The present paper aims to analyze the building technique of the Stoas of the Asklepieion at Messene, which were built in the beginning of the 2nd century B.C., and to understand a part of the Hellenistic building techniques of this region. The optical refinement of the crepidoma of the Stoa and some other unknown techniques which were employed in the Messenian Stoa confirm us that continuous endeavors of technical renovation were taken place by the Hellenistic craftsmen, following the tradition of the building techniques of Greek architecture that date back to the 4th century B.C.

**Keywords**: Hellenism, Stoa, Building technique, Construction date

1. Introduction

The building materials and construction techniques in Greek architecture have been extensively researched by both architects and archaeologists since the end of the 19th century.\(^{1}\) It is well known that ancient Greek architecture was constructed of masonry stones and roofed by wooden structures. The columns and walls were made of stones which were jointed directly one by one and connected with dowels and clamps.\(^{2}\) The structure of Greek buildings was strengthened by their weight, but it was not effective against horizontal stresses like earthquakes. Transporting stones from faraway places was not favored because it was costly, so local stones such as poros, limestone and marble were usually employed.

It was considered that these Classical building techniques began to decline soon after the 5th century B.C.: Dinsmoor mentioned that the Hellenistic architecture was ‘beginning of the decadence’ of the Classical architecture.\(^{3}\) Indeed, the fever of the handmade craftsmanship of the stone carving technique might have been declined soon after the Classical period. According to the recent research; however, it has been found out that the Classical building techniques were sustained until the Hellenistic period.\(^{4}\) For instance, the refinement technique of crepidomas, which is well-known in the Classical temples like the Parthenon, can also be observed in the early Hellenistic temples.\(^{5}\) Moreover, new knowledge from the Stoas of the Asklepieion at Messene, which was built in the first half of the 2nd century B.C.,\(^{6}\) informs us that the Hellenistic craftsmen did not only keep the traditional techniques dating back to the 4th and the 3rd century B.C. but also renovated techniques based on the requirements of individual construction projects. The sanctuary was built on a huge platform, which is measured ca. 72 m at the east and west Stoas and ca. 66 m at north and south Stoas inside of the courtyard. The Doric peristyle Temple of Asklepios is in a square court enclosed by four Corinthian stoas (Figs. 1-2).\(^{7}\) The result of the fieldwork from 2001 to 2004, as discussed as follows, shows the high-leveled building techniques that date back to the end of the Classical period. In this present paper, thus, the building techniques of the Stoas of the Asklepieion will be analyzed in order to understand the Hellenistic building techniques of this region.

2. Building material

The main structures of the Stoas are made of local limestone and poros as is normal in Hellenistic architecture. The quarries of both kinds of stone have been identified: The limestones come from the north and west quarries of Mt. Ithomi, both of which are located just near the top of the hill.\(^{8}\) The poros come from the quarry near the modern village of Kalogerorrachi.\(^{9}\) The combination of two different kinds of stones was not unusual in the Hellenistic period of Messene: In the case of the Hellenistic Fountain of Arsinoh located in the northwest of the Agora, the crepidoma of the Ionic colonnade is made of limestone, but the columns and the upper structure are made of poros instead.\(^{10}\) It is certain that the poros order was finished with stucco, as remains of stucco were observed on the architrave-frieze block (Fig. 3) and on necking of the Corinthian capital (Fig. 4). These stucco remains measure a few mm in depth. There is also stucco finishing on the wall of the fountain of the Asklepieion. Stucco was common in the Greek architectural tradition; the archaic temples in Sicily already used stucco. When the inner wall of the Hellenistic building was finished with stucco, it was decorated as if the wall were isodomic: The stucco was paneled, that is, characterized by raised panels which stand a few mm higher than surrounding margin. This technique is already seen on the wall of the Hellenistic house at Priene and of the Hellenistic house at Delos in the 3rd century B.C. (Fig. 5).\(^{11}\) The wall of the Prytaneion

\* Assist. Prof., Priority Organization for Innovation and Excellence, Kumamoto University, Dr. Eng.
at Magnesia on the Maeander might be one of the most remarkable uses of stucco with raised panels. In comparison with the inner wall of the Messenian Stoa, the stuccoed wall of the Heroon at Samothrace (ca. 325 B.C.) is also an important example. Lehman’s restoration of the inner wall shows it as embellished with the isodomic masonry base on fragments of stucco with raised panel. Stuccoed and painted walls, therefore, probably began to be used both in inner walls of the houses and the interiors of the public buildings from the Hellenistic period. Two stoa are known which have inner walls finished with stucco. According to Coulton, the inside of the walls are stuccoed at Perahora (the last quarter of the 4th century B.C.), and the Stoa of Attalos I at Delphi (241-223 B.C., style and inscription of 223 B.C.) had panel paintings on the walls which would be affected by damp. In the Stoa of Messene, the rear wall consists of toichobate, orthostate and frieze (or continuous horizontal part upside the orthostate) and rough-finished ashlar wall. Since the Stoa of the Asklepieion were designed as interior space, the upper part of the rear walls might have been finished with stucco with raised panels and painted in different colors. The decorative motif of the raised panel can be seen on the stucco wall of the Basilica at Pompeii. However, no evidence of inner walls with painted panels was found from the excavations in Messene.

