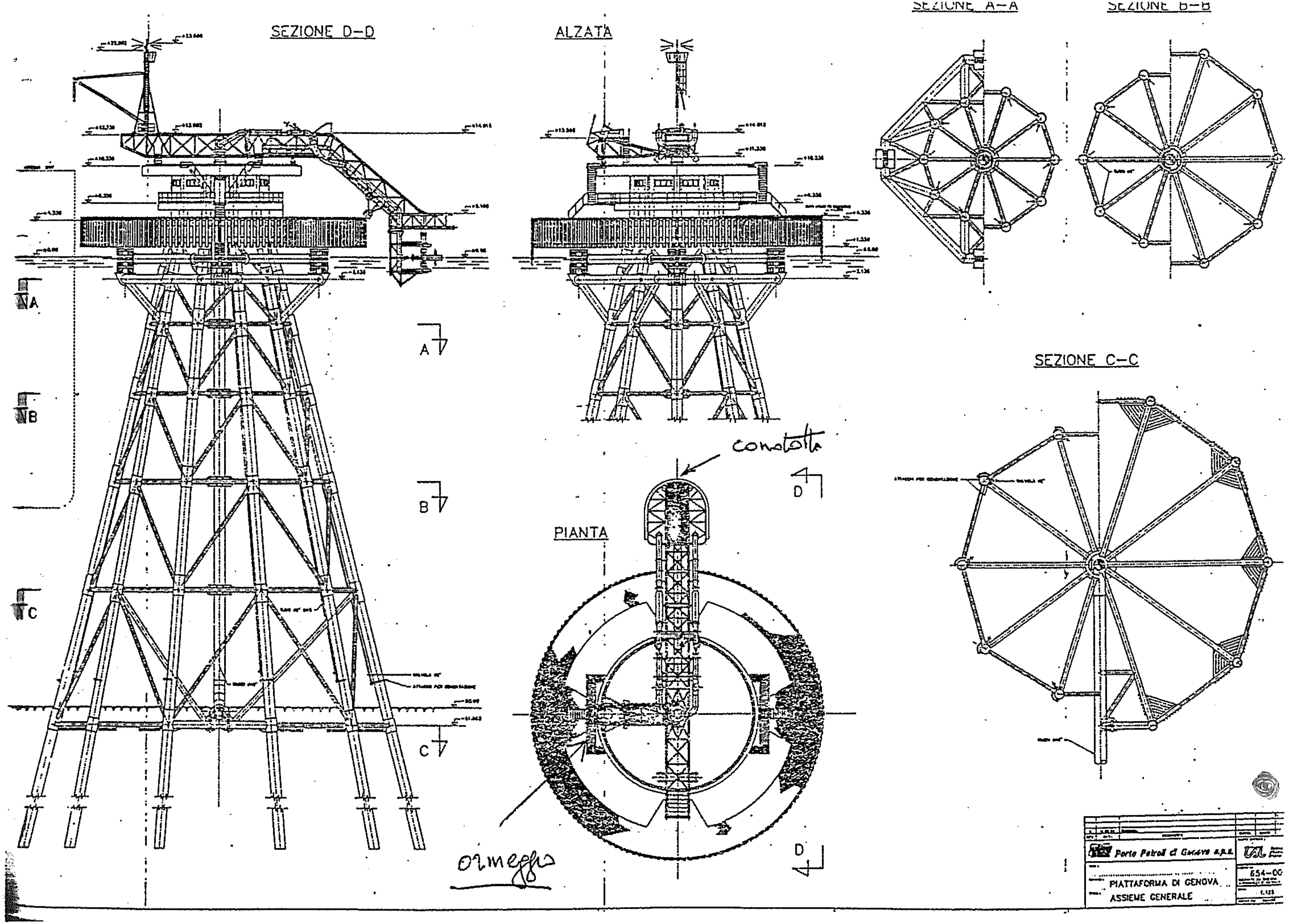
Considerando nave in zavorra occorrono 307 m. di manichette + 6% effetto moto ondoso

Totale = 325 m.

CONFIGURAZIONE SCHEMATICA DI UNA LINEA DI MANICHETTE







SEZIONE D-D
ALZATA
SEZIONE A-A
SEZIONE B-B
SEZIONE C-C
PIANTA
A
B
C
D
condotta
ormeggio
Porto Petroli di Genova s.p.a.
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ASSIEME GENERALE

