Chapter 6 Shipshed Superstructures in Phases 2, 3 and 4

6.1. Introduction

At some point in the 5th century BC Athens responded to the need to protect more effectively its navy in the Piraeus by replacing the unroofed slipways with more sophisticated roofed buildings constructed of stone, wood and tile – shipsheds. The distinctively long, sloping and parallel colonnades and walls of these shipsheds not only carried the roof, but also created well-ventilated spaces that helped prolong the lifespan of the Athenian fleet's valuable warships.[1]

The arrangement of the back-walls and to some extent side-walls of the shipsheds had the secondary function of separating the naval zones of the Piraean harbours from the public sections of the city, and of protecting the warships and shipsheds from fires that could spread into the naval zone from the city and vice-versa.

In this chapter, analyses of the three superstructure building phases identified in Area 1 of Zea Harbour will be presented individually, beginning with Phase 3. The superstructure of Phase 3 offers the best frame of reference for understanding the earlier Phase 2 shipsheds and the later possible shipsheds of Phase 4. Shipsheds with comparable superstructures found in other areas of the Piraeus and at sites around the Mediterranean are analysed and included in the study. The tile material and roof reconstructions of the Phase 2 and 3 shipsheds are presented separately in Vol. I.2, Chapter 2.

Relative Chronology

In the construction phases that follow the first unroofed slipways (Phase 1; see Chapter 5), it is the superstructure of these shipsheds – the load-bearing elements including rock-cut foundations, foundation blocks, column bases, column drums and walls (and not the ramps and side-passages, as one would expect) – that retain the best preserved remains and represent the most important evidence of the building phase se-

1. As Vitruvius (*De arch.* 5.12.7) explicitly describes when he recommends building shipsheds in such a way as to avoid "rot, the wood worm, shipworms, and all sorts of other destructive creatures…And these buildings must by no means be constructed of wood on account of fire".

quence. Therefore the superstructures are presented first and the ramp and side-passage building phases related to these colonnades are discussed in the next chapter.

The ZHP investigations have identified two distinct shipshed building phases – Phases 2 and 3 – and a possible Phase 4 in the load-bearing elements of the Area 1 shipsheds.

Shipsheds of Phase 2. The precise arrangement of the upper ends of the Phase 2 structures must remain conjectural to a certain extent, although eight colonnades have been identified, as have four ramps in the submerged part of Area 1 (Pls. 13–14, 40–42). There is also a Phase 2 ramp feature on Dörpfeld's plan (S12:R1; Pl. 13).

Shipsheds of Phase 3 (*terminus post quem* 375–350 BC; see Vol. I.2, p. 39). These are by far the best preserved remains, with a well-defined layout in an area measuring 60 x 60 m, or 3,600 m^2, of which *ca* 1,165 m^2 were excavated and surveyed in 1885–1886 (Dragátsis & Dörpfeld) and 2002–2006 (ZHP) (Pls. 2, 15–16, 40–42). From this third phase there is evidence of ten shipsheds, together with a back-wall that reaches a height of two courses.[2] Nine colonnades and a side-wall clearly delineate the individual shipsheds. In this study, the Greek letters labelling each Phase 3 ramp on Dörpfeld's plan, and thus the individual shipsheds, are listed in parentheses to allow for easy cross-referencing with the ZHP Phase 3 designations (e.g. Shipsheds 17(η) and 21(Δ) in Pls. 15–17).[3]

Direct Evidence:
The following four examples clearly demonstrate that the Phase 3 colonnades are later than the Phase 2 colonnades, and this evidence will be supported by other examples presented later in this chapter:

1) If the foundations of column position 7 in the Phase 3 colonnade dividing Shipsheds 20(π)/21(Δ) (C20/21:14–16, including the re-use of Phase 2 block C11/12:6 and its foundations C11/12:5) were built *ex novo*, just one foundation block, rather than two placed side-to-side, would have been employed, as is the case with foundations supporting column position 2 (C20/21:5–6) in the same colonnade (Pl. 26). The western-most block (C11/12:6) was initially constructed as a part of the Phase 2 colonnade, and it was clearly *in situ* prior to the construction of the Phase 3 foundations for column position 7 (Pls. 26–27).

2) In the Phase 2 colonnade dividing Shipsheds 9/10, the colonnade block C9/10:2 had been shaved down by the construction of the foundations of the Phase 3 colonnade (C18/19: 4A–4C; Fig. 192c). The construction of C17/18:13 (Phase 3) probably cut the top surface off the Phase 2 block C8/9:3 (Pl. 23a), and several rock-cut Phase 2 colonnade foundations were re-used, extended or obliterated during the construction of the Phase 3 colonnades (a number of examples are listed on pp. 100–101).

3) Dörpfeld found several column drums *in situ* (Phase 3; pp. 88–89). C18/19:1(τ) and 3(υ) are still *in situ* today (Pl. 15; pp. 95–96), and it is most unlikely that drums from an earlier shipshed building phase would have been left standing during a later phase.

Possible Shipsheds of Phase 4. In the northern part of Area 1 Dragátsis and Dörpfeld excavated a section of a back-wall, a spur-wall and three column bases (or column base foundation blocks) dividing two possible shipsheds (Pl. 17). In 1890 Wachsmuth recognised that these structures are architecturally different from the ten shipsheds south of the solid side-wall (W16/26(λ)); he posits that they belong to another type (*Klasse*) of shipshed.[4] The ZHP has excavated a number of features in the sea that are probably related to Phase 4 (Pls. 10, 15). It will be argued below that these possible shipsheds most likely post-date those of Phase 3.

Evidence
The present analysis of the architecture and building phases of the superstructures of the Area 1 shipsheds is based on the following evidence:

2. Shipsheds 16, 17(η), 18(χ), 19(φ), 20(π), 21(Δ), 22(N), 23(Π), 24(Φ) and 25.
3. Shipshed 16 is unnamed on Dörpfeld's plan (Pls. 15, 17).
4. Wachsmuth 1890: 71–72.

1) Photograph PIR 6 of the upper ends of Shipsheds 20(π), 21(Δ), 22(N) and 23(Π), presumably taken or commissioned by Dörpfeld in March of 1891 (Fig. 55; Pl. 32).

2) Dörpfeld's 1:200 scale plan of the excavated area, including (a) reconstructions of colonnades, side-walls and ramps (Pl. 17), (b) two longitudinal 1:200 scale sections of the colonnades dividing Shipsheds 20(π)/21(Δ) and Shipsheds 17(η)/18(χ), with reconstructions of the superstructure (Pls. 20a–20b), and (c) the reconstructed cross-section of three shipsheds (Pl. 20c). Based on Dörpfeld's plan, an estimated 815 m^2 were excavated in 1885.

3) The ZHP re-excavation and survey of the shipsheds preserved in the basement of Sirangiou 1, and excavations and survey of the submerged parts of the Area 1 shipsheds from 2002 to 2006 (Pl. 1). In this area, the ZHP has surface cleaned, excavated and re-excavated a total of 173 m^2 on land (Pl. 6) and about 350 m^2 in the sea (Pl. 40).

Building Phase 2 and Phase 3 have been identified primarily on the basis of evidence obtained from underwater excavations in the area between the modern quay and the interior of the T-jetty (Pl. 40). This evidence will be presented here in the discussion of the Phases 2 and 3 superstructures (see below), and the phase sequence of the ramps and side-passages is presented in Chapter 7. However, as will be seen in the discussion of the Phase 2 shipsheds, there is also clear evidence of this building phase in Dörpfeld's plan and sections (Pl. 13). The identification of Phase 4 is based on Dörpfeld's plan and the ZHP investigations in the basement of Sirangiou 1 (Pls. 15, 41).

6.2. Wilhelm Dörpfeld's Legacy

The most recent investigations of the shipsheds at Zea were directly inspired by Dragátsis' and Dörpfeld's 1885 report on their excavations in the part of the harbour that the ZHP has designated as Area 1 (Fig. 2), the northern part of Group 1 (Fig. 3).[5] During Dragátsis' and Dörpfeld's documentation of these remains, the first thorough scholarly investigation of shipsheds ever undertaken, they made two important contributions to shipshed research, and classical archaeology in general, which are worthy of elaboration: (1) they produced architectural drawings (Pls. 17, 20) of such high accuracy and level of detail that they can be merged into the ZHP digital survey plans without any significant degradation in precision (Pls. 2, 15–16, 23a, 25a; see pp. 77–79); (2) the exceptional photographic print (PIR 6) in all probability commissioned by Dörpfeld has assisted in identifying the same shipsheds, thus permitting a comparison of the state of the ruins in 1891 and today (Fig. 55; Pl. 32). Dragátsis' and Dörpfeld's 1885 excavations also inspired the present author to re-excavate and expand the investigations in order to attain a better understanding of the Zea shipsheds and the topography of the harbour.

Photograph PIR 6

It was probably Dörpfeld who, in March of 1891, produced a glass-plate negative photograph of the shipshed remains excavated by himself and Dragátsis in 1885 (Fig. 55; Pl. 32).[6] The photograph conveniently includes the so-called Pasha's House in the background. This residence was built in 1890, just a year before the photograph was taken, and still stands at Sirangiou 2 (Figs. 2, 55–56). Combined with Dörpfeld's excavation plan, the Marina Zeas map (2003) showing the lot of Sirangiou 2, the ZHP survey of the outside face of the wall surrounding Sirangiou 2 and the basement of Sirangiou 1 (Pl. 2), it is possible to identify the structures in the photograph as the upper ends of Shipsheds 20(π), 21(Δ), 22(N) and 23(Π). Apart from a small section of the back-wall barely visible under the residence's veranda today, the upper ends of these shipsheds have been completely covered by a garden and other modern structures. The very high resolution of the glass-plate negative of PIR 6, however, allows for a detailed examination of the upper ends of the shipsheds. The photograph also contains vital architectural details on the back-wall, ramps, side-passages and colonnades belonging to Phase 3 (pp. 81–84, 130–131).

5. Lovén 2008: 121–131, figs. 1–7.

6. Deutsches Archäologisches Institut Athen, negative no. PIR 6.

Analysis of Dörpfeld's Plan and Sections

The 1885 report is important not so much for its analysis as for the richly-detailed plan (Pl. 17) and the two sections Dörpfeld contributed (Pls. 20a–20b). In the upper part of the shipsheds, Dörpfeld found that the colonnades had alternating interaxial spacing. He thus reconstructed the more widely-spaced colonnades as those carrying the ridge of the saddle roof and the more narrowly-spaced colonnades as those supporting the eaves of the roof and the gutter (Pls. 17, 20). The structures in the sections are the colonnades dividing Shipsheds 20(π)/21(Δ) and 17(η)/18(χ), both of which have been identified in this study as belonging to Phase 3.

So far no evidence has been found to dispute the reconstruction of a continuous, inclining roof-line (Pl. 20); on the contrary, it will be discussed in detail later how the evidence from the ZHP investigations solidifies the basic design of Dörpfeld's inclined superstructure (see pp. 104–108, 160–161). It will be demonstrated, however, that Dörpfeld's degree of inclination of the roof, and hence the gradients deduced by later researchers from his reconstructions, is incorrect.

On Dörpfeld's sections the shipsheds are not labelled, and the identification of the colonnades dividing Shipsheds 20(π)/21(Δ) and 17(η)/18(χ) is based on comparison of the excavated areas and structures on his plan and sections (Pls. 17, 20a–20b). These identifications are augmented by a comparison with the spot-heights on the three first column bases of C20(π)/21(Δ) and C17(η)/18(χ) on Dörpfeld's plan (Pl. 17) and the vertical measurement on the same features on his sections (Pls. 20a–20b). The spot-heights and vertical measurements on the three first column bases of C17(η)/18(χ) have also been augmented by the ZHP survey (see below).

In terms of the physical evidence, it is important to distinguish Dörpfeld's *sections* of the colonnades dividing Shipsheds 20(π)/21(Δ) and 17(η)/18(χ) (Pls. 22a–22b) from his *reconstructions* of the superstructure (Pls. 20a–20b). There is a substantial difference between the two, with the latter conveying a false impression of what was excavated (Pls. 21a–21b). In the discussion of the ramp and side-passages of Phase 3 below, why and how these reconstructed sections have led to misunderstandings in subsequent research are detailed (see pp. 133–134). On Dörpfeld's *plan* the archaeological evidence and the reconstructions of walls, colonnades and ramps are easier to separate (Pls. 17–19).

In his survey, Dörpfeld took spot-heights (using the sea level as a datum zero) on three column bases in the eaves-colonnade dividing Shipsheds 17(η)/18(χ) (Pl. 20b). Today, these features remain *in situ* in the basement of a building fronting Zea Harbour at Sirangiou 1 (Pls. 2, 6). In the new ZHP survey of the same column bases, it was found that the average height difference between Dörpfeld's measurements and those taken by ZHP was 0.07 m (*MoP*: 0.01 m, see below). The more-or-less constant variation between the compared spot-heights was caused primarily by a 0.07 m difference in the datum zero, as the 87DZ used in the ZHP investigations is lower than Dörpfeld's datum zero.[7] In this way it is possible to calibrate the new spot-heights to those recorded by Dörpfeld and combine the datasets. This will be discussed at length in the presentation of the Phase 3 shipsheds.

Dörpfeld's other recorded dimensions also display a high degree of accuracy both in his work and in the construction of the shipsheds. For example, according to the data he provides the column bases in the eaves-colonnades dividing Shipsheds 17(η)/18(χ) and Shipsheds 23(Π)/24(Φ) are constructed at exactly the same level (column positions 1–3; Pls. 15–17, 20b). Similarly, the second column base in the ridge colonnades dividing Shipsheds 18(χ)/19(ϕ) and Shipsheds 20(π)/21(Δ) are also constructed at exactly the same elevation (+3.82 m), as is the second column base (C16/17:4(ι)) in the ridge colonnade dividing Shipsheds 16/17(η) when it is set back in its original position and the ZHP surveyed spot-height (+3.75 m) is adjusted by 0.07 m (calibrated +3.82 m) to tie in with Dörpfeld's datum zero.

The regularity of the spot-heights confirms that these column bases most certainly remain preserved to their original height, thus demonstrating that they are not merely foundation blocks: this piece of information has proven critical in the reconstruction of the roof arrangements of the shipsheds (see Vol. I.2, Chapter 2), as it is essential for identifying the top

7. 87DZ = Datum Zero of Ε.Γ.Σ.Α. 87 (see Chapter 1.3).

surface of the column foundations. This corollary shows that Dörpfeld and his team used extreme care in surveying the colonnades in this part of the shipshed complex. As discussed below, Dragátsis' report on column drums found *in situ* is also essential for the column base identification.

To employ Dörpfeld's 1:200 plan and sections, the margin of precision had to be tested. These were first scanned in order to prepare them for digital analysis and tracing.[8] The drawings were reproduced at 1:200 scale. The slightest slip of the pen, of 0.5 mm for example, would result in an inaccuracy of 0.10 m. The printed measurements on the plan and sections were scaled off the drawings using the *measure tool* function in Photoshop CS4. Here, after repeating the same measurement ten times, the highest inaccuracy found was 12 mm (0.012 m) at 1:1 scale. This adds 12 mm to Dörpfeld's margin of precision, which is very small considering that the originals are 1:200 hand drawings. The printed measurements on Dörpfeld's drawings permit direct testing of their margin of precision by scaling the measurements off the plan and comparing the two values (Tables 6.1–6.2; Figs. 232–233). The horizontal margin of precision (abbreviated *HMoP*) on the section of the colonnade dividing Shipsheds 20(π)/21(Δ) is 0.02 m (Fig. 233a; Pl. 20a);[9] the vertical margin of precision (abbreviated *VMoP*) is 0.03 m. On the section of the colonnade dividing Shipsheds 17(η)/18(χ) the *HMoP* is 0.01 m and the *VMoP* is 0.01 m (Fig. 233b; Pl. 20b). Dörpfeld's high level of accuracy is an extraordinary achievement considering that the plans and sections were reproduced at such a small scale (1:200). However, it should be stressed that only the printed measurements can be tested with this method and the *margin of precision* of measurements scaled off features with no printed measurements may vary considerably. The *margin of precision* of such features should be considered only as a guide.

The margin of precision of Dörpfeld's plan (Fig. 232; Pl. 17) is considerably less accurate when compared to the sections, and understandably so: it is much easier to draw a section with a level along a measuring tape, especially on bedrock and blocks, than it is to draft a plan of the same features, particularly as this step requires distance measurements. The *HMoP* on

a. Dörpfeld 1885, pl. 3a: Section C20(π)/21(Δ)		
ID	**Dörpfeld (m)**	**Scaled (m)**
Vertical printed measurements		
1c	3.50	3.54
2c	3.82	3.80
3c	4.15	4.14
4c	5.22	5.16
	Average *VMoP:*	**0.03**
Horizontal printed measurements		
1a	3.39	3.44
2a	3.39	3.40
3a	3.39	3.42
4a	3.39	3.42
5a	3.39	3.40
	Average *HMoP:*	**0.02**
b. Dörpfeld 1885, pl. 3b: Section C17(η)/18(χ)		
Vertical printed measurements		
1d	3.72	3.74
2d	3.93	3.94
3d	4.14	4.14
	Average *VMoP:*	**0.01**
Horizontal printed measurements		
1b	2.16	2.16
2b	2.16	2.14
3b	2.16	2.18
4b	2.16	2.16
5b	2.16	2.16
	Average *HMoP:*	**0.01**

Table 6.1. Margin of precision on Dörpfeld's 1885 sections of colonnades C20(π)/21(Δ) and C17(η)/18(χ) (see Fig. 233).

8. Conducted by B. Klejn-Christensen using Dörpfeld 1885: pl. 2, 1:200 plan, file format = Tagged Image File (TIFF), resolution 600 dpi; pl. 3, 1:200 sections, file format = Tagged Image File (TIFF), resolution 600 dpi. The architectural drawings were analysed in Adobe Photoshop CS4, Rhinoceros 4.0, AutoCAD 2009, MicroStation V8, then traced in Illustrator CS4.

9. A *margin of precision* listed as 0.02 m signifies that the precision of the measurement is between 0.00 to 0.02 m.

a. Vertical (v) margin of precision		
ID	**Dörpfeld (m)**	**Scaled (m)**
1v	1.10	1.10
2v	2.81	2.82
3v	3.43	3.36
4v	3.43	3.48
5v	3.16	3.14
6v	3.38	3.36
7v	3.38	3.38
8v	20.28	20.58
9v	3.38	3.34
10v	3.38	3.38
11v	3.38	3.40
12v	1.95	2.00
13v	1.73	1.72
14v	2.16	2.10
15v	2.16	2.26
16v	19.40	19.48
17v	4.32	4.28
18v	43.88	44.04
19v	3.20	3.20
20v	3.39	3.44
21v	3.39	3.42
22v	3.39	3.40
23v	3.39	3.42
24v	3.39	3.40
25v	3.39	3.38
26v	3.39	3.46
27v	3.39	3.36
28v	3.39	3.38
29v	3.39	3.32
30v	3.39	3.38
	Average *VMoP:*	**0.04**

b. Horizontal (h) margin of precision		
ID	**Dörpfeld (m)**	**Scaled (m)**
1h	6.49	6.38
2h	6.54	6.64
3h	6.50?	6.54
4h	13.03	13.04
5h	6.52	6.54
6h	6.50	6.52
7h	6.49	6.48
8h	6.47	6.40
9h	1.69	1.72
10h	3.03	3.08
11h	1.80	1.76
12h	1.70	1.74
13h	3.12	3.08
14h	1.68	1.66
15h	1.66	1.68
16h	3.14	3.14
17h	1.69	1.76
18h	1.79	1.82
19h	3.05	3.02
20h	1.63	1.62
	Average *HMoP:*	**0.04**

Table 6.2. Margins of precision on Dörpfeld's 1885 plan (see Fig. 232; Pl. 17).

the plan is 0.04 m, and the *VMoP* is 0.04 m (Table 6.2). Since these values are identical, the *margin of precision* of the plan is henceforth referred to as *MoP*: 0.04 m.

Dörpfeld's consistent measurements and careful drawings have thus permitted the ZHP to follow his plans and sections of structures that today are either missing or inaccessible due to the construction of the modern road Akti Moutsopoulou around Zea Harbour, the side roads Sirangiou St. and Kaningos St., and the adjacent buildings (Pls. 2, 15–17). These unreachable structures comprise the upper ends of Shipsheds 20(π), 21(Δ), 22(N), 23(Π), 24(Φ), 25(?), 26(?) and 27(?) and those shipsheds that were exposed further seawards, including the colonnades dividing Shipsheds C16/17(η), C17(η)/18(χ), C20(π)/21(Δ), and parts of the ramps of Shipsheds 17(η) and 21(Δ).[10] In the discussion of the Phase 2 superstructure below (Chapter 6.4), Dörpfeld's plan and sections (especially of C20(π)/21(Δ)) also contain vital evidence.

Thus the ZHP surveyed plans and sections together with the Marina Zeas map (2003) can be merged with those of Dörpfeld (Pls. 2, 15–16, 23a) according to the *margins of precision* discussed above (Tables 6.1–6.2) and below in (A) and (B). Even so, Dörpfeld may not have based all the features on the plan and sections on precise measurements taken in the field and some data may have been interpolated. It must be stressed that an error has been identified in the orientation of colonnades C22(N)/23(Π) and C23(Π)/24(Φ); accordingly they are adjusted 0.67° clock-wise using the centre of C23/24:8 as a reference point (Pl. 16). The unadjusted plan is also presented (Pl. 16a).

A) On land the ZHP X, Y, Z axes *MoP* is 0.003 m. The *MoP* is not affected when comparing scaled measurements between the ZHP plans and sections of the terrestrial parts of the excavations and Dörpfeld's plans and sections.

B) Under water, where the ZHP X, Y axes *MoP* is slightly higher at 0.005 m, 0.01 m is added to the *MoP* of all X and Y distances when comparing scaled measurements between the ZHP plans and sections of the submerged parts of the excavations and Dörpfeld's plan and sections. The Z-axis *MoP* of 0.003 m does not affect the printed height measurements on Dörpfeld's plan and sections, or vertical measurements scaled from his sections.

Dörpfeld is to be commended not only for recording these structures for posterity before they would be largely destroyed or covered by urbanisation, but also for inspiring the ZHP investigations into structures that, despite their importance in the rise and fall of ancient Athens, have largely been neglected by modern scholarship. Without his painstaking work, a great deal of information on the Zea shipsheds, one of the ancient world's largest building complexes, would have been irretrievably lost.

6.3. Superstructures of Phases 3 and 4 in Area 1 at Zea

With these considerations, it is possible to discuss the superstructure of Phase 3 (Shipsheds 16–25) and Phase 4 (possible Shipsheds 26–27; Pl. 15). On the landward side a back-wall built of limestone ashlar blocks delineates the Phases 3 and 4(?) shipshed complexes towards the city. Perpendicular spur-walls projecting shoreward tie into this back-wall, and the remains of ten inclined colonnades and a single side-wall run towards and into the sea (Pls. 15–16; Figs. 63, 67, 69, 71, 73). As discussed above, Dörpfeld reconstructed the more widely-spaced colonnades (IA: 3.38–3.39 m) as those carrying the ridge of the roof, and the more narrowly-spaced colonnades (IA: 2.16 m) as those supporting the eaves of the roof and the gutter (Pls. 17, 20). The unfluted limestone columns stood on limestone column bases which were in turn set in rock-cut foundation trenches (Figs. 73, 82); some column bases were placed on one or more foundation blocks. The Phase 3 colonnades were constructed on exactly the same orientation and position as the Phase 2 colonnades, but employed a completely different architectural matrix.

Aside from 15 or perhaps 20 Phase 2 features (see below; Pl. 13) and 17 Phase 4 features (see below; Pl. 15), Dragátsis and Dörpfeld mainly excavated the Phase 3 shipsheds in Area 1 (Pls. 15–16).

10. Column base C18/19:2(υ) was exposed in 1886 during works on Mr. Bonis' land (see p. 18).

No.	Dörpfeld's ID	Length (m)
1	Ω–β	7.40
2	β–α	15.08[11]
3	ψ	7.18
4	o	1.58
5	A	11.74
6	*unnamed*	5.86
7	B	5.00

Table 6.3. Back-wall measurements on Dörpfeld's 1885 plan. Length of wall sections are measured with a MoP of 0.04m.

6.3.1. The Back-wall of Phases 3 and 4

Dragátsis and Dörpfeld excavated five sections of the shipsheds' back-wall: Ω–β, β–α, o, A and B (Pl. 17). These are illustrated as thick black lines that represent the *in-situ* remains of the wall. The narrow, light-brown area outlined with a thin line running along the western side of the black line (the back-wall) and the spur-walls represent the rock-cut and built foundations. The latter are roughly-cut blocks under the wall at the far north exposed end of the back-wall. One section of the wall, and possibly another, were exposed in 1886, a year after the 1885 excavation: 3(ψ) and the unnamed section 6 between 5(A) and 7(B) (Pls. 15–16). The back-wall was followed for a total length of 62.12 m, of which about 53.84 m was exposed in 1885. Today the accessible parts are preserved over an estimated length of 44 m. The lengths of the individual wall sections on Dörpfeld's plan (Pls. 15–19) are listed in Table 6.3.

(1) Wall Section Ω–β

Dragátsis describes wall section 1(Ω–β) as severely damaged, a description which corresponds well with the condition of the short part of the rock-cut foundations of this wall; it is at present barely traceable in the basement of Sirangiou 1 to the north of the wall W16/26(λ) dividing Shipsheds 16 and 26(?). In 1885, this section of the wall continued under the houses in the northern part of Mr. Bonis' land plot marked with a thick red line in the northeast part of Dörpfeld's plan (Pl. 17). Dragátsis describes another poorly-built wall and mentions that it could be the foundations of section 1(Ω–β).[12] On Dörpfeld's plan this probable foundation wall appears to be composed of 11 roughly-cut blocks (Pl. 17) and not a rock-cut trench (Pl. 6; Fig. 70) or a raised rock-cut foundation (Pl. 32e; Fig. 57) as seen in the major part of the back-wall to the south of W16/26(λ), a probable indication of a different building phase. Towards the north, section 1(Ω–β) may continue under modern buildings. This part of the back-wall belongs to the possible Phase 4 shipsheds; the wall sections to the south belong to the Phase 3 shipsheds (wall sections 2–7; Pls. 15–16).