3. Building technique

3-1) Joint technique - dowel, clamp and anathyrosis

Following ancient Greek engineering tradition, the architectural blocks of the Messenian Stoa are jointed directly stone by stone without any mortar, and strengthened by iron dowels and clamps. The seams of the lower step’s blocks and the stylobate blocks are decorated with anathyrosis, and the blocks are tightly packed. The width of the flat finished edge of the anathyrosis is about 8 cm, and is found on all three sides except the bottom. Dowel holes can be seen on the rough surface finish of the lower step’s block (Fig. 6). Viewed from the courtyard side, this square dowel hole of about 4 cm was carved in the approximate center of the lower step’s block and is located on the face adjoining the stylobate block. In addition, about 35 cm from the outside edge of the lower step’s block and 40 cm from the joint surface, there is another similar-sized dowel hole and lead guide groove (Fig. 6, left). It is normal that there is no dowel on the upper side of the plinth, which is facing with the bottom of the column base. There is a square dowel hole (3.9 cm X 3.3 cm, 2.8 cm in depth) on the top of the sima to support an antefix (No.

Fig. 1 Plan of the Asklepieion at Messene and placement process of the stylobate in each stoa
Fig. 2 General view of the Asklepieion from the north-west
Fig. 3 Messene, Stoa: Stucco from the taenia of the architrave-frieze block (E44)
Fig. 4 Messene, Stoa: Stucco from the Corinthian capital (C21)
Fig. 5 Delos, inner wall of the House of the Comedians
There are two types of clamps used in the Stoas; Pi-shaped clamps were used with limestone (Fig. 6) and double-dovetail clamps (or rectangular clamp as discussed below) were used with poros (Fig. 7). The former clamp was used only with limestone on the horizontal joint of the lower step's blocks from the outer colonnade and the orthostate blocks from the rear wall. The Pi-shaped clamp has hooks at both ends, and was commonly used in Hellenistic architecture. Most Pi-shaped clamps were stolen in ancient times, but a few clamps have been discovered from the lower step of the Stoas, which are made of iron covered by lead and measure ca. 15-16 cm in length and ca. 1.3 cm in width. A clamp hole from the orthostate blocks from the rear wall measuring ca. 8 cm in height and 2.5 cm in width can be seen on the edge of the toichobate. Therefore, the clamp length is ca. 16 cm. A few rectangular clamp holes can be seen on the horizontal joint of the entablature blocks; the architrave-frieze, the backer and the geison. It is odd that the Messenian wooden clamp holes were generally shaped like rectangles rather than ‘double-dovetails’. The typical shape of the dovetail clamp hole is two trapezoids facing each other on their shorter sides (Fig. 8), but the Messenian clamp hole shapes simply rectangular. Even so, the Messenian wooden clamp can be classified as a type of wooden dovetail clamp. The wooden dovetail clamp was probably favored since the poros could disintegrate easily by human hands. The clamp hole of the architrave-frieze measured ca. 7 cm in width, 17 cm in length (half of a full clamp length) and 6.5 cm in depth, and that of the backer measured ca. 7.5 cm in width, 10 cm in length (half of a full clamp length) and 6 cm in depth. Double-dovetail clamps were used in the end of the 6th century or early 5th century B.C., but here in Messene a rectangular-shaped dovetail clamp was adopted to the Hellenistic buildings. Thus, it can be said that the building technique in the Hellenistic period of Messene was, in a way, a combination of the traditional techniques from Archaic to Classical periods. The clamp techniques used at the Stoas are generally similar to those at the Temple of Asklepios.

There are 5-8 cm square empolion holes on the top and bottom of the column drum, probably jointed by wooden dowels. Additionally, an unusual joint technique can be observed on the column drum (Fig. 9). There are four small liner holes measuring 3 cm in width and 7 cm in length at four equidistant places around the edge of column drum. It is strange that there are no hook holes for these liner holes; so they cannot be Pi-shaped clamps. These liner holes can be observed not only on the normal fluting, but also on reeded fluting. From the modern engineer’s point of view, there is no meaning for such jointing, as it is not effective against horizontal force. Nevertheless, we cannot say that the ancient engineer was not aiming to strengthen the column with this kind of empolion. The same technique can be seen on the Hellenistic buildings of the Asklepieion; on the column or pilaster of the Artemision, of the North Propylon and of the Fountain. As far as the author knows, this kind of technique is unknown until now.

There is also a unique clamp joining the architrave-frieze block and the backer block. There is a clamp hole on the top of the backer, located 0.496 m from the bottom. On the backside of the architrave-frieze block, there is also a hole located 0.486 m from the bottom. These two holes fit when the two blocks are joined with a connection of a kind of L-shape clamp (Fig. 10). A similar joint can be seen only at the south wall of the Erechtheion from Athenian
Acropolis (Fig. 11).25) The L-shape clamp of the Erechtheion joins the outwards-facing orthostate block to the backer, which has about half the height of the outer block. The difference between these two L-shape clamps is the hook. The L-shape clamp of the Erechtheion has T-shaped hooks on the both ends like a double T-shape clamp, so this clamp seems to be a variation of a double T-shaped clamp.26) The L-shape clamp of Messene, in contrast, has no hooks on the edges. Thus, it could be said that the L-shape clamp of Messene is a variation of a Pi-shaped clamp or simple linear clamp.

