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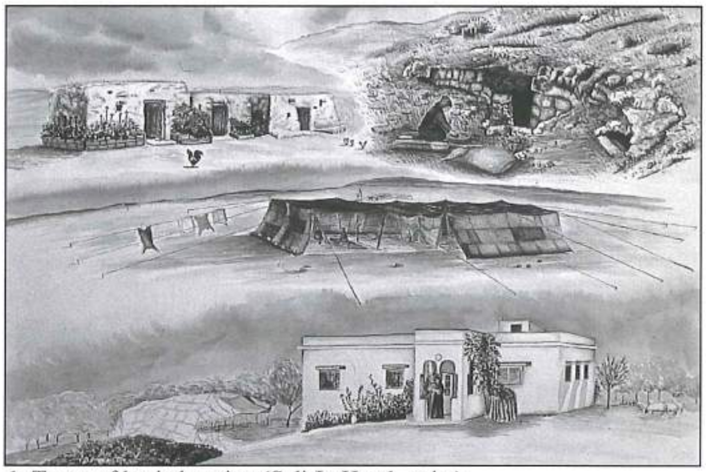
Laboring to Build a House: The Human Investment in Iron Age Construction in the Mādabā Plains

While archaeologists have studied the architectural remains of domestic buildings in the ancient Near East for decades, they seldom explore the human expense involved in the construction process. From the pre-historical periods of the stone ages we know of houses and villages constructed of mudbrick, wood or stone at least back to the sixth and seventh millennia BC. Jericho is a good example, as are Jarmo in Mesopotamia (Forbes 1967a: 22), Bayḍa in Petra, settlements in Anatolia (Hodges 1970: 39) and Merimde in the western Nile delta (Bradford: 304). What can we discover of the building process itself? And what might this tell us not only about building in Iron Age Jordan, but about construction across the millennia from Pre-pottery Neolithic to modern times.

With this paper I wish to investigate human building investment in terms of the time and energy expended constructing four-room houses during the early Iron I period. The recently excavated pillared house at Tall al-'Umayrī immediately north of the Mādabā Plains will provide the primary example and test case. Textual, archaeological, architectural, ethnographic and historical analyses, along with physiological considerations, will contribute to this examination into what it meant for ancient laborers to bring a house to completion and to maintain it.


1. Types of basic housing (Sali Jo Hand, artist).

Building in Antiquity

Next to food procurement, transport, use and disposal, the quest for living quarters protected against intrusions by natural and human agents certainly occupied a major portion of the attention of the ancients who inhabited the ancient Near East across the millennia (FIG. 1). At the outset of this investigation, it might prove helpful to explore two general notes which will inform our work: 1) the connection between agriculture and building activity and 2) basic considerations regarding human investments in household construction.

1) Archaeology in Palestine and Jordan has shed a good deal of light on agricultural connections to housing. First, the original impetus for early house construction was certainly tied to agricultural pursuits. "Generally, house-construction started with the beginning of agriculture; during the hunting and gathering stage of human history, people sought shelter in caves or under cliffs" (Khammash 1986 [citing A. E. Knauf]: 9). Natural rock enclosures, fabric tents and open windbreaks likely constituted most housing prior to buildings of wood, stone or clay, since food-procurement strategies based on hunting and gathering and even the herding of sheep and goats do not demand permanent housing in the same way settled farming does. All of this points to comparatively minimal human investment prior to the agricultural revolution in the ancient Near East. Second, major cycles of intensification and abatement in settlement patterns throughout the history of Jordan and Palestine (LaBianca 1990) remind us that human building activity never remained stable or static. Periods of abatement brought more relaxed commitments of time and energy to house and city construction. However, during times of intense occupation and increased urbanization, examples of which include the Iron Age, construction expanded and took on greater complexity than in periods of abatement.

2) Considerations surrounding building construction itself are complicated and extensive. These include several phases of activity: planning and fund-raising; provision for or reconnoitering of labor; locating, collecting, transporting and preparing materials; preparation of site; purchase or manufacture of appropriate tools; lifting, leveling and adhering building materials into place; finishing surfaces for pragmatic and aesthetic purposes; maintaining, reusing and renovating when necessary; and enduring heat, humidity, long hours, physical debilitations, pests and varying degrees of difficulty and danger in the process.

