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عمارة الطوب اللبن

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## MUD-BRICK ARCHITECTURE

### عمارة الطوب اللبن

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L'architecture en brique crue

*Mud-brick architecture, though it has received less academic attention than stone architecture, was in fact the more common of the two in ancient Egypt; unfired brick, made from mud, river, or desert clay, was used as the primary building material for houses throughout Egyptian history and was employed alongside stone in tombs and temples of all eras and regions. Construction of walls and vaults in mud-brick was economical and relatively technically uncomplicated, and mud-brick architecture provided a more comfortable and more adaptable living and working environment when compared to stone buildings.*

على الرغم أن العمارة بالطوب اللبن تلقى إهتماماً أقل من العمارة الحجرية من قِبَل المتخصصين، فقد كانت في الواقع تلك العمارة هي الأكثر شيوعاً في مصر القديمة، وكان الطوب اللبن (أو النبيء) المصنوع من الطمي أو الطين الصحراوي مستخدماً كمادة بناء بدائية للمنازل على مدار التاريخ المصري واستخدمت إلى جانب الحجارة في المقابر والمعابد في جميع المناطق وخلال جميع الفترات. كان بناء الجدران والأقبية من الطوب اللبن عبارة عن تقنية إقتصادية وغير معقدة، وعمارة الطوب اللبن وفرت ظروف معيشة وعمل أكثر راحة وتلائماً إذا ما قورنت بالمباني الحجرية.

**T**he study of ancient Egyptian architecture traditionally has focused on the monumental stone constructions and feats of engineering represented by the pyramids, the temples, and the rock-cut tombs of the dynastic era: those monuments for which Egypt is justly famous. However, this modern bias toward stone architecture passes over structures constructed with the more common building medium of mud-brick, thereby failing to consider the vast majority of ancient Egyptian architecture. In ancient Egypt, structures of all sizes and socio-economic levels were constructed of mud-brick, from the simplest of abodes to the grandest of palaces, from backyard grain storage bins to immense state-administered granaries, from the humble early phases of temples to the massive temenos

walls that encircled their final monumental stone incarnations. Throughout Egyptian history, mud-brick was employed as a building material for domestic, funerary, and religious architecture; while the resulting mud-brick structures were used for different activities, the methods of construction were the same, adapted to the strengths and limitations of the building material rather than the use of the structure.

When compared to stone as a construction material, mud-brick presented many advantages. Unlike stone, mud-brick was universally available, it being possible to produce brick from Nile alluvium or desert sediments/clays, sand, and water—resources accessible to everyone, though in varying quantity (Kemp 2000: 83 - 84; McHenry 1996:

1 - 20). Mud-brick was quick to fabricate, especially when compared to the quarrying of stone blocks, and was therefore more economical, particularly for large construction projects such as entire palace complexes or row upon row of temple storage magazines (Fathy 1989: 4 - 5; Kemp 2000: 83 - 84). Likewise, mud-brick was fast and easy to build with, as a modular and regularized construction material that did not require further trimming and modification once laid, which Egyptian stone masonry techniques frequently demanded (Arnold 1991: 115 - 124 and references cited there). Early stone construction actually employed more regularly sized blocks as a byproduct of its development out of mud-brick masonry techniques, as did the *talatat* of the Amarna Period (Arnold 1991: 120 - 122; see also van Beek and van Beek 2008: 149). Mud-brick structures offered better interior climate control than equivalent stone structures, providing more comfortable living and working spaces (Endruweit 1994; McHenry 1996: 30; for an alternate opinion, see Kemp 2000: 88). Mud-brick construction was easily modified and expanded upon, allowing for the allocation of space and the adaptation of spatial arrangements in a fashion that stone could not accommodate, thereby offering a flexibility not physically or financially feasible in stone structures (Kemp 2006: 217 - 221; for a similar phenomenon in Mesopotamia, see Stone 1981: 19 - 33). However, mud-brick construction was not without its disadvantages: mud-brick structures required continual upkeep and even with constant care would have had a limited life span (Arnold 2003: 110), in part explaining the evident dichotomy between the sacred *ḥwt nt ḥḥw m rnpwt*, “temples of millions of years,” built of stone (Erman and Grapow *WB II*: 2) and the more practical and frequently more temporal constructions executed in mud-brick.