Issue No.79, October 1994, By Subscription

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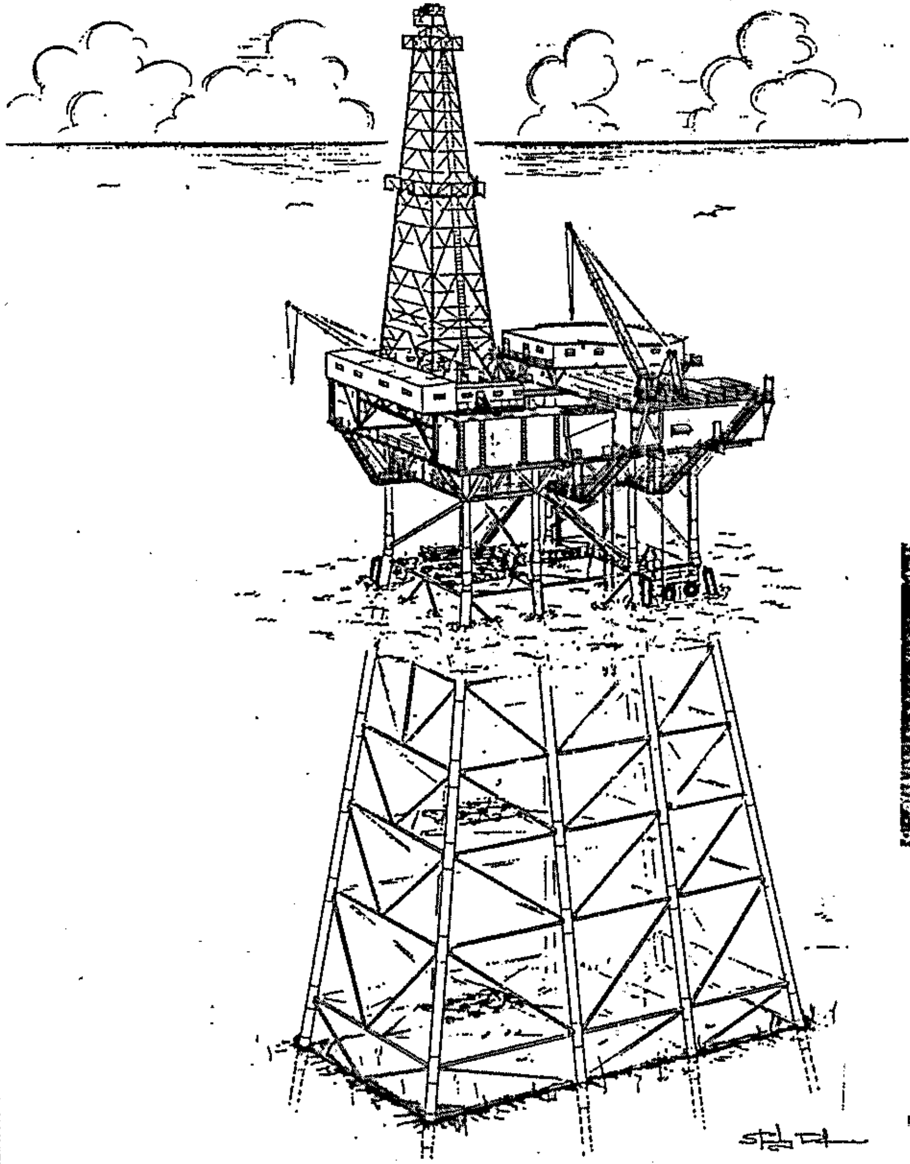


Fig. 1.1. Artist's rendering of a modern template structure. (Courtesy of McDermott Incorporated.)

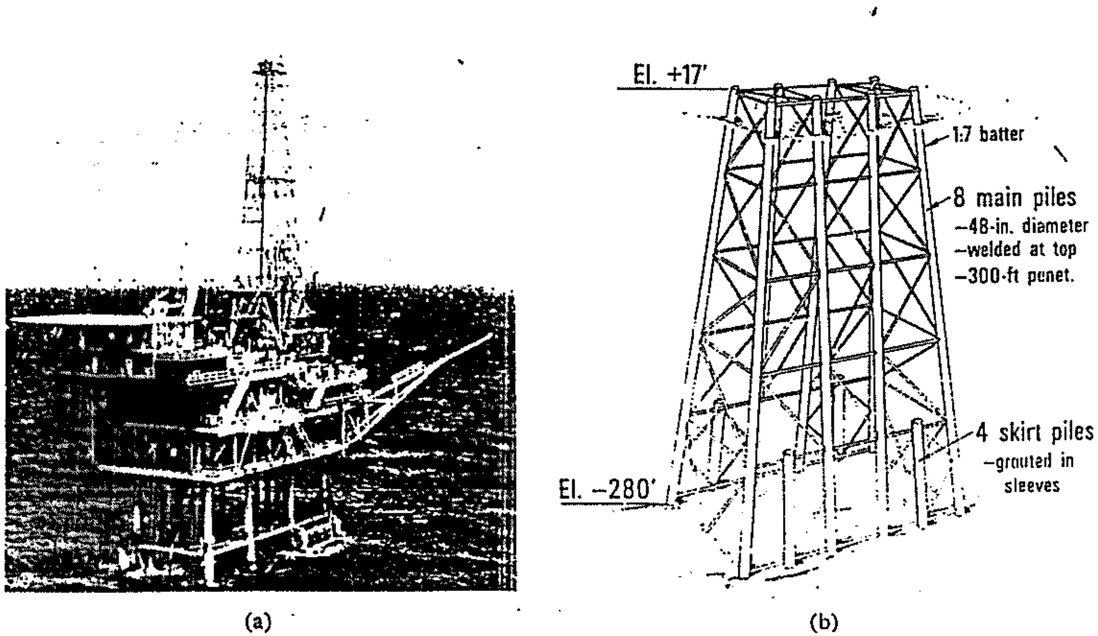


Fig. 1.3. Typical offshore template structure off Louisiana in the Gulf of Mexico: (a) installed structure; (b) substructure illustrating skirt piles. [(a) Courtesy of the American Petroleum Institute; (b) courtesy of McClelland Engineers, Inc., after McClelland, 1974.]