(2a) Wall Section BW: 1–24, β–α including part of 3(ψ)

Today, 14.15 m of the first course and 8.21 m of the second course of the northern part of this wall are preserved in the basement of Sirangiou 1 (Fig. 67; Pls. 6, 8a–8b, 15). To the south, part of the western face is covered by concrete pillar M:13; the length measurements listed here were taken on the eastern side of the wall. It should be noted that the data presented here include the northern part of 3(ψ), and therefore this wall section is named section 2a(BW: 1–24).

The wall is constructed of ashlar limestone blocks. The lowest course adapts to the changes in the height of the bedrock and can be divided into two distinct types: Type 1 (average 0.71 m; range: 0.69–0.72 m; Fig. 76) and Type 2: 0.80 m (Fig. 77). The height of the second course, built of Type 3 blocks, is *ca* 0.58 m (range: 0.57–0.58 m; Fig. 78; see also Pls. 6, 8a–8b). The types are discussed below.

The wall's rock-cut foundation trench can be followed for 17.72 m (Pl. 8b). To the south the wall continues into the modern concrete wall. The top surface of the second course is covered by a 0.005–0.010 m-thick layer of concrete, which was already present in the 1950s before Sirangiou 1 was built (Figs. 59, 62). As a result, it was not possible to examine this surface for clues of construction techniques.

A total of 20 blocks (BW:5–24) remain *in situ* in this wall section (Pls. 6, 8a–8b), which was described as being in excellent condition by Dragátsis. In 1885

11. Both wall sections 1(Ω–β) and 2(β–α) were measured to the northern side of the intersection with W16/26(λ).
12. Dragátsis 1885: 65.

it was preserved to a height of three courses (1.87 m) and reported to be 0.61 m wide.[13]

A glass-plate negative from the Municipal Historical Archive of the Piraeus shows this wall section from the north-east (Fig. 58). The date of the photograph and its commissioner are unknown, but since the Pasha's House is present, it was definitely taken after 1890, when the house was built. Compared to photograph PIR 6, dated to March 1891, the area to the south of the house has been developed considerably (Fig. 55). According to Arvanitopoulou, the shipsheds in front of the Pasha's House were visible until 1911;[14] since there appears to be a column in front of the house, it is likely that the photo was taken before this date. Spur-wall C17/18:1–5(γ) would have been clearly visible if the back-wall had been photographed from this angle in its present state of preservation (Fig. 58). The third course of the spur-wall would not have tied into the back-wall (Pls. 6, 8c–8d). In this photograph the back-wall appears to be preserved to a height of three courses, the spur-wall to two courses.

This part of the back-wall was damaged between March 1891 and the 1950s (Figs. 59, 62); it is now preserved to a height of just two courses. In the northern part only the rock-cut foundation trench is preserved. Four blocks (AE:7–10) were reconstituted into the back-wall in 2000–2001 (Pl. 8a). The architecture of the back-wall will be discussed in detail below (pp. 82–84, 126–127), after the presentation of the remaining Phase 3 wall sections.

(3) Wall Section ψ

In his appendix dated to 29 September, 1886, Dragátsis mentions that wall section 3(ψ) between α–4(ο) and other structures had been exposed some months prior when the Municipality of the Piraeus removed soil from Mr. Bonis' land.[15] This part of the wall is illustrated as a thick, light-brown line outlined in black (Pls. 15, 17). Wall section 6 between 5(A) and 7(B) is drawn in the same way, and since it is clearly visible in the photograph PIR 6 (Pls. 16–17, 32g), it is concluded that these parts of the wall were at that time *in situ*. It is likely that Dörpfeld drafted the plan before wall section 3(ψ) was exposed, and he possibly illustrated it in a different way to show that it was added later, or more likely, that it was not fully excavated. This may also indicate that section 6 between 5(A) and 7(B) was not fully exposed in 1885, and added to the plan later. The parts between wall sections 4(ο)–5(A) and south of wall section 7(B) is illustrated as a thick, light-brown line outlined in black stipples (Pl. 17). Dörpfeld was clearly reconstructing these unexcavated areas. The continuation of wall section 3(ψ) south of α is visible on a photograph commissioned by I.A. Meletopoulos in the 1950s (Fig. 62). At this time the back-wall section was exposed for a few more metres. As mentioned above, the measurements listed for section 2a(BW: 1–24) include the northern-most part of 3(ψ).

(4) Wall Section ο

Dörpfeld recorded a small section of the back-wall that projected from the northern side of the dirt road (Pl. 17). This dirt road would later be named Sirangiou St. (Pl. 15). No other evidence is available.

(5–6) Wall Section A and the Unnamed Section to the South

Wall section 5(A), illustrated as a black line, begins a little to the north of the colonnade dividing Shipsheds 20(π)/21(Δ). It ends near the southern side of the ramp of Shipshed 22(N) (Pl. 17), where it appears to continue into the unexcavated (or back-filled) area to the south (right-hand side; Pl. 32). In the photograph PIR 6, the back-wall 5(A) behind Shipshed 21(Δ) exhibits a construction similar to that of the section in the Sirangiou 1 basement (Fig. 67; Pls. 8a, 32e). The only difference is that it rests on a raised rock-cutting that protrudes slightly from the face of the wall like the orthostat course located in wall section 2a(BW: 1–24).

In the southern-most part of Shipshed 21(Δ), near the southern side of the ramp, the construction of the back-wall changes. The foundation cut in the bedrock was carved at a higher elevation creating a raised step (Pl. 32f). The elevation of the second course is similar to that of the second course in the northern part, but in order to accommodate the change in the foundations the first course was made shorter (Pl. 32g) – a good example of conserving resources by employing

13. Dragátsis 1885: 65.
14. Arvanitopoulou 1966: 38.
15. Dragátsis 1885: 70–71.

bedrock. According to Dragátsis, the height of the raised rock-cutting is 0.70 m; this measurement was most likely taken on the inside of the wall.[16] On Dörpfeld's section of C20(π)/21(Δ), the height of the raised foundations of the back-wall above the floor is 0.72 m (*VMoP*: 0.03 m; see Pl. 20a). This clearly indicates that a considerable amount of bedrock was broken up and removed, or quarried and used as blocks, to create Passage P:3 in the area between the back-wall and the upper end of the ramps. Broken-up bedrock was found during the ZHP excavations in the sea; although the bedrock fragments were not found *in situ*, they were in all probability re-used as fill material in the construction of the shipsheds (see Vol. I.2, pp. 32–34).

Dörpfeld's plan provides two spot-heights on wall section 5(A) in the area behind the colonnade dividing Shipsheds 20(π)/21(Δ) (Pl. 17). One is on top of the wall course (+6.12 m/calibrated +6.05 m), the other is on the top surface of the foundations (+5.22 m/calibrated +5.15 m). The centre in the circle of the latter spot-height is outside the western line that illustrates the rock-cut foundations, but it is clear on his section that it was taken on the top surface of the wall foundations (Pl. 20a). Dragátsis specifies that the height of the two courses in the wall is 0.90 m,[17] and this is exactly the height difference between the top of the wall (+6.12 m) and its foundations (+5.22 m). Scaled off Dörpfeld's section, the height of these two courses is 0.92 m (*VMoP*: 0.03 m). Their heights on the raised rock-cut back-wall foundation are also almost identical: Dragátsis, 0.70 m, and Dörpfeld, 0.72 m (V*MoP*: 0.03 m; Pl. 20a).

Another spot-height of +6.07 m (calibrated +6.00 m) was taken on the crown of the wall near the southern end of section 5(A); there is a height difference of 0.05 m between the northern and western part of section 5(A). Parts of the western face of the back-wall sections 5(A) and 6 are visible beneath the veranda of Sirangiou 2 (Pasha's House), but parts were covered with concrete by the owner of the house in 2003–2004.

(7) Wall Section B

This section is located behind the colonnade dividing Shipsheds 23(Π)/24(Φ) (Pl. 16). In the area of section 7(B), Kaningos St. lies at an elevation of about +5.30 m. Its construction probably damaged parts of this wall section and section 6, since wall sections 2a(BW: 1–24) and 5(A) were preserved to a height of +5.50 m and +6.00–6.05 m in 1885, the latter clearly above the modern street level. The area at the far right-hand side in the photograph PIR 6 appears to have been backfilled after the 1885 excavations (Pl. 32).

The Architecture of the Back-wall

The section of the wall preserved in the basement of Sirangiou 1 was constructed mostly of ashlar blocks of local, yellowish-grey limestone. The blocks are of roughly the same size, except in places where their length or height was adjusted to accommodate stepped changes in the elevation of the rock-cut foundations, or in areas where side- or spur-walls are tied into the back-wall (Pls. 6, 8a–8b).

In wall section 2a(BW: 1–24), still preserved in the basement of Sirangiou 1, the first course consists of two main types of blocks: Types 1 and 2 (Table 6.4). Type 1 includes BW: 5–11, 15–17, which have the following average dimensions: L: 1.19 m, W: 0.63 m, and H: 0.71 m (Fig. 76). Type 2 includes BW: 12–13 (Fig. 77). The average dimensions of these blocks are: L: 1.18 m, H: 0.80 m.[18]

The first course (average width: 0.63 m) is 0.04 m wider than the second course (average width: 0.59 m). Consequently, the first course projects slightly out from beneath the second on the western side. Furthermore, the Type 1 (H: 0.71 m) and Type 2 (H: 0.80 m) blocks are 0.12 m and 0.21 m higher, respectively, than those of the second course (H: 0.58 m). The design is recognisable as an orthostat course, a common feature of Greek architecture.[19] It is probably no coincidence that the foundations in section 5(A) are of about the same height (0.72 m, *VMoP*: 0.03 m) as block Type 1 (0.71 m), thus creating a rock-cut orthostat course (Pl. 32e; Fig. 57). The two Type 2 blocks

16. Dragátsis 1885: 67.
17. Dragátsis 1885: 67.
18. It was impossible to measure the widths on a number of blocks in the first course due to the confined space between the back-wall and the modern wall. The lower surface of BW:14 is stepped to accommodate the rise in bedrock level, and it is excluded from the average calculations as it is neither a Type 1 nor a Type 2 block.
19. Orlandos 1966: fig. 66.

Block type	Course	BW nos.	Average length (m)	Average width (m)	Average height (m)
1	first	5–11, 15–17	1.19 (blocks 6–11, 15–16) (range: 1.12–1.23)[20]	0.63 (blocks 5–8) (range: 0.62–0.65)	0.71 (blocks 6–11, 15–17) (range: 0.69–0.72)
2	first	12–13	1.18 (blocks 12–13) (range: 1.15–1.20)	n/a	0.80
3	second	18–24	1.19 (blocks 18–19, 22–23) (range: 1.15–1.25)[21]	0.59 (blocks 18–22) (range: 0.58–0.60)	0.58 (blocks 18–24) (range: 0.57–0.58 m)[22]

Table 6.4. Phase 3, back-wall, section 2a (BW:1–24), block dimensions.

(BW: 12–13) are related to the spur-wall construction in an area where the superstructure would have carried the maximum load (tiles, roof timbers, rain gutter and possibly a stone architrave). The deeper foundations (and thus higher blocks) indicate either that extra care was taken to carve out high-quality foundations in this area, or that the spur-wall was designed in such a way as to dictate the layout of the back-wall in this area.

The blocks of the second course are Type 3 blocks (Fig. 78; Pls. 6, 8a–8b) and were carved with a dimensional and proportional relationship of roughly 2:1:1 (L: 1.19 m, W: 0.59 m and H: 0.58 m; see Table 6.4). Seven blocks do not comprise sufficient evidence to recognise an ancient unit of measurement of less than 0.30 m, but there is a clear dimensional relationship between the length, width and height.[23]

As mentioned above, Dragátsis reports that three courses of the back-wall are preserved to a height of 1.87 m. Placing a block of Type 3 (H: 0.58 m) atop two courses of Type 1 (average H: 0.71 m) and Type 3 (average H: 0.58 m) results in a reconstructed height of 1.87 m. This value clearly indicates that the height of the now-missing third course was similar to that of the second course (Table 6.4). The wall construction can now be classified as most probably isodomic.[24] The height of the top of the second course (BW:18–24) is +5.50 m, whereas, as Dörpfeld's plan demonstrates, wall section 5(A) lies at +6.12 m/calibrated +6.05 m (north) and +6.07 m/calibrated +6.00 m (south) (Pls. 17–18). The height of the two courses in wall section 5(A) is markedly shorter (0.90 m) than the two courses preserved in the Sirangiou 1 basement (1.29 m to 1.38 m), but based on the spot-heights the raised rock-cut foundations effectively elevates this part of the back-wall by the equivalent of roughly one course (0.50–0.55 m). The floor level of Passage P:1 in front of wall section 2a(BW: 1–24) varies between +4.13 m and +4.20 m (Pl. 15). The height of Passage P:3 running along wall section 5(A) is deduced at +4.43 m by subtracting the scaled height of the raised rock-cut foundations on Dörpfeld's section (0.72 m, V*MoP*: 0.03 m; Pl. 20a) from his spot-height atop this feature (+5.22 m/calibrated: +5.15 m; Pl. 17). The column bases of these two areas are constructed at almost identical levels, and since Passage P:3 was constructed by removing a considerable amount of bedrock between the back-wall

20. BW:5 is excluded from the average length calculation, as it was clearly shortened to fit the foundation trench layout. BW:17 continues into the modern wall to the south and is not included.

21. BW:20 (L: 1.03 m) and BW:21 (L: 0.84 m) are excluded from the average length calculation, as they are shorter to accommodate the spur-wall block (C17/18:4) interlocking into this course of the back-wall (Pls. 6, 8a–8b). BW:24 continues into the modern wall to the south and is not included.

22. The top surface of blocks in the second course is covered with a 0.005 to 0.010 m-thick layer of concrete; as a result 0.01 m is subtracted from their heights.

23. This unit (0.30 m) is rather close to the traditionally recognised 'Attic' foot (0.294–0.296 m) and 'Ionic' foot (0.298–0.300 m); for recent references on the foot, see Jones 2001. For a recent analysis on the statistical complexity of determining ancient measurement units and further references, see Pakkanen 2007.

24. Orlandos 1966: 139–140, fig. 160.

and the upper end of these shipsheds, the higher floor level of +4.43 m in front of section 5(A), compared to section 2a(BW: 1–24) at +4.13 m to +4.23 m, may represent the intended floor level of this area.

In the left-hand (northern) part of the photograph PIR 6 the back-wall is constructed of regular ashlar blocks. Aside from the raised rock-cut foundations, this part of section 5(A) is identical to the back-wall section in the basement (Pls. 8a, 32e; Figs. 57, 67).[25] In the area behind the southern side of the ramp of Shipshed 21(Δ) the rock-cut foundations of the back-wall has a step (Pl. 32f). As a result, the first course is lower to accommodate the change of foundation height. The two courses of these wall sections meet end-to-end; compared to the left-hand section, the blocks are notably shorter (Pl. 32g). The change in design and the fact that the blocks do not interlock may point to two construction phases, or more likely that the shipshed complex was built in smaller sections that did not require interconnecting courses in the back-wall.

6.3.2. Spur-walls of Phases 3 and 4

General Observations

Four spur-walls were documented in 1885, three of which are related to the Phase 3 shipsheds. Spur-walls C17/18:1–5(γ), C21/22:1–2(Γ) and C23/24:1–2(Ρ) are located behind the colonnades with the narrow inter-axial spacing (2.16 m) that carried the eaves of the roof and the gutters (Pls. 15–17, 37). Wachsmuth notes that the fourth and northern-most Spur-wall C26/27:1 behind the colonnade dividing possible Shipsheds 26 and 27 breaks the uniformity of the aforementioned spur-walls (Pls. 15, 17);[26] this anomaly leads him to recognise the structures north of W16/26(λ) as belonging to a different type (*Klasse*) of shipsheds. The 1.10 m length of Spur-wall C26/27:1 is noticeably shorter when compared with the average length of 2.03 m (*MoP*: 0.04) of the following spur-walls: C17/18:1–5(γ), C21/22:1–2(Γ) and C23/24:1–2(Ρ) (Pls. 15–17).[27]

Spur-wall C21/22:1–2(Γ) is illustrated in Dörpfeld's plan in light brown and outlined with a black line, except for the western end, which is closed with a stippled black line; this latter convention gives a fairly certain indication that C21/22:1 was not preserved here (Pl. 17). When the thin black line above Γ on Dörpfeld's plan is compared to the parts of the structure visible in the photograph PIR 6, it is clear that Dörpfeld was intending to represent the western part of the spur-wall as constructed on a raised, rock-cut step (Pl. 32k). The solid black line probably indicates an *in-situ* block (C21/22:2) tied into the back-wall.

Spur-wall C17/18(γ) on Dörpfeld's section of this colonnade is shown in outline as one course of two blocks apparently resting on level bedrock (Pl. 20b). The blocks are, in fact, the second course blocks C17/18:4–5(γ) whose printed length measurements on Dörpfeld's plan (1.95 m) correspond exactly with those taken by the ZHP survey. Spur-wall C17/18:1–5(γ) is preserved to a height of two courses (Pls. 8a, 8c–8d). The first course (C17/18:2–3) is 2.13 m long and protrudes 0.18 m from beneath the second course (Pl. 6). Dörpfeld did not record the first course; in all probability this area had not been excavated when he drew the section (Pl. 20b). On the plan the spur-wall is illustrated as solid black and surrounded by a light-brown feature that was later identified as foundation trench C17/18:1 (Pl. 17); this gives the impression that the structure was fully excavated when the plan was drawn. This assumption is also supported by modern material in the fill of foundation trench C17/18:1. The printed measurement on the plan was clearly taken on the second course.

Architecture of the Spur-walls

Spur-wall C17/18(γ) was constructed in a rock-cut foundation trench (C17/18:1) measuring 2.15 m long and 0.77–0.78 m wide. The trench was cut 0.07–0.09 m deeper than the foundations of the back-wall (BW:3A–3B) (Pls. 6, 8a–8d). It is possible that this construction was intended to add extra structural strength; it also may have been cut more deeply to reach bedrock of the required hardness.

25. By comparing the photograph PIR 6 (Pl. 32) and Plate 16 it is clear that this change in construction is not the delineation between sections 5(A) and 6 on Dörpfeld's plan (Pl. 17).

26. Wachsmuth 1890: 71–72. Possible Shipsheds 26 and 27 are unnamed on Dörpfeld's plan.

27. C17/18:1–5(γ) (first course, L: 2.13 m; second course, L: 1.95 m (Dörpfeld 1885: pl. 2: 1.95 m). Length of C21/22:1–2(Γ): 2 m, Dragátsis 1885: 64 (scaled off pl. 2: 1.98 m, *MoP*: 0.04 m). Length of C23/24: 1–2(Ρ) scaled off pl. 2: 1.98 m, *MoP*: 0.04 m.

Block type	Course	Spur-wall nos.	Average length (m)	Average width (m)	Average height (m)
1	first	C17/18:2–3	1.07 (range: 0.99–1.14)	0.65	0.87
2	second	C17/18:4–5	1.27 (range: 1.26–1.27)	0.62 (range: 0.61–0.63)	0.60 (range: 0.59–0.60)

Table 6.5. Spur-wall C17/18(γ), block dimensions.

The spur-wall is constructed of large, well-cut ashlar blocks of limestone (C17/18:2–5) set very closely together. The eastern block (C17/18:4) in the second course interlocks with the back-wall, thus adding to the structural strength of the building (Fig. 176b; Pls. 6, 8). The southern-most spur-wall C23/24:1–2(P) appears to have been constructed in a similar fashion (Pl. 17). The parts of the block (C17/18:4) tying into the back-wall have been cut flat to fit precisely with blocks BW:20 and 21 (Pls. 8a–8b; Fig. 74).

The western-most block in the first course (C17/18:3) has *anathyrosis* on its western face (Fig. 69). The bottom of the rock-cut foundation trench (C17/18:1) beneath the block does not extend more than 0.02 m towards the west, so it is very unlikely that there was a half-column or another revetment attached to the spur-wall. Because of the large size of the block (L: 1.14 m, W: 0.65 m, H: 0.87 m), it is less likely that the *anathyrosis* indicates re-use, as it was cut specifically for this position. It is probable that the wall blocks were mass-produced according to a single type with little variation, rather than custom-made for each feature. If the block with exposed *anathyrosis* accommodated a feature, it was probably capped with a revetment. The distance between C17/18:3 and the centre of column base C17/18:7 is 1.54 m (Pl. 6); if there was a half column, its position would not have corresponded with the 2.16 m interaxial spacing of this colonnade.

The block has two slots on the northern face. As the lowest block in the spur-wall it must have been levered into place, and it is unlikely that the two slots served as lifting holes; perhaps they had some function in the design of the shipshed (Fig. 68), or perhaps they are later features. On the southern side there is a probable mason's mark shaped in a half circle (Fig. 79). The block in the course above, C17/18:5, has an incised arrow on the southern face (Fig. 80).[28] Like the back-wall, Spur-wall C17/18:2–5 is constructed of two block types, with the average dimensions presented in Table 6.5.

The spur-walls in all probability stood as high as the back-wall, thus giving the architrave a strong fixed point in the colonnades that carried the eaves, and thus the main weight of the roof. The spur-walls added structural strength to both the back-wall and to the remaining superstructure.

6.3.3. The Wall Dividing Shipshed 16 and Possible Shipshed 26

The wall dividing Shipshed 16 and possible Shipshed 26 (W16/26) is named λ on Dörpfeld's plan (Pl. 17, left side). The upper, excavated part is illustrated in solid black. Further to the west, in the unexcavated area, this structure is represented in solid light-brown outlined in black dashes. On the beach, the northern side of the structure is drawn with a continuous line, although the reason is not clear; it may represent an area in which parts of the raised foundations were exposed. The foundations of W16/26(λ) have also been located in the sea (Pls. 9, 15), and Dörpfeld clearly recorded the submerged part of this structure (Pl. 17); it is illustrated in light brown and outlined with a solid black line. The delineation is open at the western end, perhaps illustrating that W16/26(λ) continued into the silt or out of sight. According to Dörpfeld's plan the structure is 46.34 m long (*MoP*: 0.04 m). A photograph from the 1950s shows W16/26(λ) running from the beach

28. The mason's marks and other construction details, such as tool marks, will be described in more detail in a later study.

into the sea (Fig. 63).[29] In the upper part of Dörpfeld's plan, W16/26(λ) is illustrated as a black line for 11.40 m (*MoP*: 0.04 m); since he often shows *in-situ* elements in black (as seen in the sections of the back-wall and column drums found *in situ*), this may illustrate that W16/26(λ) was preserved to a greater extent in 1885. The structure in the sea illustrated in brown is partially visible in this 1950s photograph and is to some extend still visible today. The ZHP investigations followed the structure for 49.66 m (Pls. 6, 9, 15). The two western-most features of this wall, W16/26:7–8, are cut on a steeper inclination (Fig. 178a), but they are clearly a part of this structure as the northern side of W16/26:7 and the southern side of W16/26:8 align exactly with W16/26(λ) (Pl. 15).

Rock-cut Foundations for Wall 16/26

In the excavated area of the basement at Sirangiou 1, three inclined and stepped rock-cut foundation trenches, W16/26:1–3 (Pl. 6; Fig. 173a), form the foundations of W16/26(λ). The foundation trenches were followed for a total length of 10.72 m. They have a width of 0.94–0.97 m (W16/26:2). A 4.00 m-long stretch of the side-wall is preserved to a height of two courses (W16/26:9–14). At the intersection with the back-wall (BW:1), the inclined foundation trench for W16/26(λ) (W16/26:1) was cut through the level bottom surface of the back-wall foundations (Pl. 6; Figs. 72, 173a). W16/26:1 begins at the eastern bottom edge of BW:1 and at the same elevation as this feature. It is important to note that W16/26:1 does not continue east of BW:1, demonstrating that W16/26:1 was tied into the back-wall. What is more, the intentional interconnection between the foundation cuttings strongly indicates that the back-wall of Shipshed 16 and the side-wall W16/26(λ) were built at the same time. Another possibility, though less likely, is that the back-wall belongs to an earlier building phase, was then dismantled in this area, and finally rebuilt in tandem with the interconnecting side-wall W16/26(λ). The foundation cutting of the back-wall is stepped along its length in several places, probably in order to level the natural bedrock and/or to obtain a bottom surface of requisite hardness and quality (Pls. 8a–8b). Therefore, it also seems unlikely that the back-wall is later than W16/26(λ), since the stone masons probably would have cut the foundations of BW:1 some 0.06 m deeper in the area of the inclining foundation trench (W16/26:1) in order to level out this feature (Fig. 173a).

The G3-B inclination of W16/26:1 is 1:13.5 (4.2°) (Figs. 173a, 220).[30] The main part (W16/26:2B) of W16/26:2 has a gradient of 1:11.8 (4.9°), whereas its 1.20 m eastern-most part (W16/26:2A) has a markedly steeper inclination (1:7.4/7.7°). Compared to the other foundations in this part of W16/26(λ), this inclination is out of range and remains unexplained (Fig. 220).

The narrow area between the modern wall to the north that encloses the present basement and the space where the back-wall of possible Shipshed 26 connects with W16/26(λ) is mostly destroyed. Unfortunately, it is not possible to determine how the two structures were interrelated in this area. Dragátsis also describes this part of the back-wall as severely damaged.[31]

The south side of the rock-cut foundation trench W16/26:3 was not excavated by the ZHP west of feature W16/26:11. Only the top of blocks W16/26:9–11 was exposed, as these areas were inaccessible due to the narrow space between the blocks and the side of the rock-cut foundation trench (Pl. 6; Fig. 71). For the same reason, no excavations were carried out on the northern side of block W16/26:13 located next to the modern concrete pillar M:1, and in the area to the west of here.

