An Example of Possible Innovations in Mediterranean Marina Design

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The functional and architectural beauty of the harbours built on the Mediterranean coast by ancient seafaring people (e.g. Fenix, Greeks and Romans) is of unestimable value in innovative planning of tourist ports. An example of this can be seen in this report on the new marina in Manfredonia on the Adriatic coast (Italy).

1. Introduction

Since ancient times, the Mediterranean sea, and in particular the southern central coast of the Italian peninsula, together with the islands of Sicily and Sardinia, has been the preferential maritime route of peoples such as the Phoenicians, the Greeks and the Romans who where expert sailors. With the passing of the centuries, the strictly commercial role of the Mediterranean gradually spread, and the area expanded in importance not only for military strategic purposes, but also for the natural beauty of its splendid coastal areas and its vast historical and cultural heritage, which encouraged the development of tourism.

The development of recreational nautical activities requires the presence of an efficient communication network, which are represented by harbour structures, and wharfs and consequently interchange points creating links with the hinterland.

In ancient times, the choice of a harbour location was conditioned almost exclusively by the possibility of using natural areas (bays, internal lakes, river estuaries, etc.) sheltered from the sea, and thus requiring minimal manmade protection works.

Under such conditions, it was more often than not possible to combine functional and environmental aspects, thus giving rise to the creation of harbours that were well balanced both in their architecture and in their technological design, as can be seen by the presence of their archaeological remains above and below the sea.

Later, with the domination of economic interests and technological progress, planners made their choices by seeking harbour locations that would operate more efficiently , and gradually transformed the coastal area into urbanized and/or industrial areas, thus requiring more extensive harbour facilities, characterized by manmade protection works that were not always well integrated into the coastal environment.

In order to avoid spoiling the environment, it is considered that the following aspects are of fundamental importance in the design of a new harbour area:

- The choice of the site and the dimensions of the new harbour must be derived from a general harbour plan, subdivided into homogeneous territorial and physiographic areas, while maintaining the pre-existing natural situation;
- In the more specific case of Mediterranean coast, since widespread recreational nautical activities today require specialized landing stages for craft whose dimensions are similar to the vessels used in ancient times, special attention should be given to the maritime and architectural aspects that characterized the harbours of the past, and which are still today admired for their great cultural content, and particularly for their harmony with the environment.

Based on the general criteria illustrated in a master plan drawn up for tourist harbours along the coast of southern Italy (SAM) and illustrating, albeit briefly, some of the most beautiful ancient ports, this report discusses the basic choices adopted by the authors in proposing a design for a new tourist harbour at Manfredonia, in the lower are Adriatic. Its dominant architectural lines recall those of Ostia Antica built by the Romans at the mouth of the Tiber in the Ist century AD.

2. General plan for tourist harbours in central southern Italy (SAM)

The Italian Merchant Navy Ministry, has approved a Program of Harbour Feasibility under the name of SAM (Harbour System for Southern Italy), mainly concentrated on the coasts of central southern Italy. The basic objectives of the program are:

- To promote tourist activities, in order to increase the tourist flows on the coast and to develop local resources;
- To promote industry, craftsmenship and fishing activities, in connection with seaside and seafaring activities;
-To develop interest in an extremely rich environmental and cultural heritage.

With reference to tourist activities, the Programme includes a study of demand and supply, together with an thorough analysis of future development, and of the feasibility of the new harbour facilities.

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The SAM study shows that as far as supply is concerned, central southern Italy has about 250 harbours and marinas, with some 25,000 moorings, of which only 70% are operational.

Harbour facilities in central southern Italy differ from one area to another by their number of moorings, their state of preservation and efficiency. In order to determine the demand, expressed in the number of moorings, the SAM study carried out surveys which took into account variations in the level of the demand, also in relationship to possible different conditions in the European macroeconomy.

The investigations shaw that for each coastal sub-system and with reference to the high season (HS) and to the low season (LS), the present demand levels are indicated to be 43,500 moorings and 15,150 moorings, respectively.

The great difference with respect to the present supply (25,000 moorings) shows that there is an urgent need to provide a suitable development programme.

The results of the SAM study show that despite the factors of uncertainty connected this with type of investigation, the considerable difference recorded between the demand and supply means that various development situations can be adopted in order to determine the number of new moorings required. For a medium-term development, the distribution of new moorings required in the different regions of southern Italy is set out in Table I.