### *Construction with Mud-Brick*

1. Construction planning and work organization. The analysis of the methods employed to build mud-brick houses, funerary monuments, and temples can serve to

illuminate not only the structures and their construction, but also can reveal aspects of the construction planning and the levels of the organization of work and workers employed to produce the structure (Eyre 1987a, 1987b; Emery and Morgenstein 2007: 111 - 122; Rosen 1986: 75 - 91). Then, as now, construction presumably would have begun with a planning phase in which the size and layout of the structure would have been determined and the number of bricks needed for the project calculated, though this initial phase is little attested in either the textual or the archaeological record (Arnold 1991: 7 - 10; Clarke and Engelbach 1930: 47 - 68). A Ramesside scribal training piece included in Papyrus Anastasi I includes an example of the mathematical process of calculating the number of bricks that the building of a construction ramp of a prescribed size would require (P. Anastasi I 13.5 - 16.6 in Gardiner 1911: 16 - 19, 31 - 34); while the dimensions of the ramp are outlandish, the inclusion of the problem as an exercise in a scribal training text does suggest that young scribes would be required to make such calculations in real-world situations.

Once the ground plan of the structure had been decided upon, the outline of the structure would have been set out on the ground. For larger structures, it actually would have been laid out with pegs and string, presumably the stage in the planning depicted in the “Stretching of the Cord” scenes included as a standard element in the temple cycle of scenes picturing the foundation ceremony (Budde 2000: 191 - 199). For structures with simple floor plans, the first course of bricks may have been laid out on the ground as the guideline for further construction (Choisy 1904: 15; Kemp 2000: 88; Spencer 1979a: 120). Mud-brick walls could be constructed directly on an unprepared ground surface, though more commonly were provided with brick foundations and wall footings laid in trenches upon a bed of sand; this style of foundation is especially well-recorded for the Late Period temple temenos walls (Choisy 1904: 21 - 41; Clarke and Engelbach 1930: 209 - 211; Goyon

et al. 2004: 110 - 123; Spencer 1979a: 114 - 116). Occasionally, particularly along high-traffic routes, the base of the wall at ground level was protected by a footing of stone, in an effort to minimize the undercutting of the wall due to water or wind damage and traffic; stone elements also could be included in the wall proper, being most common at the quoining of building corners (Husselman 1979: 33 - 35; Spencer 1979a: 120).

2. Wall construction. The construction of walls followed upon the laying of the foundation or preparation of the area and the production of sufficient quantities of mud-brick. In addition to the brick itself, wall construction required mortar and frequently included wooden elements and mats or bundles of reeds. Mortar was sedimentologically similar in composition to mud-bricks, though rarely had straw temper (Kemp 2000: 92; Lucas 1962: 74 - 76; Spencer 1979a: 133 - 134; van Beek and van Beek 2008: 275 - 278). This mortar usually was used only in the horizontal joints between courses and not along the vertical joints between bricks in a course (Kemp 2000: 92; Spencer 1975: 1403). Even as today, mortar would have been mixed as close to the construction site as possible, whereas bricks more often were produced at a greater distance from the construction site and transported at least a short distance (as pictured in the brick-making scenes from the tomb of Rekhmira, see Davies 1943: pl. LVIII - LIX; Kemp 2000: 92). Wooden elements included in construction were comprised of the windows and doors of buildings; other architectural elements such as columns, door jambs, and lintels could be wood as well (Arnold 2003: 246; Lucas 1962: 79; Spencer 1979a: 130 - 133), though in elite residences and palaces the door jambs and lintels, as well as the window grates, often were executed in stone and inscribed with the home owner's name (Harvey 1990; Hölscher 1941: 37 - 52, pls. 32 - 38). In royal contexts, stone architectural elements are more frequently attested, with stone cladding of mud-brick walls known from residential settings, such as the Great Palace at Amarna (Pendlebury 1951: 50 - 51;