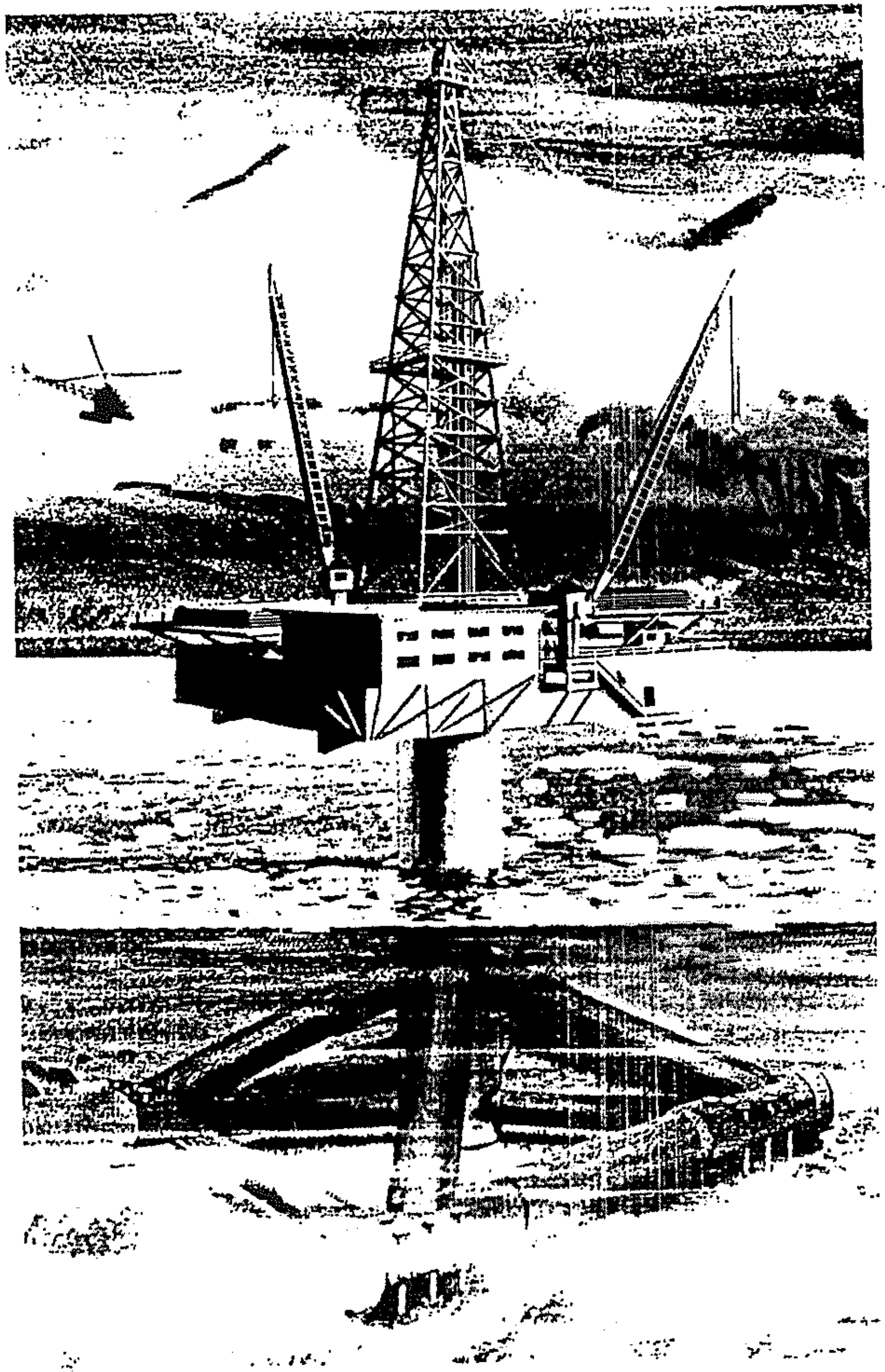


Fig. 1.8. Illustration of an ice-resistant Monopod platform installed in Cook Inlet, Alaska in 1966. (Courtesy of the Marathon Oil Company and the American Petroleum Institute.)

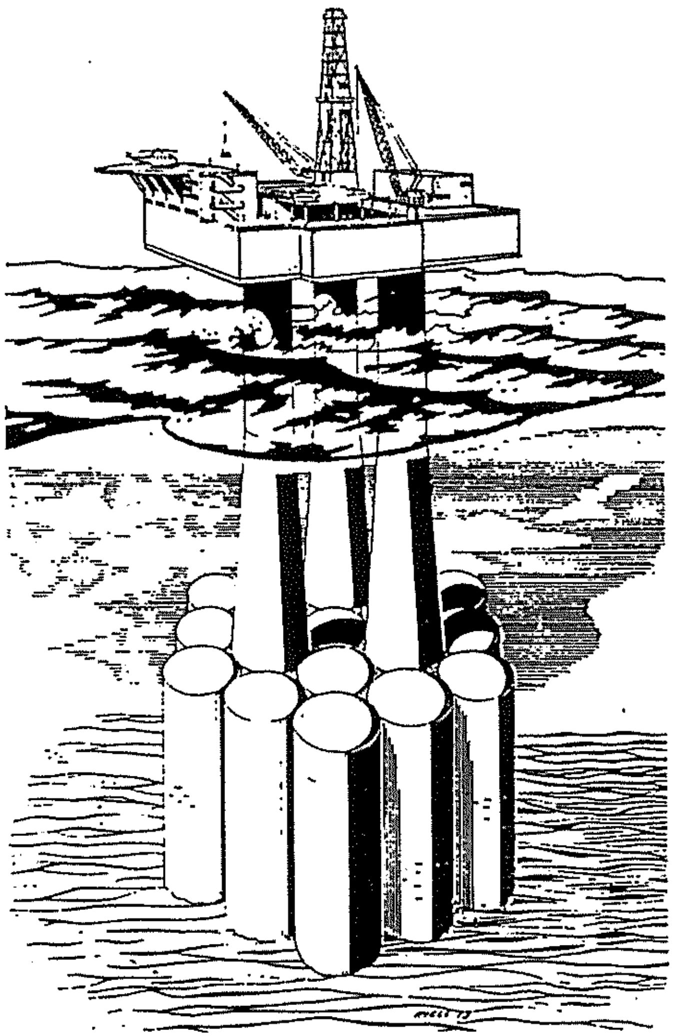
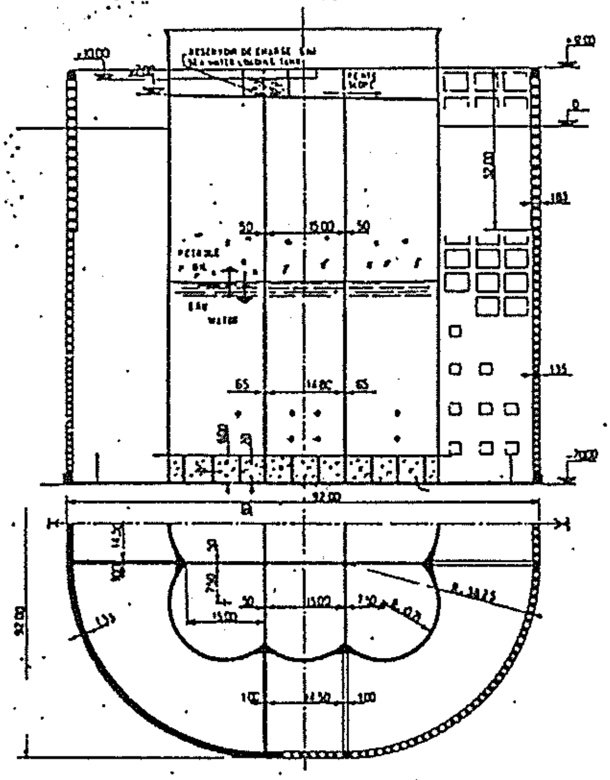


Fig. 1.9. Illustration of a concrete gravity platform used in the North Sea. (Courtesy of Exxon Company USA.)