Table I - CONNECTION BETWEEN SUPPLY AND DEMAND ACCORDING TO SAM

	Total demand		Total potential suppley			New moorings		
	Low S. A	High S. B	Total C	Exist.	Recov.	Total D = B-C	Low S.	High S.
Tuscan archipelago	390	2620	717	543	194	1903	285	1618
North Sardinia	3393	6874	3761	3429	332	3113	1525	1588
South Sardinia	2245	3500	869	635	214	2631	1683	948
Pontine System	1688	4227	2181	995	1166	2046	817	1229
Campania	5605	15056	8983	4973	4010	6073	2245	3828
South Tyrrhenian	1718	4604	2120	1167	953	2484	919	1565
North-West Sicily	1578	3360	2714	1491	1233	646	297	349
South-East Sicily	741	1895	1936	669	1267	0	0	0
Ionian Calabria	1111	2690	1466	1286	190	1224	501	723
Puglia	4007	7384	3247	2157	1090	4137	2234	1903
Abruzzi-Molise	1551	2255	845	579	266	1410	958	452
SAM Total	24027	54465	28839	17924	10915	25667	11464	14203

3. Mediterranean Harbour systems in history: the old and the new.

The major ancient civilizations bordering the coasts of the Mediterranean always used the sea routes to develop their trading activities.
Figure 1 shows that, already during the period of the Roman Empire, maritime and fluvial navigation routes were such that they served nearly all the countries bordering the Mediterranean, and others too.

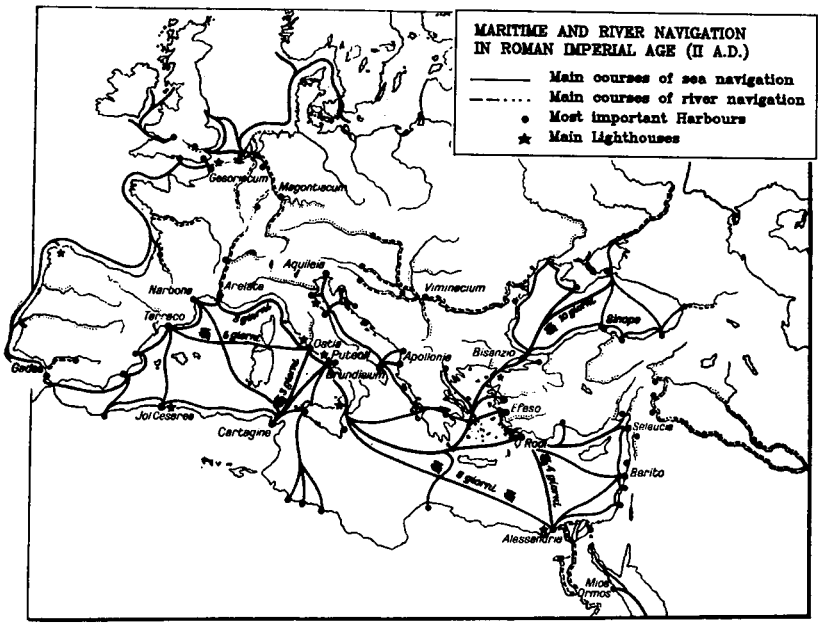


Fig.1 Maritime and river navigation during the Roman Imperial Age [2]

Naturally, traffic via the sea required the implementation of harbour facilities not only to shelter the vessels, but also to facilitate the loading and unloading of goods.

The engineering of ancient ports was always fairly simple in accordance with the technology of the time, in the sense that they were predominantly located in areas that were naturally protected from offshore waves.

The ancient Romans, who were renowned for their great building skills, discovered pozzolana (a natural sandy soil of volcanic origin, characteristic of the Campi Phlegraei area) which, when mixed with lime, produced one of the first types of hydraulic mortar, and enabled them to construct fairly large artificial maritime structures (breakwater and piers), even of great dimensions, as can be seen from the partly visible and partly submerged remains that we continue to discover even today. The Roman maritime builders not only selected sheltered site and materials resistant to sea action, but their choice was also accompanied by a great ability to identify suggested and rational configurations. That way, the new port structures blended in with the natural surroundings without a negative impact. The following paragraphs present some of the interesting results obtained in this context, limited to the description of architectural and constructional aspects.

4. Ancient Roman ports along the coasts of the Latium and Campania regions.

The principal Roman ports, the archaeological remains of which continue to reveal their ancient splendour, are to be found along the coasts of the Latium and Campania regions (Fig.2)
Figure 3 gives a general plan of the coastal area of the Campi Phlegraei, indicating the location of the port of Puteoli (now Pozzuoli), that of Portus Iulius and the port of Misenum [3].

