6. MATERIALS AND TECHNIQUES

The building description in Chapter 2 deals with all aspects of structure and design. The present chapter offers a summary of building techniques with more detailed information about materials and methods of construction.

6.1 Materials

The Bouleuterion, in its first phase, was built largely of white marble and bluish gray marble. The former probably came from quarries located around Ephesos.[245] The bluish gray marble was taken directly from Panayırdağ, where quarries are a conspicuous feature of the landscape, around the base on the east side,[246] and on the mountain itself. Brick was used only in the back-stage corridor in the construction of a blind arcade which fronted the rough south façade of the stage wall, probably late in the building's history (pl. 40, 1). Pavers made of a porous, light gray limestone[247] replaced an original marble paving in several locations. *Opus caementicium*[248] was used in significant quantities only as bedding for the marble seating and stairways of the *cavea* (pl. 12, 1), and in lesser quantities in the "petit appareil" walls inserted between the piers of the *parodoi* during the second (i.e. Antonine) phase (plan 5). The only surviving elements employing imported materials were columns of the *scaenae frons*, which were made from red Egyptian granite (pls. 73, 1–2).[249]

6.2 Stone Working[250]

Bluish gray marble was used for the basic structural elements of the building, where its roughness and the size of its units were appropriate to the functions of support and enclosure. The great curved retaining wall and the thinner wall it supported (pls. 16, 1–2) were made of bluish gray marble, as were the lower portions of the long stage wall (plan 4) and its terminal piers. The interior surfaces were hidden behind a marble revetment, either in the form of thick orthostat slabs, as in the podia of the orchestra (pl. 29, 2) and *summa cavea* (pls. 24, 1–2), and the curved rear wall (pl. 17), or thinner marble sheets, as in the column-bearing pedestals and the walls of the *scaenae frons* (plan 4; 5; pl. 36, 3). It is unlikely that the rough surface of the scene wall on the corridor side was ever intended to be seen, and at some late period an attempt was made to mask portions of it with brick (pl. 40, 1; 43, 2). The only exposed bluish gray marble surfaces were those of the curved outer wall and the corner piers. The former probably represents a cheaper and faster mode of reconstruction.[251] The original appearance of this masonry is preserved in several contiguous courses at the base of the wall between Buttresses 2 and 3 (pl. 16, 2). The blocks show a uniform rustication with carefully rounded bolsters that are angled in at the sides. These blocks are finished with a point, the beveled portions with a fine toothed chisel, and there are narrow, neatly drafted margins at the vertical joints. Similar blocks appear at the base of the front wall on the corridor side. The units of the corner piers, below the marble superstructure, display a variety of masonry styles.

The upper scene wall alternated marble string courses with doubled orthostats of which only the inner blocks were of marble (plan 5; pl. 38, 2). Marble was used for the exposed portions of the *analemmata* (pls. 25, 2; 26, 2), which were similar in construction to the upper scene wall, for the seating and steps of the *cavea*, and for the footings which supported the curved marble orthostat slabs of the podia and the rear retaining wall (pl. 18, 1). It was used for door frames, for the base moldings and molded crown blocks of the pedestals, and,

---

245 Benndorf 1906, 38–41 fig. 10; Atalay 1976/77, 59–60; Atalay 1985, 311–314. Most recently the survey by L. Moens and collaborators (University of Gent), cf. Koller 1999, 40; Jahresbericht ÖAI 1999, 381–382; Jahresbericht ÖAI 2001, 382.

246 Benndorf 1906, 39.

247 Lang-Auinger 1996, 23; Thür 2005, 22.

248 On *opus caementicium* in general s. Lamprecht 1987.

249 Mielsch 1985, 67 pl. 22 no. 749–755; Borghini 2001, 225–226.

250 On stone working in general see Rockwell 1993; Adam 1994, 29–40.

251 See chap. 2.1.1.

with the exception of some granite columns, for the aedicular architecture they supported. All vertical marble surfaces were exposed, at least in the original building phase. Holes for iron pins in the upper walls, preserved at both ends of the stage building, indicate revetment, but this represents an alteration. An orthostat block belonging to this wall, originally recorded by J. Keil and preserved in the depot under the Domitian Terrace, bears a portion of a Hadrianic letter.[252] It was later covered by marble paneling, as revetment holes in its surface show (pl. 62), into which the inscription was recut.

