

# The Ancient Harbours of the Piraeus

Volume I.1. The Zea Shipsheds and Slipways:  
Architecture and Topography

Bjørn Lovén



Monographs of the Danish Institute at Athens  
Volume 15,1

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*The Ancient Harbours of the Piraeus, Volume I.1.*

*The Zea Shipyards and Slipways: Architecture and Topography*

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## Chapter 9

# Conclusions

### 9.1. Overview

The immense historical importance of the navy of Classical Athens is evident in her struggles against Persia culminating at the Battle of Salamis, the city's central role in the First Delian League, the decades of Athens' supremacy as an imperial naval power, the victories and vicissitudes of the Peloponnesian War, and in Athens' revival and fall during the 4th century BC. With Athens' importance came that of the harbour city, the Piraeus, where large and unique structures in Zea, Mounichia and Kantharos Harbours housed hundreds of *triremes* that served as the arm of her naval might. This study, which focuses upon Zea, presents the first solid material evidence of the naval installations dating to the zenith of Athenian military, political and cultural hegemony: the 5th century BC. At the same time this study illuminates the complexity and extent of such a technological endeavour.

The principal discoveries of this study of the naval installations of Zea Harbour are the recognition of two previously unidentified building phases: the Phase 1 slipways (Pls. 3, 11–12), most likely belonging to the 5th century BC, and the 5th-century BC Phase 2 shipsheds (Pls. 13–14). In addition, the previously documented Phase 3 shipsheds (Pls. 15–16; 37) are dated and architecturally redefined: the most important architectural discoveries relating to the Phase 3 shipsheds are their identification as double-unit shipsheds and the calculation of the side-wall and colonnade inclinations.

Also among the principle discoveries is the relative sea level change since antiquity documented by the ZHP. This more precise information on the ancient sea level has led to a broader understanding of the topography of the ancient Zea and Mounichia Harbours (Figs. 3, 21). In Area 1 of Zea the ancient shoreline stretched as much as 30 to 50 m into the sea to an established *minimum* sea level change of *ca* -1.90 m and to a hypothetical *maximum* sea level change of *ca* -2.90 m measured to the 87DZ (Fig. 3; see Chapter 8.1.1, 8.2.1, 8.2.3). These extrapolations are strongly augmented by evidence found in several other areas of both Zea and Mounichia, where submerged structures have been documented at a distance of 25–54 m from the present shoreline. Moreover, structures probably related to

### a. Overall dimensions

Maximum preserved length		11.73 m	Pl. 36b; p. 158
SW3 min. reconstructed length (B)		38.20 m	Pl. 12; pp. 158–159
SW3 max. reconstructed length (B)		56.78 m	Pl. 12; pp. 158–159
Estimated total slipway width		6.60 m	Pl. 11; pp. 70–71
Ramp gradient	1:19.0/3.0° (ave.)	1:16.9/3.4°–1:20.5/2.8° (range)	Table 5.10; Pl. 12; p. 72
Open-passage gradient	1:19.4/3.0° (ave.)	1:17.0/3.4°–1:21.3/2.7° (range)	Table 5.10; p. 72

### b. Dimensions of rock-cut slots for transverse timber sleepers

Length (max. preserved)		4.34 m+	Fig. 200; pp. 59, 71
Width	0.11 m (ave.)	0.08–0.15 m (range)	Table 5.4a; pp. 56–62
Depth	0.10 m (ave.)	0.07–0.12 m (range)	Table 5.4a; pp. 56–62
Distance (side-to-side)	0.69 m (ave.)	0.57–0.85 m (range)	Table 5.4b; pp. 56–62
Distance (centre-to-centre)	0.80 m (ave.)	0.67–0.96 m (range)	Table 5.4b; pp. 56–62

Table 9.1. Dimensions of the Phase 1 slipways in Group 1 at Zea Harbour.

the back-walls of shipsheds have been found directly on the shore and in the sea (Chapter 8.1.2). This evidence strongly supports the proposal that the ancient shoreline was located between 30 and 50 m (seawards) from the present shoreline.