3-2) Building of the crepidoma

Bar holes remain in good condition on the lower step of the East Stoa. It was determined that the stylobate blocks were set in order from north to south from the positioning of two dowel holes and a bar hole (Fig. 6). The reconstructed building process of the lower step's blocks can be summarized as follows: First of all, dowel holes were prepared on top of the lower step's blocks. At that time, the relationship between the dowel holes of the bottom of the stylobate blocks and of the top of the lower step's blocks was carefully checked. Then, an iron dowel was placed in a hole, and the first lower step's block was set. Then another iron dowel was placed in another hole and the lower step's block pushed by bar from the same side of the second dowel. The bar holes were usually prepared before the placement of the lower step's block, or they might have been chiseled just before using the bar. Next, molten lead was poured into the grooved lead guide in order to fill the gap between the iron dowel and the stone. Finally, molten lead was poured into the gap of the second dowel, which could only be filled before the next lower step's block was placed. Following this process, therefore, each lower step's block was always placed by the second dowel, which has no grooved lead guide, and the bar hole was always placed on the same side of the next block. It was further determined that the stylobate blocks which support columns at the East Stoa were fixed in two places: at the lead guide groove of the dowel hole on the north side of the block, and at the dowel hole at the south edge seam of the block.

At the other three Stoa, dowel holes could not clearly be confirmed on most of the lower step's blocks, but judging from the relationship between the dowel holes with lead guide grooves and the seams on the stylobate blocks, we can estimate the order of their placement. That is, as at the East Stoa, the stylobate blocks were placed in order to cover the seams of the lower step's blocks, in the direction from the dowel holes with lead guide grooves towards the dowel holes in the stylobate block seams (Fig. 12). Thus, the placement order of the stylobate blocks would have been from north to south in the East Stoa, from east to west in the North Stoa, and from north to south in the West Stoa (Fig. 1). However, the order seems to be somewhat different at the South Stoa. Based on the above, we must assume that the stylobate blocks to the east of the stylobate block under the 11th column from the east (S11) were placed to the west, and those from the stylobate block under the 13th column from the east (S13) were placed to the east. However, no dowel holes with lead guide grooves can be verified on the surface of the lower step under the 12th column from the east (S12), on which a stylobate block was laid. On all the visible lower step's blocks, the stylobate blocks that support columns were connected to the lower step by two dowels, and the 12th column from the east (S12) was fixed by dowels on both edges. In addition, it might be inferred from dowel holes on the crepidoma block surface that the west end of the stylobate block to the west of S12 was joined to the crepidoma by a dowel. There is also a bar hole to the immediate west of the dowel hole, so this stylobate block must have been laid after the previous block, to the east of it. Thus, at the South Stoa, the first stylobate block would have been set in position under the second 12th column from the east (S12), and then the rest of the stylobate would have been set towards both the east and west.27)

Stylobate blocks of stoas are generally cut carefully in lengths relating to the intercolumniation (Fig. 13).28) Usually, stylobate blocks are cut to half the length of the intercolumniation and columns are placed in the middle of the blocks, a style commonly found in temple stylobates. Nevertheless, sometimes columns are placed on the joints of the stylobate, probably because the stoas do not need to be constructed with as much consideration of the weight of the upper structure as do temples (Fig. 14).29) In the case of Messene, the columns were placed in the middle of the stylobate block, as normal. The stylobate blocks of the Messenian Stoas were created with the same care that can be seen in the stylobate of the Temple of Asklepios of the same sanctuary.30)

3-3) Refinement of the Crepidoma

All four stoas have two colonnades and a back wall and a roof spanning them. Now, however, only the foundation remains intact in most areas. The north-south and east-west outer colonnades facing the courtyard measure about 52 m and 47 m respectively. The crepidoma of each stoa meet each other at almost perfect right angles.31) Almost all of the original crepidoma blocks of the outer colonnades remain in situ. Only a portion of the stylobate blocks
remained, and the plinth is still in situ only at the northeast and northwest corners. The stylobate and plinth blocks also remain at the inner columns, but as at the outer colonnade, their upper column blocks were excavated from the surrounding ruins. The crepidoma of the outer colonnade of the Messenian Stoa has three steps: a euthynteria, a lower step and a stylobate. According to Coulton, two-step crepidomas, consisting of a stylobate resting directly on the euthynteria, are frequently found in peristylar courts, since a three-step crepidoma would have little visual effect. Therefore, the three-step Messenian stoa crepidoma is higher than other stoas of peristylar courts. In other cases, the number of sta steps can vary from one to five. There are four examples of three-step stoas from the early Hellenistic period: the East Stoa of the Asklepieion at Athens (middle of the 4th century B.C., style and technique), the South Stoa at Corinth (the early of the 3rd century B.C., in relation to other buildings and associated findings), the Stoa at Oropos (ca. 360 B.C., style and techniques) and the Stoa of Philip at Megalopolis (original structure ca. 340-330 B.C., probably connected with Philip II of Macedon; upper parts from a later repair, style). The high-step stoa of Messene probably means the visual effect of the peristylar court was favored by the founder and builder of the Asklepieion at Messene.