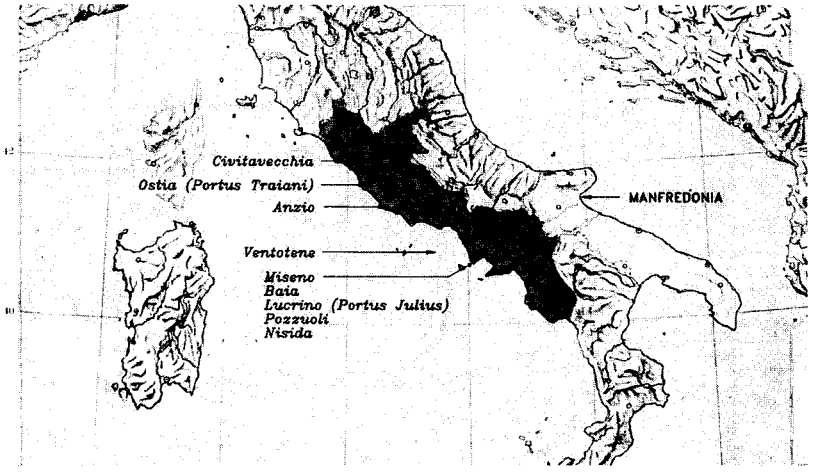


Fig.2 The ancient Roman ports on the coasts of the Latium and Campania regions

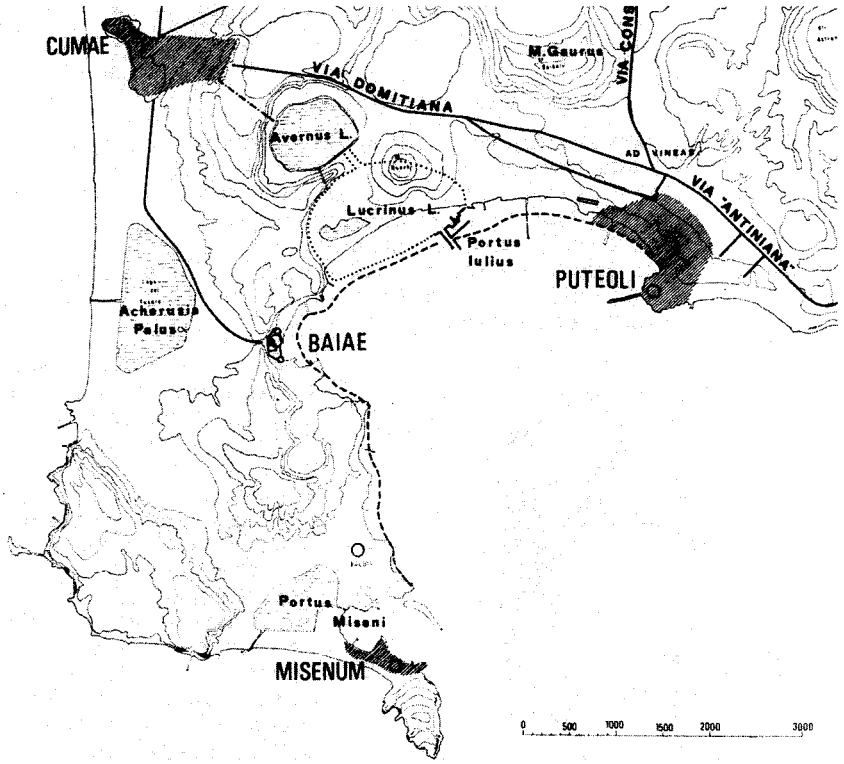


Fig.3 General plan of the coastal area of the Campi Phlegraei. The dotted line is the antique shore line.

The port of Puteoli, formed by a natural bay, already well protected from the south-easterly waves, was extended by the Emperor Caligola (37-41 AD) with the construction of a breakwater, which still exists, and which was subseguently expanded several times in later periods.

Because of the negative bradyseismic phases characterizing the area in question, a large part of the coastal strip with its ancient settlements is now submerged (Fig.3), as are both the entrance to Portus Iulius and the landing stage for the imperial villas of Baia.

Portus Iulius was built by the Emperor Augustus (27 BC - 14 AD) for military purposes. This extremely interesting engineering system made use of two natural lakes (Lucrinus and Avernus) which consequently became protected basins and, more particularly, a defence against enemy attack, with the construction of artificial canals to connect them, as seen in Fig.5. Access from the sea is through a mouth formed by two parallel piers jutting out and by a lateral breakwater made of detached piers.
The port of Misenum (Fig.4), built at the tip of Cape Misenum, also consisted of an internal basin to protect its fleet. It had with an outer harbour formed by a natural bay sheltered from the offshore winds, both laterally and frontally, thanks to the presence of a small natural island (Pennata Point) that functioned as a true offshore breakwater.