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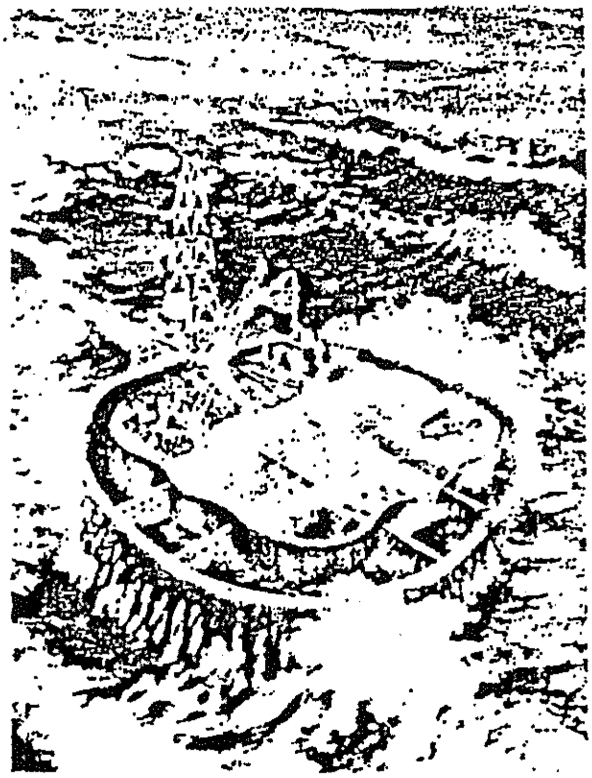

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al congresso BOSS 76 [65]: su tale problema, Mangiavacchi et al. hanno riferito in un lavoro presentato al congresso di Houston 1980 [66]; un tipo di piattaforma strallata a cavi a raggiera incrociati era stato esaminato da Albrecht al congresso Houston 1978, considerandone il comportamento dinamico [67].

Prospettive molto favorevoli sembrano essere riservate alle piattaforme galleggianti semisommerse, ormeggiate con uno o più cavi verticali (« Vertically moored platform ») (fig: 33); esposte all'inconveniente di poter subire notevoli spostamenti orizzontali a causa di onde forti, presenterebbero però i notevoli vantaggi di costi poco crescenti con l'approfondimento del fondale, secondo quanto hanno indicato Berman et al. al Congresso Houston 78 (fig. 34) [68], e di poter essere facilmente rimosse e reimpiegate; un notevole esempio a cinque galleggianti è indicato nella fig. 35 [69]. I cavi possono essere posti in tensione (« tension leg platform »), utilizzando una idea della Deep Oil Technology (USA). Considerazioni sulle varie profondità raggiunte sono state fornite da Sjoerdsma, che preconizza per il 1990

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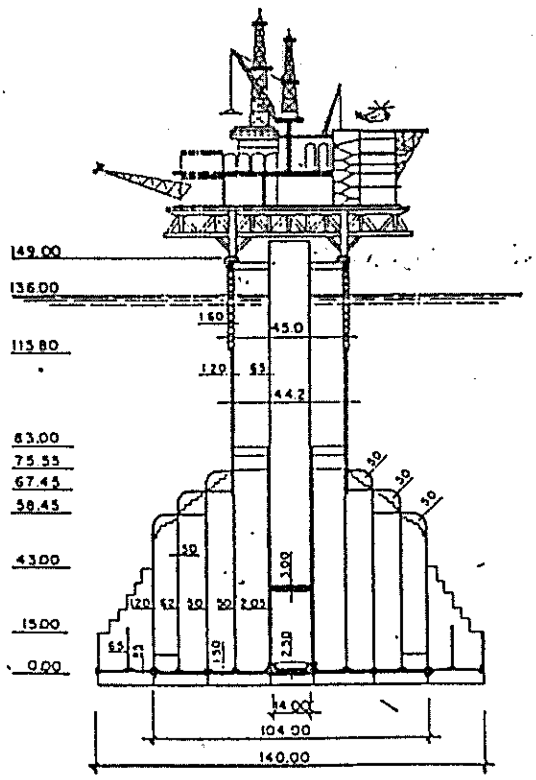
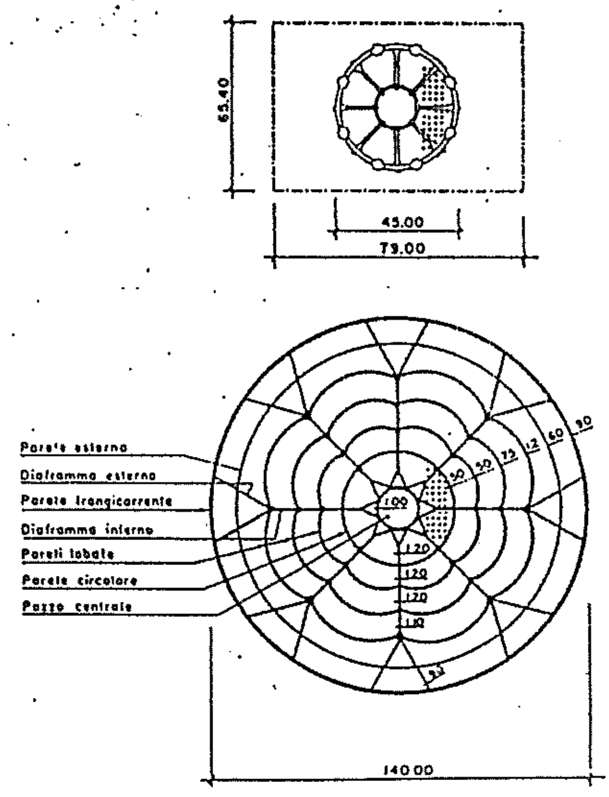