In some Hellenistic stoas, it seems to have been necessary to change the number of steps in order to fit the platform to the inclined location, as at the North Stoa at Assos (Hellenistic; style and technique). In the case of Messene, however, it was not necessary to do so, since the peristylar court is built on a huge horizontal platform. The platform is placed on naturally inclining ground, so that the south part of the platform was raised artificially. The platform of the Asklepieion at Messene was well prepared by the mid-Hellenistic architect. In addition, the crepidoma of the four Stoas of Messene curve upwards in the middle (Fig. 15, left). This crepidoma treatment looks similar to the optical refinement for which 5th century temples are famous. Such optical refinement has been detected in the Stoa at Brauron (ca. 425-416 B.C., style and techniques), the Stoa at Oropos (after. 366 B.C.), the South Stoa at Corinth (between 330 and 320 B.C.) and the NW Stoa of Thasos (early 3rd century B.C., techniques) (Fig. 16). It is interesting that the crepidoma of the Temple of the Asklepios of Messene have optical refinement (Fig. 15, right). The fact that both the colonnade of the temple and its surrounding stoa have optical refinement could be explained by assuming that both buildings were designed as a sanctuary complex together and aimed to have the same visual effect. Summing up, a developed late Hellenistic technique can be observed in the crepidoma of the Messenian Stoas. The optical refinement with the high-raised step of the crepidoma is considered to have created a visual effect together with the Temple of Asklepios located in the center of the courtyard.

Architectural refinement is also observed in the Heroon at the Stadium area of Messene. The same treatment has been observed in other Hellenistic buildings including the Ionic Propylon at Knidos, the Ptolemaion at the Hellenistic-Roman Temple at Didyma, the Artemis Temple at Sardis and the Neronian Stoa at Ephesos. This fact means that the treatment of high quality buildings of the classical period did not begin to decline immediately.
after the beginning of the Hellenistic period, but rather that the Hellenistic and early Roman buildings actually had carefully executed treatments including *scamilli inapress* or curvature. Therefore, it is not surprising that the Hellenistic stoa of the Asklepieion has upper curvature on its crepidoma.

### 3-4) Floor

Some Greek stoas have floors paved with terracotta tile, plaster marble slab, but stoa floors were usually paved simply with mud before Imperial Rome. The Messenian Stoas have floors paved with mud as was normal in Hellenistic stoas, even though they are conceptually designed as totally closed sanctuaries; that is, a kind of inner space.

The relative levels of the inner colonnade stylobate and the back wall toichobate were measured as shown in Table 1 and Fig. 17. The horizontal levels of the back wall toichobates were measured as an extension of the line connecting the inner and outer columns, indicated in Table 1 by the outer column number. That is, the height indicated by a certain column number refers to the height of the horizontal section from the courtyard side of the stoa toward the back wall. Viewing the table vertically, it can be seen that the walls of the toichobate and the stylobate inner colonnade both show a gentle slope, which is roughly similar to the gradient of the crepidoma. That is, like the crepidoma, both the toichobate back wall and stylobate inner colonnade are inclined along a water gradient.

As described above, the foundation of the outer colonnade, inner colonnade, and the back wall have the same horizontal level as the floor level. Therefore, the respective differences in horizontal height between the stylobates of the inner and outer colonnades, the outer colonnade stylobate and the back wall euthynteria, and the inner colonnade stylobate and the back wall euthynteria were calculated respectively as shown in Table 1. Results show that the horizontal height of the inner column stylobate is almost always higher than the outer column stylobate, and that of the back wall euthynteria is almost always higher than the inner column stylobate. This trend shows up clearly especially at the East Stoa. Since the foundation of the East Stoa is assumed to lie directly on the bedrock, so that horizontal variations in height are unlikely to be due to subsidence. Therefore, the above results are believed to show that the floors incline from the back wall towards the courtyard. Additionally, the difference in height between the inner and outer colonnade stylobates was calculated as the average difference between heights at each point measured, and determined as 0.062 m. Similarly, the difference in height between the outer colonnade stylobate and the back wall euthynteria was calculated as the average difference in heights at each point, and 0.126 m was obtained.

### 3-5) Double spaced inner column

The Stoas of Messene are of the so-called double stoa type, which has a two-aisled colonnade (Fig. 1). The inner colonnade has a double spaced inner column, which is arranged so that an inner column comes behind every second outer one. The earliest example of this type is found at the South Stoa at the Argive Heraion (ca. 450–425 B.C. style). According to Coulton, the double spaced inner colonnade was widely accepted at least from the 4th century B.C. The corner column of the double stoa was not a problem for the Messenian architect. He knew that the treatment of the corner column should be in order of the regular spacing; which can be seen in contemporary stoas such as the Pi-shaped Stoa on the Agora at Magnesia on the Maeander, the Stoa of Philip at Megalopolis and the Sanctuary of Zeus Stoter, all of which date around the 2nd century B.C.

### 3-6) Other minor techniques

There is a raised panel on the top of the Corinthian capital and on the upper face of the both edges of the backer (Fig. 18). As far as the author knows, no scholar has commented on this. There is no doubt that the raised

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**Table 1** Relative height of the crepidoma of outer colonnade, inner colonnade and the rear wall (corner A4 = level 0 m)

<table>
<thead>
<tr>
<th>Site</th>
<th>V(S)</th>
<th>W(S)</th>
</tr>
</thead>
<tbody>
<tr>
<td>East Stoa</td>
<td>0.61</td>
<td>0.46</td>
</tr>
<tr>
<td>West Stoa</td>
<td>0.72</td>
<td>0.66</td>
</tr>
</tbody>
</table>
| Stoa of Megalopolis and the Sanctuary of Zeus Stoter, all of which date around the 2nd century B.C.