Considerations also include a variety of building types: homes (urban and rural), expanded family dwellings with courtyards, villages, cities (with buildings like monumental temples, palaces, and public structures as well as plazas, streets and markets), fortified towers and cities (some with defensive moats, ramparts, protective walls and gates). In addition, there are many and varied components of building construction (which also demand repair): rooms formed by walls of brick, stone and plaster, floors of dirt and stone, ceilings and roofs of wood and mud, and stone and wooden furnishings. We will want to keep all of these in mind as we delve specifically into the construction of Iron I domestic housing.

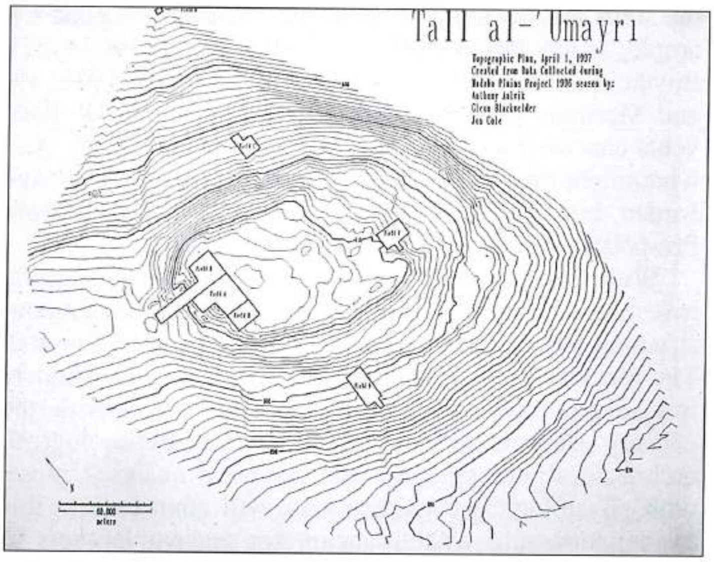
Stone House Construction During Iron I in Palestine and Jordan

Although we do not have any direct textual descriptions of the building activities or construction design of houses from the Iron I period, archaeological research has focused a good deal of attention on so-called "four-room" houses and small agrarian villages from this period. Their connections with early tribal entities we currently call Ammon, Moab, Israel, etc., have occupied archaeologists and biblical scholars with some intensity of late and will likely continue to do so for some time. A growing consensus today suggests that these tribal entities initially settled in small agricultural villages in the hill country of Palestine and Jordan, often building "four-room" houses and constructing terraces, cisterns and wine and olive presses.

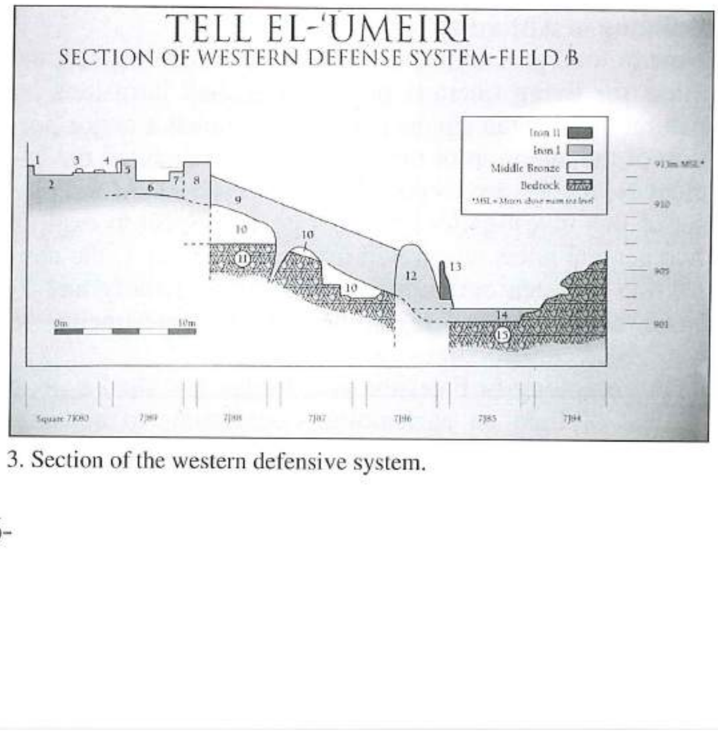
We might hope that the biblical book of Judges could prove helpful to us, given its accounts of Iron I tribal leaders and activities. Unfortunately, while it mentions "house" (*bayt*) nearly 70 times, 39 of which occurrences refer to domestic buildings or homes, it offers precious little about what these houses must have looked like and what it would have taken to construct one or a small village of them. Normally, the texts simply mention a house or houses in passing. We do read of doors on two occasions, a threshold and a household shrine. Otherwise, we are totally dependent on archaeological and anthropological resources for answers to our questions about human labor.

