Innovations in Mud-Brick: Decorative and Structural Techniques in Ancient Mesopotamia

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Innovations in mud-brick: decorative and structural techniques in ancient Mesopotamia

David Oates

Much of the evidence presented here for architectural innovation in sun-dried brick, commonly called mud-brick, has been previously published in excavation reports and, in the case of early vaulting techniques, in a contribution to *Archaeological Theory and Practice* (Oates 1973). Neither that volume nor the reports reached the wide audience that *World Archaeology* commands, and I make no apology for repeating many of my early observations. Moreover, since 1973 there have been other valuable contributions on this subject, which I acknowledge in detail in the text where they are immediately relevant and, in general, in the bibliography appended to this article. Mud-bricks were used as early as the ninth millennium BC, but I am concerned here with rectangular mould-made bricks of standard size, which were introduced in Mesopotamia at least as early as the fifth millennium (uncalibrated radiocarbon).

The material

Mud-brick was by far the most common building material employed in the ancient Near East and its use persists in the countryside to the present day. It is very well known to Near Eastern archaeologists but a brief account of its composition and characteristics may be useful to readers to whom it is unfamiliar. The essential constituents are earth, chopped straw and water. These are shovelled and trodden into a consistent mixture, which is formed into bricks of a standard size in an open mould. The bricks are then laid out to dry in the sun for at least two weeks, and are then ready for building. The mortar employed is essentially of the same composition, but more plastic because it has not been exposed to the drying process; it has, as anyone who has walked through Mesopotamian mud can testify, an extraordinarily adhesive quality. The bricks themselves are of surprising strength when new, although their resistance to fracture decreases with the decay of the straw which is their main bonding agent. Gasche (1981: 44–7 and n. 7) has carried out fracture tests on both ancient and modern bricks from Tell ed Der in northern Babylonia, but notes that his modern bricks were made from saline soil which is no longer considered suitable for the purpose, i.e. that the results of his tests on new bricks should be regarded as representing a minimal resistance to fracture. Two colours of bricks are found in ancient

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structures, red-brown and grey, representing two different sources of earth. The red-brown bricks, commonly used in monumental buildings where very large quantities were needed, were made with new earth from agricultural land outside the settlement area, the grey bricks from occupation debris excavated within the settlement itself. Red brick is often found with grey mortar. This is obviously a deliberate choice by the builder, and could result either from the use of settlement débris or the inclusion of ash. Clearly the grey mortar was thought to create a better bond, and modern builders say that grey bricks, made from settlement debris, are stronger than those made from field soil, but neither the relative strength of grey bricks nor of grey mortar has, to my knowledge, been scientifically tested.

Mud-brick has better insulating qualities than the baked bricks or concrete blocks that are rapidly superseding it, but its prime characteristics as a building material are adaptability and ease of construction. It can be readily cut and shaped, secondary changes of plan such as the insertion of a new doorway, niche or window are easily accomplished, and above all it does not require any great skill, at least in the erection of simple structures. The walls of the dig house at Tell Brak, measuring some 25m by 5m and 4m high, were built in six weeks, including the manufacture and drying of the bricks, by one master builder and four labourers. There is evidence in the monumental constructions of the Late Assyrian kings, requiring a vast labour force and millions of bricks, that the master builder confined himself to laying out the angles of a building, leaving less skilled workmen to fill in the walls between them (Oates 1961: Pl. IV). Moreover, mud-brick is very durable, provided that the tops of the walls are safeguarded by keeping the roof in good condition and that the wall faces are protected from the weather by regular replastering – the plaster is essentially the same mixture as the bricks and mortar, though chaff is sometimes substituted for straw to give a smoother finish. Some of the walls in the building that provides the evidence for later sections of this article, the Great Temple at Tell al Rimah in northern Iraq (Fig. 1), stood through many vicissitudes for at least six centuries and were still up to 10m high when excavated almost four thousand years later.

On the other hand, the nature of the constituent materials imposes certain constraints on brick manufacture. It is seasonal because, in northern Mesopotamia at least, hot sun is needed for the drying process. Earth is readily available, but water is not; the bricks for the Tell Brak dig house were made close to an irrigation pump, but the plaster was mixed on the building site and this alone required some 800 litres a day, which had to be brought from 2km away. When donkeys were the only form of transport this could present a considerable problem. It is possible that the supply of water in wells, and in watercourses which are now seasonal, may have been greater in volume and more constant in antiquity than in modern times. A gradual change might be expected as a result of deforestation on the hillsides overlooking the plain and, more recently, deep ploughing which destroys the drought-resistant, deep-rooted plants that stabilise the soil and help to retain moisture. In the last ten years the process has been greatly accelerated by the installation of an excessive number of irrigation pumps, which draw water both from artesian wells and from the few flowing streams and have caused an appreciable drop in the water table.

Secondly, supplies of straw or chaff are dependent on the harvest of the previous or the current year, not always reliable when the site – like both Tell al Rimah and Tell Brak – lies on the border of rain-fed agriculture. Again, the quantities required are very large.