note also the ambiguity this use of stone can raise when interpreting architecture, Assmann 1972) and the palace of Apries at Memphis (Petrie 1909: 1 - 5), from funerary settings, such as the pyramids of the Middle Kingdom (Goyon et al. 2004: 113 - 114), as well as from sacerdotal settings, such as the Ptolemaic pylon of the small temple at Medinet Habu (Hölscher 1939: 29 - 30). In thick walls, such as town walls or temple enclosure walls, wooden beams could be used to aid the bonding and cohesion of the mass of bricks (Goyon et al. 2004: 115 - 123; Spencer 1979a: 132), even as metal ties are used to reinforce bonding today (Kreh 1998: 14 - 15, 52 - 53; Nolan 1998: 156 - 157). Serving a like purpose in massive mud-brick walls, layers of loose reeds or reed matting could be employed, occurring regularly every set number of courses (Clarke and Engelbach 1930: 210; Spencer 1979a: 134 - 135). Wooden beams and reed mats, together with narrow air channels, traditionally have been interpreted as facilitating the (re)drying of bricks that would have been flooded annually and would have wicked moisture up from the ground under regular circumstances (Clarke and Engelbach 1930: 210; counter-argument in Spencer 1979a: 135); little analysis has taken into consideration the ways in which these additions to the wall would have aided in the structural bonding of the wall and, therefore, to the stability of the wall as a whole.

Though the role of organic materials in structural bonding has not been widely considered, the bonding patterns employed by the ancient Egyptians have been studied and bonding typologies developed. The first such typology was that developed by Mond and Myers as they attempted to address the issue of site chronology in their work at the Bucheum (Mond and Myers 1934a: 47 - 52, 1934b: pls. CXII - CXIV). Spencer improved upon Mond and Myers' original typology, primarily addressing the problem that frequently opposite faces of a given wall could be classified as two different bonding styles; Spencer's typology allows for a single description designating the bond of both faces to be given to a wall (Spencer 1979a: 7, 136 -

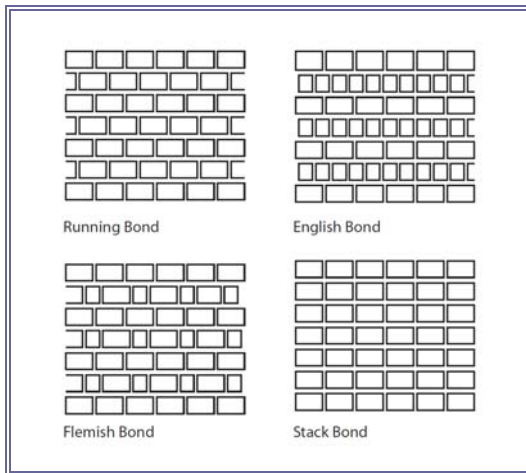


Figure 1. Standard modern brick bonding patterns.

139, pls. 1 - 20). Despite the existence of these bonding typologies, they are little applied; however, the bonding typologies for ancient mud-brick construction essentially reproduce in a highly specific fashion the basic bonding patterns still in use (Running Bond, Flemish Bond, English Bond, and Stack Bond; see fig. 1), suggesting that the nature of construction in brick, like the production of unfired bricks themselves, has not changed all that much, despite technological developments (Kreh 1998: 38 - 48; Nolan 1998: 146 - 148; van Beek and van Beek 2008: 266 - 272).

3. Roof construction. Upon the completion of the walls, mud-brick buildings were roofed in one of two fashions: with flat roofs or with vaulted roofs. Flat roofs were created by laying wood cross-beams perpendicular to the face of the wall spanning the space from wall to wall or from wall to architrave (supported by columns), laying palm ribs, reeds or reed matting from beam to beam, then covering this layer with mud plaster (fig. 2; Arnold 2003: 47; Jéquier 1924: 289; van Beek and van Beek 2008: 287 - 310; Henein 1988: 42 - 43); this style of ceiling construction is essentially identical in execution to viga and latilla construction of the American Southwest. In the most important rooms at the palace of Malqata, the underside of the ceiling was plastered, filling in the spaces between the crossbeams, in order to create a smooth, level surface for painting (Tytus 1994: 13). Vaults



Figure 2. Underside of traditional flat roof at Hassan Fathy residence, Thebes.