**Fig. 17** Levels of the floor section (in average)
panel was not decorative but protective, as it is not visible after construction and the panel faces the bottom of the upper structures; that is, the architrave-frieze or wood cross beam. In case of the round raised panel of the Corinthian, we can say that it aimed to protect the upper edge of the abacus from the architrave-frieze block, when it was placed on the capital.\(^{44}\) The same treatment can be seen on Doric capitals of the Temple of Asklepios.\(^{45}\) This conjecture might be adaptable to the backer of the Messenian stoas as well.

Lewis holes can be seen on the top of the blocks from the upper structure: the architrave-frieze, backer and the capital (Fig. 18). Several kinds of lifting devices are known in Greek architecture. In case of Messene, lifting by iron lewis was adapted probably because of fragility of the decorated upper parts made of poros. The wedge-shaped hole tapering at both ends is the typical shape of the Hellenistic lewis hole.\(^{46}\) The technique of cutting the architrave and frieze from a single block is one method used to strengthen the entablature, which is extended because the purpose of the stoa is to allow people to pass through between the columns. According to Coulton, this technique was devised in the 4th century, perhaps in Corinth.\(^{47}\) It was common to cut the architrave and frieze from one block in the late Hellenistic period, and this indicates that the architrave-frieze and backer of the Messenian Stoas belong to the tradition of Hellenistic architecture.

It was necessary to use buttresses to support the rear wall of the South Stoa, as there were no rooms behind this Stoa (Fig. 19). Buttressing was not a common technique in Greek architecture; there is only one example in the late Classical period: the South Stoa at Argive Heraion (ca. 450-425 B.C., style).\(^{48}\) Nevertheless, buttressing is sometimes used at the rear walls of Hellenistic buildings, such as at the bath at Oropos, the Terrace of Treasury at Olympia (Fig. 20) and the Hellenistic Agora at Morgantina.\(^{49}\) Therefore, the buttress technique of the Messenian Stoa belongs to the Hellenistic architectural tradition.

3-7) Repairs

It is known that the buildings of the Asklepieion at Messene had been repaired in ancient times. An inscription discovered at the Asklepieion informs us that the Stoas were restored or repaired in the early Imperial period.\(^{50}\) Another inscription was discovered by the first excavator, A. Orlandos, in 1959, and its texts relate to the restoration work between 15 B.C. and 14 A.D. during the time of Augustus.\(^{51}\) Repaired parts of the geison block, which reused an architrave-frieze block from the same Stoa, are probably related to this Roman restoration. Some geisons were found to be reused from architrave-frieze blocks (G14, G16). On G14, the second and third fasciae are present, although the first fascia is reduced by about half of the top cornice molding. Their heights are 0.107 m and 0.129 m, respectively. G16 also shows the left half of the first stage fascia in the same way, and the heights of the second and third fasciae are 0.137 m and 0.143 m respectively (Fig. 21). These values are similar to the averages for architrave-frieze blocks, (0.118 m, 0.138 m), thus these geisons seem to have made from reused architrave-frieze blocks from the same Stoa. This repairation was probably of damage caused by an earthquake, because reparations after earthquakes reusing the previous material were very frequent in ancient Greece. The column of the Temple of Zeus at Olympia was rebuilt by using the same parts from the old temple before the earthquake.\(^{52}\) The peristylar building of the Agora at Athens was taken down when the Stoa of Attalos was built on the site and its foundation and column were reused for the South Stoa II of the same Agora.\(^{53}\) The outer colonnade of the Echo Stoa at Olympia was rebuilt using columns from another building.\(^{54}\) Therefore, it is probable that the Messenian Stoas were damaged in a heavy earthquake at around the time of Augustus and were repaired mostly by using the same blocks from the Stoas.

4. Conclusion

The Stoas of the Asklepieion, which was constructed on an artificial platform, were carefully prepared before the construction. The platform is
supported by the buttress, which began to be used in the Hellenistic period. On the other hand, the high accuracy of the well-created crepidoma of the Stoa was not common to the Classical and Hellenistic stoa. The building technique of the crepidoma using Pi-shaped clamps and iron dowels is similar in character to the technique used at the Temple of Asklepios and other surrounding buildings of the sanctuary. The high accuracy of the construction of the crepidoma including the optical refinement confirms the high social status of the Asklepieion as a public space, which was probably founded by a Hellenistic king. Nevertheless, the building project of the Stoas was planned carefully so as not to waste time or cost: the back side of the crepidoma, for instance, was finished roughly as it would not have been seen after the construction. Poros stone was adapted to the upper part of the main structures because it was easy to carry from the quarry and to dress the ornamentation. This fact means that the fever of the craftmanship to cut the stone began to decline; on the other hand, the architect probably intended to develop more rational building process. Indeed, it was common to use both poros and limestone at the same time for contemporary Hellenistic buildings. The more unique techniques like the empolions of the column drum might be declined; on the other hand, the architect probably intended to develop more rational building process. Indeed, it was common to use both poros and limestone at the same time for contemporary Hellenistic buildings. The more unique techniques like the empolions of the column drum might be understood as a minor renovation by the local craftsmen. These minor renovations of building techniques might reflect the ‘experimental spirit of the age’.

In conclusion, the craftsmen of Messenian Stoas tried to renovate their minor techniques to the practical requirements of the building project, under the influence of the traditional techniques dating back to around the 4th and the 3rd century B.C.