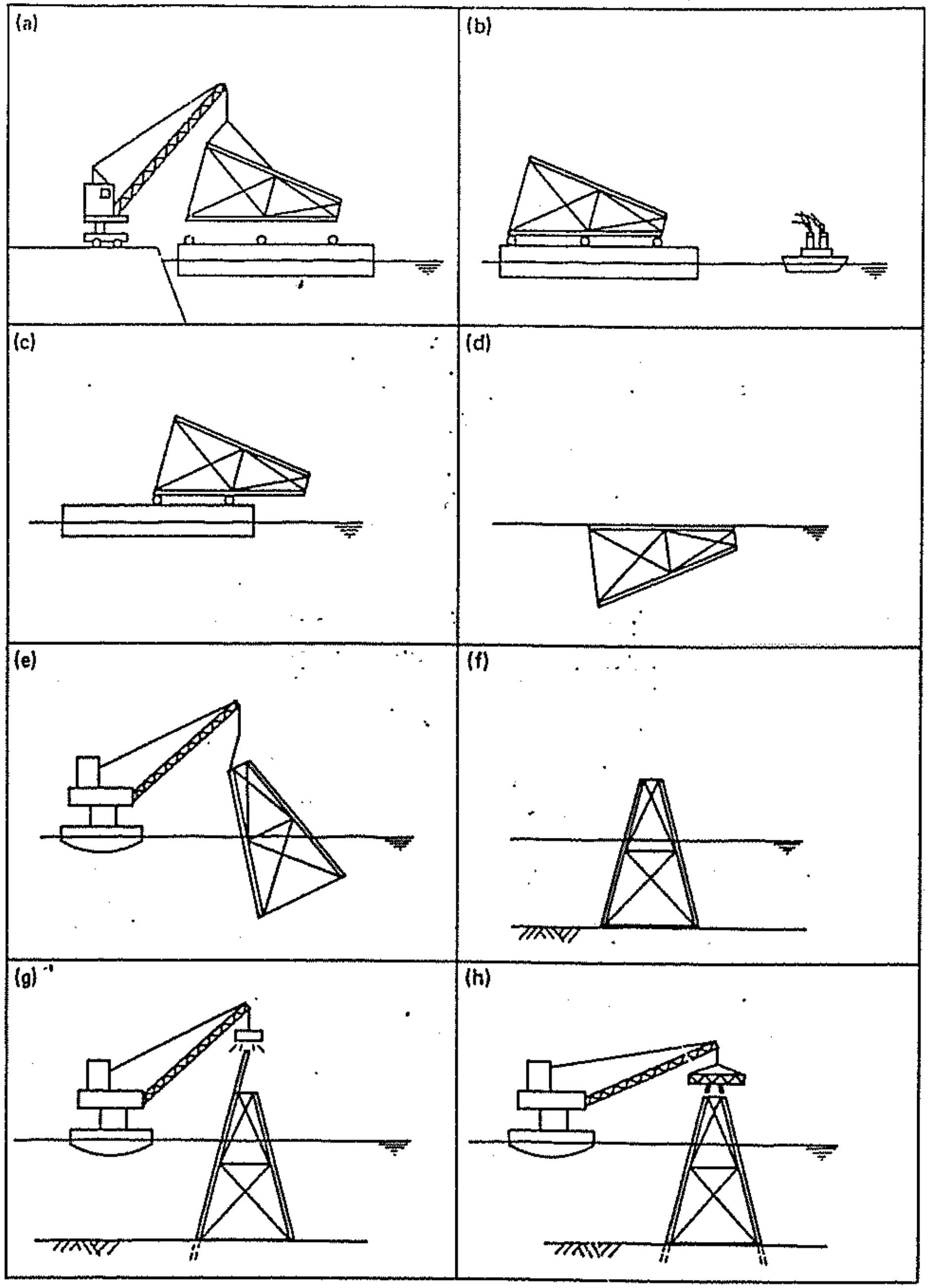


Fig. 1.2. Installation procedure for template structures.