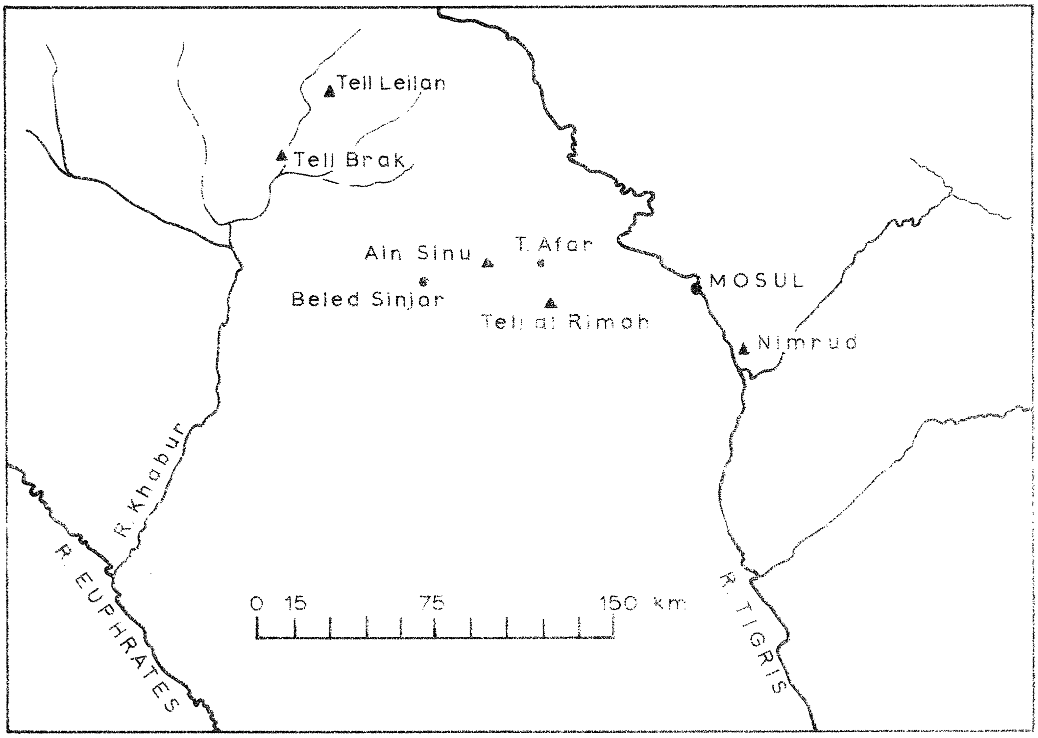

Figure 1 Map of northern Mesopotamia.

Reliable estimates are hard to obtain because present-day brick makers do not think in statistical terms, but an average estimate based on personal enquiry from a number of informants suggests that 100 bricks require a minimum of 1½ sacks, approximately 60kg. of straw, which is the product – again a rough estimate – of one eighth of a hectare of barley. The normal response to a question about the content of straw in modern mud-brick is 'The more the better', and the minimum quantity estimated here certainly exceeds the proportion quoted by Fathy (1969). To give some idea of the area of land required for the supply of straw for even a part of a major building, the foundations alone of the outer wall of the 'Palace' of Naram-Sin (c.2254–18 BC) at Brak would have required for c. 810,000 bricks and their mortar the straw from more than 13 sq km of cultivation. Add to this the internal foundation walls – all that have survived – and a superstructure which has entirely disappeared but must have stood at least 8m high, and the quantity of straw required must represent the crop from a truly formidable area of agricultural land, even when the harvest was good. Moreover, when in Late Assyrian times trench-built foundations were replaced by platforms or rafts of mud-brick, the number of bricks used in the platform alone ran into millions. It is no wonder that the Assyrian king Ashurnasirpal II (883–859 BC) brought in more than 47,000 deportees from newly conquered territory for the construction of his new capital at Nimrud. Nor is it implausible that the demand for straw for brick-making over five years, the period of construction of his North-west Palace, could have been met by more reliable crops in the Tigris valley. But outside this well-favoured region, on the borders of rain-fed agriculture, a problem undoubtedly existed. In 1957 we excavated a Roman barracks at Ain Sinu, some 95km west of Mosul, which had been built in the early years of the third century AD, obviously in haste and at a time when straw was not locally available, since there was virtually none in the bricks (Oates 1959).

Decorative techniques

An interesting example of the adaptability of mud-brick as a building material is illustrated by its employment in ever more elaborate systems of façade decoration. Mesopotamian

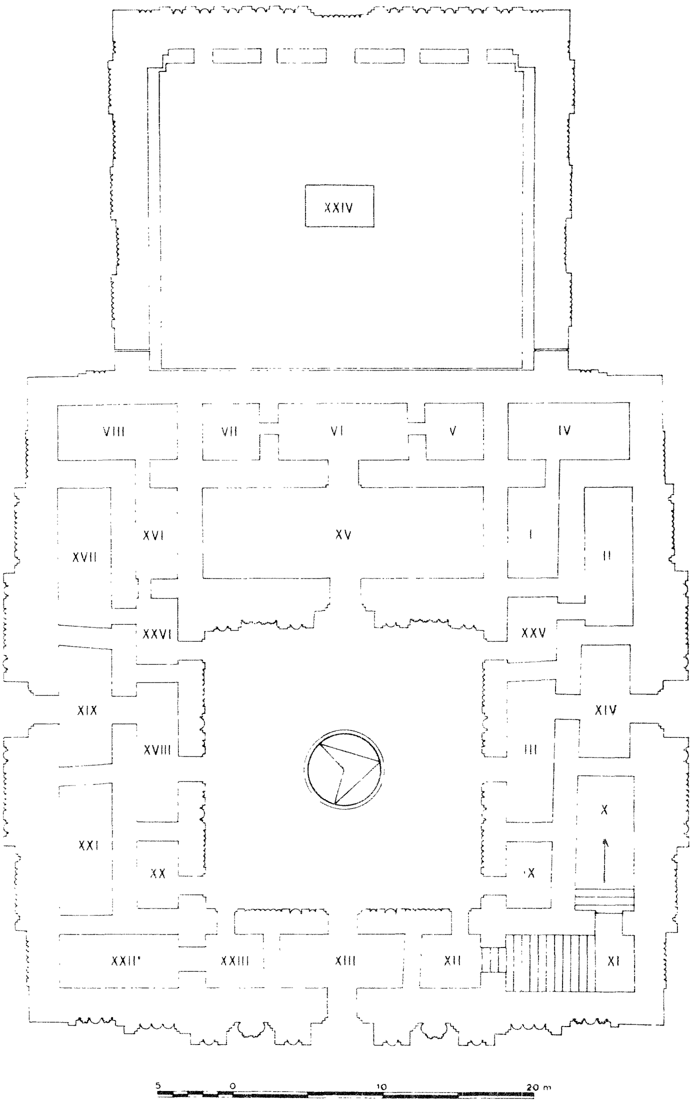

Figure 2 Plan of the Great Temple, Tell al Rimah (c. 1800 BC).

builders had, since at least the fifth millennium, taken advantage of the dramatic patterns of light and shade produced by their very bright sunlight by using rebated pilasters (e.g., Tepe Gawra XIII, Tobler 1950: Pl. XII) and – as early as the fourth millennium – engaged semi-columns on the façades of their buildings (e.g., Warka, Strommenger 1964: 378–80, Pl. 13). In the early second millennium we find semi-columns, set singly in rebated niches or in multiple panels, and formed to represent palm-trunks or ascending spirals. Such façades were first discovered in the Great Temple at Tell al Rimah in northern Mesopotamia (Oates 1965–72, 1973), and have subsequently been found at Larsa (Telloh) in southern Mesopotamia (Huot 1976) and at Tell Leilan (Weiss 1985) in northeastern Syria, where two successive temples show variants of the same decorative schemes. When, in the historical period, we can certainly identify the function of buildings decorated in this way, they appear always to have been temples.