A continuation of the rock-cut foundations of W16/26(λ) was found in the harbour basin of Zea, protruding from under the modern western outer quay reinforcement (W16/26:4) (Pl. 9). I.A. Meletopoulos commissioned a photograph of this feature in the 1950s before the modern quay was built on top of it, thus offering a unique view of how the shoreline appeared to earlier researchers. In the 1950s W16/26(λ) was exposed for at least 4 m on the shore (Fig. 63); at present it is preserved for a length of 9.26 m in the sea. Perhaps Dörpfeld illustrated the northern edge of W16/26(λ) on the beach with a continuous line because this part of the structure was visible in 1885 (Pl. 17).

29. Piraeus Historical Archive, I.A. Meletopoulos Archive.

30. See Chapter 5.2 for a detailed description of the linear regression gradient calculation method.

31. Dragátsis 1885: 65.

Block type	Course	Blocks nos.	Average length (m)	Average width (m)	Average height (m)
1	first	W16/26:9–11	1.12 (range: 1.11–1.14)	*Unknown*	*Unknown*
2	second	W16/26:12–14	1.12 (range: 1.01–1.22)	0.62 (range: 0.61–0.64)	0.58 (range: 0.53–0.60)

Table 6.6. Dimensions of blocks in W16/26(λ).

During the ZHP investigations, related identifiable features were found further into the sea: W16/26:5–8 (Pl. 9; Fig. 178a). W16/26:4–8 is perfectly aligned with the preserved part of W16/26(λ) in the basement of Sirangiou 1 (Pls. 9, 15). When the inclination (1:13.5 (4.2°, G2-T; Fig. 221c) of the top (and best preserved) surfaces of W16/26:4 and 6 are extrapolated to the back-wall of the shipshed, the line defined by the linear regression runs almost parallel to the features in W16/26(λ) preserved in the basement (Pl. 34a). These features clearly belong to W16/26(λ). Although only the top of the first course of blocks in W16/26:9–11 was excavated, it is very likely that W16/26:4 and 6 are a continuation of its foundations (Pl. 34a; see below). The steeper inclination of W16/26:7–8 remains unexplained (Fig. 221c).

Wall Construction

Two courses of limestone blocks remain *in situ* in W16/26(λ) (Pl. 6; Fig. 173a; Table 6.6).

Four architectural elements (AE:1–4) were reconstructed into W16/26(λ) in 2001–2002 by the 26th Ephorate of Prehistoric and Classical Antiquities. These blocks had been observed previously lying in a jumble to the south of W16/26(λ). AE:5 was already lying atop the second course in the 1950s (Fig. 62). Based on their shape and dimensions it is very unlikely that AE:1, 4 and 5 belong to this wall (Pl. 6; Figs. 95, 97–99, 173a).[32] Instead, the dimensions of AE:2–3 fall within or are close to the range of dimensions of the blocks from the second courses of W16/26(λ), Spur-wall C17/18(γ) and the back-wall. AE:2–3 may belong to any of these. According to Dragátsis, the back-wall was preserved to three courses in 1885 (see pp. 80–81), leaving it to speculation whether AE:2–3 originated from the now-missing third course.

The exposed tops of the three blocks in the first course of the wall dividing Shipshed 16 and possible Shipshed 26 (W16/26:9–11) protrude 0.06–0.09 m from below the second course (that is, to the south; Pl. 6; Fig. 71). Their inclinations (1:13.8/4.2°) were determined from the best preserved parts of the accessible top surface using a G2-T calculation (Fig. 220d). As in the back-wall, the projecting first course creates an orthostat course; as W16/26(λ) is inclined, this may well be the only known example of an inclining orthostat in shipshed architecture. In the second course, three blocks (W16/26:12–14) remain *in situ* (Pl. 6; Fig. 173a). The extrapolated top surface of W16/26:12–13 is aligned with W16/26:1, as are the tops of the column bases in C16/17(η) and C17/18(γ) (Fig. 230).

The G2-T inclination of blocks W16/26:12–13 is 1:12.8 (4.5°) (Fig. 221b). W16/26:14 was not included in the calculation as its top southern edge is damaged and AE:4–5 covers its top surface (Fig. 173a).

The sand and stone fill (U:1) between blocks W16/26:14 and AE:6 is a later fill that probably replaced a block or filled a gap in the wall structure (Figs. 97, 173a). Block AE:6 in the second course was not fully excavated; its top surface inclines at a much lower gradient (1:24.8/2.3°) when compared with the three *in-situ* blocks in this course 1:12.8 (4.5°) (Figs. 221a–221b). It probably belongs to later re-use of W16/26(λ), or perhaps it was pushed out of place during the construction of the modern walls to the north and west. It may also have been related to a possible opening

32. For the dimensions of AE:1–5, see Vol. I.2, p. 108.

in W16/26(λ). The wall between Shipsheds 16 and 26(?) served a number of functions. Wachsmuth posits that W16/26(λ) was a side-wall between two different types of shipsheds. He bases his argument on the observation that the two first column bases μ (C26/27:2) and ν (C26/27:3–4) in the colonnade dividing possible Shipsheds 26 and 27 to the north of W16/26(λ) are structurally different from the colonnades excavated in 1885 to the south of W16/26(λ) (Pls. 15, 17). He also asserts that the interaxial spacing of the colonnade to the north was wider (3.43 m) than that of the colonnades to the south of W16/26(λ) (IA narrow: 2.16 m; IA wide: 3.38–3.39 m). Wachsmuth further notes that Spur-wall C26/27:1 interrupts the uniformity of the spur-walls to the south of W16/26(λ).[33] As discussed in detail above, Spur-wall C26/27:1 is also noticeably shorter when compared to Spur-walls γ, Γ and P.

6.3.4. The Phase 3 Columns

A vast area of the shipsheds' superstructure was held aloft by unfluted limestone columns that stood on square limestone column bases. In some instances the column bases were positioned atop one or more foundation blocks, as is the case of column position 2 in C20(π)/21(Δ) (Pls. 20a, 21a). The bases and foundation blocks were set in rock-cut foundation trenches of varying depth and shape (Pls. 6, 20; Figs. 73, 82, 174a, 176b). The following analysis of the Phase 3 colonnades begins with the column drums themselves, followed by the column bases, foundation blocks and rock-cut foundation trenches.

'In-Situ' Column Drums

Dragátsis describes column drums as excavated "*in situ*" (κατά χώραν) on the following column bases (Pls. 15–17; (ϱ) is not visible on Dörpfeld's plan and in this study the column *drum* is named C19/20:1(ϱ)):

C17/18:7(δ)
C19/20:1(ϱ)
C20/21:2(H)
C20/21:6(Θ)
C20/21:9(I)
C22/23:1(Ξ)
C22/23:3(O)
C23/24:3(Σ)

The exceptions are column bases C21/22:3(K) and C21/22:4(Λ), which are described as having "traces of the columns."[34] Two other drums, C18/19:1(τ) and C18/19:3(υ), were found *in situ* during construction work in 1886 after the excavation had ended.[35] Apart from column drums C18/19:1(τ), C19/20:1(ϱ), C19/20:2(σ) and the drum on column base C21/22:4(Λ), all the column drums Dragátsis describes as *in situ* are marked in black on Dörpfeld's plan (Pl. 17). In the section he also shows the three column drums (C20/21:3, 7, 10; see Pl. 20a) as standing on their respective column bases, but curiously there is no column drum standing on the first column base in C17(η)/18(χ) (Pl. 20b). In photograph PIR 6, second drums are visible atop those illustrated in Dörpfeld's section, in addition to C20/21:3, 7, 10 and C22/23:2 (Pls. 16, 32h–32j, 32m). Two drums are also standing in the area of column bases C21/22:3(K), 4(Λ) and 5(M), which had been back-filled when this photograph was taken. A number of columns were clearly re-erected at some point between 1885 and March 1891 when photograph PIR 6 was taken. Arvanitopoulou reports that until 1911 the shipsheds in front of the Pasha's House (Sirangiou 2) were still visible, and that remains of these shipsheds could be seen in the sea at the time of her publication (1966).[36] The top of a column drum is in all probability visible in front of the Pasha's House in the photograph taken by an unknown photographer between March 1890 and 1911 (Fig. 58). The construction of the house had been commissioned by a Greek family living abroad, and the columns were probably dismantled when Mr. Tzivanidis' grandfather bought the house in 1911 and laid out the garden.[37]

Did Dragátsis and Dörpfeld excavate column drums *in situ*, or were they found nearby and re-erected? This is an important question, since *in-situ* column drums would identify the features on which they are standing as column bases, and not column base foundation blocks. Furthermore, the drums can with cer-

33. Wachsmuth 1890: 71–72.
34. Dragátsis 1885: 63–66. These possible drums have no feature numbers.
35. Dragátsis 1885: 70.
36. Arvanitopoulou 1966: 38.
37. Mr. Tzivanidis, pers. comm., 2008.

Feature	Bottom diameter (m)	Top diameter (m)	Height (m)
C20/21:3	0.70/0.70	0.64	1.20
C20/21:7	0.70/0.70	0.64	1.46
C20/21:10	0.70/0.68	0.64	1.20
Average	**0.70/0.69**	**0.64**	**1.29**

Table 6.7. Evidence of column drum dimensions on Dörpfeld's plan and section of C20(π)/21(Δ) (Pls. 17, 20). Two bottom diameters are listed, one each from Dörpfeld 1885: pls. 2 (MoP: 0.04 m) and 3 (HMoP: 0.02 m).

tainty be related to the shipsheds. P. Athanasopoulos argues that it would not make sense to describe the column drums as *in situ* if they were found in the vicinity of the respective column bases, since it would be difficult to determine to which column base they belonged.[38] Dragátsis and Dörpfeld were likely somehow involved in re-erecting the columns visible in photograph PIR 6; if all the drums in C20(π)/21(Δ) were re-erected during the excavation in 1885, Dörpfeld in all probability would have illustrated two drums in each of the columns in the section of C20(π)/21(Δ) instead of one (Pl. 20a). Furthermore, the column base of column drum C18/19:1(τ) is not shown (Pls. 15, 17): the column drum was probably not fully exposed when the municipality removed soil from Mr. Bonis' lot in 1886, after which Dörpfeld added it to the plan. Dragátsis also describes this column drum as found *in situ*.[39] Taking the above evidence into consideration, it is most likely that the column drums in question were found *in situ* on their respective column bases.

Column Dimensions

Dragátsis' column diameter of 0.58 m has been accepted as the lower diameter of the columns of the shipsheds excavated in 1885.[40] Dragátsis, however, does not explicitly describe the measurement as the lower diameter, nor does he specify on which column the measurement was taken. Milchöfer reports a large number of unfluted limestone column drums in the eastern part of Zea Harbour whose average diameter is 0.60 m; these he believes to be the remains of a stoa.[41] Since at least two building phases of shipsheds are known to have been present in this part of Zea, it is more likely that the column drums found by Milchöfer originated from the shipsheds, and the average diameter points to a bottom drum diameter greater than 0.58 m.

New information has been brought to light by an analysis of several lines of evidence: Dragátsis' report, Dörpfeld's plan and sections, investigations of the shipsheds in Area 1 by ZHP, and investigation of the 13 column drums first thought to originate from Dragátsis' and Dörpfeld's 1885 excavations but were actually dredged out of the sea in August 1964 (in Area 6; Fig. 2). This new material evidence helps clarify a number of questions concerning the architecture of the Zea shipsheds: What is the lower column diameter? What was the approximate height of the columns (see Chapter 8.2.4)? Is it possible to distinguish between columns belonging to the colonnades with the longer and narrower interaxial spacing of the Phase 3 shipsheds?

Column Drum Dimensions (Dörpfeld)

The bottom diameters on Dörpfeld's 1:200 plan and section are very consistent: on the plan the average diameter of column drums C20/21:3, 7 and 10 is 0.70 m (*MoP*: 0.04 m; Pl. 17) and on the section the average bottom diameter is 0.69 m (*HMoP*: 0.02 m; Pl. 20a). The average top diameter of the bottom drum is 0.64 m (*HMoP*: 0.02 m), and the average height is 1.29 m (range: 1.20–1.46 m, *VMoP*: 0.03 m). All other column drums marked in black on Dörpfeld's plan have a di-

38. P. Athanasopoulos, pers. comm., 2006.
39. Dragátsis 1885: 70.
40. Dragátsis 1885: 67, pl. 2; Blackman 1968: 182, n.†, pl. 29–30; Morrison, Coates & Rankov 2000: 132–133.
41. Milchhöfer 1881: 58.

Possible column drum	Length (m)	Width (E)(m)	Width (W)(m)
S21:R3	1.34	0.66	0.64
S21:R4	1.34	0.68	0.66
S21:R5	1.24	0.60	0.58
Average	**1.31**	-	-

Table 6.8. Dimensions of possible re-used column drums in the ramp of Shipshed 21(Δ) from Dörpfeld 1885: pl. 2.

ameter of 0.70 m (*MoP*: 0.04 m).[42] It is to be noted that there is no difference in bottom diameter between the wider (3.38–3.39 m) and narrower (2.16 m) spaced colonnades (Table 6.7).

Column Drum Dimensions of Re-used Column Drums in the Ramps of Shipsheds 17(η), 20(π) & 21(Δ)

Dragátsis mentions three re-used column drums in the ramp of Shipshed 21(Δ) and one in Shipshed 17(η).[43] On Dörpfeld's plan, three peculiar blocks (S21:R3–R5) in the mid-north side of Shipshed 21(Δ)'s ramp may be interpreted as these three features (Pls. 16–17). The peculiar blocks in Ramp 21(Δ) are drawn by Dörpfeld with three lines on the southern side, an indication perhaps that that part was rounded or had a particular profile (Table 6.8).

The 2002 ZHP excavation of Shipshed 17(η) exposed a re-used column drum (S17:R11; Pl. 6) with an extrapolated diameter of roughly 0.52 m (at its eastern end; Fig. 91), and three possible column drums (S17:R12–R14) in the southern side of the ramp. These features are cut flat on three sides, with a partial face inside the ramp structure left rounded. The northern side of the ramp foundation cutting (S17:R6) that received these blocks is rounded to mirror this shape. The similar cutting in the submerged ramp foundation of Shipshed 17(η) (S17:R7) is also rounded, and in all probability held similar blocks (Fig. 181).

The blocks in the ramp of Shipshed 21(Δ) are probably re-used column drums of a similar design (Pl. 17). During rescue excavations in 2003 Michaloupoulou exposed nine column drums re-used in the ramp structure of Shipshed 20(π).[44] Here the column drums were cut flat on four sides leaving only the corners rounded. They lie horizontally side-by-side across the ramp. In the basement of Sirangiou 1 was found column drum AE:13 (BD: 0.57 m, TD: 0.54 m, H: 1.01 m). This column drum was placed on column base C17/18:7(δ) during the reconstruction work in 2000–2001, mentioned above (Pl. 6).

Zea, Area 6 (Group 4): Column Drums at the Hellenic Maritime Museum

The 13 column drums located at the Hellenic Maritime Museum were thought until recently to originate from the shipsheds excavated in 1885 by Dragátsis and Dörpfeld in the eastern part of Zea Harbour.[45] They were analysed and catalogued in 2002 by ZHP with a view towards answering at least some of the questions raised above, but also to determine whether it was possible to identify them as the column drums shown in photograph PIR 6 (Pl. 32).[46]

Halfway through the investigations, ZHP was informed by J. Berbili of the Hellenic Maritime Museum

42. The now-missing drum standing on column base C17/18:7(δ) and drums C18/19:3, C22/23:2, C22/23:4 and C23/24:4.

43. Dragátsis 1885: 65.

44. S. Michaloupoulou, pers. comm. 2007. The author is much indebted to S. Michaloupoulou for sharing this important information.

45. J. Berbili, Hellenic Maritime Museum, pers. comm., 2000; D.J. Blackman, pers. comm., 2000. See Chapter 3, p. 20.

46. The investigations were carried out with kind permission and assistance from the Hellenic Maritime Museum by S. Hayward, T.M. Christensen, K. Lovén, C.W.D. Pochin and the present author. In addition, several column drums stored in the courtyard of the Archaeological Museum of Piraeus were examined for evidence of submersion in the sea and their dimensions were compared to the those at the Hellenic Maritime Museum. Only one drum had evidence of being submerged in the sea; none had comparable dimensions.

that the column drums were not from Dragátsis' and Dörpfeld's 1885 excavations in Area 1. Berbili had been going through the early annals of the Hellenic Maritime Museum, and, according to a handwritten document, 13 column drums were found in the sea in front of the *Rowers' Club* (Όμιλος Ερετών; Area 6, Z-G4) during dredging work for the marina in August 1964 (Figs. 2–3). The columns are described in the annals as belonging to the Zea shipsheds. In 1964 they were brought to the building lot of the planned Hellenic Maritime Museum.[47] In Arvanitopoulou's 1966 article there is a photograph of the column drums standing next to the sea on the southwest side of the harbour entrance of Zea.[48] A/A 1189/II and A/A 1189/III belong to the same column drum, clarifying why there are 14 pieces at the museum today. Although these column drums were not found in the area of Zea presently under discussion, they are included here due to their importance in analysing the *in-situ* column drums found in Area 1.

That they were found in the harbour basin during dredging work is confirmed by the machine marks on seven of the column drums (see for example A/A 1189/V; Fig. 88). These marks probably are from a mechanical excavator, or less likely, from anchor or anchor chain damage.[49] Shipshed 17(η) bears similar marks on the side-passages and ramp area close to the modern concrete quay, and these were probably caused by an excavator during the construction of the marina.

All of these column drums were cut from the local pale yellow/gray limestone, similar to the limestone used in the shipsheds excavated by Dragátsis and Dörpfeld in 1885. Column drums A/A 108, A/A 1189/VI and A/A 1189/VII exhibit bore holes carved by marine mollusks (Figs. 86, 89). There are several quarries of similar limestone close to the sea in the Piraeus, and although these quarries may have been submerged in the past, it is unlikely that mollusks bored into the stone before it was quarried. These can penetrate rock only to a depth of *ca* 0.01 to 0.03 m; as the bore holes are spread relatively evenly around the curving surface of the column drums, it is highly unlikely that they were present in the limestone before it was quarried. However, such mollusks only attack exposed stone surfaces, so the undamaged column drums of this group must have been completely buried in sediment.

Taking into account the annals of the Hellenic Maritime Museum and this material evidence, it is most likely that the column drums were originally found in the sea. Substantial remains of possible shipsheds were found in Area 6 (Z-G4) of Zea (Figs. 2–3; Chapter 4.1.4). The marine context of the column drums supports the view that they belonged to the Zea shipsheds. It is known from the Naval Inventories that 196 shipsheds were arrayed around the shoreline at Zea in 330/29 BC.[50] In this shipshed complex there were thousands of columns, each composed of several drums. Although side-walls and perhaps pier colonnades were used in some shipsheds, the probability of finding a homogenous group of column drums belonging to another building type at or near Zea's harbour basin is statistically very low in this context. Even so, the possibility that the column drums belonged to some other building type cannot be completely excluded.[51]

The column drums at the Hellenic Maritime Museum may then be considered representative of those used in the shipshed complex, with the proviso that their exact provenance remains uncertain. Adding to that uncertainty is the inability to date the columns or to assign them to a particular building phase over the life of the complex. They must therefore be included with caution in any analysis, although it will be argued in Chapter 8.2.4 that the heights of the shipsheds were in all probability determined by the ships they were built to store, possibly signifying that the height of the superstructure of a *trireme* shipshed was somewhat uniform.

Distinguishing Drums within Columns

The column drums that have survived include examples of a first drum, a second drum and a third drum,

47. The author wishes to thank J. Berbili very much for bringing this crucial unpublished document to his attention.

48. Arvanitopoulou 1966: 41, fig. 12.

49. Column drums with machine or perhaps anchor drag marks: A/A 105, A/A 107, A/A 108, A/A 1189/V, A/A 1189/VI, A/A1189/VII and A/A 1189/IX.

50. IG *II*^{2} 1627, 398–405 (see Chapter 2, pp. 13–14).

51. The flat vertical cuttings on the sides of column drums A/A 108, A/A 111, A/A 1189/I and A/A 1189/VII (see Fig. 89) may be a sign of re-use in the repair or construction of new shipsheds or in later harbour structures. Perhaps the sides of standing columns were shaved down to expand the internal space of a building.

a. Bottom diameters of lowest column drums			
Column drum	**Bottom diameter (m)**	**Projected bottom diameter (m)**	**Average (m)**
A/A 108	*0.663 (0.17 FB)*		
A/A 1189/II	*0.650 (0.19 FB)*		
A/A 1189/VI		0.669	
A/A 1189/VII		0.668	
A/A 1189/VIII		0.660	
A/A 1189/X		0.672	
A/A 1189/II	Not preserved		
A/A 1189/I	Not preserved		
			0.667
b. Top diameters of lowest column drums			
	Top diameter (m)	**Projected top diameter (m)**	
A/A 105	0.631 (0.07 *FT*)		
A/A 108	0.625 (1.28 *FB*)		
A/A 1189/I	0.628		
A/A 1189/III	*0.630 (0.22 FT)*		
A/A 1189/VII		0.615	
A/A 1189/VIII		0.630	
A/A 1189/X		0.620	
A/A 1189/II	Not preserved		
A/A 1189/VI	Not preserved		
			0.625
c. Height of lowest column drums			
	Height (m)		
A/A 105	1.361		
A/A 108	1.331		
A/A 1189/VII	1.295		
A/A 1189/VIII	1.390		
A/A 1189/X	1.300		
A/A 1189/I	Not fully preserved		
A/A 1189/II	Not fully preserved		
A/A 1189/VI	Not fully preserved		
			1.335
FT = from top *FB = from bottom*			

Table 6.9. Critical dimensions of the lowest column drums (from Area 6 at Zea Harbour). Measurements in italics are not included in the average calculations.

a. Bottom diameters of second column drums		
Column drum	**Projected bottom diameter (m)**	**Average (m)**
A/A 1189/V	0.625	
A/A 1189/IX	0.633	
		0.629
b. Top diameters of second column drums		
	Projected top diameter (m)	
A/A 1189/V	0.584	
A/A 1189/IX	0.583	
		0.584
c. Height of second column drums		
	Height	
A/A 1189/V	1.327	
A/A 1189/IX	1.370	
		1.349

Table 6.10. Critical dimensions of the second column drums (from Area 6 at Zea Harbour).

as defined by their dimensions. The lowest drums lack *empolion* cuttings on their bottom surfaces and exhibit the greatest recorded bottom and top diameters of the column drums (Fig. 87). The preserved column bases in C16/17(η) and C17(η)/18(χ) lack a rectangular cutting for an *empolion* on their top surfaces (Pl. 6; Figs. 73, 82–83) and consequently the lowest drums lack it also on their bottom surface. This points to an architectural similarity between the column drums found in the sea in Area 6 (Z-G4) and those that stood on the column bases in Area 1. In all, nine lowest drums have been identified at the Hellenic Maritime Museum (Table 6.9). *Empolion* cuttings are seen in the column bases at Oiniadai, dating to the 4th–3rd centuries BC (Fig. 44; see below). As this is also a construction feature often seen in the 4th century BC and later,[52] it may signify that the Phase 3 shipsheds are earlier than the date of the closed deposit found in the ramp of Shipshed 17(η) (*terminus post quem* 375–350 BC; see Vol. I.2, p. 39).

The bottom diameters vary between 0.660–0.672 m, with an average diameter of 0.667 m (Table 6.9a). The top diameters range between 0.615–0.631 m, with an average of 0.625 m (Table 6.9b). The height is between 1.295–1.390 m, with an average height of 1.335 m (Table 6.9c). Four partially preserved drums (A/A 105, A/A 1189/I, A/A 1189/II and A/A 1189/VI) were identified as lowest drums by comparing their preserved top or bottom diameters with the diameters of the other base column drums. Two (A/A 1189/II and A/A 1189/III) belong to the same column drum.

52. Dr. J. Pakkanen, pers. comm., 2008.

a. Bottom diameters of third column drums			
Column drum	**Bottom diameter (m)**	**Projected bottom diameter (m)**	**Average (m)**
A/A 107	0.579 (0.05 *FB*)	-	
A/A 1189/IV	-	0.579	
A/A 111	Not preserved	-	**0.579**
b. Top diameters of third column drums			
	Top diameter (m)	**Projected top diameter (m)**	
A/A 107	0.521	-	
A/A 111	0.530 (0.07 *FT*)		-
A/A 1189/IV	-	0.527	
			0.526
c. Height of third column drums			
	Height (m)		
A/A 107	1.463		
A/A 1189/IV	1.221		
A/A 111	Not preserved		
			1.342
FT = from top *FB = from bottom*			

Table 6.11. Critical dimensions of the third column drums (from Area 6 at Zea Harbour).

The bottom diameters of column drums A/A 1189/V and A/A 1189/IX are 0.625 m and 0.633 m. The fact that their average diameter of 0.629 m (Table 6.10a) is only 0.004 m greater than the average top diameter of the lowest drum (0.625 m) identifies them solidly as the second drum. They have top diameters of 0.584 m and 0.583 m, averaging 0.584 m (Table 6.10b). The second drums have a height of 1.327 m and 1.370 m, with an average of 1.349 m (Table 6.10c).

Using the same logic, A/A 107 and A/A 1189/IV are identified as the third drums. They have an identical bottom diameter of 0.579 m (Table 6.11a), a discrepancy of 0.005 m compared with the average top diameter of the second column drums (0.584 m). They

Element(s)	Average height (m)
First (lowest) column drum	1.335
Second column drum	1.349
Third column drum	1.342
Drums 1 to 3	4.026
All column drums	1.342

Table 6.12. Heights of the first three column drums (from Area 6 at Zea Harbour).