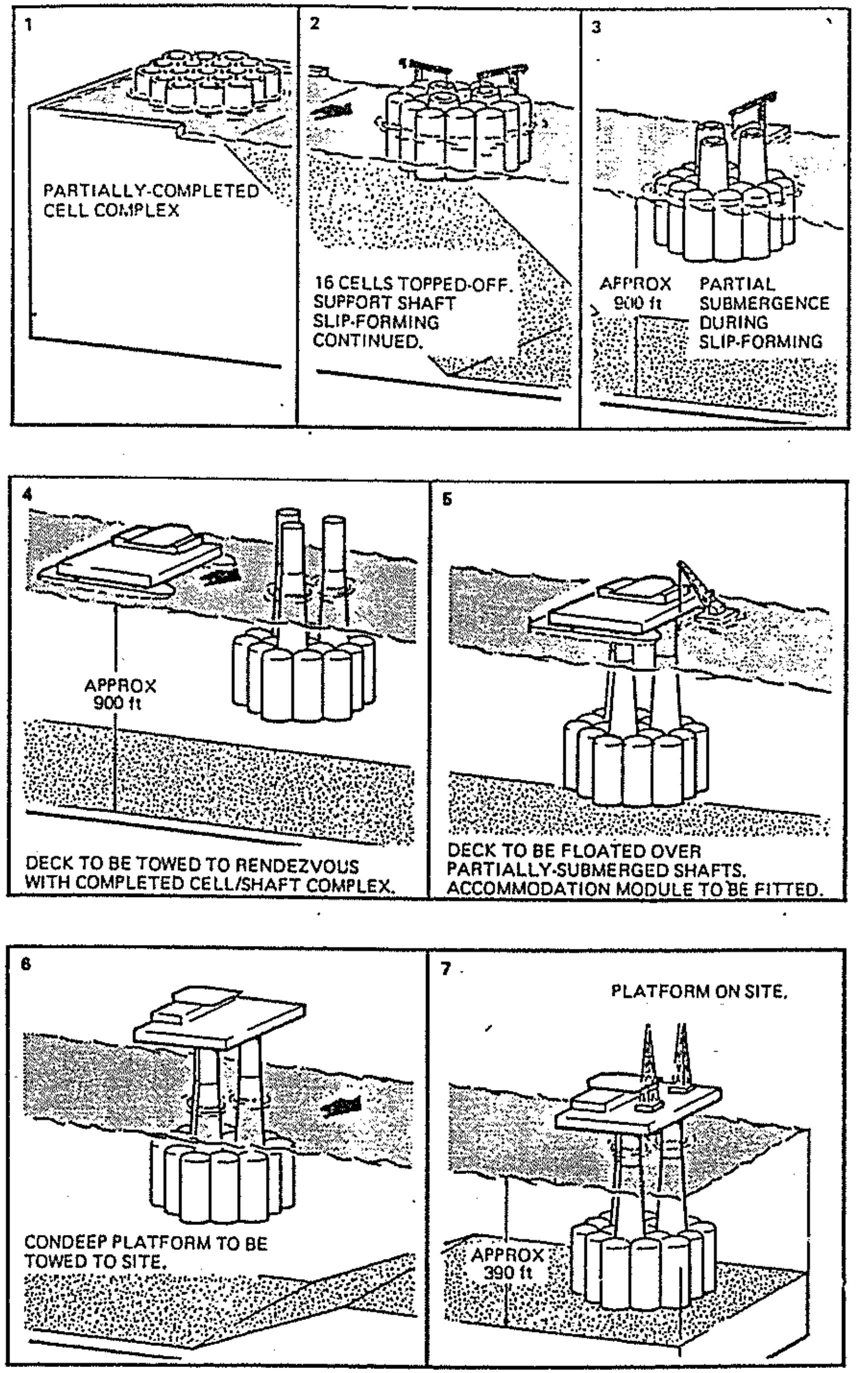
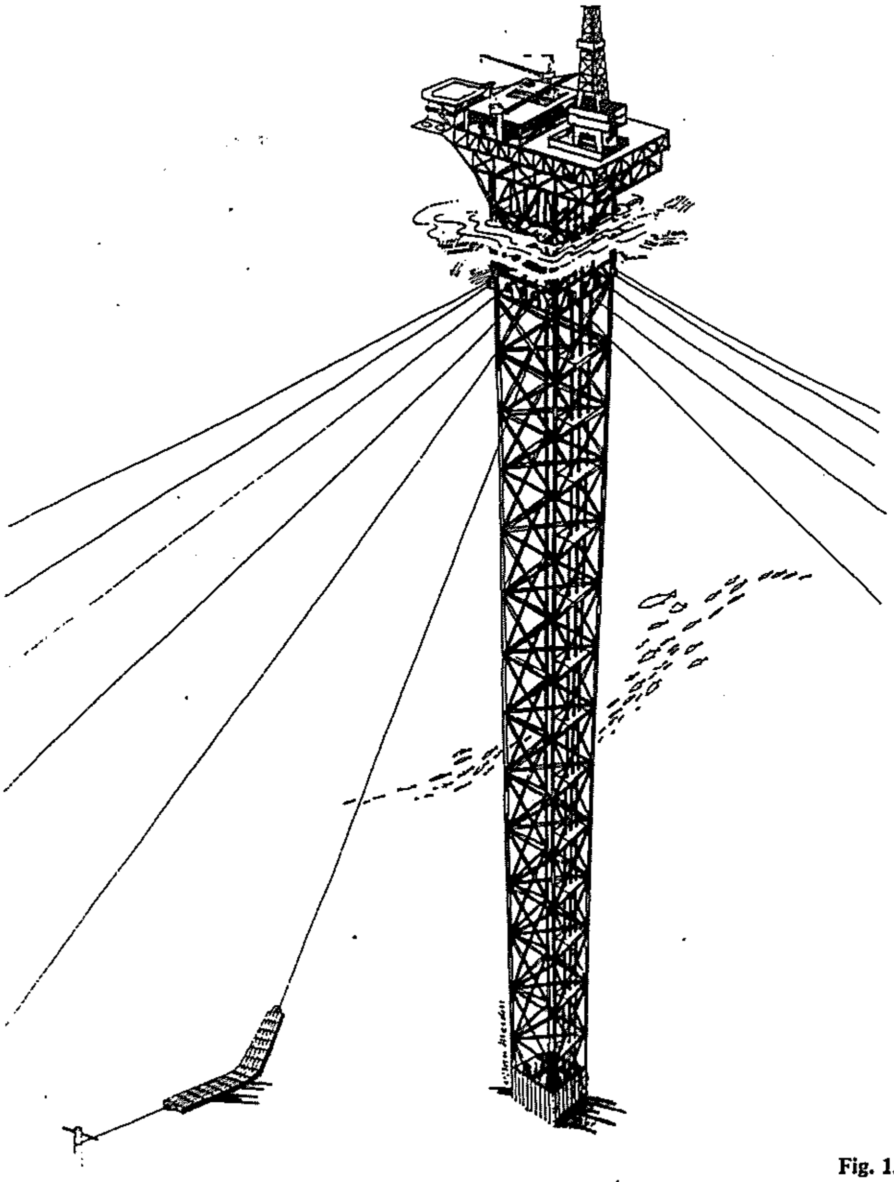


Fig. 1.10. Illustration of construction and installation procedures for concrete gravity platforms. (Courtesy of the Mobil Oil Corporation.)