The most striking example remains that found at Tell al Rimah, in the Great Temple almost certainly constructed sometime before 1800 BC under the patronage of the Assyrian king Shamshi-Adad I. The extraordinary regularity of the building itself (Fig. 2), together with its remarkable columned decoration, suggest not only a large labour force but the services of skilled professional architects. The earlier settlement at Tell al Rimah, which by the early second millennium BC had become a mound of occupation debris 100m in diameter and standing some 6m high, was levelled off to form a massive platform on which the great temple was founded. It was approached by a free-standing stair carried on vaults, and from its roof further stairs or ramps led to a high terrace, perhaps surmounted by another shrine; the whole three- or four-tiered structure must have resembled a ziggurat.

The plan of the temple and the attached high terrace or ziggurat at Tell al Rimah are shown on Figure 2. All the external and the courtyard façades were adorned with engaged columns, set singly or in groups, 277 in all; the 50 large columns were built of carved bricks, laid in complicated patterns to represent spirals or palm trunks (Pls 1, 2; Fig. 3). Each column, whether palm trunk or spiral, was built with mud-bricks bearing on their outer face patterns in relief which, by repetition in a standard sequence, produced the required motif. The basic shape of brick employed was a 60 degree sector of a circle of radius c. 29cm. The brick could have been made in a mould of this shape or it could have been cut

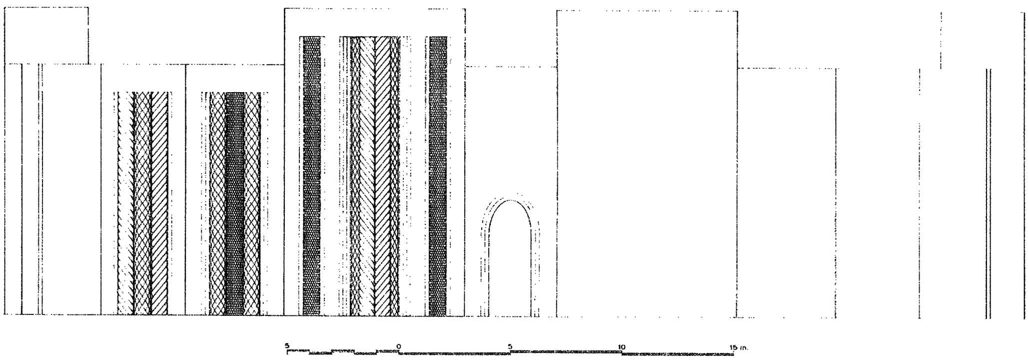

Figure 3 Reconstruction of the east façade of the Great Temple, Tell al Rimah.

Plate 1 Panel of spiral columns, external façade of antecella (XV), Great Temple, Tell al Rimah.

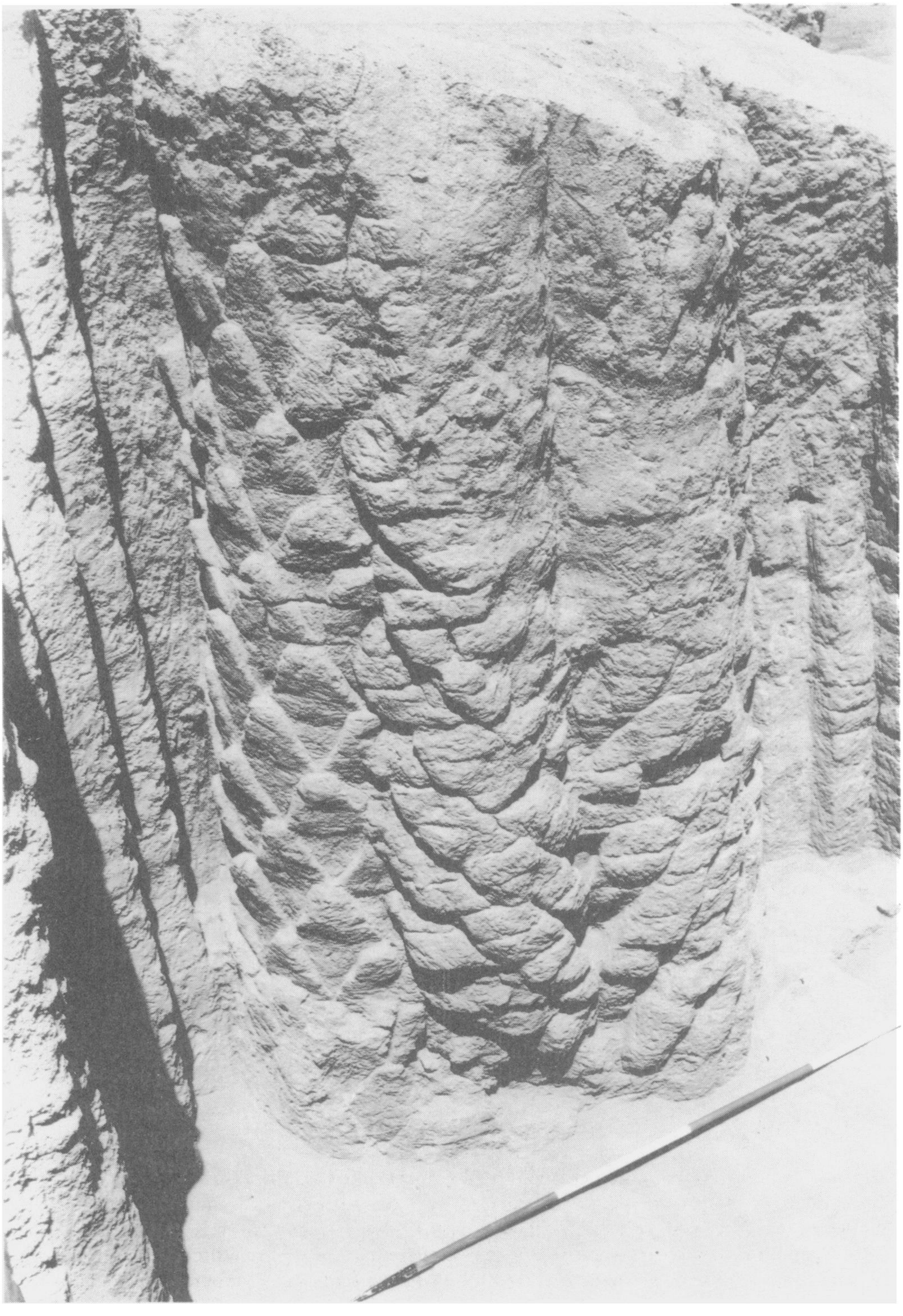

Plate 2 Spiral and palm-trunk quadruple mud-brick column, south tower, east gate of Great Temple.

from a brick, made in the standard square mould. To produce the correct outline a 60 degree angle could easily be defined by drawing the 29cm circle and then intersecting the circumference with an arc of the same radius. The ornament was then carved on the curved surface. Two types of palm trunk column were made. The motif for the one with a 'scale' pattern consisted of only one course, each brick bearing three scales; the 'diamond' type (Pl. 2, left side of column) was four courses high and required four different patterns of brick.