All visible surfaces in the building's interior, with the exception of the reveals of the stage doors, were carefully finished, normally with fine to medium toothed chisels. Drafted margins cut with flat or fine toothed chisels can be seen in the curved surface of the footing of the rear wall, and along the top edges of the fascias of the architraves. The lack of drafting in the blocks of the *analemmata* is probably due to the fact that these walls were refinished after the *pulpitum* was built.

Bedding surfaces vary in treatment. The well-preserved stretch of scene wall behind Pedestal 6 (plan 4; pl. 38, 2) shows a two-row construction consisting of marble blocks in front with bluish gray marble behind. The finely finished top surface shows the marks of the point and the toothed chisel. Shallow beds were cut in two places to receive blocks of the next course. The orthostat courses were finely finished, top and bottom, without *anathyrosis*. In the *analemma* walls, the bedding surfaces of string courses and orthostats were chiseled smooth.

Vertical joints are tight. *Anathyrosis* consists of broad margins produced with a fine toothed chisel adjacent to the face and sometimes along the top as well, while the slightly recessed center is more roughly worked with a point. The backs of marble blocks are quarry-faced or worked rough.

Setting lines appear in a number of places throughout the building, often accompanied by pry holes. Most conspicuous in Pedestals 2 and 5 (pl. 37), they are helpful in determining the precise positions of bases for statues and columns. Setting lines can also be seen in the blocks on top of the scene wall, in both kinds of marble.

6.3 Clamps and Dowels

The outer retaining wall is remarkable in that it utilized neither clamps nor dowels; stability depended instead on the sheer weight of its units, occasional changes in height within individual stones, and a series of piers and buttresses with which it was bonded. The marble portions of the building, by contrast, employed both devices; clamps connected blocks horizontally within a course, while dowels prevented the courses from shifting in relation to one another.[253] Clamps and dowels were made of iron and set with lead.[254]

Clamps connecting the blocks of the footings that supported the curved orthostat slabs of the rear wall, and of the podium of the upper *cavea*, were set a uniform distance back from the wall's outer surface. Clamps in both the orthostat and string courses of the *analemmata* were also aligned equidistant from the wall edge and close to it, as were those of the scene wall where a single row was used even in the string courses that were more than a meter wide. Doubled clamps appear only in the column-bearing pedestals of the second phase where they tied together pairs of stylobate blocks.

Clamp sizes varied with the tasks they performed. Normal clamps, such as those in the scene and *analemma* walls, and in the footings that supported the curved orthostat slabs of the *diazoma* podium and rear wall, measured between 14 and 25 cm long and were from 2–4 cm wide. The paired clamps of the pedestals were relatively large, with cuttings ca. 24–26 cm long by 4–5 cm wide, and clamp holes 5–7 cm deep. Those joining the low, thin riser slabs of the seating are 16–17 cm long and only 1.6–2.3 cm wide. Colossal clamps, measuring 28–43 cm long, anchored both the crown slabs of the pedestals and the lateral extensions of the pedestal shafts to the scene wall (pl. 37; 42, 2), while the two smaller pedestals were attached to their adjacent piers as well. In this system, necessitated by the different heights of the blocks being joined, one hook was set into a hole in the pedestal, and the other end of the clamp let down through a radially cut slot into a second hole, about

[252] See below chap. 8.2.1.

[253] On clamps and dowels in general see Adam 1994, 51–58.

[254] On dowels from the roughly contemporary Celsus Library see Hueber 1989, 224–225 fig. 8.

12 cm beyond the wall face. Slots and clamp channels were 3–4 cm wide. Channels were between 2 and 5 cm deep, clamp holes ca. 6.5 cm deep.

A complete clamp, *in situ* in the east *analemma* wall where it can be seen through a robber's hole, is 12 cm long × 2 cm wide and 3.5 cm thick. A second clamp in the podium footing, near the central staircase of the upper *cavea*, measures 15.3 × 2 cm. It is set in lead that bears the multiple impressions of a tool with a pyramidal tip used to tamp the soft metal into place. This practice of working the lead around the clamp for greater stability can also be seen in one of the large anchor clamps where the mason used a flat chisel.

Iron dowels fitted snugly into square holes in the upper blocks. The much larger holes in the bedding surfaces below, either square or rectangular, were filled with lead, generally by means of pour channels after the course above was laid. All but one of the dowel holes in the footing of the podium behind the *diazoma* lack pour channels (pl. 24, 2). They were apparently considered unnecessary as the orthostat slabs they secured, measuring only 1.10 m high and 0.18 m thick, were light enough to move into place, the molten lead having first been poured in from above. Channels were V-shaped in section, and could extend either perpendicularly or obliquely to the wall face. Those which fed the large dowel holes for the column bases were more than 0.40 m long. One dowel hole in pedestal 1 had two channels (plan 4; 5; pl. 38, 1).