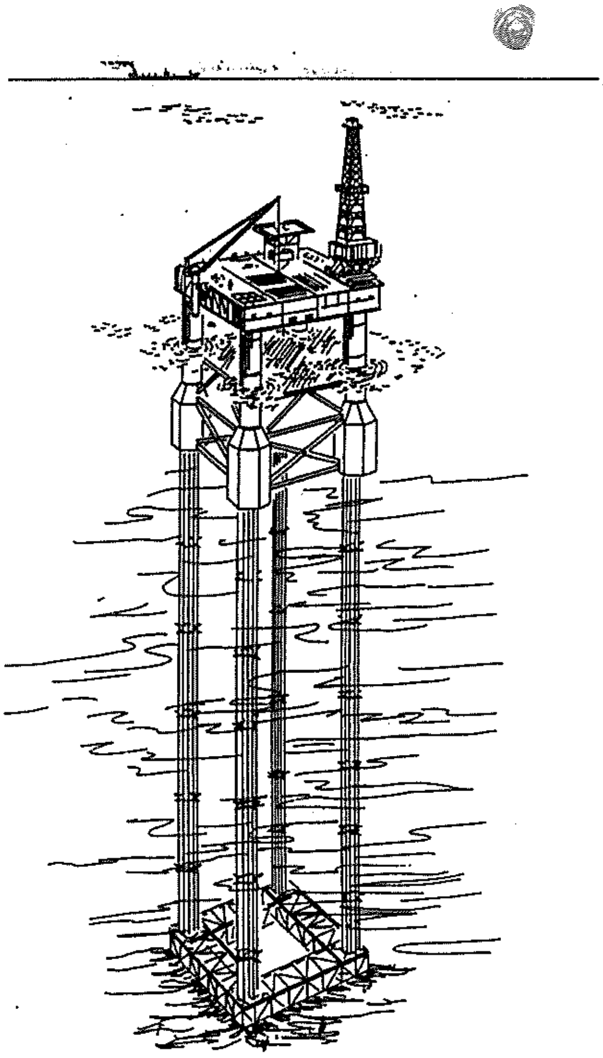


Fig. 1.14. Tension-leg concept for deep water. (Courtesy of McDermott Incorporated.)

Fig. 1.13. Guyed-tower concept for deep water. (Courtesy of Exxon Company USA.)

Deep-Water Design Forms

For water depths greater than about 1000 ft, the weight and foundation requirements of traditional offshore structures make them less attractive than other design forms. Two such forms are the guyed tower and tension-leg platform.

The *guyed-tower* concept is illustrated in Fig. 1.13. It consists of a uniform cross-sectional support structure held upright by several guy lines that run to clump weights on the ocean floor. From the clump weights, the lines then run to conventional anchors to form a dual stiffness mooring system. Under normal operating loads, the clump weights remain on the seafloor and lateral motion of the structure is restrained. However, during a severe storm, the clump weights are lifted off the seafloor by loads transferred from the structure to the clump weights through the guy lines. This action permits the tower to absorb the environmental loadings on it by swaying back and forth without overloading the guy lines. The guyed-tower concept is presently considered to be applicable to water depths of about 2000 ft.

Figure 1.14 illustrates the *tension-leg* concept. In this design, vertical members are used to anchor the platform to the seafloor. This upper part of the structure is designed with a large amount of excessive buoyancy so as to keep the vertical members in tension. Because of this tension, the platform remains virtually horizontal under wave action. Lateral excursions are also limited by the vertical members, since such movements necessarily cause them to develop a restoring force. A major advantage of the tension-leg concept is its relative cost insensitivity to increased water depths. At the present time, it appears that the main limitation on the tension-leg platform arises from dynamic inertia forces associated with the lateral oscillations of the platform in waves. These become significant at water depths of about 3000 ft (Lee, 1981).

La foreuse sous-marine SM 3000

La foreuse sous-marine SM 3000 est conçue et construite pour opérer directement sur le fond marin. Elle est capable de forer des trous dans le bed-rock ayant jusqu'à 72" de diamètre. Ces trous sont adaptés à recevoir des piles d'ancrage ou des terminaux proprement dit.

Le couple de forage est de [illegible] kg.m et la vitesse de 24 tours par minute.

L'opération s'effectue comme l'indique la figure 69.