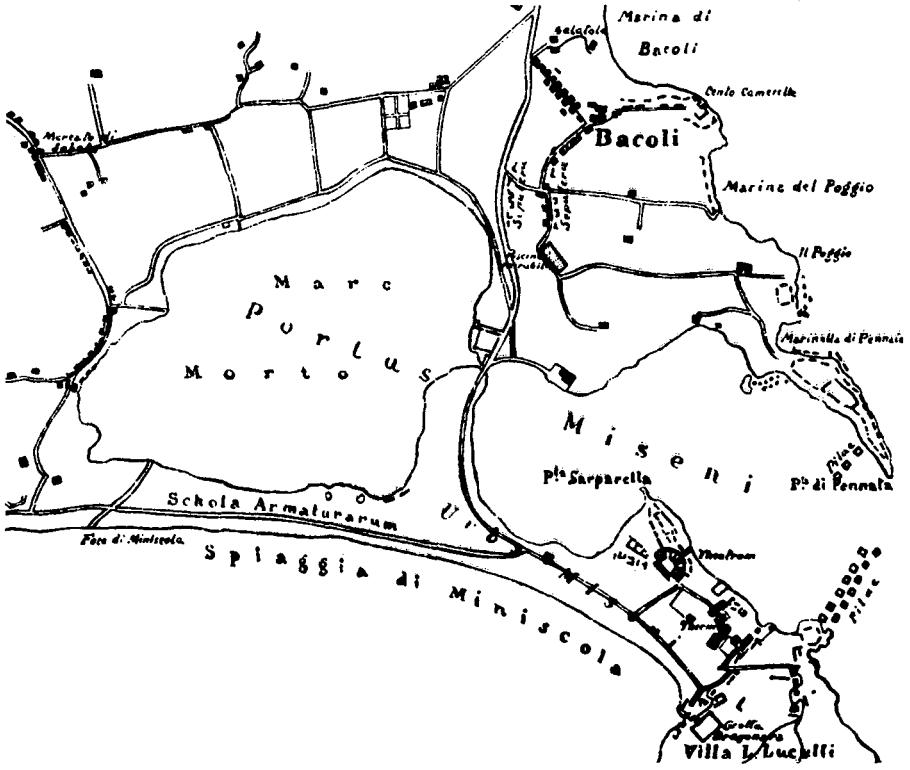


Fig.4 Portus Miseni

The ancient port of Antium (now Anzio), was built on the orders of the Emperor Nero, and is an example of how clever the Roman maritime builders were in choosing their sites. Located on the tip of the cape of Anzio, it was possible for ships to take directly to the sea and to manoeuvre with ease along the coast when leaving and entering the basin. A particularly interesting technical detail is the location of the jettiess which prevented the port from being buried under the currents of solid littoral material. Like the ports of Ostia and Civitavecchia, built later, it had two entrance basins facing one another, one to the east and the other to the west, so that in a storm the ships could shelter in the one that was protected [4].

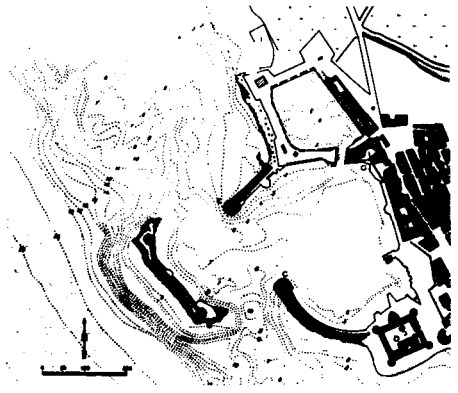


Fig.5 The ancient port of Centumcellae (Civitavecchia) [4]

The port of Civitavecchia (ancient Centumcellae) lies north of Rome (Fig.5). It was built under the Emperor Trajan, and is outlined by two jetties built as arms that from a distance appear to meet. This layout gives the structure the pleasant aspect of a maritime amphitheater. "An external island" (breakwater) which conceals the opening and creates two basins facing one another, it also protects the harbour from the dominant offshore waves caused by the south-westerly winds (Libeccio) and the south-easterly winds (Sirocco), thus producing a particularly calm inner basin.

The double port of Ostia was the first harbour to be built by the Romans, directly on the open beach. The outer harbour was built under the Emperor Claudius, close to the right side of the Tiber mouth (construction kept some 30,000 workers occupied for about eleven years). It was semi-circular in shape, jutting into the sea, with its diameter resting on the beach.

From the two extremities of the diameter two piers were built following the circumference to form part of a semi-circle, ending in two points that left a very wide opening, practical for manoeuvering in a stormy sea, but at the same time dangerous because it left the harbour basin with very little protection. To remedy this situation, classical techniques which had already been used on several occasions, were adopted to build a large artificial island (breakwater) to cover the harbour entrance, thus making the internal waters calm, and at the same time creating two basins face to face which enabled ships to enter and exit under all kinds of sea conditions.

Trajan's splendid port (Fig.6) was built inside port Claudium at Ostia, connected by a canal in a later period. On its piers, majestic warehouse buildings were arranged in the shape of a hexagon and were surrounded by internal streets onto which looked luxurious buildings, a temple dedicated possibly to the goddess of the sea and the unmistakable aqueduct, all of which was surrounded by boundary walls and sighting towers.