The Iron I four-room houses discovered by archaeologists throughout the hill country of Palestine and Jordan typically measured 10-12 m long and 8-10 m wide. The broad room, extending across the back end of the building, may have been 2 m wide and opened into an area containing three long rooms, each separated from the others by a wall or a row of pillars or posts which also supported the ceiling or roof. The two side rooms normally housed animals, leaving the central long room to serve as a courtyard for domestic activities surrounding food preparation and consumption.

This pattern is clear in likely one of the earliest and best-preserved examples of this type of house, excavated in Field B at Tall al-'Umayrī, south of 'Ammān, Jordan (perhaps the Abel-Keramim of *Jud* 11:33) (FIG. 2). The Late Bronze/Iron I city was extremely well defended with a moat, rampart and double (proto-casemate?) wall construction (FIG. 3). Interestingly, the builders utilized the broad rooms of the two adjacent buildings exposed to this point in excavation (Buildings A and B) as an integrated



2. Topographic map of al-'Umayrī.

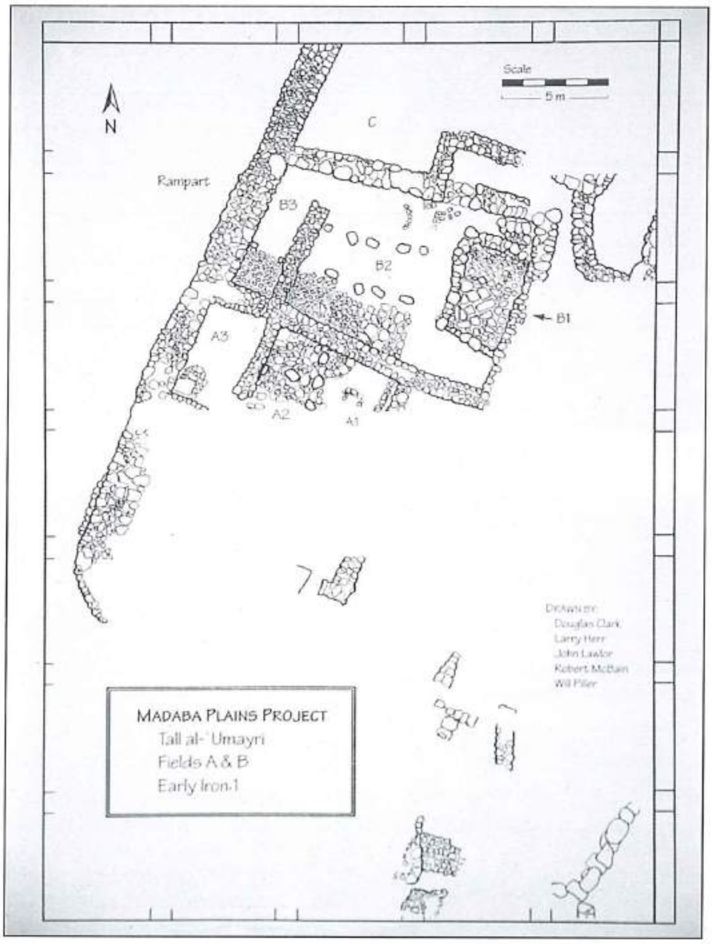


3. Section of the western defensive system.

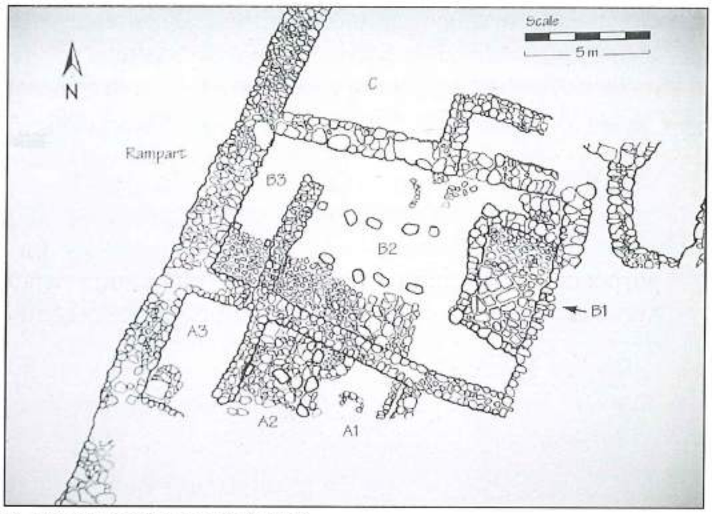
part of the double-wall defenses (FIG. 4). They thus served for storage of the householders' grain and to enhance protection of the city (FIG. 5). An animal pen extended the length of one house by 3-4 m off the long rooms.

Of the two al-'Umayrī buildings, one has been completely excavated and suggests a one-story construction for much of its extent and two stories over at least the broad room, thereby raising the height of the city wall (FIG. 6). Building (and repair) demands from the ground up would include 1) flooring, 2) exterior walls, 3) interior walls and dividers, 4) ceiling/roof and 5) the upper story with its own roof. The articles on Palestinian house construction by T. Canaan from the 1930s and Larry Stager on the family have been particularly instructive in what follows.

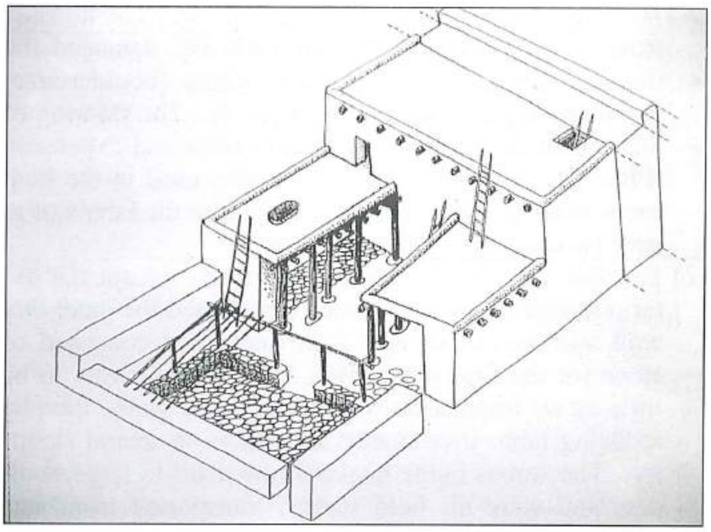
1) Both beaten-earth and flagstone floors are present in



4. Topographic map of Fields A and B.



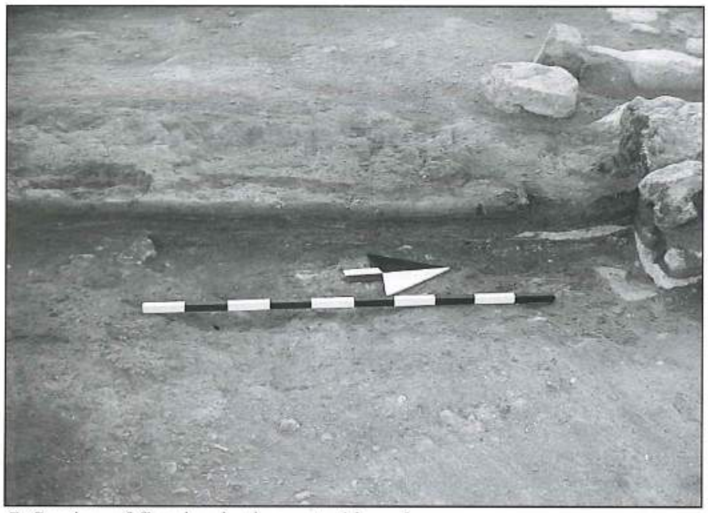
5. Topographic map of Field B.