Dowel holes were doubled in the column bases, in the corner piers and in the jamb of the door that lead from the west *parodos* to the *vomitorium* staircase. A dowel is preserved on the scene wall above Pedestal 5. It projects 3.7 cm from the bottom of a block belonging to the first marble course and has a cross section measuring 1 × 1 cm. A dowel of the same cross-sectional dimensions has left its impression in the lead that fills a large, rectangular hole in the podium base, near the central stairway of the upper *cavea*. A second impression, 1.1 × 1.5 cm can be seen in the lead preserved in a dowel hole that is 3.5 cm square at the northeast corner of the wall segment behind Pedestal 5.

6.4 Lifting

Of all the lifting devices available to Roman builders,[255] only the lewis hole is evident, and even this was used sparingly.[256] In general terms, these were cut in the upper surface of the stone to be lifted, normally close to the center of gravity. They are essentially deep, elongated rectangular slots whose narrow ends taper out towards the bottom. The lifting hardware would have consisted of two wedge-shaped pieces of metal which were jammed into the tapering sides, and a third piece with parallel sides that was inserted between them.[257] All three were connected to a single ring which was attached in turn to a crane. After the block had been lowered into place, the ring was slipped out and the three elements could be easily removed.

In the Bouleuterion, the largest lewis holes are found in the stylobate blocks of the pedestals (plan 4; pl. 37). Two of these were later provided with pour channels and used as dowel holes for statue bases. They are typically ca. 12 cm long, 5.5 cm wide and 9–12 cm deep. Some have the long sides vertical, while others narrow towards the bottom. The lewis hole in Pedestal 6 has one vertical side while the other slopes inward (pl. 38, 2). These cuttings are also seen in the three pier segments and in the pier base in the southeast corner. In the latter, the hole is 9.5 cm long by 2.5 cm wide and 6.5 cm deep. The lewis holes in the pier segments have similar measurements in plan, but are shallower, although this was probably due to the fact that the blocks were worked down after being set in place. The spring stone of the arch which once spanned the east *parodos* (pl. 27, 2) has a lewis hole that is 7.5 cm long × 2 cm wide and 6.5 cm deep.

The absence of lifting holes in the bluish gray marble blocks, even the very largest, which belonged to the curved foundation wall, is not surprising if we assume that they were quarried from the mountain into which the Bouleuterion was built, and simply let down with the help of gravity, and shifted into place. Their absence in the marble blocks of the stage building with the exception of the corner piers, however, is puzzling.

---

[255] See Adam 1994, 43–51.

[256] On lewis holes in the Celsus Library and the Agora South Gate in Ephesos see Hueber 1989, 222. fig. 3–6. On lewises in Pergamon see Aylward 2009, 309–322.

[257] Cf. Adam 1994, 48–50 figs. 102. 110.

6.5 Revetment

The curved marble orthostats of the podium at the base of the upper *cavea*, and the retaining wall at its top, acted as revetment in that they masked coarse surfaces of mortared rubble and roughly cut bluish gray marble. But as they measured between 0.20 and 0.25 m thick and were secured by a system of clamps and dowels they must be regarded primarily as structural in nature.

The stage building and the pedestals of the *scaenae frons* were revetted with thin sheets of marble which were fixed to the supporting masonry by means of iron pins.[258] As described above, the marble walls of the original phase must have been exposed as they were finely dressed, and bore at least one inscription. They were covered subsequently in the course of the renovations under Vedius. The white marble panels inscribed with the Imperial letters, preserved in the British Museum,[259] have been reconstituted from numerous fragments and given a slate backing. The few accessible edges bear saw marks which seem to be modern; they were probably cut by J. T. Wood from larger panels of unknown size and trimmed to facilitate transportation and display, and thus offer no technical information about methods of attachment. They are between 6 cm and 8 cm thick.