Figure 3. Vaulted storage magazines at the Ramesseum.

could be laid using the same bricks as were employed in the construction of walls or could be created with bricks made specifically for the job (fig. 3). In the latter case, the bricks are thinner and lighter and could even be wedge-shaped, rather than rectangular, to facilitate the shaping of the vault; specialized vaulting bricks often were scored with finger-marks when they were produced, a feature that increased the bonding of mortar to the



bricks during construction (Goyon et al. 2004: 126 - 130). Inclined vaults, or vaults whose bricks were laid at a slight angle in order to rest the weight of the vault against one of the end-walls, were more common than were vaults with bricks laid parallel to the end wall, as it was possible to erect inclined vaults without wooden framing or centering, thereby rendering them more economical to construct (Choisy 1904: 42 - 48; Fathy 1989: 6 - 12; Goyon et al. 2004: 123 - 130; Jéquier 1924: 303 - 307; Spencer 1979a: 123 - 126; Curl 1999: 701 - 703; Arnold 2003: 252 - 254). Vaults were used to roof the long, gallery-style magazines known throughout dynastic history, with perhaps the best-preserved and therefore best-known examples being at the Ramesseum (Arnold 2003: 196 - 197). Another well-known, large-scale example of a vaulted ceiling is the palace of Ramesses III at Medinet Habu where five vaults roofed the audience room of the first phases of the palace, while three vaults were used to roof the same space during the second phase (Hölscher 1941: 37 - 52, pls. 6 - 7).

### *The Architecture of Mud-Brick*

Mud-brick architecture was by no means the first use of earthen architecture in ancient Egypt, but rather followed upon an established history of pit houses and wattle and daub structures (Arnold 2003: 110; Badawy 1966: 21, 1990: 13 - 24; Lacovara 1984: 20 - 21; Smith 1938: 11 - 24). In fact, these latter types, constructed with reeds coated in mud plaster, were the source of many of the decorative architectural elements that continued into later stone architecture, becoming icons of Egyptian architectural style (torus molding, cavetto cornice, *kebekher*-frieze, scalloped parapet, column capital styles; Badawy 1966: 64 - 71). The beginnings of earthen architecture conceptually are related to other uses of sediment as a resource both for agricultural purposes and in the creation of ceramics. During the prehistoric period, mud plaster increasingly was employed for the lining of fire and storage pits, highlighting the potential of mud as an architectural resource (Kemp 2000: 78 - 79). With a shift from

ephemeral construction in reeds and mud or rounded subterranean abodes to increasingly permanent, entirely aboveground, rectilinear structures, mud-brick came into its own (Badawy 1966: 10 - 15, 21; Smith 1938: 21). Mud-brick became the building material of choice, being the primary material used for domestic architecture henceforth. Likewise, mud-brick became a standard medium for religious and funerary architecture, though stone increasingly was employed next to mud-brick in these latter situations. Unfortunately, given the historical trend in Egyptian archaeology to focus on cemeteries and temples, mud-brick domestic architecture is less well known than its funerary and religious counterparts (Haeny 1979: 85 - 94); this trend increasingly is changing, however, as the study of urban sites, such as Amarna (Kemp 1977: 123 - 139), and the residential and administrative areas of necropolis sites, such as Giza (Lehner 2002: 27 - 74; Lehner and Wetterstrom 2007: 105 - 140, 183 - 234) provide information concerning the architecture employed in such settings.

Slim as it is, archaeological evidence records a transition from prehistoric, single-room pit houses and wattle and daub structures with courtyards, hearths, and grain storage at Merimde, Omari, Hammamiya, and Maadi (Arnold 2003: 110; Midant-Reynes 2000: 4) to the multi-chambered, rectangular courtyard houses of historic times (Arnold 1989: 75 - 93; Badawy 1966: 21 - 28). This courtyard-centered abode was so foundational it even became the hieroglyph *pr*, meaning house or enclosure (Arnold 1989: 89 - 90; Badawy 1966: 21). By the New Kingdom, houses more commonly were constructed around a central living room, rather than a hypaethral courtyard, as a logical development from the courtyard-centered house; suites of bedrooms with bathing facilities and administrative spaces would have been accessed either from the courtyard or the living room, depending on the focus of the house (Arnold 1989: 78 - 80, 90). Architecturally, a distinction arose between country or estate houses, which tended to be larger domiciles with a variety of subsidiary structures for work and storage,