Column drum	Empolion cutting	Plan measurements (m)
A/A 1189/V	top	0.061/0.054/0.052/0.055
A/A 1189/V	bottom	0.065/0.059/0.059/0.057
A/A 1189/VII	top	0.045/0.055
A/A 1189/VIII	top	0.065/0.055
A/A 1189/IX	top	0.065/0.050
A/A 1189/IX	bottom	0.060/0.050/0.065/0.047
A/A 1189/X	top	0.080/0.060

Table 6.13. Plan measurements of empolion cuttings (from Area 6 at Zea Harbour).

have top diameters of 0.521 m and 0.530 m. A/A 111 has a top diameter of 0.527 m and is identified as a third drum by comparison with the top diameters of A/A 107 and A/A 1189/IV. Their average top diameter is 0.526 m (Table 6.11b). A/A 107 and A/A 1189/IV have a height of 1.463 m and 1.221 m, averaging 1.342 m (Table 6.11c).

As the 13 column drums from the Hellenic Maritime Museum can be categorised into three very homogeneous types, they in all probability belonged to the same building or to identical buildings (see Tables 6.9–6.13).

Colonnade Dividing Shipsheds 18(χ) and 19(φ): In-Situ Column Drums

A mentioned above, Dragátsis describes column drums labelled τ (C18/19:1) and υ (C18/19:3) on Dörpfeld's plan (Pl. 17) as found *in situ*. Today, the tops of column drums are visible fenced in on the pavement in front of Sirangiou 1. It is interesting that they had already been protected in this way when I.A. Meletopoulos commissioned a number of photographs of this part of the site in the 1950s (see bottom right-hand corner, Fig. 60). The area around the upper part of column drums C18/19:1(τ) and C18/19:3(υ) was surface cleaned during the ZHP investigations in order to measure their diameters. The original top surface of C18/19:3(υ) has been completely removed by a horizontal break; a diameter of 0.606 m was measured 0.10 m below the break on a well-preserved surface. The spot-height of the extant surface is +4.82 m. The height of C18/19:3(υ) above the base can be calculated from Dörpfeld's spot-height on column base C18/19:3(υ) (+3.82 m/calibrated +3.75) at 1.07 m. The heavily eroded top surface of C18/19:1(τ) has a badly damaged *empolion* cutting; its diameter is 0.598 m. By comparing the elevation of the top surface of C18/19:1(τ) (+5.35 m) with that of column base C16/17:2(θ) (+4.07 m) the height of column drum C18/19:1(τ) can be deduced as *ca* 1.28 m. The top of C18/19:1(τ) is eroded down to the bottom of the *empolion* cutting. By adding the average depth (0.044 m) of the *empolion* cuttings from the drums at the Hellenic Maritime Museum (Table 6.14; Fig. 90) the height is reconstructed at 1.32 m. This height is comparable with the three *in-situ* column drums C20/21:3, 7 and 10 (average: 1.29 m, *VMoP*: 0.03 m), the 13 column drums at the Hellenic Maritime Museum (average: 1.342 m), and the three re-used column drums (S21:R3–R5) in the ramp of Shipshed 21(Δ) (1.31 m, *MoP*: 0.04 m).

The interaxial spacing between C18/19:1(τ) and C18/19:3(υ) is 3.38 m, which is identical in the case of C16/17(η) and nearly so (3.39 m) in the case of C20(π)/21(Δ) on Dörpfeld's plan (Pl. 17). According to the ZHP survey, the centre-to-centre measurement between C16/17:2(θ) and C16/17:4(ι) is 3.38 m, with the reservation that this base does not lay flat, but is tilted slightly upwards at its western end (Fig. 174a). Interesting in this context are the remains of what

Column drum	Empolion cutting	Depth (m)
A/A 1189/I	top	0.044–0.049
A/A 1189/III	top	0.050
A/A 1189/IV	top	0.040
A/A 1189/V	top	0.054
A/A 1189/V	bottom	0.029
A/A 1189/VII	top	0.035
A/A 1189/VIII	top	0.038
A/A 1189/IX	top	0.042
A/A 1189/IX	bottom	0.050
A/A 1189/X	top	0.057
Average depth of an *empolion* cutting: 0.044 m (range: 0.029 to 0.057 m)		

Table 6.14. Depth of empolion cuttings (from Area 6 at Zea Harbour).

appear to be an iron pry-bar found lodged between the western side of C16/17:2(θ) and the foundation trench. This tool was either broken during the construction of the shipsheds, or in a failed attempt to rob the column base (Fig. 84).

It is extremely unlikely that the two column drums would have had their original interaxial spacing if they had been re-erected and re-used at some point in time before they were exposed during construction work in 1886.[53] C18/19:1(τ) was not re-erected by Dörpfeld and Dragátsis, since only the top part was exposed during the 1886 road work.

Summary of Column Drum Dimensions

The Area 1 column drums have been found to be slimmer than those stored at the Hellenic Maritime Museum: Area 1's C18/19:3(υ) has a diameter of 0.606 m at a height of *ca* 0.97 m from the base, and C18/19:1(τ) has a top diameter of 0.598 m at *ca* 1.28 m above the base. The average top diameter of the base column drums at the museum is 0.027 m wider than that of C18/19:1(τ). At the same height of 0.97 m, the average diameter of those in the museum is 0.031 m wider than C18/19:3(υ). The average discrepancy among the diameters of the drums from Area 6 and C18/19:1(τ) and 3(υ) is 0.029 m. Assuming that this discrepancy is constant along the height of the column drums, then the lower diameter of C18/19:1(τ) and 3(υ) can be extrapolated to 0.64 m. This is in contrast to the data provided by Dörpfeld's plan and sections, which show a bottom diameter of all base column drums in Area 1 at *ca* 0.70 m. Both of these figures are wider than the column diameter of 0.58 m recorded by Dragátsis.[54] By comparison, at Oiniadai the lower diameters of the shipshed columns range between 0.70–0.75 m (see pp. 119–120), and this 0.05 m variation is close to the 0.06 m discrepancy of the columns in Area 1 at Zea Harbour. It should be noted that the lower diameter of the bottom column drums found in Area 6 of Zea varies only by 0.012 m (see Table 6.9a).

It is assumed that the columns of the alternating narrowly- (IA 2.16 m) and widely-spaced (IA 3.38–3.39

53. Dragátsis 1885: 70.
54. Dragátsis 1885: 67.

m) colonnades at Zea had the same lower diameter within the range discussed above. First, column drums with the same diameter would clearly be easier to mass produce. Second, this would provide a more uniform horizontal storage space in a shipshed than colonnades of columns with alternating lower diameters where the centre the intercolumniation between the two colonnades would be off-set slightly towards that with the narrower lower diameter.

While it is not possible to eliminate the slim possibility that Dragátsis' diameter of 0.58 m represents the bottom diameter of a column in the colonnade with the narrower interaxial spacing, it is most likely that Dragátsis measured the diameter of a drum that belonged higher up in the column. In fact, the average top diameter of the second and the bottom diameter of the third column drums (0.584 m and 0.579 m) at the Hellenic Maritime Museum are identical to Dragátsis' 0.58 m.

Other evidence may be adduced to support this view. The average width of the second course in Wall 16/26(λ) (0.62 m) is close to the reconstructed diameter (0.64 m) of C18/19:1(τ) and 3(υ). The 0.65 m width of the first course in Spur-wall C17/18(γ) is also close to this column diameter. The widths of Spur-walls C21/22(Γ) (0.64 m) and C23/24(Ρ) (0.66 m) on Dörpfeld's plan (*MoP* of 0.04 m) are identical or nearly identical with the reconstructed lower diameter of 0.64 m. These approximate or identical values strongly suggest a purposefully interchangeable architecture.

While a diameter of 0.64 m is considered the primary bottom diameter of the Phase 3 columns, it cannot be ignored that the now-missing second column drums resting atop the three *in situ* lowest (first) column drums in C20(π)/21(Δ) (top diameter: 0.64 m, *HMoP*: 0.02 m) would have had a bottom diameter identical to the extrapolated bottom diameter of C18/19:1(τ) and 3(υ) (0.64 m). Even so, as argued earlier, it is very unlikely that the columns were re-erected before 1885 with an interaxial spacing of 3.38 m, a figure identical to the interaxial spacing of the more widely-spaced colonnades of Phase 3 (3.38–3.39 m). The average bottom diameter of 0.70 m (*HMoP*: 0.02 m) scaled from Dörpfeld's plan and sections is thus considered a secondary bottom diameter, as the extrapolated diameter of the *in-situ* columns supersedes these data.

Length:	0.81 m [5] (range 0.80–0.82 m)
Width:	0.81 m [4][55]
Height:	0.49 m [5] (range 0.47–0.52 m)

Table 6.15. Average Phase 3 column base dimensions. The figure in brackets gives the number of features on which the average calculation is based.

Table 6.16. Average Phase 3 column base dimensions as scaled from Dörpfeld's 1885 sections; no dimensions were scaled from Dörpfeld's plan.

Column base	Length (m)	Height (m)
C17/18:7(δ)	0.92	0.44
C17/18:9(ε)	0.90	0.44
C17/18:11(ζ)	0.88	0.44
C20/21:2(Η)	0.98	0.42
C20/21:6(Θ)	0.88	0.52
C20/21:9(Ι)	0.90	0.52
Average	**0.91**	**0.46**
Range	0.88–0.92	0.44–0.52

6.3.5. The Phase 3 Column Bases, Foundation Blocks and Rock-cut Foundations

Dragátsis and Dörpfeld documented a total of 16 Phase 3 features that can be identified as column bases, and an additional three that are probable column bases (Pl. 17). A total of six column base foundation blocks were all recorded in the section dividing Ship-

55. The width of C16/17:2 (0.89 m) is excluded from the average calculation because it differs so markedly from the width of the four other bases (0.81 m).

ZHP's colonnade ID	Spot-height (m)	Dörpfeld's ID	Dörpfeld's spot-height (m)	Difference (m)
a. Spot-height comparison for the column bases of narrowly-spaced colonnades				
C17/18:7(δ)	+4.08	C17/18:7(δ)	+4.14	0.06
C17/18:9(ε)	+3.86	C17/18:9(ε)	+3.93	0.07
C17/18:11(ζ)	+3.64	C17/18:11(ζ)	+3.72	0.08
C17/18:7(δ)	+4.08	C23/24:3(Σ)	+4.14	0.06
C17/18:9(ε)	+3.86	C23/24:5(T)	+3.93	0.07
C17/18:11(ζ)	+3.64	C23/24:6(Υ)	+3.72	0.08
b. Spot-height comparison for column bases of widely-spaced colonnades				
C16/17:2(θ)	+4.07	C20/21:2(H)	+4.15	0.08
C16/17:4(ι)	+3.75	C20/21:6(Θ)	+3.82	0.07
C16/17:4(ι)	+3.75	C18/19:2(υ)	+3.82	0.07
			Average height difference: **0.07 m**	

Table 6.17. Spot-height comparison for Phase 3 column bases.

sheds 20(π)/21(Δ) (Pls. 21a, 25b).[56] Five of these column bases (C16/17:2(θ), C16/17:4(ι), C17/18:7(δ), C17/18:9(ε), C17/18:11(ζ)) are accessible in the basement of Sirangiou 1 (Pl. 6; Figs. 174a, 176b). Their average dimensions are listed in Tables 6.15–6.16.

Analysis of Dörpfeld's Spot-heights on Column Bases and their Foundations

Before proceeding with an analysis of the colonnades it is necessary to determine heights in relation to one another. On Dörpfeld's plan and longitudinal-sections spot-heights are printed on colonnades C16/17(η), C17(η)/18(χ), C18(χ)/19(ϕ), C20(π)/21(Δ) and C23-(Π)/24(Φ) (Pls. 17, 20). For example:

1) Column bases, e.g. C20/21:2(H) +4.15 (Pls. 16–17); C17/18:7(δ) +4.14 (Pls. 15, 20).
2) Column base foundation blocks, e.g. C20/21:18 +1.00 (Pls. 16–17, 25b).
3) Rock-cut foundation trenches for column bases, e.g. C16/17:7 -0.05 (Pls. 15, 17).

Near the datum zero in the bottom right-hand corner of the plan is printed: "Note: the red numbers indicate height above the sea" (Pl. 17).[57] The spot-heights are clearly the height above and below the sea level datum zero for a given point. The vertical printed elevations on the sections of C17(η)/18(χ) and C20(π)/21(Δ) are also measured to this sea level datum zero (Pl. 20).

56. Column bases: C16/17:2(θ), C16/17:4(ι), C17/18:7(δ), C17/18:9(ε), C17/18:11(ζ), C18/19:3(υ), C20/21:2(H), C20/21:6(Θ), C20/21:9(I), C22/23:1(Ξ), C22/23:3(O) C23/24:3(Σ), C23/24:5(T) and C23/24:6(Υ). Probable column bases: C16/17:7(K), C21/22:5(M) and C24/25:2(Ψ). Column base foundation blocks: C20/21:5, 12–13, 15–16 and 18. The Phase 2 colonnade features are not included here.
57. Dragátsis 1885: pl. 2.

Shipshed	Spot-height (m)	Shipshed	Spot-height (m)
C17/18:7(δ)	+4.14	C23/24:3(Σ)	+4.14
C17/18:9(ε)	+3.93	C23/24:5(T)	+3.93
C17/18:11(ζ)	+3.72	C23/24:6(Υ)	+3.72

Table 6.18. Dörpfeld's 1885 corresponding heights of the three upper-most column bases.

There is an average height difference of 0.07 m (± 0.01 m) between the ZHP spot-heights (87DZ) on the top of the *in-situ* column bases in C16/17(η) and C17(η)/18(χ) and the corresponding upper column bases in C20(π)/21(Δ), C17(η)/18(χ) and C23(Π)/24(Φ) on Dörpfeld's plan and sections (Table 6.17).

According to the data provided by Dörpfeld, the three upper-most column bases in the narrowly-spaced colonnades dividing Shipsheds 17(η)/18(χ) and Shipsheds 23(Π)/24(Φ) rest at exactly the same level (Table 6.18; Pls. 17, 20).

When calibrated to Dörpfeld's spot-heights, the second column base in the widely-spaced colonnade C16/17:4(ι) also rests at exactly the same elevation as C18/19:3(υ) and C20/21:4(Θ): +3.82 m (Pls. 17, 20). The ZHP surveyed spot-height on C16/17:2(θ) is +4.07 m (calibrated to Dörpfeld's +4.14 m); it differs by just 0.01 m compared with C20/21:2(H) at +4.15 m. The uniformity of the spot-heights conclusively demonstrates that these features are most certainly preserved to their original height.

This uniformity in spot-heights also demonstrates that extreme care was taken in constructing the corresponding colonnades in the Phase 3 shipshed complex at nearly the same elevation. It is therefore concluded that the column drums described by Dragátsis as found *in situ* are elements of shipshed columns, and that the blocks on which they once stood are column bases.[58] Significant to the study of the superstructure is the information contained in Dörpfeld's plan and sections with regard to the colonnade dividing Shipsheds C17(η)/18(χ) and C20(π)/21(Δ) (Pls. 17, 20), and that dividing Shipsheds C16/17(η) and C23(π)/24(Φ) (Pl. 17). This evidence, when combined with the ZHP plans and sections, permits analysis of major parts of the colonnades that are now either destroyed or covered by modern buildings (Pls. 2, 15–16, 23a, 25a).

Rock-cut Foundations in Phase 3

In the basement of Sirangiou 1 there are two distinct types of Phase 3 rock-cut foundation trenches for column bases. In the first type, three column bases (C17/18:7(δ), C17/18:9(ε) and C17/18:11(ζ)) are set in three shallow, irregular and roughly square rock-cut trenches (C17/18:6, C17/18:8 and C17/18:10) (Pl. 6; Fig. 73). In the second type, the column bases are either fully set into a deep trench (column base C16/17:2(θ) in trench C16/17:1; Fig. 82) or set into a foundation trench of varying depth (0.03–0.42 m; column base C16/17:4(ι) in foundation trench C16/17:3; Fig. 83). Aesthetic considerations clearly did not dictate the shape of the foundation trenches of the Phase 3 shipsheds. Instead, the layout was determined by practical parameters, such as the height of the surrounding natural bedrock, its hardness, and the choice not to remove bedrock that could have been used in the side-passages. How the foundation trenches impacted the *interior space* of the shipsheds will be discussed at length in Chapter 7.5.

On Dörpfeld's sections of C17(η)/18(χ) and C20-(π)/21(Δ) there is an obvious difference between the

58. Of course there remains the remote possibility that these elements may have been re-erected for secondary and unknown purposes after the shipsheds went out of use, but it seems almost impossible that they would have been re-erected with consistently alternating inter-axial spacings of 2.16 m and 3.38–3.39 m.

rock-cut features in the eastern and western half of these colonnades (Pls. 20–21). In colonnade C17(η)/18(χ) there are no clear man-made features in the bedrock between rock-cut foundation trenches C17/18:6, 8 and 10, but the natural bedrock may have been worked roughly down to the present slope (Pls. 20–21; Figs. 73, 176b). The same is true for the two column base foundations C17/18:12–13 (Pl. 23a) which appear to exhibit the same characteristics as C17/18:6, 8 and 10 (Pl. 24; Fig. 176b). We see a marked difference west of foundation trench (C17/18:13) for column position 12 (Pl. 24). The rock-cut trench (C8/9:2; Pls. 13, 23) and the block placed here (C8/9:3) have no logical architectural relation to the 2.16 m interaxial spacing of the Phase 3 colonnade. When compared to the colonnade section C17/18:6–11 the construction of a long (6.18 m) foundation trench (C17/18:14; Pls. 23a, 24) for column positions 14–16 clearly indicates that earlier features were levelled for the Phase 3 colonnade foundations (Pl. 24). As discussed below, the blocks identified as foundations for the Phase 2 superstructure are either standing in deep- or shallow-cut foundations just large enough to accommodate them (see Chapter 6.4).[59] Since the Phase 2 foundations that were not extended in Phase 3 are clearly defined (Pl. 4), it is most likely that the very long foundation trenches of C16/17:7 (2.78 m) and C17/18:14 (6.18 m) (Pl. 15) were constructed in Phase 3 to level the Phase 1 slipways in the colonnade areas and were designed either to re-use, extend or level out the Phase 2 colonnade foundations. These types of Phase 3 foundations begin 31.74 m (*MoP*: 0.04 m) and 31.44 m (*HMoP*: 0.01 m), respectively, from the inside of the back-wall and are preserved for a distance of 58.57 m (*MoP*: 0.01 m) in C23/24:10 (Pl. 16).

The design and layout of these features also clearly indicate the need to build up substantial foundations for the Phase 3 colonnades. Foundations built to a considerable depth are a common feature in stoai and temples with heavy superstructures. The best comparative evidence is found in the Mandraki shipsheds in Rhodes City, where the foundations of the colonnades reach a maximum depth of *ca* 3.4 m (see pp. 121–123). In the possible shipshed documented by Meletopoulos, the colonnade foundations also appear to have been built to a considerable height (see pp. 40–42). At both Mandraki and in some areas of Zea, the relatively level topography of the construction sites dictated the need to build up foundations to obtain the required height above sea level (Fig. 15). It is probably no coincidence that the long colonnade foundations of Shipshed 17(η) in Phase 3 at Zea begin at nearly the same distance from the back-wall (see above).

A similar picture can be observed in the section of C20(π)/21(Δ) (Pls. 20a, 21a, 26). The foundations of column position 6 and the colonnade east of it were cut into the natural sloping bedrock, with no evident man-made structures between them. All are rock-cut trenches, with the exception of the raised foundation C20/21:11. Between the foundations of column positions 8 (C20/21:17–18) and 10 (C20/21:20) in the Phase 3 colonnade are three features that evidently do not belong to this structure: two adjacent blocks (C11/12:8) set in foundation trench C11/12:7, and a raised rock cutting (C11/12:9). It will be shown in the discussion of the Phase 2 superstructure below that these features belong to this earlier building phase (Pls. 25b, 26).

A number of Phase 3 foundations are formed from the re-use and extension of Phase 2 colonnade features. The estimates of extension are based on the preserved length of the feature minus the average length of the intact Phase 2 colonnade foundations (1.35 m) closed on all four sides. The following list provides the best examples of Phase 2 features extended in Phase 3:

1) C7/8:1 extends *ca* 1.43 m (*MoP*: 0.04 m) westward forming C16/17:7 and accommodating Phase 3 column position 10 (Pls. 13, 15, 25a).

2) C7/8:2 extends *ca* 2.50 m (*MoP*: 0.05 m) westward forming C16/17:8 and accommodating Phase 3 column position 11 (Pls. 13, 15, 25a).

3) C7/8:3 extends *ca* 2.64 m westward forming C16/17:9 and accommodating Phase 3 column positions 12 and 13. Column position 13 stands above the transition between C16/17:9 and C7/8:4. The loca-

59. Average dimensions of intact rock-cut Phase 2 foundation trenches: length 1.35 m; average width of 1.10 m (see p. 112).

tion of column position 13 is identified by pry marks C16/17:9a–b (Pls. 13, 15, 25a; Fig. 181).

4) C7/8:5 extends *ca* 0.71 m eastward forming part of the foundations (C16/17:10) accommodating column position 14 (Pls. 13, 15; Fig. 181). This column stood above the eastern side of C16/17:10 (Pl. 25a).

5) The 6.18 m-long foundation trench C17/18:14, which was cut to accommodate column positions 14–16, in all probability levelled the Phase 2 colonnade foundations for column positions 4 and 5 in colonnade C8/9 (Pls. 13, 15, 23a).

6) Column base foundation block C9/10:2 has been shaved down by Phase 3 features, creating foundations for column positions 14–15 (C18/19:4A–C); excavated for a length of 4.91 m (Pls. 13, 15, 26; Figs. 188, 192c).

7) C14/15:4 extends 2.42 m westward forming C23/24:9 and accommodating Phase 3 column position 24 (Pls. 13, 16, 23b; Figs. 213–214, 216a).

Based on the evidence provided in Dörpfeld's plan and sections, it is possible to interpret the structural change in the western part of the foundations of these colonnades as representing two or more construction phases. In the sea there has been found solid evidence of a building phase earlier than Phase 3 in the superstructure, one that ties in perfectly with Dörpfeld's data. An analysis and identification of the earlier Phase 2 shipsheds will be presented at length below (Chapter 6.4).

6.3.6. The Interaxial Spacing and Intercolumniation of the Phase 3 Colonnades

Dörpfeld's Interaxial Spacing of the Individual Colonnades

According to the printed measurements on Dörpfeld's plan and longitudinal-sections, the interaxial spacing of the wider colonnades varies between 3.38 m (C16/17(η)) and 3.39 m (C20(π)/21(Δ)) (Pls. 17, 20).[60] The more narrowly-spaced colonnade dividing Shipsheds 17(η)/18(χ) has an interaxial spacing of 2.16 m.

In the basement of Sirangiou 1, no columns are preserved *in situ*. The interaxial spacing is based on the assumption that the centre of a column drum was placed precisely in the middle of a column base. The four corners of the column bases were cut to sharp, precise edges (Fig. 85) – an indication that great care was taken to place them in the correct position along the longitudinal axis (Pl. 6). The centre-to-centre measurement between C17/18:7(δ) and C17/18:9(ε) is 2.19 m, and that between C17/18:9(ε) and C17/18:11(ζ) is 2.16 m. According to the ZHP survey, the interaxial spacing between column drums C18/19:1(τ) and C18/19:3(υ) is 3.38 m (Fig. 231), but since their bases are inaccessible, it is not possible to verify whether the columns stood centrally on their column bases. The greater spacing between C17/18:7(δ) and C17/18:9(ε) shows that the bases were not always positioned with an interaxial spacing of 2.16 m, but that the final adjustments were done between the axes of the lowest column drums. A few centimetres of variation in interaxial spacings is not uncommon within a singular building in monumental Greek architecture.[61] The distance between the centres of column base C17/18:7(δ) and the well-defined column base foundation trench C14/15:1 (Pls. 13, 15; re-used as the foundations of column position 18 in the narrow spaced colonnade C23(Π)/24(Φ)), is 36.74 m. This results in an interaxial spacing of 2.16 m, thus revealing that Dörpfeld's interaxial spacing measurements for the narrow colonnades cannot be far off (Pl. 16).[62]

In the more widely-spaced colonnade dividing Shipsheds 20(π) and 21(Δ), Dragátsis reports a distance of 2.60 m between each of the three first column bases, C20/21:2(H), 6(Θ) and 9(I).[63] The average length of the column bases preserved in the Sirangiou 1 basement is 0.81 m; since Dragátsis records a distance of 2.60 m, this value must represent a measurement between the nearest sides of two column bases with an interaxial spacing of 3.39 m (2.60 m + 0.81 m = 3.41 m). The interaxial spacing between C22/23:1(Ξ) and

60. It must be noted that the western part of C16/17:4(ι) has been pushed upwards at some point in time (Fig. 174a).

61. Coulton 1975: 95–97.

62. Between column positions 1 and 18 there are 17 interaxial spacings: 36.74 m/17 = 2.16 m.

63. Dragátsis 1885: 64.

Shipshed	Printed (m)	Scaled (m)	ZHP (m)
16	*6.49*	*6.38*	*6.48*
17(η)	6.54	6.64	6.50
18(χ)[68]	*6.50* (?)	6.54	6.45
19(ϕ)[69]	6.52	6.54	-
20(π)[70]	6.52	6.54	-
21(Δ)	6.52	6.52	-
22(N)	6.50	6.48	-
23(Π)	6.49	6.54	-
24(Φ)	6.47	6.38	-
Average	**6.51**	**6.52**	**6.48**

Table 6.19. Interaxial spacing between adjacent colonnades of the Phase 3 shipsheds: comparison between the printed interaxial spacing between the colonnades on Dörpfeld's 1885 plan, scaled measurements on the printed interaxial spacing and ZHP measurements.