Except for Area 1 at Zea, the chronology of the structures that form the basis of the topographical reconstructions of the Zea (Fig. 3) and Mounichia Harbours (Fig. 21) is unknown at present, but the reconstructions probably represent a realistic picture of these harbours during their last major active period in the late 330s–320s BC.

## 9.2. Chronology and Phase Evolution

The conclusions presented in this chapter on the chronological framework of the Phase 1 unroofed slipways, the Phases 2 and 3 shipsheds, and the possible shipsheds of Phase 4 in Area 1 at Zea are based on (a) an analysis of sequences of rock-cut and built construction features (relative chronology), (b) the closed deposit found in U:2 in the ramp area of Phase 3 Shipshed 17(η) (relative chronology), and (c) ancient historical sources (absolute chronology). It should be kept in mind that while the sequence of

building phases is quite clear, their chronological anchoring is tied only to ancient historical sources (discussed in Chapter 2) and the closed deposit in U:2 (see Vol. I.2, p. 39). Thus, the chronology must remain provisional until more data are brought to light in future investigations. This chapter also presents the architectural data of Phases 1–4 including reference to the detailed analyses of the individual architectural elements in Chapters 5–7 (see Tables 9.1–9.4).

### 9.2.1. The Phase 1 Slipways

The first phase of construction in Area 1 of Zea Harbour consisted only of unroofed slipways, which were designed to facilitate hauling, slipping and maintenance operations. The ability to store warships on the shore also increased the amount of manoeuvring room within the harbour basin.

The Phase 1 slipways were inclined rock-cut structures (1:19/3.0°) with a reconstructed *maximum* length of 56.78 m, of which 11.73 m have been documented. They measure *ca* 6.60 m wide at their assumed upper middle parts (Pls. 3, 11–12, 36b). Table 9.1 lists the dimensions of the Phase 1 slipways.

Slipways 2 and 5 are particularly important because they do not relate to a Phase 2 superstructure, nor to

any colonnade elements of Phase 3 (Pls. 3, 40). Thus they represent two essential pieces of evidence for identifying the building phases in Area 1. The southern portion of the ramp of Slipway 5 was first destroyed during the construction of Phase 2 colonnade feature C13/14:2, and subsequently by the construction of Phase 3 colonnade feature C22/23:5 (Fig. 170). The difference in plan orientation between the ramp structure of Slipway 2 and the adjacent colonnades of Phases 2 and 3 is  $3.8^\circ$ , an angle that would have cut the southern side of the later superstructures *ca* 18 m to the west, that is, still on the ancient shoreline based on the established *minimum* sea level change of *ca* -1.90 m (Pl. 11). In addition, there is solid evidence that the Phase 1 ramps were deliberately levelled in most of the later ramp and colonnade areas. For example, the construction of the rock-cut ramp foundations for Shipsheds 9 and 10 of Phase 2 removed substantial portions of the ramp areas of Slipways 2 and 3 (Pls. 3, 40; Figs. 111, 224b, 226b). The area where they are levelled and where the tops of the inclining ramp features were shaved off match exactly in Slipways 2 and 3 (Pl. 3). These correlations strongly indicate that these Phase 2 ramps were carved as part of the same overall plan. Furthermore, the rock-cut Phase 3 colonnade foundation trench C17/18:14 was most likely constructed to even out Slipway 2 (Pls. 11–12).

Based on this evidence, it is concluded that the unroofed slipway construction phase is definitely earlier than Phases 2 and 3 and bears no structural relationship to either.

Phase 1 is tentatively dated between the late 480s and the early 470s BC based on the hypothesis that Athens required naval installations to accommodate and maintain her quickly-growing fleet in this period. The slipways may have been initiated at some point between the vote to build the fleet in 483/2 BC (after the Laurion silver strike) and 480 BC (Battle of Salamis). Alternatively, construction may have begun shortly after the victory in the Battle of Salamis, or after the creation of the Delian League in 478 BC (pp. 10–11). Perhaps slipways were already constructed in the Piraeus between 493/2 and 483/2 BC. The beginning of the Themistoclean fortification building program in 493/2 BC (p. 10) represents a *terminus post quem* for the first major construction works in the Piraeus, but it

is more likely that the construction of the Phase 1 slipways was associated with the formation of the Athenian fleet in the late 480s/early 470s BC. It is also possible, based on the present data, that the Phase 1 slipways may date earlier or even later than these events. Future excavations and research in Zea Harbour may shed more light on these difficult chronological issues.