and town houses, which were constructed on smaller plots of land and therefore were all-inclusive, with the work and storage areas integrated into the house proper (Badawy 1968: 15 - 75; Quirke 2005: 55 - 96). Two categories of urban housing can be distinguished, based primarily on the organization of the urban setting: planned towns, especially those attached to royal funerary monuments, are attested from the Old Kingdom at Giza (Lehner 2002: 27 - 74), including the complex of Khentkawes (Hassan 1932: 35 - 67), from the Middle Kingdom at el-Lahun (Arnold 1989: 84 - 88; Petrie 1890: 21 - 32, 1891: 5 - 8; Quirke 2005: 55 - 96), and from the New Kingdom at Deir el-Medina (Valbelle 1975: 1028 - 1034) and at the workmen's village at Amarna (Kemp 1987: 21 - 50); these planned towns were composed of regularly laid out houses of nearly identical plan, though frequently with size differentiation reflecting an administrative hierarchy (Quirke 2005: 69 - 73, 87 - 88). The Nubian fortresses of the Middle and New Kingdoms provide another example of planned urban (or semi-urban) settings, though were unique in their entirely self-contained nature (only Buhen appears to have possessed an attached settlement) and in their need to be adapted to the local topography for defensive reasons (Lawrence 1965). Less systematically planned towns, such as Thebes (Strudwick and Strudwick 1999: 194), would have offered greater flexibility in style of house plan, though construction still was constrained by plot size. In such urban settings, houses were constructed with two or more stories to make the best possible use of space (Arnold 2003: 110 - 112, 247). By the Ptolemaic Period, these multi-storied town houses were constructed with a concave foundation and battered walls, reaching up to three stories and being provided with vaulted cellars. Unfortunately, it is primarily the first level of these structures that survives, making it difficult to reconstruct the upper floors with any certainty; generally, the vaulted rooms of the cellars were employed for storage, with the vaults providing structural support for stairs leading to the upper stories. The

construction of these houses from the Ptolemaic and Roman Periods is marked by the increased use (and survival) of wood in the corners of the structures and the better preservation of wooden window casings, doors, jambs, and lintels (Spencer 1979a: 98 - 103). Contemporary with these tower houses are examples of houses arranged around a peristyle courtyard, an architectural style harkening back to the Middle Kingdom but reinterpreted during the Ptolemaic and Roman Periods in light of the influence of Mediterranean architecture (Alston 2002: 44 - 127). Houses dating to the Ptolemaic and Roman Periods have been studied most extensively at Karanis (Husselman 1979), but are also known from Philadelphia, Theadelphia, Qasr Qarun, and Dimai in the Fayum (Spencer 1979a: 98 - 103), and in the Nile valley at Hermopolis (Roeder 1959), Medinet Habu (with Coptic occupation in very similar style houses as well; Hölscher 1954), Armant (Mond and Myers 1934a: 179 - 185), Edfu (Bruyère et al. 1937; Michalowski et al. 1938; Michalowski et al. 1939), and Elephantine (Grossmann 1970: 126 - 129).

Even as it was used to house the living, so too was mud-brick employed to protect the dead. Paralleling its increased use in domestic settings, mud-brick was utilized to line the burial chambers of prehistoric tombs, as at Cemetery T at Naqada (Petrie 1896: 18 - 20, 24) and the Decorated Tomb at Hierakonpolis (Tomb 100, see Quibell and Green 1902: 20 - 21; Kemp 1966: 13 - 22). Its use in funerary settings expanded during the 1<sup>st</sup> and 2<sup>nd</sup> Dynasties, being employed for chambers and vaults at Naqada (Petrie 1896: 18 - 29), Tarkhan (Petrie 1914: pls. XII - XIV; Petrie et al. 1913: 8), el-Mahasna (Garstang 1989: 8 - 17), Naga el-Deir (Reisner 1908: 5 - 11, 16 - 35), Abydos (Petrie 1901: 7 - 15; Randall-MacIver and Mace 1902: 34, pl. IV), Giza (Daressy 1905: 99 - 106; Petrie 1907: 2 - 3, pls. II, VI), and Saqqara (Emery 1949: 1 - 12). As time progressed, mud-brick was also used in the construction of tomb superstructures, as the mastabas at Naqada, Tarkhan, Abu Rawash, Giza, and particularly Saqqara attest (Brinks 1975: 1214 - 1231). The