C22/23:3(O) is not printed on Dörpfeld's plan, but Dragátsis reports that it exhibits the same distance as the bases in C20(π)/21(Δ) (IA: 3.39 m). He also reports that the spacing of column bases in colonnades C24/25:1(X) and C24/25:2(Ψ) is the same as between C22/23:1(Ξ) and C22/23:3(O).[64] Although this is not a very clear way to describe the spacing between the colonnades, it does convey the notion that the two colonnades have an interaxial spacing in the vicinity of 3.39 m. In Dragátsis' summary of the architecture of the shipsheds, the interaxial spacing of the more widely-spaced colonnades is defined as 3.39 m. This information was in all probability based on the interaxial spacings of C20(π)/21(Δ).[65]

Dragátsis also indicates that the column bases in the narrowly-spaced colonnade dividing Shipsheds C23(Π)/24(Φ) (C23/24:3(Σ), C23/24:5(T) and C23/24:6(Υ)) exhibit the same spacing as the column bases in the colonnade dividing Shipsheds 21(Δ)/22(N) (C21/22:3(K), C21/22:4(Λ) and C21/22:5(M)).[66] Neither Dragátsis' report nor Dörpfeld's plan provides the specific measurements on these colonnades. As discussed above, in all probability, the interaxial spacing of C23(Π)/24(Φ) was close to the measurement of the narrowly-spaced colonnade dividing Shipsheds 17(η) and 18(χ) (2.16 m). According to Dragátsis, the narrowly-spaced colonnades in front of the spur-walls have an interaxial spacing of 2.06 m. This is in all probability a typographic error, since his interaxial spacing of the more widely-spaced colonnades (3.39 m) corresponds with the printed measurements on Dörpfeld's plan and section of C20(π)/21(Δ); Dragátsis probably meant 2.16 m, as printed by Dörpfeld.[67]

64. Dragátsis 1885: 64–65.
65. Dragátsis 1885: 67.
66. Dragátsis 1885: 65.
67. Dragátsis 1885: 67.
68. Dörpfeld put a question mark next to this interaxial spacing, expressing some doubt about the measurement. The measurement is excluded from the calculation.
69. The interaxial spacing of Shipsheds 19(ϕ) and 20(π) is calculated by dividing by two the printed measurement between the axes of colonnades C18(χ)/19(ϕ) and C20(π)/21(Δ) (13.03 m).
70. The interaxial spacing of Shipsheds 19(ϕ) and 20(π) is calculated by dividing by two the printed measurement between the axes of colonnades C18(χ)/19(ϕ) and C20(π)/21(Δ) (13.03 m).

Dörpfeld's Interaxial Spacing between Adjacent Colonnades

The interaxial spacing between two adjacent colonnades delineating one shipshed represents the interaxial width of an individual shipshed. This measurement is essential for understanding the space between the colonnades and will be discussed at length later in this chapter. On Dörpfeld's plan, the printed interaxial spacing between the colonnades varies between 6.47 and 6.54 m – an indication that the width of the shipsheds varied within a range of 0.07 m. The average printed interaxial spacing is 6.51 m. This is close to the average of the scaled interaxial spacing (6.52 m), but here the range is wider (6.38 to 6.64 m, *MoP*: 0.04 m; see Table 6.19). The interaxial width of Shipshed 16 is not included in the average calculation because its northern side is defined by Wall 16/26(λ).

Dragátsis' Width between Adjacent Colonnades

In Dragátsis' summary of the architecture of the colonnade the width between the columns of a shipshed is 6.30 m. The measurement is based on the width of a ramp (3 m) and the distance from the columns to each side of the ramp (1.65 m). Dragátsis does not state whether the measurements are taken from a specific shipshed or are average measurements.[71]

Dörpfeld's interaxial spacing between adjacent colonnades varies from 6.47 to 6.54 m (range of scaled measurements: 6.38 to 6.64 m; *MoP* : 0.04 m), the ZHP measurements vary from 6.45 and 6.50 m (Table 6.19). The average distance from the centreline of the colonnade to the side of the ramp on Dörpfeld's plan is 1.71 m (see Table 7.8). The accessible remains in the basement of Sirangiou 1 yield an average distance of 1.72 m. Consequently, Dragátsis' 1.65 m does not represent the average distance from the centreline of the colonnade to the side of the ramp. Shipsheds 17(η), 22(N) and 23(Π) are in the vicinity of 1.65 m, but their ramps are wider than the 3 m used in Dragátsis' calculation (3.24 m, 3.12 m and 3.14 m). Nor does the measurement appear to have been taken from the side of a column base to the side of a column base in an adjacent colonnade, where the average distance is 5.70 m. The average ramp width in reality is 3.12 m; Dragátsis' ramp width of 3 m does not correspond with any of Dörpfeld's measurements, nor those of the ZHP survey (see Table 7.2). It is not at all clear where Dragátsis took the measurements used in the 6.30 m width calculation, but it clearly does not represent the interaxial spacing, intercolumniation, or the distance between the closest sides of two column bases. It appears that he confused the numbers or made a typographical error, and hence these measurements are excluded from this study. It is possible that he wrote the 1885 report from his own notes before he saw Dörpfeld's plan and sections.

Intercolumniation of Individual and Adjacent Colonnades

Based on the average 0.64 m extrapolated bottom diameter of the column drums C18/19:1(τ) and C18/19:3(υ) (see pp. 96–97), the intercolumniation (i.e. the distance between the bottom sides of columns) in the widely-spaced colonnades (IA 3.38–3.39 m) is 2.74–2.75 m, and that in the narrowly-spaced colonnades (IA 2.16 m) is 1.52 m.

The lower diameters of columns can vary and thus affect these figures. At Oiniadai, for example, the lower diameter range varies by as much as 0.05 m (0.70–0.75 m, see pp. 119–120). As the bottom diameter of 0.64 m of the columns at Zea is based on an extrapolation, it is possible that the average bottom diameters of 0.70 m scaled from Dörpfeld's plan was within the range of the actual bottom diameter of the Phase 3 shipsheds, resulting in lower range intercolumniations of 2.68–2.69 m (IA 3.38–3.39 m) and 1.46 m (IA 2.16 m).

The intercolumniation between two adjacent colonnades based on a bottom column drum diameter of 0.64 m, together with the average interaxial spacing between the colonnades of 6.51 m, comprises our primary dataset. The secondary dataset is based on calculations from Dörpfeld's bottom column drum diameter of 0.70 m. These present two possible measurements for the maximum internal width of the Phase 3 shipsheds:

1) Primary average intercolumniation: 5.87 m
(range: 5.83 m to 5.90 m)

2) Secondary average intercolumniation: 5.81 m
(range: 5.77 m to 5.84 m)

71. Dragátsis 1885: 67.

6.3.7. The Inclination of the Superstructure in Phase 3

One of the most important aspects of the Phase 3 shipsheds is the inclination of the superstructure. Its importance is due to the fact that no original or near-original surfaces of the keel-supporting ramp section (for example, the slots for transverse timbers sleepers found at Kos; Fig. 52) and side-passages are preserved to an extent that would allow their gradients to be calculated. The reconstructed gradients of the ramp and side-passages must therefore be based on those of the Phase 3 superstructure, from which they could not have differed by any significant amount. A keel-supporting ramp structure that differed even slightly in its inclination from the roof superstructure would have markedly affected the available free space between the underside of the roof and the top surface of the ramp; the only exception would be in the upper-most part of the building, where the ramp rose to meet the upward-curving stern of the warship (see Chapter 7.3).

The inclination of the Phase 3 superstructure is based on a detailed analysis of its individual elements: the foundations, column bases and inclined side-wall W16/26(λ).[72] The most extensively preserved remains in Area 1, the submerged foundation of the colonnade dividing Shipsheds 23(Π) and 24(Φ), comprise the crucial evidence that allows the inclination to be calculated with reasonable accuracy (Pls. 15–16, 34, 35).

Since the lower parts of the Phase 3 shipsheds have been destroyed, the gradient of the superstructure also provides the only reliable data that allow the total length of the Phase 3 shipsheds to be reconstructed by extrapolation. By extrapolation, this inclination also allows us to compute the location of the ancient harbour front and provides important evidence on the amount of localised relative sea level change since antiquity (see Chapter 8.1). It is important to keep in mind that a natural shoreline is quite different from a constructed harbour front: the lower ends of the shipsheds of Phases 2 and 3 required massive adjustments to the natural shoreline.

The uniformity of the spot-heights on the column bases in colonnades C16/17(η), C17(η)/18(χ), C18(χ)/19(φ), C20(π)/21(Δ) and C23(Π)/24(Φ) shows that these features are preserved to their original full height.[73] The regularity between spot-heights on the column bases also demonstrates the high precision and quality of the original architectural work.

The inclination of the column bases are thus calculated from the spot-heights on the top surfaces of the column bases and the interaxial measurements printed on Dörpfeld's plan and sections (Pls. 17, 20a–20b). These are augmented by the spot-heights and interaxial spacings of the five accessible *in-situ* column bases in the basement of Sirangiou 1 (Pl. 6). Since column base C16/17:4(ι) has been pushed slightly out of place, the inclination between this base and C16/17(θ):2 is based on Dörpfeld's recorded interaxial spacing and the ZHP survey spot-heights.[74]

The average gradient of 1:10 (5.7°) of the three identified column bases C17/18:7(δ), C17/18:9(ε) and C17/18:11(ζ) (IA: 2.16 m) is based on spot-heights recorded by Dörpfeld and verified by the ZHP investigations. Since Dörpfeld's spot-heights on the three identified column bases in C23/24:3(Σ), 5(Τ) and 6(ϒ) are identical to his vertical measurements on C17/18:7(δ), 9(ε) and 11(ζ) (Pls. 17, 20b; Table 6.17), and the ZHP spot-heights on the same features vary within ± 0.01 m, the column bases in the two colonnades most likely would have resulted in a similar inclination (Table 6.20).[75] The average inclination of the identified column bases in the more widely-spaced colonnades in C16/17(η) (IA: 3.38 m) and C20(π)/21(Δ) (IA: 3.39 m) is 1:11 (5.2°). The average gradient of C16/17(η), C17(η)/18(χ) and C20(π)/21(Δ) is 1:10 (5.7°).[76]

72. The well-preserved W16/26(λ) is the only side-wall in Area 1.
73. See pp. 98–99; C16/17:4(ι) is not *in situ*, but the spot-height of +3.75 m is solidly reconstructed from its height (0.52 m) and the height of it foundation trench C16/17:3 (+3.23 m).
74. The data provided by Dörpfeld allow the inclination to be calculated using two significant digits. For example, the height difference between column base C20/21:2(Η) and its neighbour C20/21:6(Θ) is 0.33 m (two significant digits) and the interaxial distance is 3.39 m (three significant digits), resulting in an inclination between their top surfaces of 5.6°, or 1:10 (two significant digits). The gradient of wall W16/26(λ) was calculated using the G2-T and G3-B methods (Figs. 220–221; see also pp. 55–56). The data from W16/26(λ) allow the gradients to be calculated using three significant digits.
75. The interaxial spacing of C23(Π)/24(Φ) is in all probability 2.16 m (see p. 101).
76. Both Dörpfeld's and the ZHP measurements on C17(η)/18(χ) are included in the calculations.

a. Inclination of column bases in widely-spaced colonnades (IA 3.38–3.39 m)			
Column base	**Spot-height (m)**	**Height difference (m)**	**Inclination**
C16/17:2	+4.07	-	-
C16/17:4	+3.75	0.32	1:11/5.2 ° (IA: 3.38 m)
C20/21:2(Η)	+4.15	-	-
C20/21:6(Θ)	+3.82	0.33	1:10/5.7° (IA: 3.39 m)
C20/21:9(Ι)	+3.50	0.32	1:11/5.2° (IA: 3.39 m)
Average		0.32	1:11/5.2°

b. Inclination of colonnade foundation blocks related to C20(π)/21(Δ) (IA 3.39 m)			
Foundation block	**Spot-height (m)**	**Height difference (m)**	**Inclination**
C20/21:12	+2.31	-	-
C20/21:13	+2.02	0.29	1:12/4.8°
C20/21:16	+1.66	0.36	1:9/6.3°
C20/21:18	+1.00	0.66	1:5/11°

c. Inclination of narrow-spaced colonnades (IA 2.16 m)			
Column base	**Spot-height (m)**	**Height difference (m)**	**Inclination**
C17/18:7	+4.08	-	-
C17/18:9	+3.86	0.22	1:10/5.7°
C17/18:11	+3.64	0.22	1:10/5.7°
C17/18:7(δ)	+4.14	-	-
C17/18:9(ε)	+3.93	0.21	1:10/5.7°
C17/18:11(ζ)	+3.72	0.21	1:10/5.7°
C23/24:3(Σ)	+4.14	-	-
C23/24:5(Τ)	+3.93	0.21	1:10/5.7°
C23/24:6(Υ)	+3.72	0.21	1:10/5.7°
Average		**0.21**	**1:10/5.7°**

Table 6.20. Inclination of Phase 3 column bases and colonnade foundation blocks. Greek letters after the feature code designate a calculation based on Dörpfeld's measurements; all unnamed features in C20(π)/21(Δ) are based on Dörpfeld 1885. For each column base, height difference and inclination are relative to the previous value.

Dörpfeld includes a reconstruction of foundation blocks, column bases, columns and a roof superimposed upon the two longitudinal-sections of C17(η)/18(χ) and C20(π)/21(Δ) (Pls. 20a–20b). He reconstructed their superstructures on a gradient of 1:10 (5.7°). This value matches or is very close to the average calculated from his interaxial distances and spot-heights on the *in-situ* column bases in their respective colonnades: C17(η)/18(χ) at 1:10 (5.7°) and C20(π)/21(Δ) at 1:11 (5.2°). On the reconstructed section of C20(π)/21(Δ), Dörpfeld obviously recognised features C20/21:12–13, 16 and 18 as foundation blocks for columns (Pls. 20a, 21a, 25b); the irregularity of the inclination between these features 1:12 (4.8°) to 1:5 (11°) clearly shows that these features are not preserved to their original height (Table 6.20).

The second course in the Phase 3 side-wall dividing Shipshed 16 and Shipshed 26(?) (W16/26:12–13) is constructed on a gradient of 1:12.8 (4.5°) (Figs. 173a, 221b). The first course (W16/26:9–11) is less steep at 1:13.8 (4.2°) (Fig. 220d). The foundations rest on gradients that are either steeper, such as W16/26:2B (1:11.8/4.9°) or within this range, such as W16/26:1 (1:13.5/4.2°) and W16/26:4, 6 (1:13.5/4.2°). The much steeper inclination of the small section at W16/26:2A (1:7.4/7.7°) remains unexplained (Figs. 220–221).

The difference in the gradients of the two courses in W16/26(λ) (1:13.8/4.2° to 1:12.8/4.5°) and in colonnades C16/17(η), C17(η)/18(χ) and C20(π)/21(Δ) (averaging 1:10/5.7°) demonstrates that the inclination of the column bases cannot be used as a clear indication of the gradient of the superstructure above the top of the upper-most column drum. At least three solutions may be presented to explain the inclination of W16/26(λ):

1) The inclination could have been adjusted at the crown of the wall to that of the column bases, or through a slight change of gradient in each course of blocks. This explanation, however, as discussed below, is nearly impossible, as the 1:10/5.7° inclination would place the column bases in positions 24 to 26 in C23(Π)/24(Φ) below their extant foundations (Pls. 16, 34d). Furthermore, it would have been quite impractical to adjust the inclination of the wall (first course 1:13.8 (4.2°); second course 1:12.8 (4.5°); average 1:13.3 (4.3°) to the steeper inclination of the column bases at 1:10 (5.7°). It would have been more logical and efficient to construct the wall at the required gradient from its foundations upward.

2) The columns had a capital design with a slanting *abacus* or a similar architectural member in the entablature that adjusted the inclination of the colonnades to that of W16/26(λ). This would require columns of different heights.

3) The superstructure was built incorporating elements of both (1) and (2).

These considerations make it abundantly clear that the superstructure of Phase 3 had an inclined construction: it would have been impractical and unrealistic to construct a wall on an inclination, and then adjust the crown of the wall to support a horizontal (or near-horizontal) roof construction.

The complications surrounding the determination of shipshed gradients resulted in some premature or erroneous conclusions. According to Dörpfeld's reconstruction, seen above, the gradient of the superstructure is close to 1:10 (5.7°) based on the inclination of three first column bases closest to the back-wall in C17(η)/18(χ) and C20(π)/21(Δ) (Pls. 21a–21b; Table 6.20). Blackman probably also bases his 1:10 *shipshed* gradient on the inclination of the colonnades here, near the back-wall.[77] The physical evidence presented in Dörpfeld's plan and sections clearly speaks against a 1:10 (5.7°) gradient. One example is the ramp of Shipshed 21(Δ) on Dörpfeld's plan. According to the spot-height of +3.17 m on S21:R3(Δ2), located 16.66 m from the inside of the back-wall (Pl. 18; *MoP*: 0.04 m), the ramp, at a 1:10 gradient, would intersect the 1885 sea level 31.70 m from this point, or 48.36 m from the back-wall, and not at 37.29 m from the back-wall, as listed in previous research (Pl. 17; see also pp. 133–134).[78]

New evidence belonging to the Phase 3 colonnades found under water during the ZHP investigations has

77. See Blackman 1968: 181.
78. Blackman 1968: 182; Morrison, Coates & Rankov 2000: 132; Garland 2001: 156.

From	To	IA	Equals
C16/17:1 (+3.60 m)	C16/17:3 (+3.23 m)	3.38 m	1:9.1/6.3°
C17/18:6 (+3.61 m)	C17/18:8 (+3.37 m)	2.16 m	1:9.0/6.3°
C17/18:8 (+3.37 m)	C17/18:10 (+3.12 m)	2.16 m	1:8.6/6.6°

Table 6.21. Inclination of rock-cut foundations in C16/17(η) and C17(η)/18(χ) based on the interaxial spacing.

also proven this earlier proposed gradient incorrect. The bottom surface of the longest preserved Phase 3 colonnade foundation trench (C23/24:10), cut for the column base positions 25 and 26 in the colonnade dividing Shipsheds 23(Π) and 24(Φ), lies submerged at -0.96 m (Pls. 16, 24; Figs. 214, 216a). The first three column bases (counted from the back-wall) in colonnade C23(Π)/24(Φ) have exactly the same top surface height as their analogues in C17(η)/18(χ), and although the exact interaxial spacing is unknown, it is safe to assume that in C23(Π)/24(Φ) these column bases had an inclination very close to the average gradient of C17(η)/18(χ) (1:10/5.7°). The top surface of the first column base in colonnade C23/24:3(Σ) is located at +4.14 m (Pl. 17; calibrated: +4.07 m).[79] The linear distance between the centres of the column base positions 1 and 25 is 51.84 m. At a gradient of 1:10 (5.7°) the top surface of the column base position 25 would have been located at -1.11 m, which is physically impossible (Pl. 34d). This is especially clear if one takes into account that the bottom column drum would not have been standing directly on the rock-cut surface foundation, but on a column base like those found in the basement of Sirangiou 1, whose average height is 0.49 m (Table 6.15). Farther to the west, partially destroyed by modern dredging, is the western part of C23/24:10 cut at -0.96 m for column position 26 (Pls. 16, 24; Figs. 214, 216a). Although damaged, it can be identified as part of the colonnade foundations. Here, the top surface of a column base in a colonnade constructed on an inclination of 1:10 (5.7°) would have been located at -1.33 m. These measurements and incongruities argue strongly against the notion that the average gradient between the top centres of the column bases near the back-wall represent the gradient of the entire superstructure.

On the other hand, it is possible to calculate the maximum inclination between column base position 1 and the reconstructed top surfaces of column base position 26 (-0.47 m) using the average Phase 3 column base height (0.49 m), with the reservation that it could have been higher or lower. The height difference between column base positions 1 and 26 is 4.54 m over the course of 54.00 linear metres, resulting in a gradient of 1:11.9 (4.8°).

This is a marked difference with important consequences. If, for example, the length of the superstructure is extrapolated (reconstructed) to the minimum level of the shoreline in the Classical period located at -1.90 m (87DZ), and employing a 1:10 (5.7°) gradient, then the length from the centre of the first column position can be reconstructed as 59.7 m, whereas the reconstructed length of a superstructure with a gradient of 1:11.9 (4.8°) is 71.04 m.

Reconstructing column position 26 with a hypothetical foundation block and a column base (as seen in C20/21:5), each 0.49 m high, reduces the gradient to 1:13.3 (4.3°). This value is within the range of the inclinations of the first (1:13.8/4.2°) and second (1:12.8/4.5°) courses in W16/26(λ), and it is identical to their average of 1:13.3 (4.3°). It is also within range of the foundation inclination of W16/26(λ) (1:11.8/4.9° to 1:13.5/4.2°). It will be recalled that this wall and its foundations were followed for a total length of 49.66 m (Pls. 15, 35a).

79. Dragátsis 1885: pl. 2.

Placing a second foundation block at C23/24:10 would lower the inclination to 1:15.2 (3.8°), which is clearly out of the range of the inclination of Wall 16/26(λ) (1:13.8/4.2° to 1:12.8/4.5°).

The findings of the ZHP investigations demonstrate that the gradient between the foundation cuttings for the colonnades does not reflect that of the column bases and it cannot be used to reconstruct the column base or roof-line inclination. The examples listed in Table 6.21 are the gradients between the reconstructed centre points of the foundation trenches of column bases C16/17:2(θ), 4(ι) and C17/18:7(δ), 9(ε) and 11(ζ). Since the average gradient of 1:8.9 (6.4°) is steeper than the inclination of the top surfaces of the column bases, and would locate the foundation trench for column base position 26 at -2.49 m (much deeper than -0.96 m, where it was found), the foundations clearly do not reflect the gradient of the superstructure. The natural bedrock was obviously too steep in this area, and the inclinations were probably adjusted intentionally, step by step, using the different elements of the superstructure (i.e. column bases, columns and perhaps an inclined *abacus*).

In conclusion, the different inclinations of the column bases (1:10/5.7°) and their foundations (1:8.9/6.4°) cannot be used to reconstruct the roof-line gradient. Nor can the inclination of the column base foundations be used to reconstruct the top surface gradient of the column bases, and vice-versa. Instead, it is possible to derive a minimum gradient of 1:13.8 (4.2°) from the first course of W16/26(λ), and a maximum of 1:11.9 (4.8°). The maximum, derived from the inclination of the Phase 3 column bases in C23(Π)/24(Φ) (1:11.9/4.8°), is based on a sound reconstruction of an average size Phase 3 column base (a height of 0.49 m) set in foundation trench C23/24:10 for column position 26 (Pls. 16, 24; see above). Evidence has shown that care was taken in antiquity to construct each of the Phase 3 column bases at exactly the same height or within ± 0.01 m. This permits a high degree of confidence in considering C23(Π)/24(Φ) representative of the other Phase 3 colonnades.

The question still remains of how the superstructure was arranged in relation to these inclinations. It is possible to consider three scenarios, in order of probability. These are Superstructure Inclination Theories (SIT) 1–3:

1) SIT-1 (most likely). The variation of 0.3° in the gradient between the first course (1:13.8/4.2°) and the second course (1:12.8/4.5°) in W16/26(λ) is taken as an indication that the gradient was adjusted course by course in this side-wall. In this case, the inclination would range between the gradient of the second course (1:12.8/4.5°) and the reconstructed maximum gradient of colonnade C23(Π)/24(Φ) (1:11.9/4.8°), with a mid-range of 1:12.3 (4.65°; Pl. 34d). If the inclination was adjusted through the courses of W16/26(λ), it was probably closer to the latter gradient.

2) SIT-2 (possible). The inclination of the superstructure, based on the average inclination of the first course (W16/26:9–11) and second course (W16/26:12–13) (Figs. 220d, 221b), is 1:13.3 (4.3°): the gradient could possibly have been within the range of 1:13.8 (4.2°) to 1:12.8 (4.5°).

3) SIT-3 (least likely). The gradient falls within the full range of the inclinations defined by the first course in Wall 16/26(λ) (1:13.8/4.2°; Fig. 220d) and the maximum inclination of C23(Π)/24(Φ) (1:11.9/4.8°).

6.3.8. The Possible Phase 4 Shipsheds

The above analysis of the Phase 3 superstructure, including the Phase 4 back-wall section 1(Ω–β) and Spur-wall C26/27(?), make it possible to recognise a probable later phase, Phase 4, in the form of two possible shipsheds, Shipsheds 26(?) and 27(?). These were both excavated by Dragátsis and Dörpfeld in 1885 (Pls. 15, 17; Fig. 231). Four features in the harbour basin – S26:SSP:2(?), C26/27:6(?), S27:SSP1(?) and S27:SSP2(?) – may belong to these buildings (Pls. 10, 15). Today, only a very limited area of the upper part of Shipshed 26(?) is accessible in the basement of Sirangiou 1 (Pl. 6). Apart from a narrow section of what is most probably the inclining southern side-passage (S26:SSP1(?)), Shipshed 26(?) is covered mostly by a modern building (Akti Moutsopoulou 15). On one of the Meletopoulos photographs taken in the 1950s, before Akti Moutsopoulou 15 was built, a wider section of S26:SSP1(?)

was visible north of W16/26(λ) where there existed a section of inclined and in all probability worked bedrock (Fig. 61).[80] Although there is no evidence of a ramp structure it is most probably a shipshed.

On Dörpfeld's plan (Pl. 17) there are no features illustrated between the colonnade dividing Shipsheds 26(?) and 27(?) and the side-wall W16/26(λ). Since there is no opening in the back-wall in section 1(Ω–β) between C26/27(?) and W16/26(λ), this area could not have been used to access the shipsheds from outside the complex (Pl. 15).