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Abbreviations

Academic Journals

AJA: American Journal of Archaeology
AthMitt: Mitteilungen des deutschen archäologischen Instituts, Athenische Abteilung
BCH: Bulletin de Correspondance Hellénique
BSA: Annual of the British School of Archaeology at Athens
Ergon: Εργα της ελληνικής Αρχαιολογικής Εταιρείας
Horos: Ηρώς. Ένα Αρχαιολογικό Περιοδικό
Prokt: Πρακτικά της ελληνικής Αρχαιολογικής Εταιρείας

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Durum 1892: J. Durm, Handbuch der Architektur 2, Theil Bauftile Historische und technische Entwicklung, Darmstadt, 1892.
Humann 1904: C. Humann, Magnesia am Maeander; Bericht über die Ergebnisse der Ausgrabungen der Jahre 1891-93, Berlin, 1904.
Scranton 1951: American School of Classical Studies at Athens, Corinth; Results of Excavations Conducted by the American School of Classical Studies at Athens (1932- ); vol. 1.3, R. L. Scranton, Monuments in the Lower Agora and North of the Archaic Temple, Princeton, New Jersey, 1951.
Notes
1) The bibliography of the building techniques of Greek architecture might be summarized as follows: Durm made the first research of the building technique of the Asklepieion in the end of the 19th century. Durm (1892); Dinmsoor reported the concealed iron beam of the Propylaea of Athenian Acropolis and so on. (W. B. Dinmsoor, “Structural Iron in Greek Architecture,” AJA 26, 1922, pp. 148-158; Martin might be the first scholar who concentrated on the building techniques and process of the Greek architecture in detail. (Martin 1965); Orlando studied the step by step account of techniques from quarry to roofing with references of the ancient text. (A. Orlando, Les Matériaux de construction et la technique architecturale des anciens Grecs, 1966-68); Müller-Wiener reported the building techniques on a book of the Greek building knowledge in general. (Müller-Wiener 1988); Korres made a detailed discussion about the joint technique of the Parthenon including the presumption that the iron clamps were created so thin that they were aimed to avoid breaking the marble block. (M. Korres, “Wilhelm Dürpfelds Forschungen zum Vorparthenon und Parthenon,” AthMitt 108, 1993, pp. 59-76; id., “Der Plan des Parthenon,” AthMitt 109, pp. 53-120, Pls. 18-24); Korres also made wonderful drawings of quarrying, transporting and building which are helpful to understand the building techniques. (M. Korres, From Pentelicum to the Parthenon, 1995) See also Höcker 2008, pp. 39-45.
4) Lauter 1986, p. 48. Mud bricks were crucial materials as well as stones in Mesopotamia, because of the lack of wood.
6) All evidences from the chronology of the architectural ornamentation and archaeological evidences lead to the consensus that Stoa is dated to around the first quarter of the 2nd century B.C. This construction date agrees with the dating of the Temple of Asklepios and the sculpture program of Damophon. It is not acceptable here that the building from the sanctuary belongs to the time before the 2nd century B.C. by Birtchas (Birtchas 2008, pp. 68-74), because the dating of the architectural ornamentation of the Stoa and the Temple of Asklepios does not agree to it. On the other hand, the dating of the coins from the stock room behind the Fountain is against the dating of the Stoa after the mid-2nd century B.C. (Sioumpara 2011, pp. 211-212, esp. fns. 613, 619). Therefore, the Stoa will be roughly dated to the first half of the 2nd century, or preferably to the first quarter of the 2nd century B.C.
7) The Asklepieion was excavated by A. Orlandos between 1956 and 1974. Orlandos published his excavation results as annual reports in Prakt, Ergon, BCH, etc., and they were also summarized in A. Orlando, NEIÆPÆRÆ EIÆN MEÆÆHNH (1957-1973),” in H. von U. Jantzen (ed.), Neue Forschungen in griechischen Heiligtümern - Internationales Symposium in Olympia vom 10. bis 12. Oktober 1974 anl. der Hundertjahrfeier der Abteilung Athen und der deutschen Ausgrabungen in Olympia, Tubingen, 1976. The final report of his excavation has not been published yet. The author, as a member of the Architectural Mission of Kumamoto University to Ancient Messene (leader: J. Ito), joined this archaeological campaign and surveyed the Stoa of the Asklepieion for one or two months in each season from 2001 to 2004. As a result, the Stoa were restored as Corinthian Stoa with two ailed colonnades. The results of them have been published in some articles as follows: R. Yoshitake et al., A Survey of the Stoa of The Asklepieion in Messene,” Architectural Institute of Japan (576), 2004, pp. 207-214; R. Yoshitake et al., “A Study of The Stoa of The Asklepieion in Ancient Messene : Reconstruction of the order and roof structure,” Architectural Institute of Japan (585), 2004, pp. 207-212.
10) Reinhold 2009, Figs. 6-7.
11) The Hellenistic house of Priene; Wiegand 1908. The Hellenistic house of Delos; Bulard 1908.
12) Humann 1904, p. 138, Fig. 150.
16) According to Westage, several different colors were used for finishing the inner wall of the Hellenistic house: White was the basic color; red, black and yellow were used very often, and sometimes green and blue were also used. Toichobates were generally colored red, and orthostates black. R. G. Westgate, “Space and Decoration in Hellenistic Houses,” BSA 95, 2000, pp. 397-400. See also a similar study from the view of the first style of the Hellenistic house of Pompeii, P. G. Bilde, “The International Style: Aspects of Pompeian First Style and its Eastern Equivalents;”, in P. G. Bilde, I. Niesieux, and M. Nieslen (eds), Aspect of Hellinism in Italy (Acta Hyperborea) 5, 1995, pp. 151-177.
17) Ohr 1991, Pts. 16-17.
18) There is usually no doweel at the bottom of the column to join the stylobate and the column. Two column drums from the Stoa at Amphiparion, Oropos have no doweel holes at the lower end. J. J. Coulton, “The Stoa at the Amphiparion, Oropos,” BSA 63, 1968, p. 157.
19) Dinmsoor 1950, pp. 174-175.
20) We could record only one clamp remaining, because the lower step was covered with mud by the present excavator for tourism purposes. However, Plate 4 certainly shows a clamp in situ, and more clamps probably also exist.
21) For the typical form of the double-dovetail clamp, see Durm 1892, p. 78; Dinmsoor 1950, p. 175, Fig. 64 (a). In contrast, the dovetail clamp hole from the Hellenistic Fountain of Arisinoé at Messene clearly has the shape of a ‘dovetail’. Reinhold 2009, Fig. 45.
22) Double-dovetail clamps have their origins in Egyptian architecture. See also Dinmsoor 1950, p. 174-175; Martin 1965, pp. 238-279; Orlandos 1966, Vol. 2, pp. 179-183; Coulton 1977, p. 49, fn. 81.
25) The L-shape clamp of the Erechtheion; Caskey 1927, p. 48, Fig. 31; Martin 1965, p. 273, Fig. 119.
26) Double L-shape clamps were widely used in the 5th century B.C. buildings, especially in the Athenian acropolis. Martin 1965, pp. 238-279. Korres has a unique opinion that the dowel and the clamp of the Parthenon are comparatively thin as joints of a huge temple because they are aimed to break in case of earthquakes in order to protect the expensive marble stones. His assumption is probably right in the case of Attica but not in the case of Peloponnesus, which is one of the most famous earthquake regions of ancient times. M. Korres, “Der Plan des Parthenon,” AthMitt 109, 1994, pp. 54-120, Pls. 18-24.
27) The same technique can be seen on the crepidoma of the Temple of the Asklepios at Messene. Sioumpara 2011, pp. 187-190, Figs. 118-119.
29) The Stoa I at Kalauria (last quarter of the 5th century B.C.; capital profile and wall technique); the Stoa at Brauron; ca. 425-416 B.C.) and the East Stoa of the Asklepieion at Athens (the middle of the 4th century B.C.; style, technique and material), Coulton 1976, p. 110.