The cutting of the component bricks for the spiral columns presented a slightly more complex problem in geometry, although the basic knowledge required was no greater. Each bore on its outer face parts of two adjacent strands of the spiral separated by a slanting groove, the angle of which determined the twist of the spiral. The outline of the brick was laid out as shown in Figure 4; the radius of the individual strands was approximately half that of the sector brick and their centres were 15 degrees off the line of

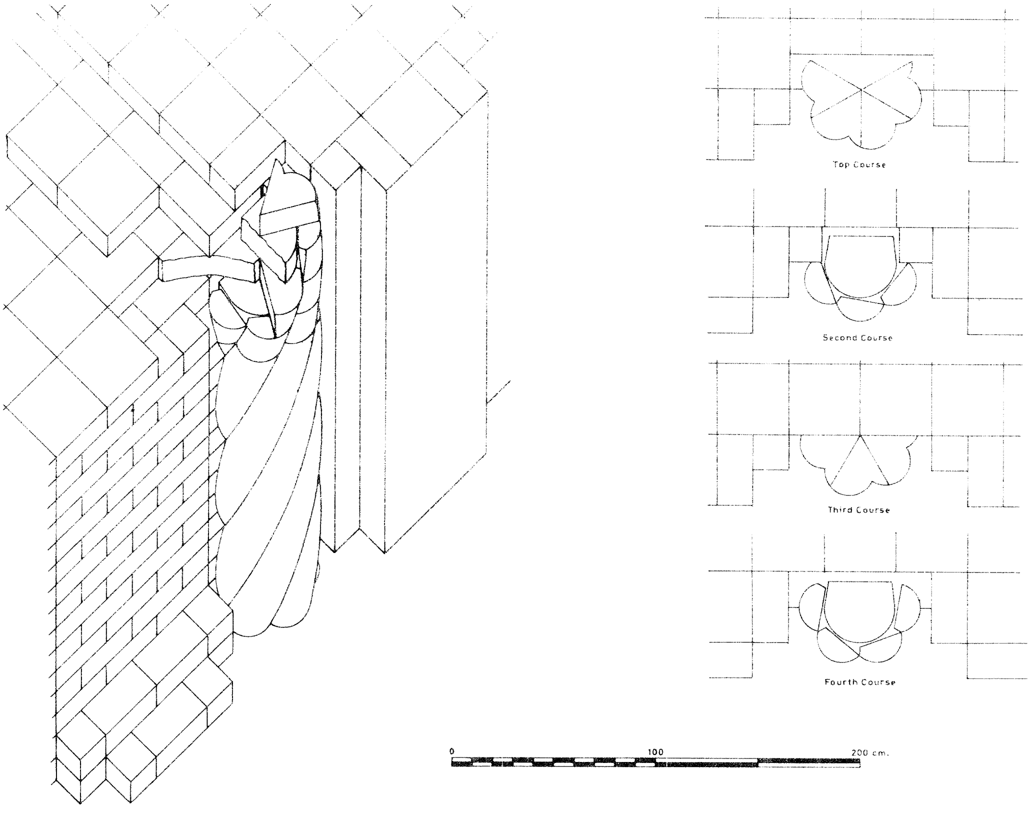

Figure 4 (a) Diagrammatic reconstruction of a spiral column on the west façade of the Tell al Rimah ziggurat (b) with successive course plans. The top course consisted of four sector bricks; these completed an arc of 240 degrees, and half of each of the two lateral bricks was set into the wall face. In the second course is a horse-shoe bonding brick, overlying the points of three sector bricks, which formed a semi-circle and thus made a straight joint with the wall face. The fourth course consisted of a horse-shoe brick surrounded by four segments of strands forming an arc of 240 degrees, so that half of each lateral segment was set in the wall. The gaps between the bricks were filled with brick fragments and mortar; see pp. 395–6.

the sides of the brick, to the right or left according to whether a right-hand or left-hand spiral was required. The angle of the groove to be cut on the outer face was established by shifting the position of the centres on the under surface of the brick through an arc of 15 degrees, again to the right or left as required. This was the underlying principle that governed the original design of the bricks on the architect's drawing board. The actual method of cutting them was probably less sophisticated than the theory. The use of templates would have been an obvious labour-saving device, but we cannot show that they were used and we can demonstrate in one instance that they were not. On one brick we found that the centre of the strand on the upper surface was marked by a circular depression such as might be made by rotating a man's thumb, and the radius was approximately the span between thumb and forefinger, which apparently served as a primitive pair of compasses. Indeed it is likely that the basic design followed a principle long established, applied at Tell al Rimah by masons with long experience of executing it by rule of thumb.

The use of these bricks alone would have produced half-columns of the required patterns, provided they were laid with an axial twist of 15 degrees in successive courses. But there would have been no satisfactory bond between the half-column and the wall behind it. This difficulty was overcome by using the complete sector bricks only in alternate courses, interspersed with bonding bricks of horse-shoe shape which overlay the points of the sector bricks and penetrated to a depth of half a brick into the wall face. The profile of the spiral was continued by cutting smaller pieces of brick in the shape of the missing segments of individual strands and setting them around the circumference of the horse-shoe. The sequence of brick-laying is illustrated in Figure 4. An inspection of the drawing will show that this arrangement produced vertical joints one half brick behind the wall face in the first, second and fourth courses. The column was therefore locked into the wall by a horse-shoe bonding brick in every second course, and every second bonding brick was overlaid by a square brick penetrating a full 35cm into the wall.

A similar system was employed in the construction of the two types of palm trunk. A close parallel for the diamond palm trunk motif and the technique of construction can be found in the approximately contemporary bastion of king Warad-Sin at Ur (Woolley 1939: 42–3). This, together with the fact that the plan of the temple itself was of the southern Babylonian type (with a 'breitraum' cella) and that the techniques of decoration are used with an expertise suggesting long practice, strongly supports the idea of a Babylonian origin for these architectural techniques, preserved for us at Tell al Rimah owing to the relative unimportance of the site which left its main temple undisturbed for some 600 years, long enough for later occupation debris to cover over and preserve the earlier levels of the building (Pl. 3).