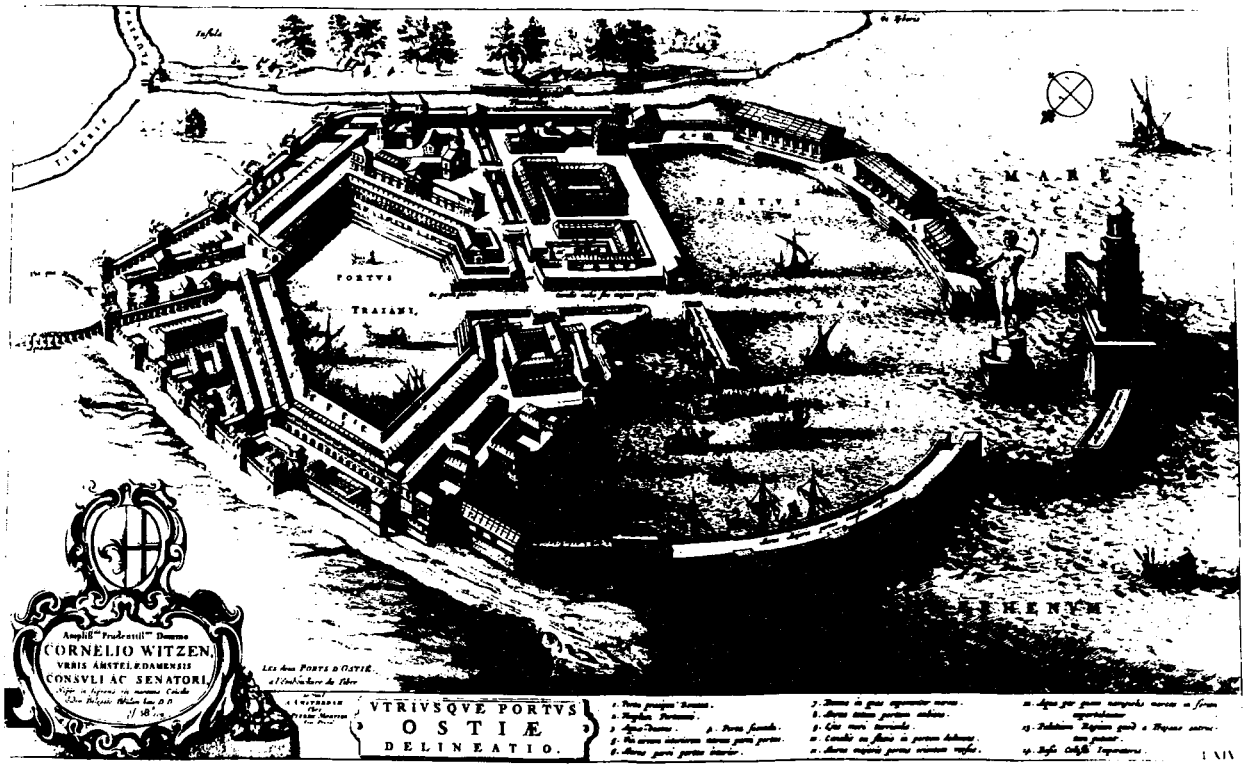
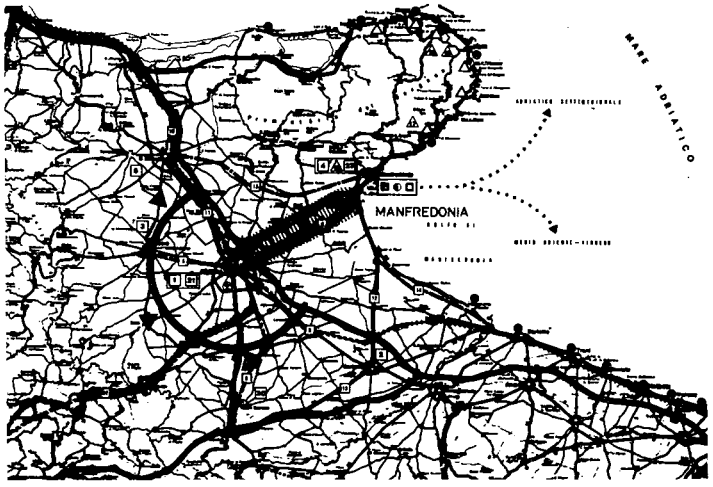


Fig.6 The ancient port at Ostia - a large artificial island to cover the harbour entrance

5. Proposed design for the marina of Manfredonia.

The plan proposed by the MUCAFER and other companies which make up the Consortiums COIMA and ICOM to build a tourist harbour at Manfredonia comes under the broader "integrated programme" of public works all along the coastal strip of southern Italy [5].



The Adriatic coastal strip where the new port of Manfredonia is located, has a small number of moorings compared to those present on the Mediterranean coast (about 10% of long piers, and only 2% of open berths). However there is a demand for some 4,100 new moorings in the Puglia region. The geographical choice of Manfredonia is justified first and foremost by its easy access to such lovely places (as Gargano, Tremiti Islands, Yugoslavia and Greece) and also because of the fact that it is possible to create an efficient network of infrastructures to connect it with the mainland (Fig.7).