At present, Phase 1 in Area 1 at Zea Harbour represents the earliest identifiable slipway structures in the Graeco-Roman world, and these slipways are the earliest material evidence of inclined structures using transverse timber sleepers with open-passages.

Whatever their precise date of construction, the unroofed slipways proved uneconomical and impractical because they failed to protect warships from fungal rot (due to exposure to rain) and sun-related damage, which drastically shortened their lifespan.

### 9.2.2. The Phase 2 Shipsheds

Phase 2, which consisted of monumental shipsheds, was initiated after Phase 1. These structures were built in order to offer better protection to the fleet, and the design and size of the buildings forcefully communicated Athens' naval supremacy.

The Phase 2 shipsheds consisted of parallel colonnades with an interaxial spacing of 3.97 m, an average interaxial width between the colonnades of 6.48 m and a central ramp structure *ca* 1.52 m wide (Pls. 13–14, 29–31). No clear evidence of a back-wall has been found.

These shipsheds were clearly constructed on an inclination (Pl. 27), but neither the original gradient of the Phase 2 superstructure nor that of the ramp structure can be calculated due to insufficient evidence (see pp. 117–119, 137–139). Therefore, the *minimum* and *maximum* lengths of the Phase 2 colonnades can only be cautiously estimated at approximately 54 and 70 m, respectively, of which 36.91 m (*MoP*: 0.05 m) have been documented (see Chapter 8.2.2). Table 9.2 lists the dimensions of the Phase 2 shipsheds.

The best evidence for the chronological sequence of Phases 2 and 3 is found in the foundation for column position 7 in the colonnade dividing Phase 3 Shipsheds C20( $\pi$ )/21( $\Delta$ ) (Pl. 26). If the foundations of column position 7 were built *ex novo*, just one foundation block would have been employed rather than two, as is the



<b>a. Overall dimensions: colonnades</b>		
Maximum preserved length	36.91 m	Pl. 13; p. 128
Minimum estimated length	approximately 54 m	Pls. 14, 43; p. 159
Maximum estimated length	approximately 70 m	Pls. 14, 43; p. 159
Inclination of colonnades	<i>unknown</i>	pp. 117–119
Interaxial spacing	3.97 m	Table 6.23; Pls. 13–14, 27–28; pp. 114–116
Reconstructed intercolumniation	<i>ca</i> 3.30 m	Pl. 14; pp. 116–117
Interaxial spacing of adjacent colonnades	6.48 m	Pls. 13–14, 29; p. 116
Reconstructed intercolumniation of adjacent colonnades	<i>ca</i> 5.81 m	Pls. 14, 29; pp. 116–117
<b>b. Average dimensions of colonnade feature</b>		
Rock-cut colonnade foundations	1.35 x 1.10 m (ave.)	Fig. 194; Pl. 13; pp. 112–113
Colonnade foundation blocks	1.17 x 0.87 x 0.54 m (ave.)	Table 6.22; Fig. 194; Pls. 13–14; pp. 113–114
<b>c. Overall dimensions: ramp and side-passages</b>		
Maximum preserved length of ramp	33.21 m	Pl. 13; pp. 137–138
Width of ramp structure	<i>ca</i> 1.52 m	Fig. 187; Pls. 14, 29; pp. 137–138
Gradient of ramp	<i>unknown</i>	pp. 137–139
Estimated width of side-passage	<i>ca</i> 2.05 m	Pls. 14, 29; pp. 140–141
Gradient of side-passages	<i>unknown</i>	

Table 9.2. Dimensions of the Phase 2 shipsheds in Group 1 at Zea Harbour.