Recently, a much earlier ceremonial complex of the Akkadian period (c. 2250 BC) has been discovered at Tell Brak, in northeastern Syria (Oates 1989). Here the façade of a large courtyard was decorated with small, and up to now unique, semi-columns moulded in the mud-plaster (Pl. 4).

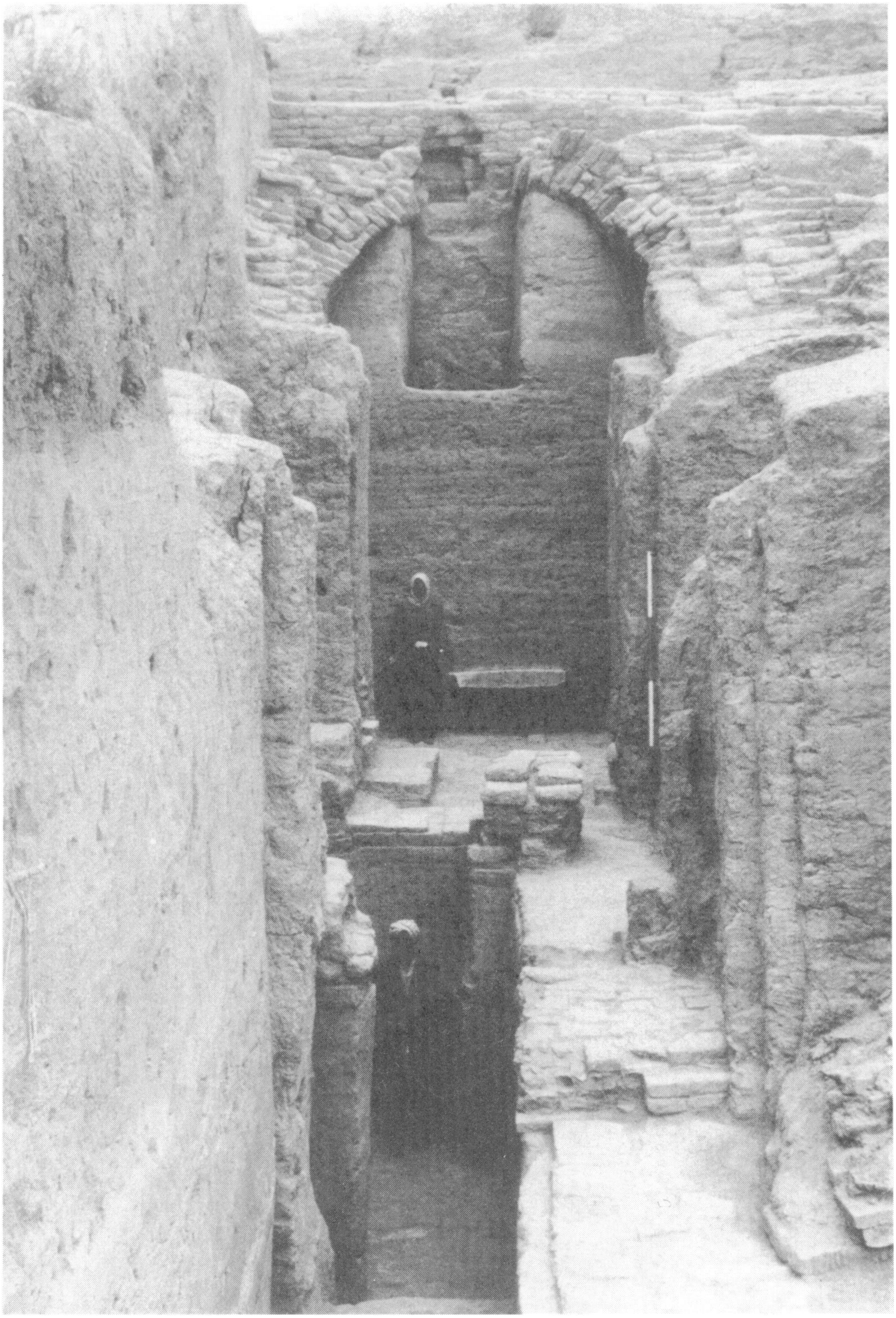

Plate 3 The sixteenth-century shrine and ante-chamber from the east, Great Temple, Tell al Rimah; the original floor level of the columned building can be seen some 3 metres below the sixteenth-century floor.

Plate 4 One of the towers with moulded semi-column ornament, overlooking a courtyard of the new Akkadian ceremonial complex at Tell Brak (third millennium BC).

Structural techniques

The most startling feature of the construction of the Great Temple, however, was the widespread use of vaulting. The stair that led up to it from the city was carried on three vaults of progressively increasing height (Oates 1968: Pl. XXXI). Within the building, vaults were employed to roof many if not all of the ground floor rooms. In some cases the evidence is lacking, notably in rooms approached through wide doorways; these doorways were almost certainly arched, and we may suspect that the builders preferred to avoid the problems of intersecting arches and vaults by using the traditional Mesopotamian flat ceiling of mud and matting supported on timber in these chambers. We cannot assume, however, that any problem was beyond their capacity, for they displayed considerable virtuosity in the use of vaulting to support the upper flight of stairs within the temple that led to the second storey. Here, spanning a ground floor some 8m long, we found a series of eight transverse vaults of increasing height, each supporting two treads of the mud-brick stair (Fig. 5).

The construction of these vaults requires little comment, for they were all of the familiar pattern with voussoirs laid radially, known in Mesopotamia since well before 3000 BC, though usually in underground structures where the ground rather than the associated wall takes the thrust of the vault (cf. e.g. Besenval 1984: 77ff.). The unusual feature to a modern eye is the high-pitched profile of these vaults (Fig. 6; Room VIII). The first few courses are gradually corbelled inwards, and thereafter the voussoirs are turned at an angle which permits each to be supported by its predecessor and the adhesion of the mud mortar until the gap has narrowed to approximately half its original span. Thus only the