30) Sioumpara 2011, Pls. 21-23.

31) The angles of the crepidoma at the four corners measure as follow: 90.008 degrees between North and West Stoa, 89.973 degrees between West and South Stoa; 90.022 degrees between West and South Stoa; and 89.997 degrees between South and West Stoa.

32) Coulton 1976, p. 110, fn. 2. In the following cases, the stylobate even looks to be directly on the foundation; the West Building at the Argive Heraion (Waldstein 1902, Pl. 24), the Leondaiion at Olympia (Curtius 1892, Pl. 75), and the Heroon at Kalydon (Dyggve 1934, Pl. 2).


34) Bouras 1967, pp. 32-33, Fig. 14.


38) The dimensions for the curves are as follows:

<table>
<thead>
<tr>
<th>Stoa at Brauron</th>
<th>rise</th>
<th>stylobate or lower step length</th>
<th>rise as percentage of length</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.025 m</td>
<td>29.19 m (at s.)</td>
<td>0.0856 %</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Stoa at Oropos</th>
<th>rise</th>
<th>stylobate or lower step length</th>
<th>rise as percentage of length</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.24 m</td>
<td>110.15 m (at s.)</td>
<td>0.218 %</td>
<td></td>
</tr>
<tr>
<td>0.18 m</td>
<td>110.15 m (at s.)</td>
<td>0.163 %</td>
<td></td>
</tr>
<tr>
<td>S. Stoa at Corinth</td>
<td>0.15 m</td>
<td>164.38 m (at s.)</td>
<td>0.0915 %</td>
</tr>
<tr>
<td>NE Stoa at Tassos</td>
<td>0.144 m</td>
<td>97.415 m (at s.)</td>
<td>0.1477 %</td>
</tr>
<tr>
<td>N. Stoa at Messene</td>
<td>0.033 m</td>
<td>51.943 m (at c.)</td>
<td>0.0635 %</td>
</tr>
<tr>
<td>S. Stoa at Mesene</td>
<td>0.166 m</td>
<td>51.939 m (at c.)</td>
<td>0.3196 %</td>
</tr>
<tr>
<td>E. Stoa at Messene</td>
<td>0.298 m</td>
<td>46.789 m (at c.)</td>
<td>0.6369 %</td>
</tr>
<tr>
<td>W. Stoa at Messene</td>
<td>0.446 m</td>
<td>46.823 m (at c.)</td>
<td>0.9525 %</td>
</tr>
<tr>
<td>N. col. of Temple of Asklepios</td>
<td>0.040 m</td>
<td>27.970 m (at c.)</td>
<td>0.1430 %</td>
</tr>
<tr>
<td>S. col. of Temple of Asklepios</td>
<td>0.027 m</td>
<td>27.976 m (at c.)</td>
<td>0.0965 %</td>
</tr>
<tr>
<td>E. col. of Temple of Asklepios</td>
<td>0.030 m</td>
<td>13.966 m (at c.)</td>
<td>0.2927 %</td>
</tr>
<tr>
<td>W. col. of Temple of Asklepios</td>
<td>0.036 m</td>
<td>13.664 m (at c.)</td>
<td>0.2635 %</td>
</tr>
</tbody>
</table>

The measurements are based on our new survey (Stoa of the Asklepieion at Messene), Coulton 1976, p. 111, fn. 4 (stoa at Brauron, Oropos, Corinth and Tassos) and Sioumpara 2011, pp. 36-37 (Colonnade of the Temple of Asklepios at Messene).