case with Phase 3 feature C20/21:5–6 supporting column position 2 in the same colonnade. This demonstrates that the Phase 2 colonnade feature C11/12:6 was *in situ* prior to the construction of the Phase 3 foundations for column position 7. The construction of the foundations (C18/19:4) for the colonnade dividing Phase 3 Shipsheds 18(χ)/19(φ) levelled the Phase 2 colonnade foundation trench and foundation block C10/11:2–3 (Fig. 192c). Several other foundations of the Phase 2 colonnades were re-used, extended or destroyed during the construction of the Phase 3 colonnades (pp. 74, 100–101). Furthermore, the rock-cut ramp foundations (S17:R7) of Phase 3 Shipshed 17(η) removed the southern side of the Phase 2 ramp foundations of Shipshed 8 (S8:R1; Fig. 167). It is highly improbable that the several column drums found *in situ* in the Phase

3 shipsheds (pp. 88–89) would have been left standing from an earlier phase of shipshed construction. The combined evidence demonstrates conclusively that the Phase 2 shipsheds are earlier than those of Phase 3.

Several re-used column drums were found in the ramp structures of the Phase 3 shipsheds (see p. 90). It is likely that they relate to the demolition (most probably of the Phase 2 shipsheds) mandated by the Thirty Tyrants in 404/3 BC (see p. 12). This evidence provides a probable *terminus ante quem* for the Phase 2 shipsheds. Alternately, the Phase 2 shipsheds could have been demolished in the 4th century BC, prior – *terminus ante quem* 375–350 BC – to the construction of the Phase 3 shipsheds. If this is the case, the active period of the Phase 2 shipsheds could extend into the 4th century BC. The Phase 2 shipsheds were in all probability

**a. Overall dimensions: superstructure**

SIT-1 inclination of superstructure	1:12.3 (4.65°)	1:12.8 (4.5°) to 1:11.9 (4.8°)	Pls. 37, 43; pp. 104–108
<i>Colonnades</i>			
Max. preserved length (outside of back-wall)	59.20 m		Pls. 15–16; p. 127
Min. reconstructed length (-1.90 m)	78.27 m		Pl. 43; pp. 159–162
Maximum reconstructed length (IV)	88.98 m		Pls. 37, 43; pp. 159–162
Interaxial spacing	2.16/3.38–3.39 m		Pls. 15–16, 20, 24–26, 37; pp. 101–102
Intercolumniation	1.52/2.74–2.75 m		Pls. 15–16, 20, 37; p. 103
Interaxial spacing of adjacent colonnades	6.51 m	6.47–6.54 m (range)	Table 6.19; Pls. 15–17, 33, 37; pp. 102–103
Intercolumniation of adjacent colonnades	5.87 m	5.83–5.90 m (range)	Pls. 15–17, 33, 37; p. 103
Reconstructed column shaft height (IA: 2.16 m)	5.37 m	5.16–5.57 m (range)	Pls. 33, 37; pp. 162–165
Reconstructed column shaft height (IA: 3.38–3.39 m)	6.71 m	6.45–6.96 m (range)	Pls. 33, 37; pp. 162–165
Dörpfeld's reconstructed column shaft height (IA: 2.16 m)	5.15 m		Pls. 20b, 20c; pp. 162–165
Dörpfeld's reconstructed column shaft height (IA: 3.38–3.39 m)	7.00 m		Pls. 20a, 20c; pp. 162–165
<i>Side-wall W16/26(λ)</i>			
Max. preserved length (outside of back-wall)	49.66 m		Pls. 16, 34a, p. 86
Width (second course)	0.62 m (ave.)	0.61–0.64 m (range)	Table 6.6; Pl. 6
<i>Back-wall</i>			
Maximum preserved length	about 44 m		Pls. 6, 8, 15–16; p. 80
Width (first course, Type 1)	0.63 m (ave.)	0.62–0.65 m (range)	Table 6.4; Pl. 6; p. 82
<i>Spur-walls</i>			
Average length	2.03 m (ave.)	1.98–2.13 m (range)	Pls. 6, 8, 15–17; p. 84
Width, C17/18(γ) first course	0.65 m (ave.)		Table 6.5; Pl. 6

Table 9.3a. Dimensions of the Phase 3 shipsheds in Group 1 at Zea Harbour (continued on p. 172).

built in the 5th century BC. Based on historical evidence it is likely that these shipsheds were built sometime during the 470s–430s BC (see pp. 11–12).