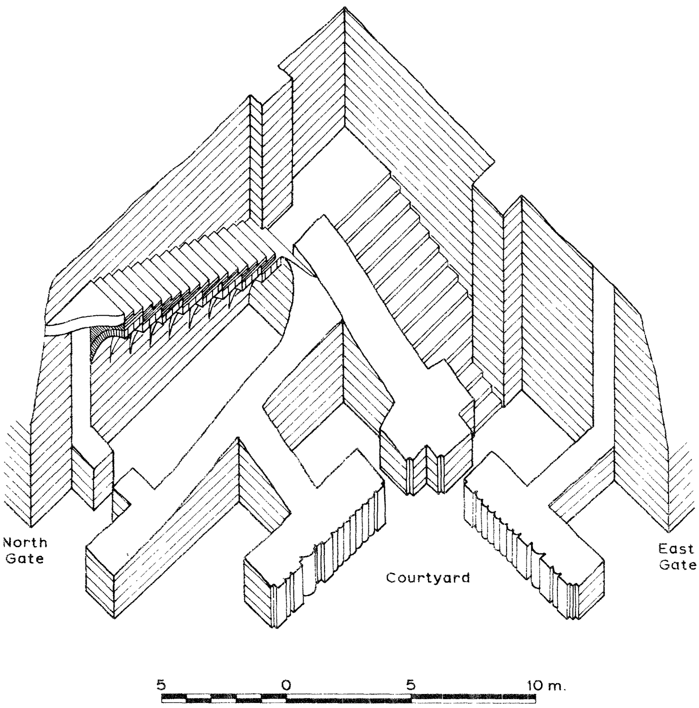

Figure 5 Axonometric reconstruction of the stairs, showing the vaults beneath the second flight.

crown of the vault needs the support of scaffolding. This was obviously intended to economize in the use of timber, but the shortage of timber is a fact of Mesopotamian life that probably dictated the adoption of this method long before we find it all Tell al Rimah. In general the builders of the temple display a familiarity with their techniques and material that can only derive from a long tradition, and chance alone has provided us with the evidence from Tell al Rimah. An example of this, particularly convincing because it occurs in an inconspicuous position, is the head of an internal doorway that still stands to its full height. Doorways of this size in ancient and modern buildings are usually spanned by timber lintels, often of poplar which is readily available in the locality. Here, however, the mason has chosen to build a flat arch, a feature which one would have thought impossible to execute in unsupported mud-brick, but which has survived for almost four thousand years (Pl. 5; Fig. 6: doorway, room II).

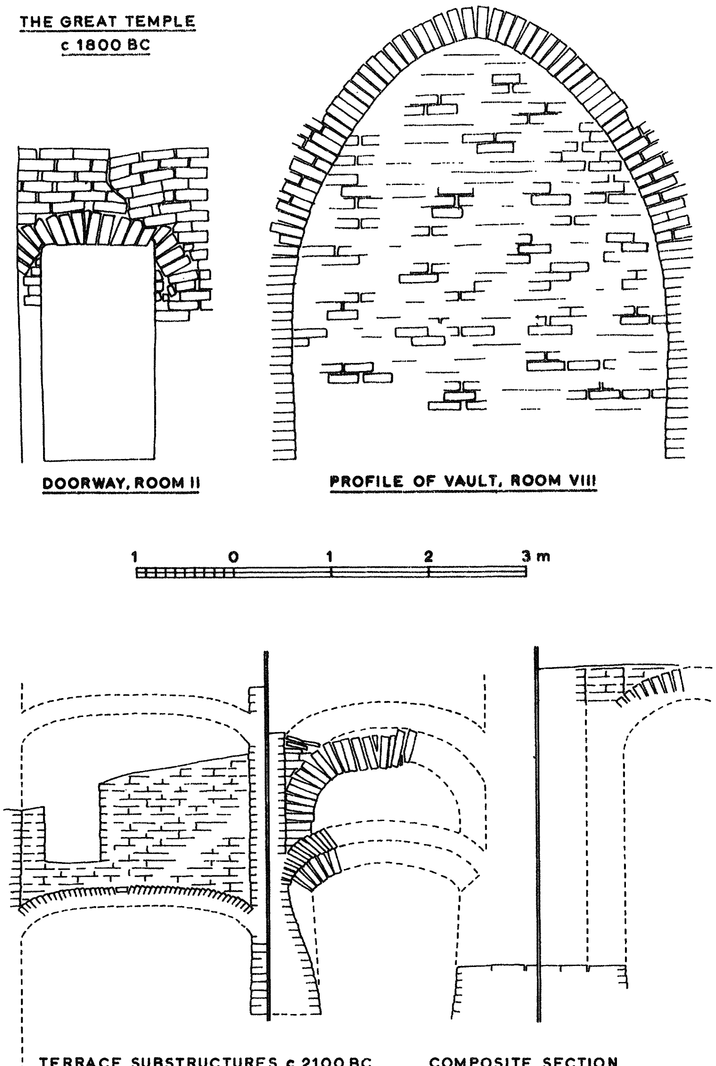

Figure 6 Examples of mud-brick vault and arch construction, Tell al Rimah, late third and early second millennium BC.

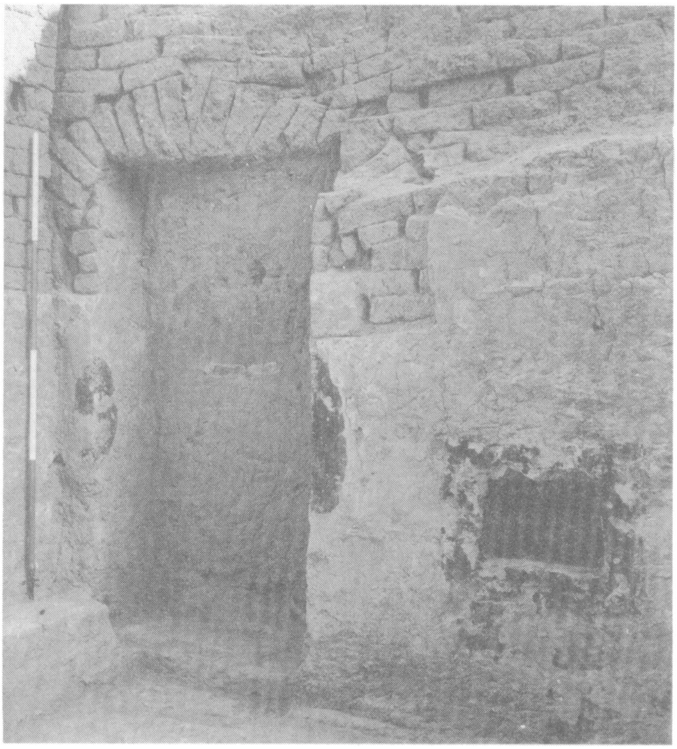

Plate 5 Flat arched doorway, leading from room XXV to room II, Great Temple, Tell al Rimah.