mastabas from Saqqara offer the quintessential examples of palace façade style niching and buttressing; highly intricate examples of niching occurred during the 1<sup>st</sup> Dynasty, but became increasingly simplified through the 2<sup>nd</sup> and 3<sup>rd</sup> Dynasties and were replaced in the 4<sup>th</sup> Dynasty by straight-sided mastabas, a style that continued into the Middle Kingdom (Emery 1949: 1 - 12; Spencer 1979a: 16 - 25); classic examples of this style of mastaba dating to the 6<sup>th</sup> Dynasty occur at Balat/Ain Asil (Minault-Gout and Deleuze 1992: 15 - 30, 67 - 75; Valloggia 1986: 13 - 25, 1998: 42 - 46). Being related to royal burials, the Predynastic and Early Dynastic enclosures at Abydos (Kemp 1966: 13 - 22) and Hierakonpolis (Quibell and Green 1902: 19 - 20, pl. LXXIV) also display palace façade niching, as does a single example of a gateway within the town site of Hierakonpolis (Weeks 1971 - 1972: 29 - 33). The use of mud-brick in funerary monuments continued from the Old Kingdom into the Middle Kingdom, when not only mastabas but even the cores of royal pyramids were executed in mud-brick. The pyramids of the 12<sup>th</sup> Dynasty—of Senusret II at el-Lahun (Petrie et al. 1923: 2 - 8), of Senusret III (de Morgan 1895: 47 - 50) and of Amenemhat III at Dahshur (de Morgan 1895: 87), of Amenemhat III at Hawara (Petrie 1890: 6, 12 - 16), and of Amenemhat IV and of Queen Neferusobek at Mazghuneh (Petrie et al. 1912: 41, pls. XXXIX - XLV)—and of the 13<sup>th</sup> Dynasty at Saqqara—of Userkara Khendjer and of an unknown king (Jéquier 1933: 28 - 30, 60 - 63)—continued the pyramid-building tradition of the Old Kingdom, but demonstrate an economy in the use of a mud-brick core cased with stone, which the all-stone Old Kingdom Pyramids lack (Goyon et al. 2004: 113 - 114). Mud-brick pyramids were built into the New Kingdom as private funerary monuments, especially in the Theban area and at Saqqara, though these miniature pyramids were no longer solid brickwork but had internal, vaulted chambers that served as the tombs' chapels (Goyon et al. 2004: 133 - 140; Spencer 1979a: 46 - 49). Mud-brick continued to be used for the lining for burial chambers and for roof vaulting for

the subterranean portions of tombs through the New Kingdom and into the Late Period, when the construction of tomb superstructures in mud-brick experienced a revival well-exemplified by still-standing monumental pylon entrances of the tombs of Mentuemhat (IT 34) and Padineith (IT 197) in the north Asasif area of the Theban necropolis (for these and other Late Period tomb structures, see Eigner 1984: 71 - 89). Ptolemaic, Roman, and even Coptic tombs continued to employ mud-brick (Spencer 1979a: 44 - 58).

Alongside and related to its use for funerary monuments, mud-brick was employed for the construction of both mortuary and divine temples, as well as for the vast complexes of structures that surrounded these temples, providing storage for temple goods and dwellings for temple employees. In the Old Kingdom, mud-brick frequently was used to finalize the construction of stone mortuary temples quickly if the structure was not yet complete at the king's death, as the pyramid temple of Menkaura at Giza (Reisner 1931: 30) and the temple of Neferirkara at Abusir (Borchardt 1909: 17, 38) demonstrate. However, during the 5<sup>th</sup> Dynasty, a pattern of original construction executed in mud-brick and later reconstructed in stone emerged at the solar temples at Abu Ghurab. The solar temple of Userkaf originally was built of mud-brick, but soon after was reconstructed in stone, with work on the complex continuing through the reigns of his successors Neferirkara and Niuserra, though ultimately the structure was completed in mud-brick and plaster (Ricke 1965: 1 - 30); the solar temple of Niuserra likewise was originally built of mud-brick, which eventually was replaced with stone construction (Borchardt 1905). Like the 5<sup>th</sup> Dynasty solar temples, many divine temples started as mud-brick edifices that eventually were reconstructed using stone, thereby limiting the evidence for mud-brick temples before the New Kingdom. Some mud-brick temples do survive though, particularly from the Middle Kingdom. Examples include a temple at Hermopolis, a temple of Seankhkara Mentuhotep at Thebes,