6. Artist's rendition of Field B pillared building (Rhonda Root).

the al-'Umayrī four-room house. Although not appearing to demand much by way of human labor, the dirt floors often reveal more attention to composition and installment than one might expect.[1] The fine layers of flooring, some laid contemporaneously and others accumulated over time, show ash and enough clay content to keep the surface smooth and basically level (FIG. 7). Of course, the sections of stone flooring require greater investment in the installation process. One third of the broad room was paved by flat large cobbles and small boulders, as was one of the side long rooms (FIG. 8). This task was back-bending work and demanded time and effort to locate and collect the flat

[1] Iron Age floor construction at Beersheba illustrates to what degree laborers improved on the process over time. Upon a bed consisting of "debris, gravel and pebbles, broken bricks, etc." (Itzhaki and Shinar 1973: 19), those laying the floor deposited an underlayer measuring up to 1 m in depth, made up of "alternating and interfingering layers and lenses of brown loess (containing the remains of ash and charcoal), which alternate with a grey mixture of silty soil and ashes" (19). The surface (.05-.10 m thick) consisted of "thin laminated layers of loess, cobble stones, plaster sheaths, or a firm grey mixture of silt and ashes" (19). The ashes were taken from wood burned especially for this purpose.

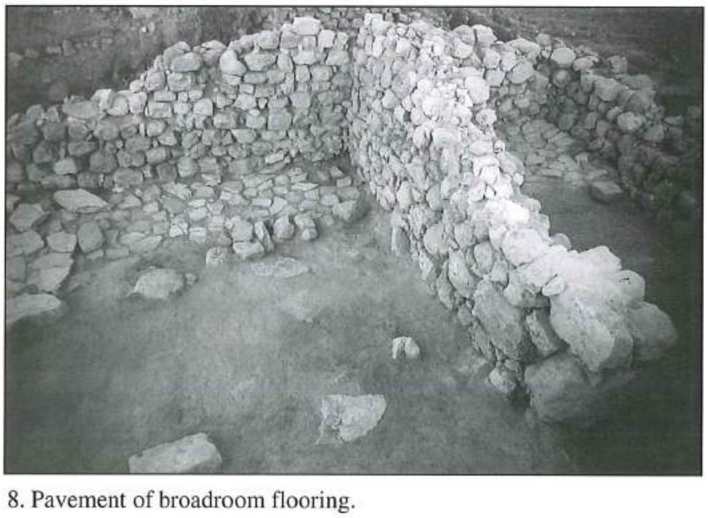


7. Section of flooring in the central broadroom.

stones. An earthquake around 1200 BC damaged the floors, necessitating repairs with larger (boulder-size) and more angular flag stones (FIG. 9). The flooring of the animal pen also showed renovation and expansion (FIG. 10). Most of the repair stones used in the long room and the animal pen would require the labors of at least two men to transport and lay.

2) Exterior walls were around 1 m thick, except the exterior broad-room wall, which constituted the outer city wall and measured over 2 m thick, and consisted of stone for the first story (FIG. 11). There appears to be little or no foundation to most of these walls, thereby reducing labor investments as well as structural stability. The stones range in size from small to large boulders and were all field stones, transported from surrounding slopes or robbed out of nearby buildings from earlier periods. These would be chinked with cobbles to stabilize the wall.

Calculations based on 85% volume of the space the walls occupy, given the specific gravity of typical lime-