Fig.7 The infrastructures to connect the port of Manfredonia with the mainland

The new port unfolds due west of another existing harbour structure (to be restored), equipped for commerce and fishing. It will therefore be possible, even by implementing a single polyfunctional maritime port (fishing, trade and tourism), to provide a rational response to various types of traffic, and in particular to tourist traffic for the whole complex.

All this was made possible by an in-depth study not only of the maritime aspects, but also of the architectural and aspects town planning features, required in order to render the entire facilities environmentally compatible with the existing landscape.

5.1 Functional characteristics of the new tourist harbour.

The new tourist harbour will be of the permanently operational type, i.e., with moorings and repair service areas intended for use all year round. It is designed to accommodate 800-900 craft but can be expanded to accommodate at total of 1,200.

The plan of the external facilities unfolds along the sides of a hexagon open to the south-east at the harbour mouth. The latter is protected by a breakwater placed perpendicularly to and connected with the existing secondary breakwater.

Inside the entrance, along its axis, a pier is built onto the mainland and ends with a hexagonal platform, on which some of the harbour's recreational and service facilities will be located. The berthing and mooring wharfs are located along the central pier.

The slipway is on the right side of the harbour entrance, in the area directly touching the secondary breakwater of the existing port. This choice was made in order to provide a separate service area which would avoid interfering with the activities of the tourist harbour, so that the services occupy less valuable service areas in the existing urban context.

The offshore breakwater, orthogonal to the secondary breakwater, is of the traditional rockfill type. It will be overflowable because a high crest would create an ugly barrier for the panorama both from the land and from the sea.

The design is integrated by a series of precautions on land aimed at improving circulation, accommodation, and services, and provides for repair yards, parking lots, offices, commercial areas, hotels and restaurants, green open spaces for sports and leisure activities, taking into account the latest demands in this type of market for increasingly more qualified services.

The walkways from the moorings are designed to channel users into an urbanized area, which opens directly on to the harbour, complete with offices, shops, bars, restaurants and hotels. From this area, which acts as a screen that delimits the more predominantly tourist area, it will be possible to reach the commercial and business area through openings and walkways, supermarkets, bank, post office, telephones, meeting places, and the sailing club.

A walkway links the business center to the nearby bus terminal. It is designed to provide an interchange terminal between urban and extra-urban transport facilities which consist of a maneuvering and parking area of approx 2,700sq.m and a bus station (700sq.m covered area), directly connected to the rest of the area by an underground walkway with shops on either side.

A multiple use sports area has been planned for the local inhabitants and visitors, with a basket ball court, bowling field, theater, skating rink and tennis court.

An area of 13,000 sq.m is earmarked for parking lots, distributed so as to serve the different areas rationally.

5.2 The architectural design: a return to the past

The configuration of the harbour repeats the hexagonal matrix typical of Trajan's ancient port of Ostia, open at its lower base where it looks out to the open sea (Figs. 8-9).

The only harbour entrance is protected, as in the Roman ports, by a second, separate breakwater, which is the secondary breakwater of the existing fishing harbour (approx. 690m long).

The hexagonal matrix is divided symmetrically into two entrance basins by a central pier connected to a hexagonal island. On both the pier and the island there are all the necessary services which, together with similar facilities on the mainland, recall the architecture of the ancient port of Ostia, where a series of buildings was erected on the perimetral structures, providing not only services such as warehouse but also buildings an imperial palace, temple, aqueduct, etc.

The offshore structures of the new harbour basin are made up of reinforced concrete caissons. The proposed solution does not consider the classical scheme of elements forming a vertical wall but, the external protective layer of caissons is triangular in shape.

There are openings between the caissons, for the water to flow through, with a device similar to that adopted in the Roman ports. The external walls are hollow and communicate with internal expansion chambers (Jarlan caissons) so as to reduce the coefficient of reflection of the structure (Fig. 10).

The crest is hydrodynamic with a double curve which, in addition to increasing the dissipation effect in the run-up phase of the incident waves, gives the structure a pleasant and original shape.