Figure 4. North temenos wall at Dendera showing concave and convex sections.

and mud-brick foundation walls dating to the reign of Senusret I at Tod, as well as the single spectacular example of the Satet Temple of Elephantine, the excavation of which revealed multiple iterations of mud-brick construction before an increasing number of stone architectural elements were added, starting in the 11<sup>th</sup> Dynasty and continuing through to the 18<sup>th</sup> Dynasty (Dreyer 1986: 11 - 36). Frequently, excavations have uncovered the temple enclosure walls contemporary with both early brick and stone temples, even when there remains little to no evidence of the original temple structure itself, as at Abydos and Medamud (Spencer 1979a: 62 - 63). Massive temple temenos walls became increasingly common through time, with many kings of the Late Period reconstructing enclosure walls, particularly with the expansion of temple precincts, as at Karnak and Elkab (Spencer 1979a: 64 - 82). These temenos walls were constructed in sections with either alternating convex and concave

sections or alternating concave and horizontal sections, rather than with straight, horizontal joints (fig. 4; Arnold 2003: 256; Choisy 1904: 21 - 42; Goyon et al. 2004: 115 - 123; Spencer 1979a: 114 - 116). Also commonly attested from the New Kingdom and continuing into the Late Period was the construction of small mud-brick chapels within temple complexes, as at the Temple of Amun at Karnak and at the Temple of Ptah at Memphis (Spencer 1979a: 64 - 82). Another Late Period phenomenon of mud-brick religious construction was the casemate platform, a block of cellular masonry whose walls supported those of the structure built atop—the casemate platform walls built according to the plan of the superstructure—with the interstices filled with sand. Examples of these structures, erected as foundations for temple structures, are known from Tanis, North Saqqara, Medamud, Elkab, and Naukratis (Arnold 2003: 49 - 50; Muhs 1994: 99 - 113; Spencer 1979b: 132 - 137, 1999: 295 - 300).

### Conclusion

Because of its easy and economical production and universal availability, mud-brick was used throughout Egyptian history for domestic, funerary, and religious structures. A simple material with which to build, mud-brick was a construction medium ideally suited to Egyptian environmental and cultural conditions. The universality of mud-brick as a building material in ancient Egypt would have created a living environment that no longer survives intact, but which the study of mud-brick architecture reveals. As academic focus shifts increasingly to consider

mud-brick alongside stone with continued archaeological excavation at urban settings throughout the country, increasing numbers of structures constructed with mud-brick will be available for and in need of detailed study. As archaeological and geological practices become ever more specialized and technological, the study of mud-brick architecture will be better equipped to analyze both newly uncovered and previously excavated structures brick-by-brick and will be able to begin to address questions heretofore unanswerable and to consider questions currently imponderable.

### Bibliographic Notes

Spencer (1979a) remains the only volume dedicated solely to mud-brick architecture in ancient Egypt. Goyon et al. (2004) offers the most up-to-date consideration of construction in mud-brick, information also included in Jéquier (1924), Clarke and Engelbach (1930), and Lucas (1962), while Kemp (2000) presents his consideration of mud-brick in the broader context of the use of earth as a resource, a valuable perspective not heretofore fully articulated. For architecture in general, both in mud-brick and in stone, Dieter Arnold (2003) provides a useful reference for specific items, while Badawy (1966, 1968, 1990) and Smith (1938) remain the standard references for a synthetic treatment beyond individual site reports. Van Beek and van Beek (2008) provide a global perspective on mud-brick production and construction, particularly useful for information relating to more modern constructions throughout the Near East, while Henein (1988) presents an in-depth study of the construction and life in a single, traditional village in Upper Egypt near Luxor. Emery and Morgenstein (2007) offer a reconstruction of the ancient Egyptian work organization employed for a specific mud-brick structure; Eyre (1987a and b) is the standard reference for work organization in ancient Egypt more generally.

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Figure 1. Standard modern brick bonding patterns. (After Nolan 1998: 147.)

Figure 2. Underside of traditional flat roof at Hassan Fathy residence, Thebes. Photograph by the author.

Figure 3. Vaulted storage magazines at the Ramesseum. Photograph by the author.

Figure 4. North temenos wall at Dendera showing concave and convex sections. Photograph by the author.