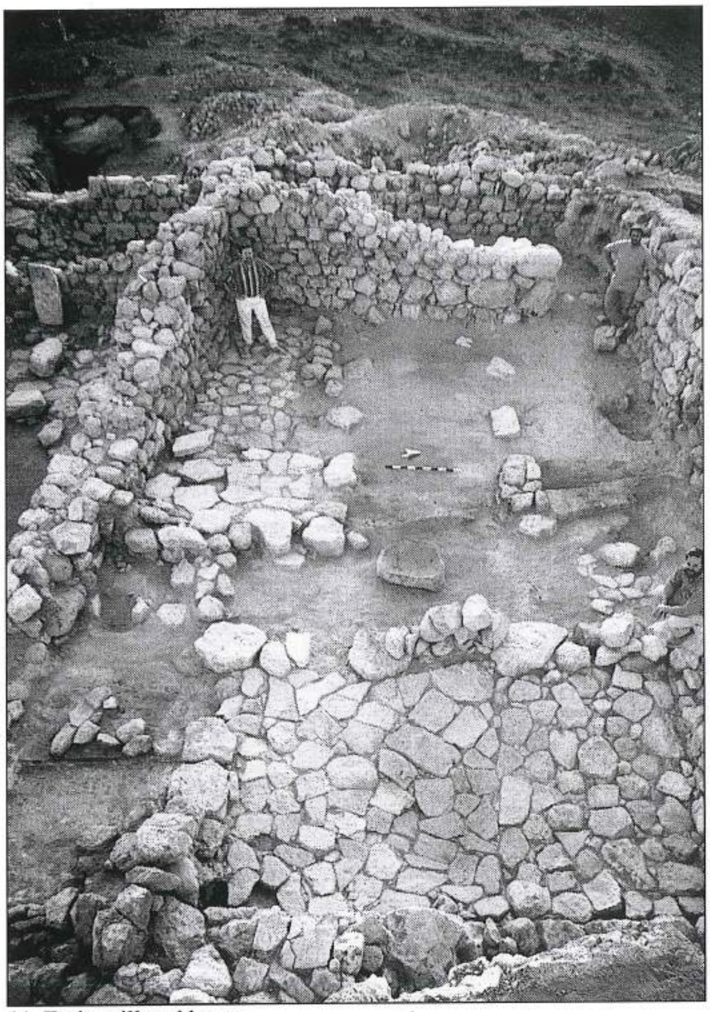


8. Pavement of broadroom flooring.

9. Pavement repairs.

10. Eastern animal pen floor.

stone wall stones used in central Jordanian construction, suggest a cumulative weight of the outer wall stones of 250.69 tons (TABLE 1). These figures speak profoundly of the huge mass of stone being moved and put in place



11. Entire pillared house.

during this operation.

On the basis of personal communication with Dr Raouf Abujaber, landowner at Tall al-'Umayrī and Jordanian historian, it would require two men, a builder and a porter, one long day to construct an unfinished stone wall of this nature, 1 m wide, 2 m high and 3 m long. One should add another day's labor for two additional men and a donkey if the stone was not already on site. It would thus have taken four men and a donkey, if one accounts for the thickness of the broad-room outer wall at al-'Umayrī, the extension encompassing the added animal pen, and the height from the ground level up, approximately one month of concentrated labor to collect stones for and construct the exterior walls of the first story. The project would certainly take longer, however, if home owners did most of the work themselves since they would need to build during times free from other tasks (like plowing, planting, harvesting) required for subsistence.

At the same time, the evidence suggests a fairly hurried attempt to rebuild the city following the earthquake of 1200. And, given the integration of these buildings into the defenses of the town, the entire population held a stake in this construction at the point on the site most vulnerable to military assault.[2]

Exterior walls were also likely plastered over to prevent erosion from the annual rainfall which can be heavy and intense during the winter and early spring months. This demanded significant amounts of lime plaster and assumes all the labor involved in the manufacture of lime along with its application and maintenance.

The production of lime was, by all counts, a demanding process. If modern practice is any guide, work-

TABLE 1. Wallmass for four-room pillared building at Tall al-'Umayrī.

	width	length	height	volume	mass (w/0.8)	mass (w/0.85)
outer wall	2 m	8.5 m	2 m	34 m3	69100 Kg	73400 Kg
north wall (w)	1 m	7.5 m	2 m	15	30500	32400
north wall (e)	1 m	4.25m	2 m	8.5	17300	18400
south wall	1 m	14 m	2 m	28	56900	60500
divider wall	0.9 m	5 m	2 m	9	18300	19400
east wall	1 m	10 m	2 m	20	40600	43200
animal pen wall	0.4 m	6.2 m	0.6 m	1.5	3000	3200
total				**116**	**235700**	**250500**
outer walls	227900Kg X 2.2		= 501380 lbs	= 250.69 tons (non-metric)		
total walls	250500 Kg X 2.2		= 551100 lbs	= 275.55 tons (non-metric)		

2 Fortifying a site with a beaten-earth rampart and casemate wall system, to take an example from the varying defense systems apparent in this period, represents another major undertaking. It involves the location and collection of appropriate kinds of earth, clay, crushed nari chunks and charcoal pieces for the rampart, the preparation and mixing of these elements, the deposition of lensing layers which interlocked for better bonding, and the never ending task of maintaining the steeply sloping rampart against annual, seasonal erosion. Also encompassed is the daunting task of constructing a wall system. Locating and either quarrying or collecting, then transporting, large boulders is demanding, back-breaking labor, however many pack animals might be utilized. Digging foundation trenches for and laying the courses of the outer wall (2-4 m or more in thickness and perhaps two to three stories high) and the inner and cross walls engages architects, masons and laborers for months. Wall towers, the gate system and construction of a citadel added to the complexity of the task and the length of time it took to complete it.

ers dug lime kilns deep into the ground with a circular design, then lined them with stones and built them so they extended above ground in a roughly vaulted dome (FIG. 12). Their depth was typically greater than their diameter and ventilation was achieved through a vent on the windward side. Wood or thistles and weeds, gathered over several days and placed in direct contact with the stone, fueled the fire which normally burned steady for three to six days.