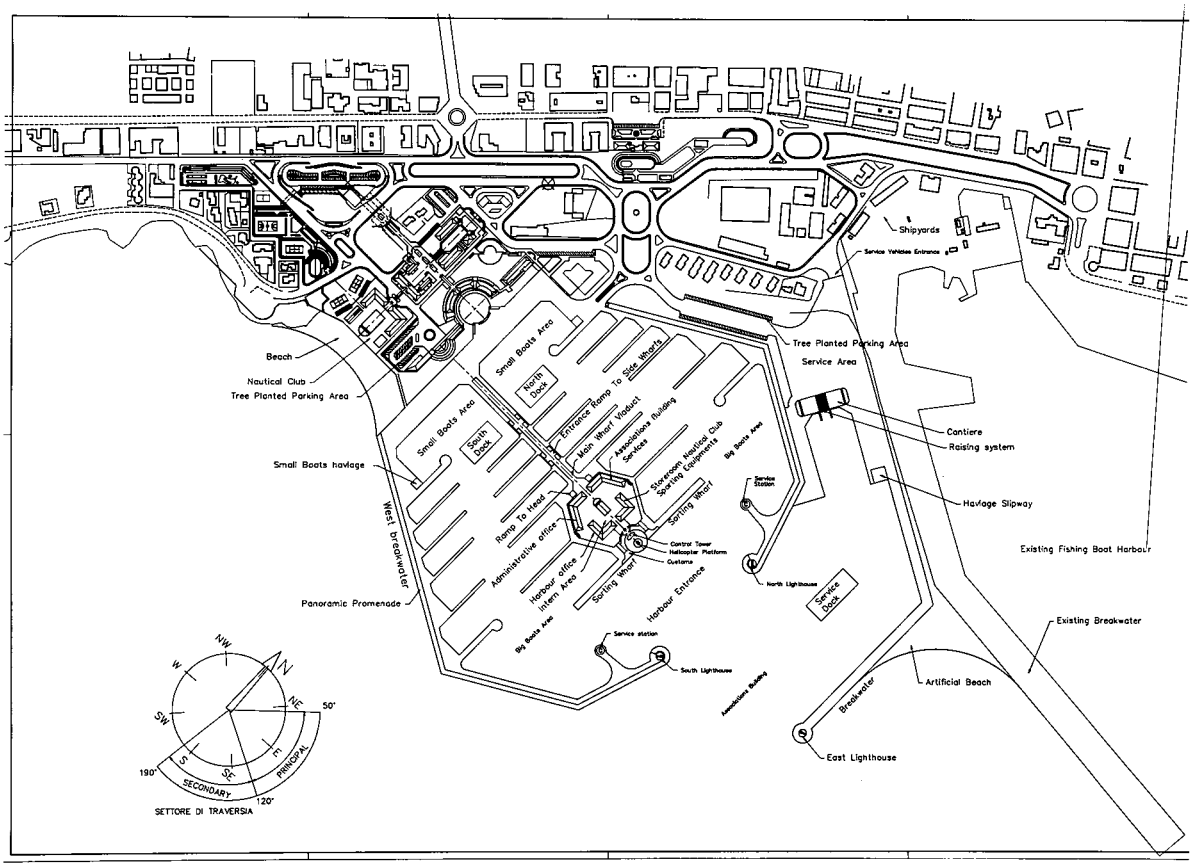


Fig.8 Functional desing

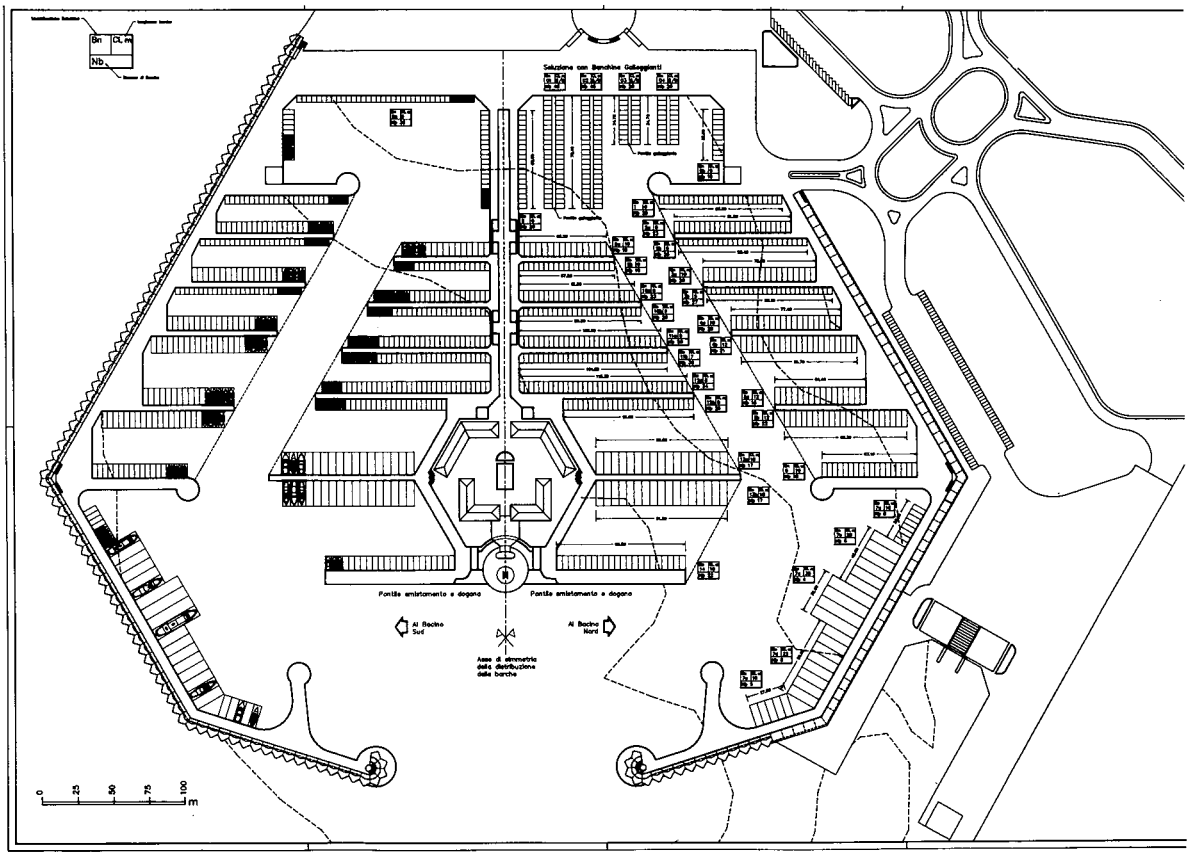


Fig.9 Master layout

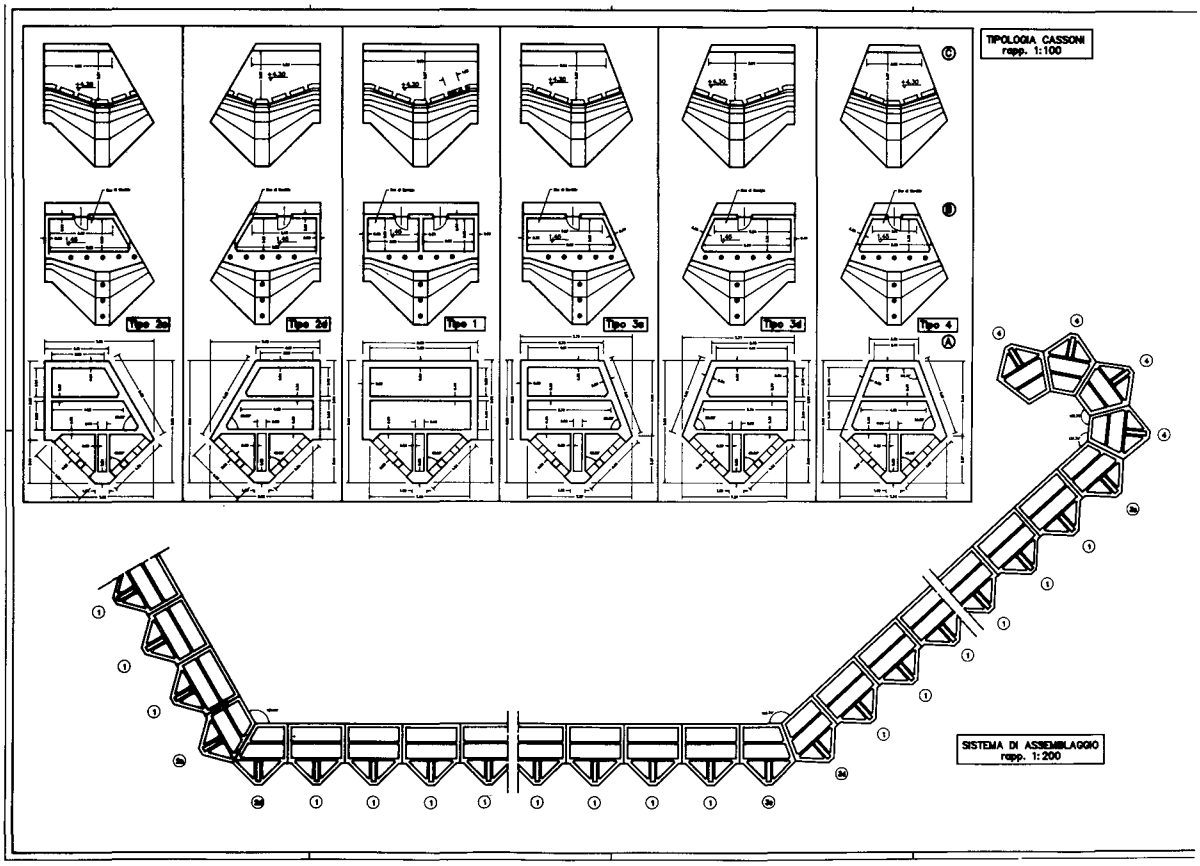


Fig.10 Same shop drawings

6. Conclusions

The architectural and cultural heritage of the ancient ports in Mediterranean sea area (the Mare Nostrum of the ancient Romans) is fundamental in the history of technology. What the Roman maritime architecture passes on to us of its seafaring traffic which, with respect to the navigational needs of the time was functional and efficient, is still applicable to the design of a modern tourist harbour for craft similar in size to those used by the ancient Romans.

This reference to the past not only affords protection from wave action, from silting up and from pollution, blending the structures of the coastal panorama with the environment throug a design that has movement and pleasing forms, but it also connects the area with major tourist and cultural attractions, thus giving rise to innovative solutions in designing a new tourist harbour in the Mediterranean.

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