A number of holes in the scene wall measuring 2 × 2 cm held anchor pins of which four are preserved (plan 4). Arranged in two pairs, these secured the pilaster bases behind the first and second columns. The holes of each pair are spaced 0.34 m apart and are 0.32 m above the stylobate, the same height as the one preserved column base. Projecting from the iron plugs are flat nails which extended out before being bent down and inserted into holes in the tops of the pilaster bases. The same method was used to attach the base moldings of the pedestals to the masonry behind them. But the marble sheets masking the pedestal shafts, which had a maximum thickness of only 2 cm, were held in place by straight pins whose holes can be seen in the tops of the base moldings and in the under surfaces of the stylobate blocks.

The numerous anchor holes visible in the piers probably belong to the first phase, remaining in use through the second phase, when the walls around the three original doorways were revetted with the rest of the façade. When the second and fifth doorways were cut through, iron pins in their sides secured either thin door jambs or marble sheeting. Aside from the cuttings for the pilaster bases and pedestal base moldings, the numerous anchor holes visible in the preserved wall surfaces are without an obvious pattern, but must reflect the arrangement of revetment slabs of various sizes. Some piers also show anchor holes in their exterior corners, and the pier against which Pedestal 1 was built has a pair of holes for horizontal pins in its upper surface.

6.6 Petit appareil

This well-known method of Roman construction, found throughout Ephesos,[260] was used only in the walls built up between the piers of the *parodoi* in the Antonine phase (plan 5), to support vaults which carried extensions of the seating to the stage wall. These walls were capped at the level of the tall bases above the pillars with leveling courses made of re-used orthostats, above which the walls continued to the springing of a rising vault. Short segments of *petit appareil* were built on the same vertical plane on the two corner pillars hiding the tall pedestals and bases which had supported the corner pilasters in the first phase. The walls were made of mortared rubble faced with stones worked flat on their outer surfaces and set in regular courses which varied from 0.16 to 0.24 m in height. The vertical joints are generally narrow with adjacent stones sometimes touching, while the horizontal mortar beds are thick and normally contain smaller stones and bits of terracotta.

6.7 Brickwork

Brickwork appears in the Bouleuterion only in the rear corridor where it was used in walls that were built up against the rough south face of the scene (pls. 40, 1; 43, 2).[261] The existing buttresses were encased in a masonry

[258] This is also the case for the marble revetment of the Nymphaeum Traiani, cf. Quatember, FiE (forthcoming). Marble slabs in the domestic context of the "Hanghäuser" are also often secured by bronze pins. See Koller 2004, 111–124.

[259] See below chap. 8.2.2–8.2.6.

[260] For example the back wall of the Nymphaeum Traiani and the "Kaisersaal" of the Vedius Gymnasium and the East Gymnasium; see Quatember 2009, 463–465.

[261] For a summary on the usage of brick in Greece and Asia Minor see Dodge 1987, 106–116. On brick formats in Ephesos see Thür

made of re-used stones to a height of 0.30–0.50 m. These piers then continued in brick and were joined by broad brick arches. The bricks measure 30–32 × 16–30 × 4–5 cm and vary in color from an orange-yellow to red. The mortar beds are generally shallow, measuring ca. 2 cm. Vertical joints are less regular.

6.8 Paving

The paving of the orchestra was laid after the orchestra was widened and thus belonged to the latest major phase in the history of the building (pls. 8, 2; 12, 1–2). It was removed in the 1960's in the course of W. Alzinger's search for the Hellenistic Bouleuterion. Early excavation photographs and drawings show long, polished pavers finely joined, laid in tapering rows. Faint plaster lines on the curved face of the podium's base molding, which the pavers abutted, give a thickness of ca. 6 cm.

The marble paving which covered the *pulpitum* and *parodoi* (pls. 3,1; 6, 1; 12, 1–2) was also removed in order to excavate the stage, and can be seen only in old photographs. This was apparently patched sometime in antiquity by paving stones made of a soft, light gray limestone, some of which remain at the outer ends of the *parodoi*, and in front of the stairway of the western *vomitorium*. This type of paving survives also in the rear corridor near SD 2 and 5 and the lateral doors (SD 1 and SD 7), and it is possible that the entire corridor was originally covered with it. This stone was also used in some of the piers that supported the brickwork of the late arcade. Its softness made it ideal for patching, as pieces could be easily cut to fit irregular spaces where they were needed. Pavers with their sides exposed measure 6–10 cm thick. The space directly south of Stage Door 1 shows two layers. This material is known from the "Hanghäuser" (Terrace Houses) where it is used for doorjambs and other structural features.[262]

(L. Bier)

2005, 22–23; Thür 2009, 483–496.

[262] Lang-Auinger 1996, 23; Thür 2005, 22.