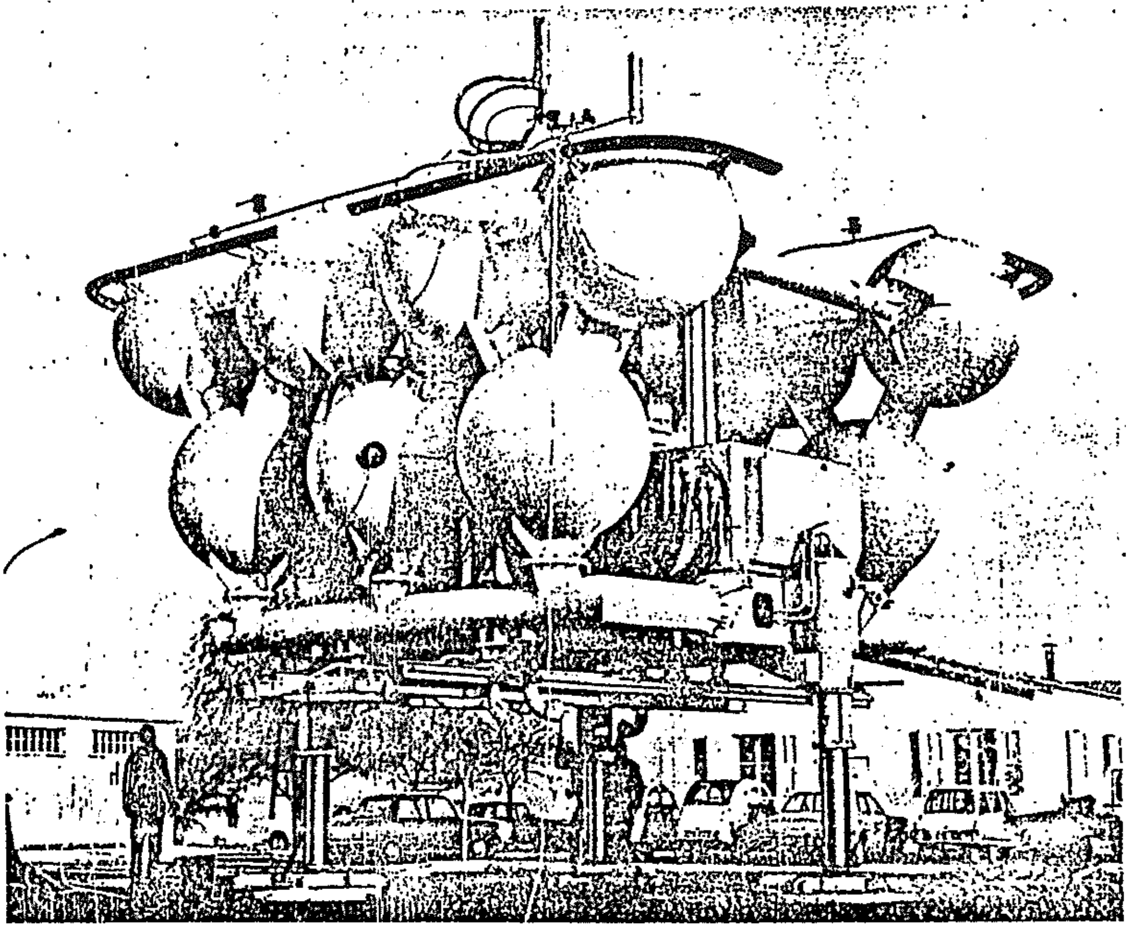


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Fig. 68
Foreuse sous-marine.

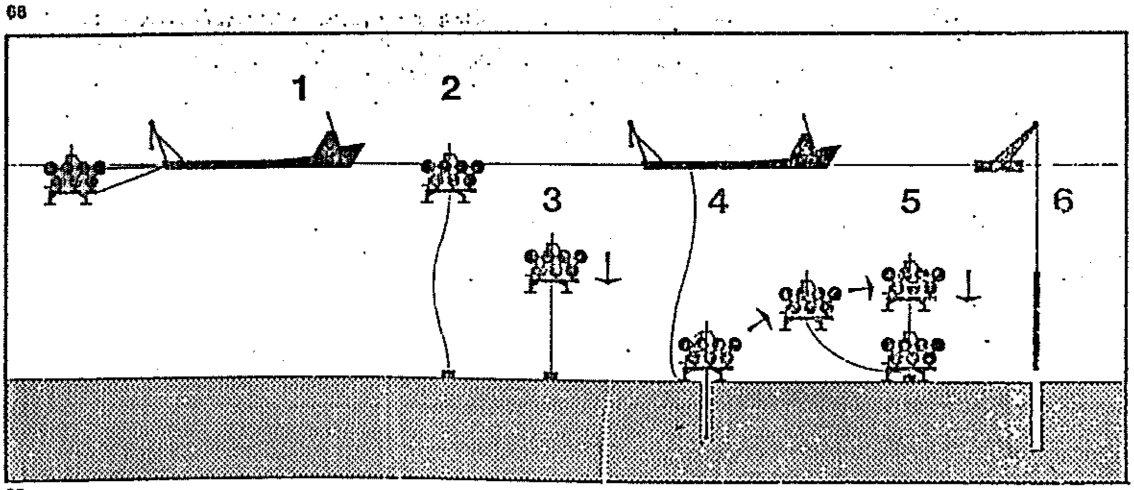

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Fig. 69
Opérations de forage dans la roche.

1. L'unité de forage est remorquée sur le site au moyen d'un remorqueur ou bateau de service. Les sphères de ballastage ménagent une réserve de flottabilité de 5 tonnes.

2. Environ 2 tonnes de corps-mort sont descendues et placées au point de forage.

3. On remplit les sphères d'immersion. L'unité de forage a une flottabilité de 500 kg et descend au fond sur son treuil.

4. L'unité est placée en position finale au fond. Toutes les sphères sont pleines, son poids dans l'eau est alors de 33 tonnes. On retire alors les 2 tonnes de corps mort mentionnées plus haut et on les place au prochain point de forage.
Puis le forage commence. Cette opération est accomplie par des plongeurs-foreurs.

5. La SM 3000 peut être déplacée d'un point à un autre sans qu'il soit nécessaire de la remonter en surface, si la distance entre les 2 points de forage est faible (quelques mètres). L'élingue du treuil est alors frappée sur le corps mort positionné sur le second point de forage. Les ballasts sont remplis d'air. La SM 3000 vient ainsi se mettre à la verticale du 2e forage. Sa mise en place finale s'effectue comme décrit ci-dessus (3 et 4).

6. Une fois que le trou est achevé, on peut installer une pile qui sert de point d'ancrage horizontal pour une structure fixe. On la fixe dans le sol en injectant du coulis de ciment ou de béto

8.5 PIERS

8.5.1 General considerations

Piers may be divided into three types: (a) piers consisting mainly of reclaimed land and bordered by quays, (b) piled piers, and (c) floating piers. The first type is merely a particular arrangement of a quay structure which is dealt with in 8.4. The other two types are dealt with below.

The layout of piers in the plan also varies. Finger piers abut the shore at one end while T-head and L-head piers are connected to land by a trestle and/or a causeway with an access road.

8.6 JETTIES

The characteristics of a jetty as defined in 8.1 are that it consists of a number of individual structures each of which support a special type of loads. The mooring dolphins pick up the pull from the hawsers, the breasting dolphins support fenders which absorb berthing impacts and on shore wind loads on the moored vessel and loading platforms support special loading or unloading equipment but normally no horizontal forces apart from wind loads on the equipment.

A typical layout of a jetty with one berth, only, is shown in Fig. 8.6(a). Catwalks which connect the various dolphins and platforms are indicated.

DOLPHINS

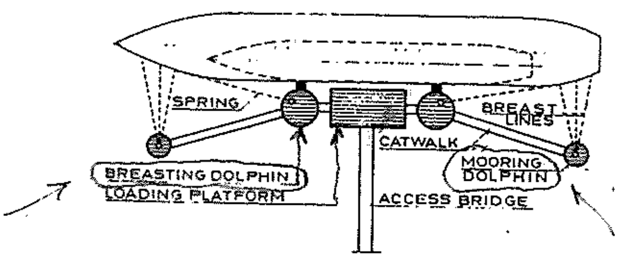

Fig. 8.6 (a) Typical Single Berth Jetty