The estimated *maximum* length of about 70 m is problematic, as it seems too long to be a single-unit shipshed and too short to be a double-unit shipshed. If the Athenians were able to house their 350–400 *triremes*<sup>1</sup> in the shipsheds in the Piraeus at the beginning of the Peloponnesian War (431 BC), then some ship-

sheds at Zea and Mounichia must have been of the double-unit shipshed type. Otherwise it would have been impossible to fit this number of warships into the Piraean harbours. Based on the available evidence, it is therefore unknown as to whether or not the Phase 2 structures were single- or double-unit shipsheds.

1. Gabrielsen (2008: 47–73) favours the higher end of this range.

### b. Average dimensions of colonnade features

Column bases	0.81 x 0.81 x 0.49 m	Table 6.15; Figs. 73, 82–83; Pls. 15–17; pp. 97–98
Lowest column drum	H: <i>ca</i> 1.28 m; BD: <i>ca</i> 0.64 m; TD: <i>ca</i> 0.60 m	pp. 95–97

### c. Overall dimensions: ramp and side-passages

Maximum preserved length of ramp	52.22 m		Pl. 16; p. 132
Width of ramp structure	3.12 m (ave.)	3.03–3.24 m (range)	Table 7.2; Figs. 93–94; Pls. 6, 15–17, 32; pp. 130–132
Estimated gradient of ramp	about 1:12.3 (4.65°)		p. 134
Width of side-passage to side of the column base	1.31 m (ave.)	1.25–1.39 m (range)	Table 7.7; Fig. 73; Pls. 6, 15; pp. 139–140
Width of side-passage to side of column shaft	1.40 m (ave.)	1.34–1.48 m (range)	Table 7.7; Pls. 6, 15; pp. 139–140
Gradient of side-passages	<i>unknown</i>		

Table 9.3b. Dimensions of the Phase 3 shipsheds in Group 1 at Zea Harbour (continued from p. 171).

#### 9.2.3. The Phase 3 Shipsheds

The Phase 3 double-unit shipsheds were designed to house a fleet greater than the shoreline at the time allowed or was available in the naval zones in Zea and Mounichia, and perhaps also in Kantharos.

The Phase 3 colonnades were constructed on exactly the same orientation and position as the Phase 2 colonnades, but employed a different architectural layout. The colonnades had alternating interaxial spacing. The widely-spaced colonnades (IA 3.38–3.39 m) carried the ridge of the roof, and the narrowly-spaced colonnades (IA 2.16 m) supported the eaves and the gutters (Pls. 15–16, 33, 37). The average interaxial spacing between the colonnades was 6.51 m, the central ramp structure width averaged 3.12 m, and the side-passage width averaged 1.31 m. The side-wall W16/26(Λ) defined the northern limit of the Phase 3 shipsheds; the southern delimitation is unknown. Toward the east, the back-wall separated the naval base from the civic sector of the city (Pls. 15–16). The colonnades, and in all probability the keel-supporting ramp section and the side-passages, were constructed

on an inclination close to the SIT-1 mid-range of 1:12.3 (4.65°). The total length of the Phase 3 shipsheds at column-base level is reconstructed hypothetically at 88.98 m, of which 59.20 m (*MOP*: 0.01 m) have been preserved. In this reconstruction, the narrowly-spaced (IA 2.16 m) colonnades have 40 columns, the widely-spaced (IA 3.38–3.39 m) colonnades have 29 columns (Pl. 37). It must be stressed that 78.27 m of the 88.98 m length can be reconstructed with a high degree of certainty based on the established *minimum* sea level change of *ca* -1.90 m that has occurred since the Classical period.<sup>2</sup> Several architectural features constructed on land in the Classical period have been found around this depth (-1.90 m; see pp. 147–148). Most important are the possible shipshed colonnade foundation blocks found in Group 1 (top surface: -1.60 m; standing on a fill at: -1.93 m) and Group 7 (top surface: -1.75 m) at Mounichia Harbour. They extend seawards

2. The 0.63 m average width of the first course in the back-wall (Type 2 blocks; Table 6.4), plus half a column base (0.41 m), plus the 77.23 m-long colonnade based on the SIT-1 inclination extrapolated to -1.90 m equals 78.27 m (see pp. 159–162).