As discussed above (see p. 84), Wachsmuth notes that the fourth and northern-most spur-wall (C26/27:1) behind the colonnade dividing Shipsheds 26/27(?) breaks the uniformity of the Phase 3 spur-walls, and argues that the shipsheds to the north of W16/26(λ) belong to another type of shipshed.[81] Furthermore, he points out that the interaxial spacing of the column bases (or foundation blocks) is greater in C26/27(?) (3.43 m) than in the more widely-spaced Phase 3 colonnades (3.38–3.39 m). Dragátsis describes the first two bases (C26/27:2(μ), C26/27:3–4(ν)) as "double high" (i.e. two courses high), and suggests that they may be the remains of piers or built-up foundations for columns. The third base, C26/27:5(ξ), is described as "simple as all the others".[82] The top course of C26/27:3–4(ν) appears to be constructed of two rectangular blocks placed side-by-side. Scaled from the plan (Pl. 17), C26/27:2(μ), 3–4(ν) and 5(ξ) measure 1.30 x 1.30 m, 1.42 x 1.30 m and 0.94 x 0.84 m (*MoP*: 0.04 m), respectively. The colonnade is preserved for a length of 11.24 m (*MoP*: 0.04 m).

Dörpfeld produced no sections or spot-heights on the colonnade features in C26/27(?). It is therefore impossible to relate the height of these remains to the possible colonnade feature C26/27:6(?) found in the area of the harbour basin where the continuation of colonnade C26/27(?) would be expected (Pl. 15). The possible Phase 4 features lie on the same orientation as W16/26(λ). Furthermore, S27:NSP1(?)–2(?) and S26:SSP2(?) are clearly related to the same building phase, and they probably belong to the foundations of Shipsheds 26(?) and 27(?) (Pls. 10, 15).

The interaxial spacing between C26/27(?) and W16/26(λ) is 6.41 m (*MoP*: 0.05 m). When the bottom column drums are reconstructed using the Phase 3 lower diameter of 0.64 m and Dörpfeld's lower diameter of 0.70 m (see above, pp. 89–90, 95–97), the clear space between the second course of W16/26(λ) (0.62 m) and C26/27(?) would be 5.78 m (*MoP*: 0.04) or 5.75 m (*MoP*: 0.04 m). These values give a slightly narrower internal space, but are comparable to that of Phase 3 at 5.87 m (Dörpfeld: 5.81 m, *HMoP*: 0.02 m). It is unlikely that these features are the remains of piers, because Dragátsis describes the third base C26/27:5(ξ) as being of the same design as the other (Phase 3) column bases. In the unlikely case that the colonnades were comprised of piers, the clear space between C26/27(?) and W16/26(λ) would then be 5.46 m (*MoP*: 0.04 m; Fig. 231).

Based on their distinct architectural difference, Shipsheds 26(?) and 27(?) are considered to belong to another section of possible shipsheds, and may represent a later or, less likely, an earlier building phase. According to the ZHP investigations, these structures were built between the Group 5 shipsheds and the Phase 3 shipsheds of Area 1 (Group 1; Figs. 2–3).

6.4. The Phase 2 Superstructure

The preserved elements of the Phase 2 superstructure are the earliest identifiable shipshed remains found in Area 1 and include part of the colonnades of Shipsheds 8–10, 12, 14, and possible Shipsheds 7, 11, 13 and 15 (Pl. 13).[83] Additional evidence consists of 13 re-used column drums and perhaps three more possible re-used column drums that were found in the ex-

80. Akti Moutsopoulou 15 was built as a part of the Sirangiou 1 apartment complex.

81. Wachsmuth 1890: 71–72.

82. Dragátsis 1885: 66.

83. Phase 2 features are identified in colonnades C7/8, C8/9, C9/10, C10/11, C11/12, C12/13, C13/14 and C14/15. Since all these colonnades are each flanked by at least one identified Phase 2 ramp structure they are identified as belonging to shipsheds (see Chapter 7.1 & 7.4 for the identification of the Phase 2 ramps). No ramp structures were found in Shipsheds 11(?) and 13(?), and although they are most probably shipsheds they are classified here as 'possible shipsheds' to maintain methodological consistency. Possible Shipsheds 7 and 15 are each outlined by just one colonnade, and as a result cannot be identified positively as shipsheds. The physical evidence is described in detail in the catalogue in Vol. I.2, Chapter 3.

cavated area of the Phase 3 shipsheds.[84] The identification of these remains as Phase 2 shipsheds entails an analysis of their features, positions and dimensions.

6.4.1. Foundation Trenches and Blocks of the Phase 2 Colonnades

In Area 1 at Zea, between the modern quay and the T-jetty, were found two blocks *in situ*: C9/10:2 and C10/11:3 (Pl. 4; Fig. 111). They are set in parallel, rock-cut foundation trenches C9/10:1 and C10/11:2, and outline the colonnades of Shipshed 10 (Fig. 194). Similar parallel features are found to the north and south in the form of two pairs of rock-cut foundation trenches in the colonnades delineating Shipsheds 8 (C7/8:4 and C8/9:7) (Pl. 4; Fig. 180) and 14 (C13/14:2 and C14/15:2) (Pl. 4; Figs. 122–123, 207). These, together with other extant Phase 2 features, form eight colonnades consisting of ten or perhaps 11 parallel column positions with an interaxial spacing of 3.97 m (Pl. 13).[85] The delineation of the upper end of the colonnades is uncertain, but, as discussed below, their position can be approximated from the evidence Dörpfeld provides. On the westward side of Area 1 the Phase 2 shipsheds have been destroyed by intrusive dredging (Pl. 4).[86]

Beginning in the northern part of Area 1 (Pls. 4, 13), column position 8 of the rock-cut trench in the colonnade dividing Shipsheds 7(?) and 8 (C7/8:5) accommodated a column base or column base foundation block similar and parallel to C9/10:1 and C10/11:2 (Pls. 4, 13; Fig. 180). Its foundation trench was later extended east to accommodate column position 14 (C16/17:10) in the Phase 3 colonnade (Pls. 15, 25a; Fig. 181). The bottom elevations of C9/10:1 (-1.11 m) and C10/11:2 (-1.09 m) also lie at about the same level as C7/8:5 (-1.07 m). In the southern-most part of Area 1 remains of the severely damaged rock-cutting C14/15:3 have been identified as a column base foundation trench due to its location in the area of column position 8 (Pls. 13, 23c) and its elevation (-1.07 m to -1.12 m) is clearly in range of the above-mentioned features.

Based on the well-defined and parallel colonnade foundation trenches C7/8:4, C8/9:7, C13/14:2 and C14/15:2 (Pls. 4, 13) at column position 7, the preserved northwest corner of the severely damaged feature C10/11:1 was identified as part of a similar colonnade foundation trench (Pls. 4, 13; Fig. 194). The preserved northwest corner of this cutting lies in the same approximate line as the aforementioned features. Furthermore, the short section of the northern side lines up with the northern side of C10/11:2 (Fig. 194). The preserved area of C10/11:1's bottom surface lies at -0.84 m, which is the same depth as that of C8/9:7. It is also close to the bottom elevation of C7/8:4 (-0.89 m) and C13/14:2 (-0.82 m). C14/15:2 (-0.95 m) was cut deeper than the other features in column position 7, perhaps in order to reach bedrock of the required quality.

To the west of column position 8 (exemplified by the well-defined colonnade features C9/10:1–2 and C10/11:2–3) is column position 9. This is evidenced by C14/15:4, which is defined on three sides (Pls. 4, 13; Fig. 213). It is clear that this area accommodated a column base or a column base foundation block. This foundation trench was later extended westward to accommodate column position 24 in the Phase 3 colonnade dividing Shipsheds 23(Π) and 24(Φ) (C23/24:9; Pl. 23b; Figs. 214, 216a). West of C14/15:4 were excavated the western-most preserved remains of the Phase 2 colonnades, C14/15:5, which interconnected with the 3.97 m interaxial spacing and comprised column position 10 (Pls. 13, 23c). To the west, the remains of both the Phases 2 and 3 shipsheds were destroyed by dredging.

On Dörpfeld's plan the two colonnade features C7/8:3 and C14/15:1 lie parallel to each other and are highlighted in the area of the sea not covered by the modern quay (Pls. 4, 13, 17). In his section draw-

84. Shipshed 17(η): one re-used column drum S17:R11, three possible column drums S17:R12–R14. Shipshed 20(π): nine re-used column drums. Shipshed 21(Δ): three re-used column drums (see p. 90).

85. At a relatively early stage in the identification process it became clear that these colonnade features with their roughly 4 m interaxial spacing were interrelated, and the subsequent feature identifications were based on this measurement. The calculation of a 3.97 m interaxial spacing was made at a later stage; here it is described in detail on pp. 114–116. The evidence is comprised of 30 identifiable Phase 2 colonnade features: 12 are derived from Dörpfeld's plan and sections (with the possibility of an additional five), 18 from the ZHP underwater investigations.

86. See also Pl. 40.

ing, Dörpfeld documents another foundation trench in the colonnade between his shipsheds Δ and π (C11/12:10), parallel to C7/8:3 and C14/15:1 (Pls. 13, 20a, 21a, 25b). This feature is not documented in plan view and appears to have been destroyed towards both the east and west (Pl. 22a). C11/12:10's location has been inserted in plan view and added to the reconstructed plan based on the evidence provided by the section of the feature (Pl. 13).

During the ZHP investigations, C7/8:3 was relocated and excavated, as was the well-defined colonnade foundation trench C14/15:1 (Pls. 4, 13; Figs. 180, 207). C14/15:1 is the only foundation trench closed on all four sides (i.e. not extended in Phase 3) at column position 6. It was the missing link that allowed the identification of the following partially preserved, but clearly parallel, Phase 2 features to the north in column position 6: C13/14:1, C12/13:1, C11/12:10, C8/9:6 and C7/8:3 (Pl. 13). All these features (with the exception of C11/12:10, which has not been re-investigated) were re-used and extended westward during Phase 3 in order to accommodate the next column in this later building phase (Pls. 13, 15–16, 40).

These colonnade foundations are particularly interesting since the Phase 3 colonnade appears to have incorporated the foundation features of Phase 2's column position 6 where column position 12 in the widely-spaced (3.38–3.39 m) colonnade and column position 18 in the narrowly-spaced (2.16 m) colonnade line up horizontally within a few centimetres (Pls. 15–16). This and other points of correlation between the two building phases will be discussed in detail in Chapter 8.2.3.

As discussed above, there are a number of features on Dörpfeld's plan and sections that bear no structural relation to the foundations of the well-defined Phase 3 colonnades. The most prominent of these are the blocks and their foundation trenches between column positions 12 and 13 in C17(η)/18(χ) (C8/9:2–3; Pls. 21b, 23a), and those of column positions 8 and 9 in C20(π)/21(Δ) (C11/12:7–8; Pls. 21a, 25b). These features are parallel to each other on both the plan and sections (Pls. 13, 17, 20) and interconnect accurately with the 3.97 m interaxial colonnades found in the sea (Pls. 13, 24, 26). They comprise the third row of columns identified in the Phase 2 colonnades.

In foundation trench C8/9:2 there is space for another similarly-sized block next to C8/9:3 (Pls. 13, 23a), and C8/9:3 is in all probability the remains of colonnade foundations originally constructed as two parallel-oriented blocks set side-by-side. Feature C11/12:8, set in foundation trench C11/12:7, is also a colonnade foundation block. C11/12:8 is rectangular on Dörpfeld's section, and appears to be one block. However, in plan view, attention should be drawn to a line dividing the feature in two, suggesting perhaps that C11/12:8 was constructed of two blocks (Pl. 17). There is also a rectangular slot on its northern side. The pry marks in the bottom of C14/15:1 shows that the column foundations placed here were also constructed of two rectangular blocks set side-to-side (Fig. 207).

To the east of C11/12:7–8 lie three rectangular blocks with a similar size and shape: C11/12: 6, 4, and 2(?) (Pls. 21a, 27). C11/12:4 and 6 are tied in with a 3.97 m interaxial spacing, and so they are identified as Phase 2 colonnade features in column positions 1 and 2, respectively (Pls. 13, 26). The dimensions of feature C11/12:2(?) are similar to the identified Phase 2 blocks (see below), but it does not tie into the 3.97 m interaxial spacing; it is therefore classified as a possible Phase 2 block (at column position 0). There are no visible features east of C11/12:3–4 relating to the 3.97 m interaxial alignment, and Phase 2 did not continue east of C11/12:1(?)–2(?) (Pl. 27). C11/12:1(?)–2(?) may somehow be related to the back-wall of the Phase 2 shipsheds. Perhaps it is the remains of a spur-wall. It is also possible that a Phase 2 block was moved and re-used in the Phase 3 colonnade when it was built.

West of the well-defined column position 3 (C11/12:7–8) is the partially submerged feature C11/12:9, which defines column position 4 (Pls. 13, 26). The feature appears to be a raised rock-cutting on Dörpfeld's section (Pl. 20a), but because of its comparable dimensions and close association to the blocks in the 3.97 m interaxial Phase 2 colonnades, there is a possibility that it is a block (Pl. 27).

Farther to the north, the eastern part of the foundation cutting C7/8:1 has no logical relation to the Phase 3 colonnade C16/17(η) (IA: 3.38 m). It is therefore classified as a Phase 2 colonnade feature in column position 4 based on its conformance to the 3.97

m interaxial spacing (Pls. 13, 25a).[87] By the same logic, C7/8:2 is classified as the foundation of column position 5. Both features were extended west in Phase 3 (C16/17:7 and 8) to conform to the 3.38 m interaxial spacing (Pl. 25a).

In the colonnade just to the south, and parallel to the two above-mentioned Phase 2 features, may lie the remains of column position 4 (C8/9:4(?)) and column position 5 (C8/9:5(?)) in the colonnade dividing Shipsheds 8 and 9; parts of these features could have been left over from the construction of 6.18 m-long C17/18:14 (Pl. 23a). To the east of here the short section C8/9:1(?) may belong to Phase 2.

In sum, ten or perhaps 11 column positions forming eight colonnades have been identified in Area 1 at Zea, and these delineate five identified shipsheds and four possible shipsheds (Pl. 13). There is no clear evidence of a back-wall associated with this building phase at the upper end, towards what would have been the civilian zone of the Piraeus. The 3.97 m interaxial spacing of the Phase 2 colonnades could not extend past C11/12:3–4 (Pl. 25b). If C11/12:1(?)–2(?) were the foundations of a Phase 2 column, then the last two columns would have been more closely spaced (3.44 m, *HMoP*: 0.02 m), as seen in the section of the colonnade dividing shipsheds 2 and 3 at Oiniadai (Fig. 46). Here, the interaxial spacing between column positions 1 and 2 is 0.14 m shorter (2.12 m) than the average interaxis of 2.26 m (see Table 6.32). It is also possible that this last block was related to a back-wall, but since there is only evidence of these features in a section plan from Dörpfeld, this hypothesis cannot be tested adequately. No evidence can be related to Phase 2 east of C11/12:1(?)–2(?): the only man-made features in this area are those in the well-defined Phase 3 colonnade (Pls. 22a, 26). It is not known exactly where the Phase 2 shipsheds ended on the shoreward side (or lower end), but since it could not have extended past C11/12:2(?), it definitely ended to the east of either C11/12:2(?) or 4, the former lying about 17.12 m, the latter 20.48 m (*MoP*: 0.04 m), from the 1885 shoreline. Since the ramp feature documented by Dörpfeld is interpreted as belonging to Shipshed 12 of Phase 2 (S12:R1), it is likely that Phase 2 structures continued to C11/12:2(?) (Pls. 13–14; see. p. 138).

The Rock-cut Foundations of Phase 2

The average plan dimensions of the eight intact rock-cut Phase 2 foundation trenches identified above are 1.35 x 1.10 m.[88] These dimensions are used to reconstruct the position of Phase 2 foundations that are partially preserved or only documented in Dörpfeld's section drawings in plan view (Pl. 13).[89]

The intact Phase 2 foundation trench C14/15:1 (Pl. 13; Figs. 122, 207) in column position 6 was re-used in column position 18 in the more narrowly-spaced (IA: 2.16 m) Phase 3 colonnades (Pls. 16, 23b). As mentioned above, this is one of the positions (II) where the alternately-spaced Phase 3 colonnades align horizontally (Pls. 16, 37, 43). The pry mark C14/15:1b, located slightly off-centre to the west in C14/15:1, shows that the foundations consisted of two blocks set side-by-side (Fig. 207). Dörpfeld documented one (C9/10:2–3) or perhaps two (C11/12:7–8) Phase 2 foundations constructed in the same way, but it should also be noted that the Phase 4 colonnade feature C26/27:3–4(ν) appears to be constructed in a similar way (Pl. 17).[90] Since this construction method has not been recorded in any Phase 3 colonnade feature, it is most likely that the height of -0.63 m represents the original Phase 2 bottom surface of C14/15:1. The average elevation of the foundation trenches in column position 6 is -0.64 m (range: -0.54 m to -0.70 m), a figure that strongly indicates that some of the features extended in Phase 3 retained their original bottom surface. This is seen especially in the case of C7/8:3 (-0.66 m) and C8/9:6 (-0.66 m). This hypothesis is strengthened by the position of colonnade foundation C7/8:5 (-1.07 m). This feature was extended eastward in Phase 3, but

87. The positions of the features C16/17:6–8 and C7/8:1–2 have been drawn in section view based on the evidence provided in Dörpfeld's plan (Pl. 17, see also Pl. 15).

88. Intact Phase 2 foundation trenches: C7/8:4, C8/9:2, C8/9:7, C9/10:1, C10/11:2, C13/14:2, C14/15:1 and C14/15:2. Length and width of the individual features vary, and the calculation is based on the average dimensions of each feature.

89. Partially-preserved Phase 2 foundation trenches or features only documented in Dörpfeld's sections: C7/8:1–3, 5; C8/9:1(?), 4(?)–5(?), 6; C10/11:1; C11/12:10; C12/13:1; C13/14:1, and C14/15:3–5.

90. Similar construction features were found in the colonnades of possible shipsheds excavated by Dragátsis (1892; Fig. 18) and Meletopoulos (1882; Figs. 14–15) in Group 4 at Zea, and by the ZHP in Groups 1 and 7 at Mounichia.

	Length (m)	Width (m)	Height (m)
a. Average Phase 2 block dimensions			
C9/10:2	1.21	0.85	*0.19*
C10/11:3	1.12	0.89	*0.38*
Average	**1.17**	**0.87**	*0.38*
b. Average Phase 2 block dimensions on Dörpfeld's 1885 plan and sections			
Average	1.16[92]	0.90[93]	0.54[94]
Range	1.10–1.26	0.88–0.92	0.52–0.56

Table 6.22. Phase 2 colonnade block dimensions.

preserved nearly at the same depth as C9/10:1 (-1.11 m) and C10/11:2 (-1.09 m) (Pl. 13). This demonstrates that C7/8:5 was not cut deeper by the Phase 3 colonnade foundations, and that the Phase 2 bottom surface is intact.

In sum, it has been demonstrated that the only features, with the exception of the possible Phase 2 feature C11/12:1(?)–2(?) visible on Dörpfeld's sections of colonnades C17(η)/18(χ) and C20(π)/21(Δ) east of the identified features in the Phase 2 colonnade (column position 1), are the Phase 3 column bases and their foundations with apparently unworked bedrock in between (Pls. 13, 24, 26). The architectural layout of the Phase 3 colonnades (IAs: 2.16 m/3.38–3.39 m) could only re-use the foundations of Phase 2 (IA: 3.97 m) in a few instances. This is clearly illustrated in the areas covered by both Phases 2 and 3, where there are multiple features present unrelated to the individual colonnades (Pls. 23–26). The Phase 3 colonnade utilised the same space as Phase 2 and partially destroyed it, as has been made clear from the ZHP investigations and analysis of Dörpfeld's work.

Dimensions of Colonnade Blocks

There is no clear evidence that can lead to the identification of any extant blocks as Phase 2 column bases (see pp. 117–119).[91] The two *in-situ* blocks C9/10:2 and C10/11:3 (Fig. 194) measure 1.21 x 0.85 m and 1.12 x 0.89 m, respectively (average: 1.17 x 0.87 m; Table 6.22a). In plan view (Pl. 13) the unexcavated or missing parts of the colonnades are reconstructed with these average posited column base dimensions. The average plan dimensions of the Phase 2 blocks identified in Dörpfeld's plan and sections are clearly comparable at 1.16 m (*HMoP*: 0.02 m) x 0.90 m (*MoP*: 0.04 m) (Table 6.22b). It should be stressed that these averages are based on very few features, but it is clear that the Phase 2 colonnade blocks are larger than the Phase 3 column bases and foundation blocks (Tables 6.15–6.16).

The construction of Phase 3 foundations C18/19:4A–4C created a continuous level surface by shaving off the top of *in-situ* block C9/10:2 (Fig. 192c). As a result, this block is preserved only to a height of 0.19 m (top spot-height at -0.91 m), whereas C10/11:3 is preserved to 0.38 m (top spot-height at -0.71 m).

The top surface of rectangular block C8/9:3 lies at the same elevation as C17/18:13 (Pl. 23a). The top surface of C8/9:3 (calibrated +0.54 m) is only 0.05 m below that of C11/12:8 (calibrated +0.59 m), so the re-shaping of this latter block in Phase 3 may have entailed shaving it down 0.05 m to a height of 0.34 m. The Phase 2 colonnade blocks in Dörpfeld's section

91. Such positive evidence would include *in-situ* column drums, drum 'shadows' (marked erosion between the exposed area and the area covered by the drum), mason's marks (rock-cut or painted), or cuttings that align the drums to their bases, as seen in Oiniadai (Sears 1904: pl. IX, see Fig. 44).
92. Length (*HMoP*: 0.02 m): C11/12:4 (1.26 m); 6 (1.10 m); 8 (1.12 m).
93. Width (*MoP*: 0.04 m): C8/9:3 (0.88 m); C11/12:4 (0.90 m); 6 (0.90 m); 8 (0.92 m).
94. Height: (*VMoP*: 0.03 m): C11/12:4 (0.54 m); C11/12:6 (0.56 m); C11/12:8 (0.52 m).

of C11/12 and C20(π)/21(Δ) have an average height of 0.54 m (*VMoP*: 0.03 m) (Pls. 21a, 25b). The dimensions of the possible Phase 2 block C11/12:2(?) are roughly comparable (length: 1.28 m, *HMoP:* 0.02 m; width: 0.98 m, *MoP*: 0.04 m; height: 0.48 m, *VMoP:* 0.03 m).

The average length (1.17 m) and width (0.87 m) of the colonnade blocks are based on ZHP measurements, whereas the average height (0.54 m) is based on Dörpfeld's data (Table 6.22).

6.4.2. The Interaxial Spacing and Intercolumniation of the Phase 2 Colonnades

Interaxial Spacing of the Individual Colonnades in Phase 2

The evidence of interaxial spacing in Phase 2 is relatively sparse when compared to Dragátsis and Dörpfeld's well-defined, and the ZHP's relatively well-defined, recorded Phase 3 spacings, which are based on *in-situ* column drums in colonnades C18(χ)/19(φ), C20(π)/21(Δ), and identified column bases in colonnades C16/17(η), C17(η)/18(χ) and C20(π)/21(Δ). Any basis of calculation of their interaxial spacing must rest primarily on those Phase 2 blocks documented in colonnades C9/10, C10/11 and C11/12. Even here, however, the calculation is based on the assumption that the columns stood directly over the centre of the individual blocks. This can be problematic, for none of the blocks can be identified as column bases, and it is unlikely that the columns were precisely centred on them. Therefore, it must be stressed that the interaxial spacing of the Phase 2 colonnades cannot be determined with a high degree of precision: it probably varied within a few centimetres around the calculated interaxial spacing of 3.97 m. Although this value is not accurate to the centimetre, it does allow a general reconstruction of a realistic longitudinal matrix of Phase 2 (Pls. 13–14, 24, 26).

The interaxial spacing is based on (A) the calculated centres of blocks C9/10:2 and C10/11:3 (column position 8), which lie just 0.02 m off the longitudinal axis from each other (Pl. 28); and (B) the measured centres of C11/12:4, 6 and 8 (Pls. 13, 27). The interaxial spacings are measured along the longitudinal axis stretching between the calculated centres of C9/10:2 and C10/11:3 at column position 8 in Shipshed 10 to the blocks in the colonnade dividing Shipsheds 11 and 12 (Pl. 27). Features C11/12:2(?) and 9 are included in this section to illustrate how they interrelate with the Phase 2 colonnade (Table 6.23).

The average interaxial spacing between the centres of column position 8 in Shipshed 10 and C11/12:4, 6, 8 is 3.97 m (*MoP*: 0.03 m); these distances are either identical or within 0.01 m of this measurement (Pl. 27; Table 6.23). The centre of the raised feature C11/12:9 is also in range (3.96 m), whereas block C11/12:2(?) is clearly out of range (3.91 m). Features C11/12:4, 6, 8 and 9 clearly fit a colonnade layout with an interaxial spacing of about 3.97 m. They can be securely identified as the remains of the Phase 2 colonnades (Pls. 13, 27).

Measured directly on Dörpfeld's section, the average interaxial spacing between C11/12:4, 6 and 8 is 4.01 m (Pl. 27; Table 6.24), and the distance from C11/12:8 to 9 is nearly identical (4.00 m); here again, C11/12:2(?) is completely out of range (3.44 m). Although it is only the spacing between C11/12:2(?) and C11/12:4 that is out of the interaxial range of the Phase 2 colonnade, the variation of the measurements, ranging from 3.97 m to 4.04 m (Table 6.24; Pl. 27), indicates that the blocks were not positioned precisely in relation to each other along the longitudinal axis.

The average plan view dimensions of the eight intact colonnade foundations are 1.35 x 1.10 m, those of the two *in-situ* blocks C9/10:2 and C10/11:3 are 1.17 x 0.87 m, and those on Dörpfeld's plan average 1.16 m (*VMoP*: 0.03 m) x 0.90 m (*MoP*: 0.04 m) (Pl. 13). The centre of a Phase 2 block could not have been placed far from the centre of its relatively confined foundation trench (maximum possible longitudinal displacement E-W: ± 0.09 m; maximum possible displacement to the sides N-S: ± 0.12 m). The calculated centres of blocks C9/10:2 and C10/11:3 are displaced 0.01 m north/0.04 m east, and 0.05 m north/0.03 m west, respectively, from the calculated centres of their foundation trenches C9/10:1 and C10/11:2. This clearly shows that the foundations were not constructed with great precision and that the blocks were not centred within the foundation trench. Instead, they were aligned to another set of longitudinal and horizontal lines of reference by adjusting them east-west and north-south in their individual trenches.