Radial brick vaults were standard throughout the buildings of the original complex. There was, however, another tradition of vault construction used in work that is more likely to have been executed by local masons, and our earliest example of this was found in terrace substructures in the south slope of the mound, dating to sometime around 2100 BC. A composite section through this building is illustrated at the bottom of Figure 6. It was a honeycomb of small vaulted chambers, accessible through low doorways opening off narrow passages and at least three storeys high. The plan (Oates 1970: Pl. VIII) lacked regularity, since the builders obviously laid out the main lines of the supports required at the upper level and filled in the intervening space with a serious of more or less flimsy structures erected by rule of thumb and taking advantage of earlier masonry where it existed. We were immediately reminded of the substructures of the much later Great Palace of the Byzantine Emperors in Istanbul (Talbot Rice 1958: Fig. 14 and Pls. 5–7), where a very similar though much larger system of vaulted chambers was employed to terrace the slope of the site overlooking the Bosphorus in the fifth century AD. The resemblance, moreover, extends beyond the common feature of terracing by a system of vaults to the detail of the distinctive method of vaulting employed.

This is commonly known as 'pitched-brick' vaulting, in which the need for wooden centring is virtually eliminated by laying successive rings of bricks with their edges across the long axis of the vault. The brick-laying starts from both ends simultaneously, and each ring is inclined at a slight angle to rest on its predecessor, which supports it during construction. When the rings meet in the middle, there remains a lozenge-shaped gap in the crown of the vault that is then filled with ring segments of diminishing size and finally

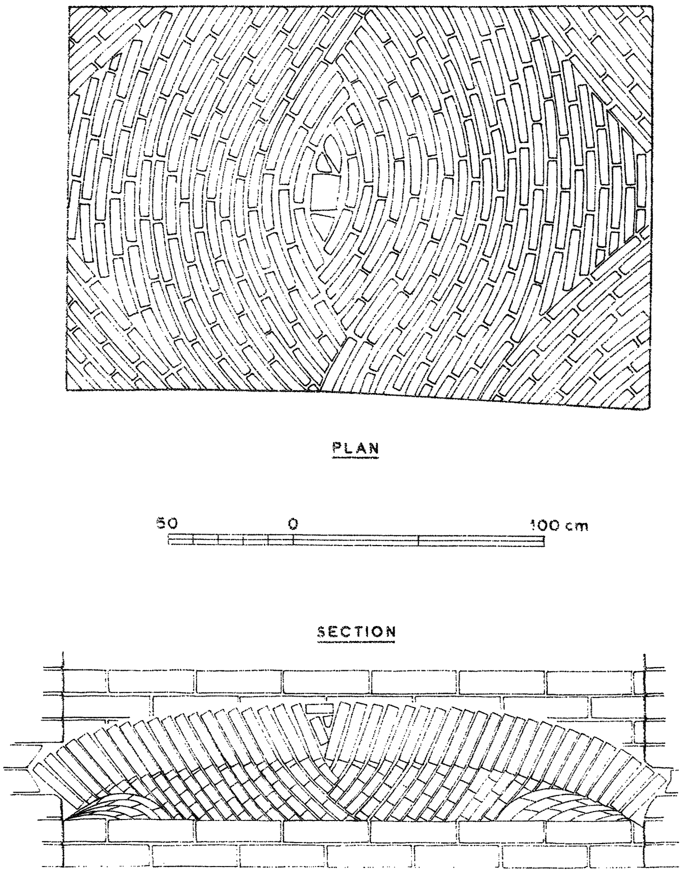

Figure 7 Plan and section of pitched-brick vault on pendentives, Tell al Rimah, late third millennium BC.

plugged with brick fragments. This is the method employed in the Great Palace, but at Tell al Rimah there are significant refinements. Whereas the Byzantine builders began their construction by carrying the end walls of the chamber to a greater height than the side walls and resting incurving triangles of brickwork against them to support the first complete ring, their Mesopotamian predecessors started from the same level on all four walls and built shallow pendentives to carry the ends of the vault. One complete example of this type has survived and is illustrated in plan and section on Figure 7 (see also Pl. 6). In another version which survives only in an incomplete form (Oates 1970: Pl. VIa), the pitched-brick rings were apparently omitted and the pendentives were continued inwards until they met and interlocked. In both types the vaulting bricks are much smaller than those in the walls and arches, and in some cases are keyed with diagonal finger grooves. Most of the vaults in our structure were surprisingly flat in profile, and were presumably not required to carry heavy loads although the spaces between them were certainly accessible and may have been used for storage. But on occasion the builders had to employ a higher curvature to override an arch at one end of a passage and the pendentives then assume the familiar modern profile. It is worthy of remark that the arches used in the walls that presumably outline the load-bearing structure are of the conventional radial type (Fig. 6, section).

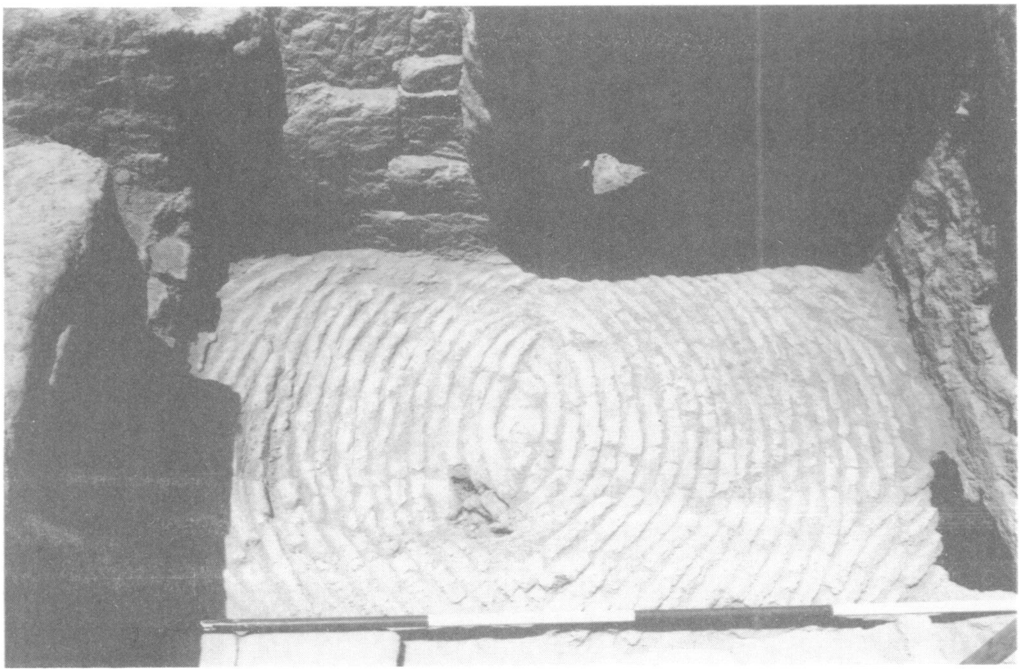

Plate 6 Domical vault, Tell al Rimah, c. 2100 BC.