## Overall dimensions

### Colonnades

Maximum preserved length	11.24 m	Pl. 17; p. 109
Estimated gradient of superstructure	1:12.3 (4.65°)	p. 128
Interaxial spacing	3.43 m	Fig. 231; Pls. 15, 17; p. 109
Interaxial spacing between C26/27(?) and W16/26(λ)	6.41 m	Fig. 231; Pl. 15; p. 109

Table 9.4. Dimensions of the possible Phase 4 shipsheds in Group 1 at Zea Harbour.

32.5 and 40 m, respectively, from the 2003 shoreline. The extrapolations are also reinforced by the evidence of possible shipshed structures documented for a length of about 65 to 70 m in Group 2, and roughly 79 to 88 m in Group 5 at Zea Harbour (see pp. 152–153). Table 9.3a-b lists the dimensions of the Phase 3 shipsheds.

The deposit in U:2 provides a *terminus post quem* of 375–350 BC for Shipshed 17(η), with the reservation that the pit could, although it is very unlikely, represent a ramp repair in an earlier shipshed (see also Vol. I.2, p. 39). The historical sources demonstrate a marked increase in the size of the fleet between 378/7 and 353/2 BC, and there are strong indications of major shipshed construction in the period from the late 350s to the early 330s BC (pp. 12–14). Structures of Phase 3 were in all probability standing in some form in 330/29 BC when one of the Naval Inventories, IG *IP*<sup>2</sup> 1627, 398–405, listed 196 shipsheds at Zea; otherwise it would have been extremely difficult to fit 196 shipsheds along the reconstructed, Classical-period shoreline. The upper end of the chronological range of Phase 3 is most probably defined by the *terminus post quem* of U:2 (375–350 BC).

The Phase 3 shipsheds have nearly the same average interaxial width (6.51 m) as the Phase 2 shipsheds (6.48 m), the latter built at a time when the *trireme* was the largest warship of the Athenian fleet. Although the Phase 2 shipsheds were in all probability built in the 5th century BC, the latest possible date for their use is 375–350 BC (*terminus ante quem*). Since Phase 2 predates the first evidence of warships classified as *fours* and *fives* in the Athenian Navy (listed in the Naval Inventories of 330–324 BC), it is concluded that Phase

2 shipsheds were built for *triremes*, and that those of Phase 3 were most probably also built for *triremes*. The Phase 2 and 3 shipsheds in Area 1 represent the only shipsheds that can be related directly to a fleet of *triremes*.

### 9.2.4. The Possible Phase 4 Shipsheds

The two possible Phase 4 shipsheds probably post-date the construction of the Phase 3 shipsheds (see pp. 86, 127). The three preserved column positions in the colonnade dividing Shipsheds 26/27(?) have an interaxial spacing of 3.43 m (Pl. 15). The interaxial spacing between the preserved colonnade (C26/27(?)) and the side-wall W16/26(λ) is 6.41 m (*MoP*: 0.05 m). Since the Phase 4 shipsheds share the side-wall W16/26(?) with the Phase 3 shipsheds, their inclination was probably close to the SIT-1 mid-range of the Phase 3 shipsheds: 1:12.3 (4.65°). Based on their close association with the Phase 3 shipsheds they are classified as possible double-unit shipsheds. Table 9.4 lists the dimensions of the possible Phase 4 shipsheds.

## 9.3. Closing Remarks

The naval installations that were built in Zea Harbour in the second quarter of the 4th century BC, and probably also parts of the 5th century BC, are amongst the largest building complexes of antiquity. In the late 330s BC the shipsheds at Zea extended over an area of more than 55,000 m<sup>2</sup>; including the shipsheds in the Kantharos and Mounichia Harbours, the total area covered by the shipshed complexes in the Piraeus

was close to 110,000 m<sup>2</sup>. Hundreds of colonnades and side-walls carried the massive tiled roofs of these shipsheds, which clearly conveyed the Athenians' de-

termination to 'monumentalise' and glorify the naval bases that protected their fleet of swift *triremes* at the height of the city-state's power.