Distance between column position 8 of Shipshed 10 and:	Distance (m)	IA (m) with the following spacings				
		4	5	6	7	8
C11/12:9	15.85	3.96				
C11/12:8	19.85		3.97			
C11/12:6	23.82			3.97		
C11/12:4	27.87				3.98	
C11/12:2(?)	31.31					*3.91*
						Average: **3.97 m**

Table 6.23. (above) Interaxial spacing of the Phase 2 colonnades. MoP: 0.03 m.

Table 6.24. (below) Distance between measured centres of Phase 2 colonnade features in C11/12 (HMoP: 0.02 m; see also Pls. 20a, 27).

Features in C11/12	Distance between measured centres (m)
C11/12:2(?) – C11/12:4	*3.44*
C11/12:4 – C11/12:6	4.04
C11/12:6 – C11/12:8	3.97
C11/12:8 – C11/12:9	4.00
Average	**4.00**

As discussed earlier, this is also the case in the Phase 3 colonnades; for example, column bases C17/18:7(δ), C17/18:9(ε) and C17/18:11(ζ) are clearly not placed at the centres of their foundation trenches (Pl. 6).

The centres of the intact foundation trenches were calculated to determine whether their centre-to-centre measurements are interrelated, and whether they are somehow related to the interaxial spacing of the *in-situ* blocks (Pl. 28; Table 6.25). The average interaxial spacing between the rock-cut foundations of column positions 6 and 7 is 3.95 m (Table 6.25a), whereas the average spacings between the foundations of column positions 7 and 8 are slightly shorter at 3.90 m (Table 6.25b). These three column positions have an average interaxial spacing of 3.93 m. On average, the interaxial spacing of these foundation trenches is 0.04 m shorter than that of the Phase 2 blocks (3.97 m). Their posi-

a. Interaxial spacings between foundation trenches: column positions 6 to 7	
Features	**IA (m)**
C7/8:4 to C14/15:1	3.95
C13/14:2 to C14/15:1	3.94
C14/15:2 to C14/15:1	3.96
Average	**3.95**
b. Interaxial spacings between foundation trenches: column positions 7 to 8	
C7/8:4 to C9/10:1	3.94
C7/8:4 to C10/11:2	3.85
C9/10:1 to C13/14:2	3.96
C9/10:1 to C14/15:2	3.93
C10/11:2 to C13/14:2	3.87
C10/11:2 to C14/15:2	3.84
Average	**3.90**
c. Interaxial spacings between foundation trenches and blocks: column positions 7 to 8	
C7/8:4 to C9/10:2	3.90
C7/8:4 to C10/11:3	3.88
C9/10:2 to C13/14:2	3.92
C9/10:2 to C14/15:2	3.89
C10/11:3 to C13/14:2	3.90
C10/11:3 to C14/15:2	3.87
Average	**3.89**

Table 6.25. Interaxial spacing of the intact Phase 2 colonnade foundations and in-situ blocks (see Pl. 28).

Shipshed/Feature nos.	IA (m)	Average (m)
a. Shipsheds 8–9		
Rock-cut foundations between C7/8:4 and C9/10:1	12.91	
Foundations to block, between C7/8:4 and C9/10:2	12.91	**6.46**
b. Shipshed 10		
C9/10:1 to C10/11:2	6.52	
C9/10:2 to C10/11:3	6.48	**6.50**
c. Shipsheds 11–13		
Distance between C10/11:2 and C13/14:2	19.21	**6.40**
Distance between C10/11:3 and C13/14:2	19.26	**6.42**
d. Shipshed 14		
C13/14:2 to C14/15:1	6.48	
C13/14:2 to C14/15:2	6.55	**6.52**

Table 6.26. Phase 2: Interaxial spacing between foundation features in adjacent colonnades.

tions were adjusted after the blocks had been placed in their foundations. C13/14:2 and C14/15:1–2 are the only features that allow the interaxial spacing to be measured between features belonging to an individual shipshed (Shipshed 14): they average 3.95 m (Pl. 28).

It is clear that the interaxial spacing of all the foundation trenches could not have fallen 0.04 m short of the fairly well-defined interaxial spacing of the blocks (3.97 m) that they were cut to hold, since this would have made the blocks farthest to the west not fit in their extant foundation trenches.

Interaxial Spacing of the Adjacent Colonnades in Phase 2

For the interaxial spacing of adjacent colonnades (i.e. the interaxial width of the individual shipsheds) there is only one measurement for Shipshed 10: 6.48 m between blocks C9/10:2 and C10/11:3. As noted above, the calculated centres of the foundation trenches were analysed to determine whether the foundation cuttings conform to a certain pattern north-south (Pl. 28; Table 6.26). It was found that the average interaxial spacing of the foundation trenches and the blocks are identical at 6.48 m. The Phase 2 shipsheds are therefore reconstructed with an interaxial spacing of 6.48 m between adjacent colonnades (Pls. 13–14).

Intercolumniation of Individual and Adjacent Colonnades

The intercolumniation of *ca* 5.81 m between two adjacent Phase 2 colonnades is reconstructed tentatively based on the average bottom column diameter of 0.667 m (0.67 m) derived from the column drums now stored at the Hellenic Maritime Museum (Table 6.9a)[95]

95. Column drums A/A 108, A/A 111, A/A 1189 VII have been cut flat on one side, and based on this evidence of re-use it is tentatively hypothesised that these belonged to an 'early' shipshed building phase. The re-used column drums found in the Phase 3 shipsheds were worked in a similar way.

Column position	Elevation (m)	Height difference (m)	Gradient
0(?)	+1.77 (*MoP:* 0.01)		
1	+1.37 (V*MoP:* 0.03)	*0.40*	*1:8.6/6.6º*
2	+0.99 (V*MoP:* 0.03)	0.38	1:10.5/5.4º
3	+0.59 (*MoP:* 0.01)	0.40	1:9.9/5.8º
4	+0.19 (V*MoP:* 0.03)	0.40	1:9.9/5.8º
5	not preserved		
6	not preserved		
7	not preserved		
8	-0.71 (*MoP:* 0.01)	0.90	1:17.6/3.3º
9	not preserved		
10	not preserved		

Table 6.27. Top surface elevation of Phase 2 blocks, including change in elevation and the inclination of one column position relative to the next. Gradients are based on 3.97 m IA (except between 0(?) and 1 where the 3.44 m IA is used, see Table 6.24). All elevations are calibrated to the 87DZ.

and the average interaxial spacing between the Phase 2 colonnades of 6.48 m (see above). The intercolumniation in the individual Phase 2 colonnades is *ca* 3.30 m, based on the interaxial spacing of 3.97 m and the above-mentioned bottom column drum diameter of 0.67 m.

The Structural Layout of the Superstructure in Phase 2

With respect to the colonnades of Phase 2, two questions remain: (a) were they constructed on an inclination, and (b) can any of the blocks be identified as column bases? It is reasonable to assume that the relatively large number of column drums employed in the Phase 3 shipsheds originated from the Phase 2 structures, although there is a slight possibility that the load-bearing elements were comprised of piers.[96] The analysis presented here is based on the hypothesis that stone columns (and not piers) were employed to carry the roof (Tables 6.27–6.28).

In the southern part of Area 1 of Zea, the elevations of the roughly level foundation trenches of the well-preserved colonnade C14/15 are given in Table 6.29 (Pls. 13, 23c).

The foundations of column positions 7, 9 and 10 are almost level at a depth ranging from -0.91 to -0.96 m (Pl. 23c; Table 6.29). These are clearly the foundations of the Phase 2 colonnade, but it is not possible to calculate the gradient of the superstructure with any precision from the wide range of gradients calculated between the Phase 2 blocks or their rock-cut foundations (see Tables 6.27–6.28).

As demonstrated in the analysis of the keel-supporting ramp section and side-passages (see Chapter 7.3, p. 134), the height of the slipway is almost always located at the same level or in the vicinity of the top surface of the column bases. This is a logical design, since a taller ramp structure in this part of the shipshed would affect the amount of open space under the roof.

When the Phase 2 colonnade blocks C9/10:2 and C10/11:3 are compared to the elevation of the ramp foundations it becomes clear that these are most likely not column bases. Phase 2 colonnade block C9/10:2 has been shaved down to an elevation of -0.91 m by the construction of the foundations of the Phase 3 colonnade (C18/19:4; Fig. 192c). In the sea, C10/11:3

96. See p. 90 for a discussion of the re-used column drums in the ramp structures of Phase 3.

Column position	Elevation (m)	Height difference (m)	Gradient
0(?)	+1.21 (*VMoP:* 0.03)		
1	+0.83 (*VMoP:* 0.03)	*0.38*	*1:9.1/6.3°*
2	+0.43 (*VMoP:* 0.03)	0.40	1:9.9/5.8°
3	+0.14 (*VMoP:* 0.03)	0.29	1:13.7/4.2°
4	-0.12	0.26	1:15.3/3.7°
5	-0.45	0.33	1:12.0/4.8°
6	-0.64	0.19	1:20.9/2.7°
7	-0.87	0.23	1:17.3/3.3°
8	-1.09	0.22	1:18.0/3.2°
9	-0.96	+0.13	-
10	-0.91	+0.05	-

Table 6.28. (above) Average bottom elevation of rock-cut foundation trenches in the individual column position foundation, including change in elevation and the inclination of one column position relative to the next. Gradients are based on 3.97 m IA (except between 0(?) and 1 where the 3.44 m IA is used, see Table 6.24). All elevations are calibrated or measured to the 87DZ.

Table 6.29. (right) Elevation of rock-cut foundations in C14/15.

Column position	Feature	Elevation (m)
6	C14/15:1	-0.63
7	C14/15:2	-0.95
8	C14/15:3	-1.07 to -1.12
9	C14/15:4	-0.96
10	C14/15:5	-0.91

(-0.71 m) represents the only evidence of a Phase 2 block's top surface that can be related to an adjacent Phase 2 ramp structure (Shipsheds 9 and 10; Pl. 13; Fig. 223b).

The built-up horizontal ramp foundation in Shipshed 9 (S9:R6–R9) is located at -0.52 m; its level foundation (S9:R1–R2) stretches for 8.45 m. This clearly demonstrates that it is not the original top ramp surface in the area of the well-preserved top surface of block C10/11:3, which is located at -0.71 m (column position 8; Fig. 223b). This feature is about 0.19 m below horizontal ramp blocks S9:R6–R9. In the ramp of Shipshed 10 (best exemplified by S10:R2), the bottom of the horizontal rock-cut foundation is located only 0.13 m below the top surface of the adjacent colonnade block C10/11:3 (Fig. 199d). Considering that an inclined ramp structure would clearly have sloped well above this point, it appears quite unlikely that C10/11:3 is a column base. On the other hand, block C11/12:2(?) (+1.84 m; calibrated +1.77 m) is located in the vicinity of the only identifiable Phase 2 ramp feature, S12:R1, which rests at +1.90 m (calibrated +1.83 m). Although this evidence is inconclusive, and C11/12:2(?) does not fit into the 3.97 m interaxial spacing established for the colonnades, it cannot be ruled out that the block was somehow related to the Phase 2 superstructure.

It is not possible to determine if the preserved blocks in column positions 1–4 are column bases, but their inclination of 1:10.1 (5.7°) cuts through preserved column positions 6–10, and this clearly does not represent the inclination of the Phase 2 superstructure (Pl. 27).

In summary, insufficient evidence precludes the possibility of calculating the inclination of the Phase 2 superstructure to any precision. Similarly, it is not possible to calculate the inclination of the Phase 2 ramps from the extant evidence from Area 1 (see Chapter 7.4). The Phase 2 shipsheds were clearly constructed on an inclination, but only excavations into the modern harbour front may bring to light evidence of their gradients.

6.5. Relevant Comparative Superstructures from Other Shipshed Sites

A number of sites in the Mediterranean provide useful comparanda to the Phases 2 and 3 superstructures at Zea. The most contemporary and comparable shipsheds are those from the 4th–1st century BC at Oiniadai, where the roof structures rested on unfluted Doric stone columns. Shipsheds identified at Kos (3rd cen-tury BC) and Mandraki (Rhodes City, after the first quarter of the 3rd century BC) represent a secondary line of comparative evidence. A tertiary source is found in the remains of three possible shipshed sites on Corfu, where the superstructures rested on parallel colonnades. These sites and structures are discussed here to determine whether there are any similarities in the dimensions and structural layout between them and the Phases 2 and 3 shipsheds in Area 1 of Zea.

Other possible and identified shipshed remains found on Aegina, at Apollonia in Cyrene (Libya), Naxos (Sicily), Marseille, Sounion, Phoenician Kition and Punic Carthage provide useful comparative dimensions in the form of interaxial widths between the load-bearing elements, internal widths between the load-bearing elements and the lengths of the superstructures of the shipsheds as indicated by preserved side-walls or *stylobate*s. These structures are not discussed in detail here, but their dimensions are listed in Table 6.32.

6.5.1. Primary Comparative Superstructures

Oiniadai, Western Greece

At some point in the 4th century BC, a shipshed complex was built at Oiniadai. A total of five colonnades have since been excavated (Fig. 44).[97] Investigations revealed rock-cut spur-walls projecting from both the rock-cut back-wall behind the colonnades and from the centre axis of the ramp structures. The spur-wall between shipsheds 2 and 3, the only one preserved in front of a colonnade, is 2.20 m long and 0.90 m wide.[98] Remarkably, this spur-wall reached about 7 m in height, and taller spur-walls were found behind the longitudinal central axis of the ramps.[99] On Sears' plan the average dimensions of the spur-walls at the upper ends of the ramps are 2.58 m long ([4], range: 2.45 m to 2.68 m), and 1.10 m wide ([4], range: 0.86 m to 1.30 m).[100]

Several column bases and at least one bottom column drum were also found here. The bases measure 0.80 x 0.80 x 0.30 m – dimensions that are almost identical to the plan measurements of the Zea Phase 3 bases (0.81 x 0.81 m). They rest in rock-cut foundation trenches that measure 1.20 x 1.10 m.[101] Their top surfaces have *empolion* cuttings.[102] On Powell's section, column bases 3–6 are constructed on an average gradient of 1:8.6 (6.6°), whereas the gradient increases between bases 2–3 (1:6.3/9.0°) and 1–2 (1:2.8/19.7°).[103]

Kolonas found a bottom column drum *in situ* with a lower diameter of 0.70 m, and he also reports two drums with a diameter of 0.73 and 0.75 m.[104] Sears, however, reports a lower diameter of 0.72 m on a bot-

97. In this study the shipsheds are numbered 1–6 (from south to north). See Sears 1904: 227–237, pls. IX–X (drafted by B. Powell); Kolonas 1996: 164–167; 1997: 148.

98. According to the printed measurements on Powell's plan.

99. Sears 1904: 228–229. According to Sears, the measurement was taken with extreme difficulty; the heights of the taller spur-walls have yet to be published.

100. Sears 1904; averages based on printed measurements from pl. IX by Powell.

101. Kolonas 1990: 155.

102. Sears 1904: pl. IX.

103. These calculations are based on vertical heights and interaxial spacings printed on column positions 1–6 on Powell's section of the colonnade dividing shipsheds 2 and 3 (Sears 1904: pl. X; Fig. 46).

104. Kolonas 1990: 156.

tom column drum that was not found *in situ*.[105] Based on these four measurements, the average lower diameter of the column is calculated at 0.73 m (range 0.70–0.75 m).

The top column drum diameter of 0.62 m can be deduced from the lower diameter of the *echinus* on the capital described by Sears. According to his measurements, the *abacus* is 0.80 x 0.80 x 0.20 m. The *abacus* has the same plan dimensions as the column bases. The *echinus* has a straight profile and a bottom diameter of 0.62 m, a top diameter of 0.76 m and a height of 0.20 m.[106] These features, in addition to an *echinus-abacus* height proportion of 1:1, are comparable with other capitals dating to the 4th century BC.[107]

The average interaxial spacing of the first six column positions in colonnade dividing shipsheds 2 and 3 is 2.26 m ([8], range: 2.12 m to 2.34 m). The interaxial width between the colonnades dividing shipsheds 2/3, 3/4 and 4/5 is 6.78 m,[108] and their intercolumniation is between 6.03 m to 6.08 m, using Kolonas' lower diameters of 0.70 m and 0.75 m.

The dating of the shipsheds relies on several factors. The Corinthian tiles discovered during the shipshed excavations, as Sears reasonably asserts, were used in the construction of the roof.[109] The stamped tiles can be divided into two chronological groups. Two tiles with the genitives ΦΙΛΩΝΟΣ and -ΝΟΣ have been dated epigraphically to the 4th–3rd centuries BC; the date range is based on the *sigma*, which is not straight-sided.[110] The stamp ΟΜΙΛΟΥ was found on two tiles. Based on epigraphic morphology, these letters appear to be later than the first group: they are more straight-sided and uniform and can be compared to inscriptions from the 3rd and 2nd centuries BC.[111] Sears thinks that the stamp ΟΜΙΛΟΥ was earlier than ΦΙΛΩΝΟΣ and -ΝΟΣ, which is clearly not the case. Kolonas reports large quantities of Corinthian and Laconian tiles with the stamps ΟΙΝΙΑΔΩΝ, ΑΚΑΡΝΑΝΩΝ and ΦΙΛΙΠΠΩΝ in the genitive plural, and ΦΙΛΩΝΟΣ in the genitive singular.[112] Powell, writing in the same year as Sears, found a tile with the stamp ΦΙΛΙΠ- in the Large Tower in the southeast area of the harbour fortification. Based on the tower's higher position, he argues that the tower tiles may have dropped into the shipshed complex.[113] Such tiles could have been used in both buildings. According to Polybius (4.65.1–11), Philip V conquered Oiniadai in 219 BC without substantial resistance, and it is clear from the text that the shipshed complex was already in existence at this time. The year 219 BC thus represent a reliable *terminus ante quem* for the shipsheds. Guarducci and Powell reconstruct the tile stamps ΦΙΛΙΠ [-ΠΟΥ] as relating to building programmes carried out under Philip V.[114] As mentioned above, Kolonas found tiles in the shipshed complex with the stamp ΦΙΛΙΠΠΩΝ, and since there is no material evidence for the singular, it is likely that Powell and Guarducci's reconstructions are incorrect.

The first group of stamped tiles (dated to the 4th and 3rd centuries BC), the Doric capital of late Classical proportions, and the fact that Xenophon (*Hellenica* 4.6.14) writes that the Athenians employed the city as a naval base during the Corinthian War (395–387 BC) suggest a 4th century BC date for the first building phase of the shipsheds. The second group of tiles indicates that there was either more than one building phase or major repairs to the original construction. The shipshed complexes probably saw active use between the 4th and 1st centuries BC.[115]

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105. Sears 1904: 229.
106. Sears 1904: 231, pl. X. The *echinus* is called a *torus* in Sears' article, and apparently the capitals have no neck (Fig. 45).
107. Lawrence 1996: 69–70. Doric capitals of the 3rd century BC and later also have an *echinus-abacus* height relationship of 1:1, but they tend to be narrower than the lower diameter of the column. The Oiniadai capital is 0.80 m wide, and the average lower diameter is 0.73 m. The relationship does not quite conform to 4th-century BC norms: more typically the *abacus* width is only slightly greater than the lower diameter (see, e.g. Pakkanen 1998: tables D1 and D2 in App. D).
108. Based on Sears 1904: pls. IX, X.
109. Sears 1904: 235–237, figs. 51–54. The caption for fig. 55 describes a tile stamp, but the text of the article describes it as impressed on a jug. The ambiguity requires its exclusion from analysis here. See also Vol. I.2, Chapter 2 for a discussion of the tiles found at Oiniadai, and how they relate to the findings from Area 1 at Zea.
110. Guarducci 1969: 486–502; Powell 1904: 170. Powell dates tiles with the stamp ΦΙΛΙΠ- to the 3rd century BC.
111. Guarducci 1969: 486–502.
112. Kolonas 1996: 165.
113. Powell 1904: 170.
114. Guarducci 1969: 500–501; Powell 1904: 170.
115. Kolonas found a number of Roman graves inside the shipshed complex. In the stratum above the slipways he found Hellenistic ceramics, among which were mould-made bowls of figured type, West Slope Ware and black glaze fragments (Kolonas 1996: 164–165; 1997: 148). Their lower chronological range provides a reliable

6.5.2. Secondary Comparative Superstructures

Kos City, Kos (Dodecanese)

The remains of four column positions, interpreted as the remains of a shipshed colonnade, were found during excavations in the harbour of the main city on the island of Kos (Fig. 52).[116] The colonnade foundations, located to the west in the harbour, are composed of two rectangular limestone blocks, set side-by-side, and are preserved to a height of two courses. In plan view the average interaxial spacing of the colonnade foundations is *ca* 2.70 m ([3], range *ca* 2.55 m to *ca* 2.80 m). The unfinished excavations of the colonnade prevent measurement of the interaxial spacing between this colonnade and the side-wall or *stylobate*, which was constructed partially from re-used blocks. Blackman interprets the cuttings in the blocks as "curious post holes",[117] but these blocks are identical to those in the well-defined ramp structure to the northwest, and were therefore in all probability originally part of a ramp. Kantzia describes the wall as level along its excavated length, and as standing to the same height as the colonnade; it may have served as a *stylobate*. These observations clearly indicate that the foundations were not constructed on an inclination.[118] Sections of the colonnade and the wall have yet to be published, thus precluding any detailed analyses of the structures.

A 3rd century BC date assigned to the structures is based on finds found in a test trench dug into the ramp area.[119] The colonnade may belong to an earlier or later building phase. The re-used ramp blocks in the side-wall, which are identical to those in the ramp structure, indicate that this part of the superstructure was built later than the ramp.

Mandraki, Rhodes City, Rhodes (Dodecanese)

The remains of six shipshed colonnades (A–C, E–G) and a side-wall (D) oriented north-south are preserved at this site in the southeast side of Mandraki Harbour (Fig. 49); they date to a *terminus post quem* of the first quarter of the 3rd century BC (Knoblauch's Period 2).[120] The colonnade foundations were re-used in two successive building phases, Periods 3 and 4, which both date to the first half of the 2nd century BC.[121] Towards the south, colonnades C, E–F, and wall D were overbuilt by a Roman tetrapylon (Fig. 49). To the north, modern buildings cover the seaward end of the shipsheds. Mandraki is particularly interesting because shipsheds of two different sizes are preserved side-by-side: a *wide* type (DE, EF and FG) and a *narrow* type (AB, BC and CD) (Fig. 49).

Except for wall D, all of the column foundations were constructed of two rectangular limestone blocks laid side-by-side in the header-stretcher method. These were preserved to a height of two to six courses (maximum height: *ca* 3.40 m). The blocks have an average length of 1.45 m ([19]; range: 1.30 m to 1.55 m), a width of 0.70 m ([20]; range: 0.60 m to 0.80 m) and height of 0.60 m ([50]; range: 0.45 m to 0.70 m).[122] The average plan dimensions of the foundations are 1.45 x 1.40 m.

When comparing the size of the foundation in the narrow shipsheds with those of the wider shipsheds, the latter appear to have construction elements of larger dimensions, as seen in Table 6.30.

According to Knoblauch's measurements, the interaxial spacing of the colonnade positions in the *narrow* shipshed CD is 2.68 m ([3]; range: 2.65 m to 2.75 m), whereas that of the *wide* shipshed FG is 3.08 m

indicator for when the shipsheds went out of use: West Slope Ware was produced until the late 1st century BC. Figured Megarian bowls are found in severely reduced numbers in the 1st century BC; S. Rotroff doubts that they were produced in this century, and argues that they were produced in Athens until the mid-2nd century BC (Rotroff 1982: 19).

116. Kantzia 1992: 632–635, fig. 12, pls. 355–357.

117. Blackman 2004: 79, fig. 6.

118. Kantzia 1992: 634.

119. Kantzia 1992: 635.

120. Blackman, Knoblauch & Yiannikouri 1996: 420–422. The individual shipsheds at Mandraki are noted in this present study by the superstructures delineated on Knoblauch's plan (e.g. shipshed CD).

121. The chronology presented by Blackman and Knoblauch has not been adjusted to the ceramic dates provided by Yiannikouri's study in the same article (Blackman, Knoblauch & Yiannikouri 1996: 408), and the dates presented here are based on this article. The Periods 3 and 4 ramps contained ceramics of the same date range (mid-3rd century to the first half of the 2nd century BC), and they were probably built within a short period of time in the first half of the 2nd century BC. The earthquake of 227/26 BC cannot be used as a *terminus ante quem*, as layers 2β (Period 3) and 2α (Period 4) both contained material from the 2nd century BC.

122. Scaled off Blackman, Knoblauch & Yiannikouri 1996: fig. 6: B1, C1–C3, F1–F3 and G2–G4. Heights are based on Knoblauch's sections (fig. 17): A1 (west); B1 (east); E1 (north); F1 (north); F2–F3 (east); G2–G4 (east).

a. Wide shipsheds: colonnade foundation	
Length:	1.50 m [10] (range 1.40–1.55 m)
Width:	0.70 m [4] (range 0.70–0.75 m)
Height:	0.60 m [37] (range 0.45–0.70 m)
Average dimensions: **1.50 x 1.40 m**	
b. Narrow shipsheds: colonnade foundation	
Length:	1.40 m [9] (range 1.30–1.50 m)
Width:	0.65 m [10] (range 0.60–0.80 m)
Height:	0.60 m [13] (range 0.50–0.65 m)
Average dimensions: **1.40 x 1.30 m**	

Table 6.30. Mandraki (Rhodes), dimensions of colonnade foundations (from Blackman, Knoblauch & Yiannikouri 1996: figs. 6, 17).