Historical connections

We cannot place these discoveries in historical perspective, since we have no evidence from the great cities of southern Babylonia where major developments in architecture are likely to have taken place. Recent excavations in the Hamrin area of eastern Iraq have revealed an interesting group of massive circular structures of the early third millennium BC with roof-supporting vaults still *in situ* (Fujii 1981; Gibson 1981). These vaults, however, are of the simple corbelled form (as are, for example, the entrances to the later Third Dynasty tombs at Ur, Strommenger 1964: Pl. 125) and the evidence from the Great Temple at Tell al Rimah remains unique. The latter was, none the less, a derivative building, following in ideal form a plan which had been developed in the cities of Sumer and Bablylonia under the late third-millennium BC Third Dynasty of Ur, and probably designed by southern architects. We may reasonably assume that the radial brick vaults employed in it were a common feature of later third- and early second-millennium construction wherever these architects worked, and that the unique evidence for them at Tell al Rimah is an accident of survival attributable to the fact that the town, when thrown back on its own resources, could not afford to maintain – still less to replace – its principal temple as was the custom in wealthier and more populous centres. It is unlikely that any major architectural innovation would have been tried for the first time in a country town, and the wide variety of uses to which the radial vault was put argues that the builders had a long familiarity with its potential. With this in mind we may even postulate a continuous tradition of vaulting in free-standing structures – there are many examples of its use below ground in tombs – that goes back at least to the earliest known example at Tepe Gawra at the end of the fourth millennium (Speiser 1935: Pl. XXIVa, though even this example is not entirely free-standing, the spring of the vault lying at ground level). Certainly later in the third millennium three techniques of vaulting were in simultaneous use – radial, pitched-brick and corbelling – and it may be that the adoption of radial vaults in monumental architecture should be attributed to the school of architects that arose under the patronage of the kings of the Third Dynasty of Ur and perhaps under their Akkadian predecessors, from about 2350 BC onwards.

The later history of radial vaulting is not well documented (for a recent summary, see Besenval 1984). We know that it was employed in the reconstruction of the Rimah temple, probably in the early sixteenth century, and perhaps a century later in the Mitanni Palace at Tell Brak (Oates 1987: Pls XXXV, XXXVI and Fig. 5) and the store-rooms of the Kassite palace at Aqar Quf (Baqir 1945: Figs 18, 19), though in this last instance the vaults are much lower in pitch. We may assume that the technique was not lost, since many Late Assyrian reliefs of the ninth to seventh centuries BC show the characteristic high-pitched profile on the gate arches of besieged cities. But the vault was not extensively used in the great palaces and temples of this time, in which the main reception rooms were up to ten metres wide and massive timbers, often identified in the texts as cedars of Lebanon, were available to the builders as part of the tribute of the Assyrian Empire. By the sixth century the radial vault had been translated into baked brick, probably in Babylonia where the use of this material as a structural element, rather than a protective surface, seems to have originated; both arch and vault now approximate to the classical semi-circular profile (e.g. the 'Hanging Gardens' at Babylon, Koldewey 1914: Fig. 62).

On the subject of pitched-brick vaulting we are little better informed. (For the Egyptian evidence, see Van Beek 1987.) Again the variety and familiarity with the technique evinced in the terrace substructures at Tell al Rimah argue a considerable period of development but, as we have already pointed out, the pitched-brick vault appears to have been used above ground not in monumental buildings designed by architects but in more flimsy structures that would have been erected by local builders. This is borne out by later evidence from Tell al Rimah (Oates 1970: 21), where pitched-brick vaults are found from the seventeenth to the fourteenth centuries BC, always in contexts that suggest the obvious and easy method of roofing a small room (e.g. Oates 1965: Pl. XX). It is especially revealing when, in the fifteenth century, it was found necessary to replace the radial vault in one of the rooms of the Great Temple, now sadly diminished in size and importance, a pitched-brick vault was inserted at a lower level (Oates 1966: Pl. XIXa). The only technical change that took place during the second millennium was, as far as we know, a simplification; the use of pendentives was abandoned in favour of the simple vault in which the rings of brick-work rested against the end walls. It would not be safe to assume that the earlier expertise had been lost. Very few of the relatively unimportant buildings that might have been roofed in this way would survive to the height from which the vault sprang, and the residential areas of Mesopotamian sites on which they could occur have been largely neglected by excavators concerned to justify their expenditure by more spectacular discoveries. We certainly cannot claim that the Mesopotamian invention of the pendentive in the third millennium BC influenced its use as the standard method of supporting a dome in later Roman and Byzantine architecture. On the other hand the simple version of the pitched-brick vault, for which there is no evidence in Mesopotamian buildings of the Late Assyrian and Neo-Babylonian periods, clearly survived as a domestic building technique that was later translated into baked brick and employed in monumental architecture. Ward Perkins (1958) has shown that its use in Constantinople in the fifth century AD derived from earlier Near Eastern prototypes, and the classic Mesopotamian example is the Arch of Ctesiphon, the principal reception hall in the winter palace of the Sassanid kings, built in the sixth century AD and still the largest single span of unreinforced brick work in the world (height 28.4m, span 25.5m). There can be no doubt of a continuous tradition in the basic technique, and it is doubly interesting that one of the parallels cited from Roman Egypt by Ward Perkins (1958: Fig. 20B) shows a pitched-brick vault in mud-brick, supported on shallow pendentives and virtually identical with the late third millennium example illustrated in Figure 7 from Tell al Rimah.

Obviously we cannot suggest a direct tradition linking these two structures, so far apart in time and space. The common factor is the use of sun-dried, moulded mud-brick as a building material which is both cheap enough to replace timber for roofing, especially in arid regions, and far more flexible in the shapes that can be achieved. It lacks the structural strength of mortared rubble or concrete, but its durability is remarkable. Both its characteristics and its place in the history of architecture deserve more study than they have yet received.

25.vii.89 *Cambridge*

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Abstract

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Innovations in mud-brick: decorative and structural techniques in ancient Mesopotamia

Mud-brick is one of the most adaptable and versatile of building materials. Its early use in the Near East is discussed, with particular reference to its employment in elaborate façade decoration, for example in the spiral and palm-trunk semi-columns of the Great Temple at Tell al Rimah (c. 1800 BC) and in various types of vault. Evidence is discussed for the contemporary use of three techniques of sun-dried mud-brick vaulting – radial, pitched-brick and corbelled – at least as early as the second half of the third millennium BC.