39) It is notable that Cooper reported not only the horizontal curvature but also the vertical curvature of the wall of the Heroon. Cooper, op. cit.


41) Occasionally a more durable floor was laid. In Stoa C at Selinous there was a floor of terracotta tiles. At Perachora a floor of shingles set in plaster on a rubble foundation was laid in the Stoa and over the surrounding area, and the Stoa at Palladion at Athens had a similar floor. The Stoa of Attalos at Athens and the Stoa at Lato had floors of marble chips set in lime mortar. But the remains of such floors are rare, and paved floors do not seem to have been used in stoae before the Imperial period. In the Stoa with Wings at Thasos, regular marble slabs, some of which are still in situ, were supported on vertical slabs set in the earth, but the floor and its supporting slabs are structurally independent of the rest of the building.” (Coulton 1976, p. 146)


43) C. Humann 1904, pp. 107-134.

44) The raised panel on the capital is probably related to the strength of material. Yoshitake surveyed the Corinthian capitals at Pompeii in 2004. According to the results, 199 Corinthian capitals were discovered in the site of Pompeii. The capitals are made mostly of tuff, sometimes limestone and rarely marble. The swelling part of the upside of the capital was observed in the capitals made of tuff and limestone, but not the marble capitals. This fact demonstrates that the swelling is related to the strength of material: the tuff capitals, which were used in the peristylar rooms of the house, have relatively high swelling on the capital. (This research was carried out as part of the field work of the Palaeological Association of Japan in November and December 2004.)

45) Sioumpara 2011, Figs. 90-83, esp. see elevations.

46) According to Dinsmoor, Lewis holes that taper on only one end were only found in the best Classical period, and those tapering on both ends date to the late Hellenistic period. Dinsmoor 1950, p. 174.

47) Coulton 1976, p. 145. There are four examples from Peloponnese, all dating from the 4th century to the beginning of the 3rd century B.C.: the Stoa of Apollo Maleatas at Epidaurus, the Stoa at Perachora, and the temple of Asklepios and Hellenistic NW Stoa at Corinth.


54) Koehnig 1994, Pls. 72-74.

55) It is widely known there was some relationship between Messene and Philipp V of Macedonia (Plutarch, Aratus). However, it is difficult to prove because of the lack of historical information.

和文要約

ギリシア建築史の頑学ディンズムアの言葉に象徴されるように、ヘレニズムの建築は「衰退期 (decadence)」の建築という理解が主流であった。すなわち、ヘレニズム建築は古典期の建築よりも劣るものと考えられてきた。確かに、古典期に見られるような手仕事による切石の施工への情熱が、ヘレニズム期には薄れていたことは疑いない。しかし近年の研究成果によれば、こうしたヘレニズム建築の理解は必ずしも適切ではなく、古典期の伝統的な建設技術に従いながら、比較的高い技術レベルを保持していたと言われている。例えば、パルテノン神殿などの建築に見られる多くは、古典期の高度な技術レベルを示す例としてよく知られているが、最近では前4世紀末から前3世紀の神殿からも報告されている。こうした中、筆者はヘレニズムの都市遺跡として知られる、メッシネのアスクレピオス神殿に近い在地調査を行った。その結果、ストアの建設技術には古典未期から前4世紀にまで遡る古い建設技術が見られるのと同時に、他の遺跡では見られない建設技術も観察された。

アスクレピオス神殿のストアは、一部が人工的なテラスの上に立っており、入念な事前準備のもとに建造された。三段のステップからなるストアの基壇には垂直方向にむかうものが含まれている。同様のむくりは、中庭に立つアスクレピオス神殿の基壇でも確認されている。また、ストアに使用されたコの字型のクランプや鉄のダボは、中庭に立つアスクレピオス神殿と基本的に同じ技術であり、これら技術は公共建築としての神殿の社会的ステイタスの高さを裏付けている。他方で、正面列柱基壇の背後を荒く仕上げたり、装飾の多い上部構造には石灰岩よりも柔らかいボロスを採用したりすると、施工の手間を省く工夫も見られる。このことは、古典期の手仕事による精度の高い施工技術への熱意が薄れたことを示しているが、同時に、効率的に規模の大きな公共建築を建てようとする意図が伺えるよう。さらに、円柱ドラムの側面に見られる接合部は、現代の技術者から見れば構造的に無意味であるが、地元の建築技術者によって控えめな技術的改良が試みられていたことを示している。メッシネに見られる建設技術者たちのこうした努力は、ヘレニズムの「実験的な時代精神 (ラウター)」を反映しているだろう。このように、メッシネの建設技術者たちは、前4世紀半ばから前3世紀半ばまで遡るギリシアの伝統的な建設技術をある程度保持しつつ、新しい建設プロジェクトにおいて求められる技術的課題に応えようとしていた。

（2012年7月10日審査受領，2012年12月4日採用決定）