Shipshed	IA (m)	IC (m)
a. Narrow shipsheds		
AB	5.60	5.03
BC	5.45	4.88
CD	5.94	5.37
"Average"	**5.66**	**5.09**
b. Wide shipsheds		
DE	7.84	7.27
EF	7.35	6.78
FG	7.74	7.17
"Average"	**7.64**	**7.07**

Table 6.31. Mandraki (Rhodes), interaxial widths and intercolumniation of the narrow and wide shipsheds (from Blackman, Knoblauch & Yiannikouri 1996: fig. 24).

([3]; range: 2.92 m to 3.16 m). The width between the probable wooden posts or stone piers within each colonnade was not calculated.

The interaxial widths of the narrow and wide shipsheds are also based on Knoblauch's measurements (Table 6.31), whereas the distance between the wooden posts is based on the 'average' width (*ca* 0.57 m) of the two rock-cut features preserved in the top surface of D2 (*ca* 0.50 m) and D3 (*ca* 0.64 m). These features help divide *narrow* shipshed CD from *wide* shipshed DE.

Wall D was constructed of large, coarse limestone blocks. It was exposed for 8.18 m and is 1.35 m wide. On the top surface of the wall were found two bases with rectangular cuttings (D2: *ca* 0.56 x *ca* 0.50 m; D3: *ca* 1.00 x *ca* 0.64 m);[123] these probably supported stone piers or wooden posts of similar dimensions, although a wooden post with a length of about 1.00 m is highly unlikely. The interaxial spacing (*ca* 2.75 m) between D2 (+10.06 m) and D3 (+9.50 m) gives an inclination between the two features of *ca* 1:5 (11°).

Knoblauch believes that wall D is earlier (Period 1) than the colonnades (Period 2) and dates to the 4th century BC based on its construction technique. Wall D, however, is founded on the same layer as the pier foundations (layer 4), which contains material dating from the 4th century BC to the first quarter of the 3rd century BC. This date range thus represents a *terminus post quem* for both wall D and the piers.[124] Knoblauch further argues that in their initial stage these elements belonged to structures other than shipsheds and were only later re-used and integrated into the shipshed complex.[125] It is highly unlikely, however, that a wall not related to the shipsheds was running at the correct orientation and height as the shipsheds, and that an earlier structure would dictate where this substantial building complex was to be built. Since wall D divides the wide and narrow shipsheds, one could speculate that these shipsheds were not constructed at the same time, and

123. Scaled off Blackman, Knoblauch & Yiannikouri 1996: fig. 6. Knoblauch's bar scale is precisely drawn at 1:200.
124. Blackman, Knoblauch & Yiannikouri 1996: 420–422. Layer 4 contained primarily ceramics of the 4th century BC, but a Rhodian skyphos handle (27/22) dates the lower chronological range of the layer to a *terminus post quem* of the first quarter of the 3rd century BC.
125. Blackman, Knoblauch & Yiannikouri 1996: 380, 392–398.

that this wall originally ended a section, and was taken down to the present level when the complex was expanded. The piers were re-used in Periods 3–4, and the latest ramp structure (Period 4) related to the superstructure dates to the first half of the 2nd century BC.

The colonnade positions are parallel in both the narrow and wide shipsheds. However, the pier foundations of both types are not perfectly aligned, and the interaxial spacings vary markedly within the individual colonnades and among other colonnades (Table 6.31). Apart from the larger width noted by the excavators, the column positions in the wider shipsheds also have a wider interaxial spacing, and the foundations of the superstructure appear to have larger dimensions (Table 6.30).

6.5.3. Tertiary Comparative Superstructures

Corfu City, Corfu (Ionian Islands)
Corfu boasts three sites with colonnades that possibly belong to shipsheds. One of the sites is located in the ancient harbour at Hyllaikos (Corfu A), and two are found in the ancient harbour at Alkinoos (Corfu B and Corfu C).

Corfu A. At Hyllaikos, Kanta-Kitsou excavated two parallel colonnades running roughly in an east-west direction. The northern colonnade was followed for 25 m (10 positions) and the southern colonnade for 33 m (13 positions). In the northern colonnade, the top surface of the second courses of column positions 1–2, 4–5 and 8–10 have slots with a length of *ca* 0.25 to 0.30 m, a width of *ca* 0.20 to 0.25 m and a depth of 0.18 m. These slots were probably cuttings for vertical wooden posts supporting a roof structure.

Based on the additional block placed atop these features in post positions 1–2 and 4–5 Kanta-Kitsou cautiously identifies two building phases (named A1 and A2 here) in this colonnade.[126] Most of the later blocks have a circular cutting in the top surface (diameter: 0.33–0.36 m, depth: 0.03–0.05 m). A column drum with a height of 0.87 m and a diameter of 0.30 m was found to the north of column positions 5–6. Kanta-Kitsou relates this to the later building phase.[127] This is a very narrow lower column diameter, and it could not have been used as any part of a column expected to be about 5–7 m high, found at other shipshed sites (see Chapter 8.2.4). This strongly indicates that the building was not a shipshed.

According to the excavator, the inside measurements between the colonnades vary between 4.8 and 5.1 m, and the space between the foundations of the individual colonnades is 2.10–2.20 m.[128] In the plan, the colonnades have an interaxial width of about 5.90–6.00 m. Towards the west, apparently as a result of the displacement of the foundations for column position 10 in the northern colonnade, the width narrows to about 5.45 m. The scaled interaxial spacing of the individual colonnades is *ca* 2.60–2.70 m.[129]

The top surface of those features exhibiting slots most probably represents an earlier building phase in positions 4–5 and 8–10. They are roughly level, whereas positions 1–3 are constructed on a slope. The colonnade foundations stand on a layer of sand containing ceramics from the Late Archaic period. Accordingly, Kanta-Kitsou dates the use of the building from the Late Archaic/Early Classical period to the Late Hellenistic/Early Roman period. Above the colonnades were found a thick destruction layer of Corinthian tiles, probably belonging to the roof of the building. The tile stamps include a Δ (*demos*), which indicates that the building was public.[130]

The evidence that would identify this structure as a shipshed is ambiguous. Since no ramp feature can be assigned to the colonnades, and as there is no clear inclination in the superstructure, the two colonnades cannot be identified as belonging to a shipshed.

Corfu B. In the harbour at Alkinoos, Dontas excavated a colonnade that he identifies as parts of a shipshed.

126. Kanta-Kitsou 1997: 338–340.
127. Kanta-Kitsou 1997: 340.
128. Kanta-Kitsou 1997: 339.
129. All measurements have been scaled off Kanta-Kitsou 1997: pls. 3–4 (1:200). The interaxial width was measured between column positions 2, 3, 8 and 9. The interaxial spacing of the northern colonnade was measured between the centres of the rock-cut slots of column positions 1–2 (*ca* 2.60 m) and the west sides of 4–5 (*ca* 2.65 m). In the southern colonnade the interaxial spacing was measured between the centres of the foundation blocks in column positions 1–2 at *ca* 2.70 m.
130. Kanta-Kitsou 1997: 340.

The colonnade foundation in the right-hand side of Dontas' section has a *ca* 0.13 x 0.13 m slot in the top surface.[131] The remaining four features are not preserved to their original height. It is unlikely that the slight slope of 1:60 (1°) is intentional. The interaxial spacing is *ca* 3.00 m ([4], range: *ca* 2.85 m to *ca* 3.10 m).[132] Based on the available material it is not possible to identify the structure as belonging to a shipshed.

Corfu C. At another site in Alkinoos Harbour, Preka-Alexandri excavated two parallel colonnades. They were constructed on a sand layer containing Archaic period material. In the destruction layer above the colonnades were found charcoal, fragments of white stone (limestone or plaster?), numerous tiles, and a coin of Corcyra dated to 300–229 BC. The coin supplies a *terminus post quem* for the possible destruction of the building.

Preka-Alexandri reports a spacing between the foundations in the individual colonnades of 2.0–2.2 m and an approximate width between the insides of the two colonnades of 4.50 m.[133] The average interaxial spacing of the colonnades is *ca* 2.70 m ([11]; range: *ca* 2.55 m to *ca* 3.05 m), and the average interaxial width between the colonnades is *ca* 5.55 m ([5]; range: *ca* 5.35 m to *ca* 5.80 m).[134] There are no features such as socket holes in the top surface or circular cuttings, as seen in the colonnades excavated by Kanta-Kitsou, or any other features that help identify the surviving elements as the top surface of colonnade foundations. In section the colonnade features appear to have been constructed on a very slight inclination of about 1:90 (0.6°). Such a low value fails to indicate intentional or even circumstantial inclination. What is more, although the colonnades found by Preka-Alexandri are more narrowly spaced (IA: *ca* 5.55 m) compared to those excavated by Kanta-Kitsou (IA: *ca* 5.90–6.00 m), the average interaxial spacing of the individual colonnades (*ca* 2.70 m) is very close to that of the two colonnades found in the harbour at Hyllaikos (*ca* 2.60–2.70 m). These characteristics, in addition to the presence of tiles stamped with a Δ (*demos*), strongly suggest that these are large colonnaded public buildings.

In sum, the mostly horizontal colonnade foundation features found at Corfu, in addition to a complete lack of ramp remains, strongly suggest that these are other building types, such as stoai or large storage facilities such as storage buildings.[135] The structures therefore must be used with strong reservations with regard to shipshed comparanda.

Summary

It now remains to detail the working averages derived from the primary, secondary and tertiary stone courses in order supply relevant comparanda with the Phase 2 and 3 shipsheds at Zea (Table 6.32). Note that with the exception of Oiniadai and Mandraki, the available evidence from other sites is extremely sparse, and in most instances remain unpublished and must be scaled off plans and sections. One obvious conclusion can be drawn on the above evidence: the most common design is parallel colonnades at other possible and identified shipshed sites (Figs. 37, 44, 49).

131. Dontas 1968: pl. 1.
132. Scaled off Dontas 1968: pl. 1.
133. Preka-Alexandri 1996: 256–257, pl. 1.
134. Scaled off Preka-Alexandri 1996: pl. 1.
135. Coulton 1976: fig. 20 (p. 193). Archaic stoai with parallel external and internal colonnades are found at Samos (South Stoa and North Stoa) and Argos (Argive Heraion, North Stoa). There are also a number of later examples. In addition, storage buildings with this colonnade design have been found at Rhodes (see Kondis 1957: 131–132).
136. Based on measurements printed on Knoblauch 1976: pl. 16. Average interaxial width: 6.6 m ([6] range: 6.5 m to 6.6 m); average internal space between load-bearing elements of the superstructure: 5.82 m ([6], range: 5.72 m to 6.17 m); length of superstructure scaled off Knoblauch 1976: pl. 17.
137. Flemming 1965: 170–173; Flemming 1971: 103–109.
138. Blackman & Lentini 2003: 397, 405. Interaxial spacing based on the width of walls delineating slipway 1 (1.12 and 1.20 m).
139. Hermary, Hesnard & Tréziny 1999: plan (p. 156). According to the excavators, the width is 6.0–6.5 m, but on the plan the average internal space is *ca* 7.0 m. The scaled measurements are used here.
140. Callot 1997: 74; Christou 1997: 914.
141. The interaxial width between the colonnades increases 0.3 m (Hurst 1975: 19, n.1: from 5.9 to 6.2 m) over 15.0 m. Thus the interaxial width widens 0.02 m per metre. Twenty-two out of 30 shipsheds were more than 45 m long (Hurst 1994: 35). At a length of 45 m, the interaxial width would be increased to ca 6.8 m (5.9 m + (0.02 x 45.0 m) = 6.8 m+). The width of the blocks in the colonnades average *ca* 1.0 m (Hurst 1975: 19), and the range of the intercolumniation is *ca* 4.9 m to 5.8 m+. The reconstructed measurements of the shipsheds found along the shore in the northern part of the harbour are not listed here, as they are based on the narrow shipsheds on Ilôt de l'Amirauté (Hurst 1994: fig. 12.2).
142. Blackman 1996a: 113.
143. Hurst 1994: fig. 2.1 ("robber-trenches" scaled from this figure).

Location	IA (m)	IA width (m)	IC/CW (m)	Preserved Length (m)	Inclination
Zea, Area 1					
Phase 2	3.97	6.48	-	36.91	-
Phase 3	2.16/3.38–3.39	6.51	5.87 (5.81)	59.20	1:12.7 (4.5°) to 1:11.9 (4.8°)
Phase 4	3.43	6.41	-	11.24	
Primary Comparanda					
Oiniadai	2.26 m [8]	6.78 [2]	6.05 [2]	48	1:8.3 (6.9°)
Secondary Comparanda					
Kos	2.70 [3]	-	-	9.20	*horizontal*
Mandraki (narrow)	2.68 m [3]	5.66 [3]	5.09 [3]	9.50	1:5 (11°)
Mandraki (wide)	3.08 m [3]	7.64 [3]	7.07 [3]	11.95	1:5 (11°)
Tertiary Comparanda					
Corfu A1(?)	2.6–2.7	5.9–6.0	5.65–5.75	33	*horizontal*
Corfu A2(?)	2.6–2.7	5.9–6.0	5.60–5.70	33	*horizontal*
Corfu B(?)	3.00 [4]	-	-	13.40	1:60 (1.0°)
Corfu C(?)	2.70 [11]	5.55	-	19.40	1:90 (0.6°)
Aegina(?)[136]	-	6.6 [6]	5.82 [6]	35	-
Apollonia[137]	-	-	*ca* 6.0	40	*stepped horizontal*
Naxos, Sicily[138]	-	6.61	5.58	34.70	*stepped horizontal*
Marseille(?)[139]	-	*ca* 7.8	*ca* 7.0	*ca* 41	*horizontal*
Kition[140]	-	*ca* 6.0	*ca* 5.2	*ca* 30	*stepped*
Carthage, narrow[141]	-	*ca* 5.9–6.8	*ca* 4.9–5.8	*ca* 27	-
Carthage, wide[142]	-	*ca* 8.1–9.0	*ca* 7.1–8.0	*ca* 15	-
Carthage, North/NE[143]	-	-	-	8.3	-

Table 6.32. Shipshed and possible shipshed superstructures from other sites in the Mediterranean and those in Zea Harbour.

Feature	Length (m)	Width (m)	Height (m)
Wall 16/26(λ), second course [3]	1.12	0.62	0.58
Spur-wall C17/18(γ), second course [2]	1.27	0.62	0.60
Back-wall, second course	1.19 [4]	0.59 [5]	0.58 [7]

Table 6.33. Comparison of block dimensions in the second courses of Wall 16/26(λ), Spur-wall C17/18(γ) and the back-wall. The number in brackets in the first column shows the number of features on which the average calculation is based. Number of measurements listed in brackets.

6.6. A Summary of the Superstructure Arrangements in Area 1 of Zea Harbour

6.6.1. Phase 3

The blocks of the first courses in the back-wall, Spur-wall C17/18(γ), and probably also in Side-wall 16/26(λ) were adjusted to offset the variation in elevation of the rock-cut foundations and to create a uniform inclination or level surface for the upper courses. This is seen most notably in the vicinity of Spur-wall C17/18(γ) (Pls. 8a–8d) and in the marked step seen in the rock-cut foundations behind the southern (right-hand) part of the ramp of Shipshed 21 (Pl. 32f). The average width and height of the second course of W16/26(λ) are comparable to the averages of the second courses in Spur-wall C17/18(γ) and the back-wall (Table 6.33). The blocks composing Wall 16/26(λ) are shorter, but since all these structures were laid out block-by-block, the length was often adjusted to fit interlocking structures, such as the junction of Spur-wall C17/18(γ) and Wall 16/26(λ) (Pl. 6). As a result, length is the most variable dimension in the preserved parts of the second courses. Although the number of blocks is sparse, the architectural similarities in the widths and heights of the second courses are a reliable indication that they belong to the same building phase (Table 6.33).

Back-wall

The back-wall's architectural function was to carry a part of the load of the roof and to stabilise the superstructure by providing an anchoring point for the wall dividing Shipsheds 16 and 26(?) and the spur-walls (Pls. 6, 8). The back-wall also protected the upper ends of the shipsheds and their contents from rain, and also served as a fire barrier in case of potential conflagrations originating from the city side of the harbour.

No doorways or throughways were found in the excavated part of the back-wall of the Area 1 shipshed complex at Zea. A later possible entrance was cut in the back-wall in the area behind Shipshed 16, as evidenced by the partial removal of the two northern-most *in situ* blocks (BW:5–6) by a rough and uneven rock cutting (Pls. 8a–8b; Fig. 75). This feature possibly represents a later doorway, probably cut after the shipsheds went out of use, thus indicating secondary use of this part of the shipshed complex. It is evident from the photographic material commissioned by Meletopoulos that BW:6 (BW:5 is covered) already had this cutting in the 1950s before Sirangiou 1 was built (Fig. 61).

The lack of evidence for an established opening in the back-wall led Blackman to speculate that "there must have been some doors through this wall; none have been found, but the wall was only preserved to a height of two or three courses, and the doors may have been fairly high up and approached by wooden steps of which no trace has survived."[144] Wooden stairs would probably have been secured or fastened into rock-cut slots either in the wall or on the floor, but in the back-wall of Shipsheds 16–18, and in the bedrock in front it, no rock cuttings can be related to wooden or stone stairs. Indeed, stairs in this area would have limited the space required for the stern of the

144. Blackman 1968: 182–183.

ship, as well as the usable space on ground level. Significantly, Dragátsis does not mention any doorways or throughways in the back-wall.

Blackman's asserts that "…the doors [in the back-wall] may have been few in number and access to the ships fairly restricted."[145] If there were doors, in the documented Phase 3 shipsheds in Area 1, workers would have had to zig-zag between the raised upper ends of the ramps and the spur-walls that support the eaves of the roof behind the colonnades with the shorter interaxial spacing (Pls. 15–16). Furthermore, the bedrock between Spur-wall C17/18(γ) and the first column base is not level, and does not give the impression of being used as an intentional passage, although it could have been levelled with fill (Fig. 176b).

Spur-walls

Shipsheds with spur-walls have been excavated in Oiniadai and Kition, and possibly in Mounichia in the Piraeus (Group 3; Fig. 29) and Carthage. Architecturally, none of these sites are directly comparable with the Area 1 shipsheds at Zea, although the spur-walls at Oiniadai provide important evidence regarding the height of shipshed superstructures. The height of the superstructure is discussed in detail in Chapter 8.2.4.

Wall 16/26(λ)

W16/26(λ) was in all probability initially constructed as a side-wall that ended one complex or a section of shipsheds. Blackman proposes that W16/26(λ) could also have functioned as a fire wall, a very likely secondary purpose.[146]

W16/26(λ) was likely built at the same time as the Phase 3 back-wall south of this area. The structurally distinct shipsheds divided by W16/26(λ) likely represent two building phases, with possible Shipsheds 26 and 27 probably built later than Phase 3 (Pl. 15).[147] Consequently, the roof of Shipshed 16 may have been dismantled, after which W16/26(λ) was adjusted to carry the eaves of both Shipshed 16 and possible Shipshed 26. Compared to the primary (0.64 m) and Dörpfeld's secondary (0.70 m) lower diameters of the Phase 3 colonnades the wall was clearly wide enough to support the adjoining eaves of two roof sections; it may initially have been constructed so that the complex could be expanded northwards.

It is important to note that the extrapolated centre range of the SIT-1 inclination, 1:12.3 (4.65°), connects the top surface of W16/26:12–14 and bottom surface of W16/26:1 (Figs. 173, 230). The reconstructed height of the third course (0.58 m) interconnects perfectly with the top surface of the first course in the back-wall: this clearly shows that the SIT-1 inclination cannot be far off target (Pls. 34a, 35a; Fig. 230). Further, the interaxial spacing between W16/26(λ) and the colonnade dividing Shipsheds 16 and 17(η) is 6.48 m (Table 6.19); this is very close to the average interaxial spacing of the Phase 3 shipsheds, whereas the interaxial spacing of Phase 4 is narrower at 6.41 m (*MoP:* 0.05 m; Fig. 231). This evidence strongly indicates that wall W16/26(λ) and the back-wall were built at the same time (Phase 3), and that the structures (Phase 4) north of W16/26(λ) were built later (Pl. 15).

Colonnades

The matrix of the alternating narrowly- and widely-spaced Phase 3 colonnades is very well defined (Pls. 15–16).

In the ridge-bearing colonnades, 15 column positions are identified over a length of 51.12 m (C18/19:4; Pls. 15, 26). They have an average interaxial spacing of 3.39 m, and an intercolumniation of 2.75 m (Pl. 35b). The average interaxial spacing of the more narrowly-spaced eave colonnades is 2.16 m, and the intercolumniation is 1.52 m. Twenty-six column positions have been identified (Pl. 35c), and their foundations have been followed for 59.20 m (*MoP*: 0.01; C17/18:4 to C23/24:10; Pls. 15–16). No evidence of column positions 4–10 and 21–23 have been found, but they can be plausibly reconstructed based on column positions 1–3, 11–20, and 24–26.

The intercolumniation of both colonnades is based on the extrapolated lower diameter (0.64 m) of the two *in-situ* bottom column drums found in the colonnade dividing Shipsheds 18(χ)/19(φ) (C18/19:1(τ), 3(υ)). The 0.64 m lower diameter supersedes the average

145. Blackman 1968: 183.
146. Blackman 1968: 182.
147. As discussed above, there is no evidence to show how the back-wall of possible Shipshed 26 interconnected with W16/26(λ).

lower diameter 0.70 m on Dörpfeld's 1:200 plan (*MoP*: 0.04 m) and section (*HMoP*: 0.02 m). It is very likely that the lower column diameter varied within several centimetres, as seen at Oiniadai (0.70–0.75 m).

The distance between the first column position and the back-wall varies in each colonnade (e.g. in widely-spaced colonnades C16/17(η): 3.16 m, and C20(π)/21(Δ): 3.20 m). This affects the overall matrix of the colonnades. Moreover, the interaxial spacing of the wide colonnade varies within 0.01 m. There may be a higher variation in individual instances. The reconstructions based on these measurements, therefore, present standardised-measurement, fixed-matrix colonnades, varying slightly from the physical remains (Pls. 15–16).

According to the printed measurements on Dörpfeld's plan, the interaxial spacing varies from 6.47 m to 6.54 m, with an average of 6.51 m (Pl. 17). The average intercolumniation, i.e. the interior free space between the bottoms of the columns, is 5.87 m (range: 5.83 m to 5.90 m), based on the 0.64 m lower column diameter.

Sixteen column bases were identified as belonging to the first three column positions of both colonnade types. Their average dimensions are 0.81 x 0.81 x 0.49 m. It has been determined that the average inclination of 1:10 (5.7°) of column positions 1–3 does not represent the overall inclination of the column bases, or that of the roof ridgeline and eave lines. The reconstruction of the inclination of the entire superstructure is based on the most likely theory SIT-1 (Pls. 35, 37). Here the inclination ranges between the gradient of the second course of W16/26(λ) (1:12.8/4.5°) and the reconstructed maximum gradient of colonnade C23(Π)/24(Φ)(1:11.9/4.8°) with a mid-range of 1:12.3 (4.65°).

6.6.2. Phase 4

The design of the three column positions and one spur-wall preserved in the colonnade dividing Shipsheds 26/27(?) (Pls. 15, 41; Fig. 231) is clearly different from that of Phases 2 and 3 (Pls. 13, 15–16). The Phase 4 spur-wall behind C26/27(?) is noticeably shorter at 1.10 m, as compared to the average length of those of Phase 3, which project 2.03 m (*MoP*: 0.04) from the back-wall. Furthermore, the interaxial spacing is greater in C26/27(?) (3.43 m) when compared to the interaxial spacing of the widely-spaced Phase 3 colonnades (3.38–3.39 m), and markedly shorter than those of Phase 2 (3.97 m). Based on the primary, average 0.64 m lower diameter of the Phase 3 colonnades, the clear space between the second course of W16/26(λ) (0.62 m) and C26/27(?) would be slightly narrower at 5.78 m, *MoP*: 0.05 m (based on Dörpfeld's 0.70 m bottom diameter: 5.75 m, *MoP*: 0.05 m) when compared to that of Phase 3 at 5.87 m (based on Dörpfeld's 0.70 m bottom diameter: 5.81 m, *HMoP*: 0.02 m). Since Shipshed 26(?) shares W16/26(λ) with the identified Shipshed 16, the inclination of the Phase 4 structures is estimated at the SIT-1 mid-range of 1:12.3 (4.65°). Due to these architectural differences, it is concluded that possible Shipsheds 26 and 27 belong to another section of possible shipsheds, and most probably represent the latest identified building phase, Phase 4 at Zea.

6.6.3. Phase 2

The matrix of the Phase 2 colonnades with its ten preserved column positions is well defined over a length of 36.91 m (*MoP*: 0.05 m). There are no remains of a back-wall (Pl. 13). The column foundations were set parallel to each other in rock-cut foundation trenches forming colonnades with an average 3.97 m interaxial spacing, and an average interaxial spacing of 6.48 m between the colonnades. Eight intact rock-cut foundations have average dimensions of 1.35 x 1.10 m, and two *in-situ* blocks found in the sea provide an average foundation block size of 1.17 x 0.87 x 0.54 m. The inclination of the Phase 2 superstructure cannot be calculated due to insufficient evidence.

The shipsheds at Oiniadai and Mandraki also have parallel column positions, but their interaxial spacing and widths vary markedly from those of the Phase 2 shipsheds at Zea Harbour. Here, Phase 2 represents the widest interaxial average of any known shipshed or possible shipshed site (see Table 6.32).

A number of rock-cut features (U:20, U:24, U:28, U:32 and U:35) are probable foundations for wooden scaffolding related to the construction of either the Phase 2 or Phase 3 colonnades (Pl. 40). They appear to be constructed in a rough grid, on the same orientation as these colonnades.