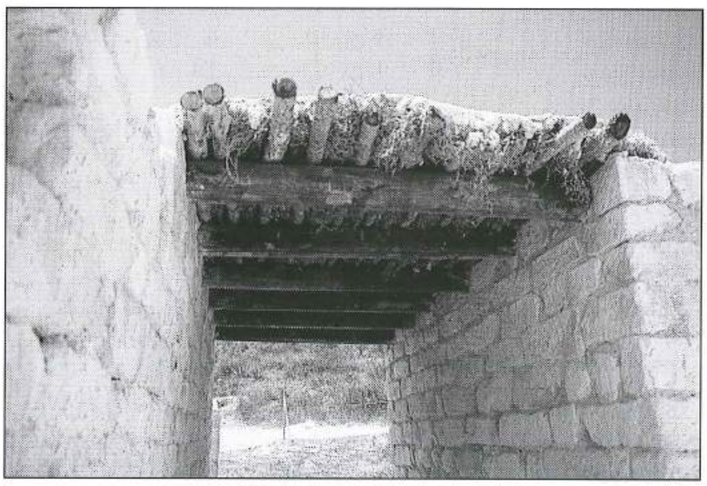
In the process of manufacture, limestone is heated to ca. 900°C, causing its decomposition into quicklime. The lime is then hydrated and mixed with temper such as sand to form an adhesive paste which, when molded and allowed to air-dry, hardens and maintains its shape (Christopherson 1991: 343). To accomplish this process, the ancients paid dearly:

> Although the technology involved in the production of lime plasters is relatively simple, the expense in raw materials and manpower is great. In order to produce 1.00 ton of lime plaster, 1.50 to 2.00 tons of limestone and 2.00 tons of wood are necessary (William Kingery 1988, personal communication). Add to this the manpower involved in building the kiln, collecting the tons of limestone and fuel, firing of the kiln, removing the burned lime, mixing the lime with water and temper, and finally using the plaster in construction. It is obvious that the lime plaster industry was a very labor/energy intensive operation and its product would have been expensive. In fact, the amount of labor involved makes it likely that lime plaster was in some respects a luxury item, especially during the earliest periods of its use (Christopherson 1991: 344).

While Iron Age builders usually utilized wood for kilns in the Mādabā Plains region (common oak was likely the dominant tree at the time [Younker 1989]), one example from Palestine illustrates use of a locally abundant shrub (*Sarcopoterium spinosum*, thorny burnett). It burns hot and rapidly, but it takes from 5000 to 7000 bundles in order to produce two tons of quicklime (Christopherson 1991: 345).

3) The interior stone walls would demand the same kind of labor, although some interior walls were not as thick as exterior ones and some apparently did not reach the ceiling, nor would they require the same degree of maintenance. This is true at al-'Umayrī of the animal pen walls, which stood less than 1 m high and were built rather sloppily. It is also true of the divider walls between the three long rooms. These were comprised of five wooden posts each, resting on stone post-bases set into the floor. Sometimes mangers separated animal from human areas, but, if they existed at al-'Umayrī, they must have been wooden because nothing remains of them following the massive fire which destroyed the town in ca. 1150. In any case, the ancient builders needed to locate, fell, transport, trim to size and install the posts.
4) Large amounts of wood were also required for the beams spanning between walls and posts, for rafters between beams, and for additional ceiling/roof support, as the reconstruction at Tall Marisha demonstrates (FIG. 13). Atop the wood, workers laid smaller brush and then thick layers of mud, clay or plaster. Because of potential erosion due to heavy annual rains, maintenance and repair of roofs were particularly important. Normally, house holders utilized large stone rollers (approximately 1 m long and perhaps 0.3 m in diameter) to flatten and resolidify roofs following rainstorms.
5) The second story of the four-room house at al-'Umayrī consisted of walls built entirely of large mudbricks (FIG. 14). These contained temper of straw and sand. They demanded the same time and energy as bricks

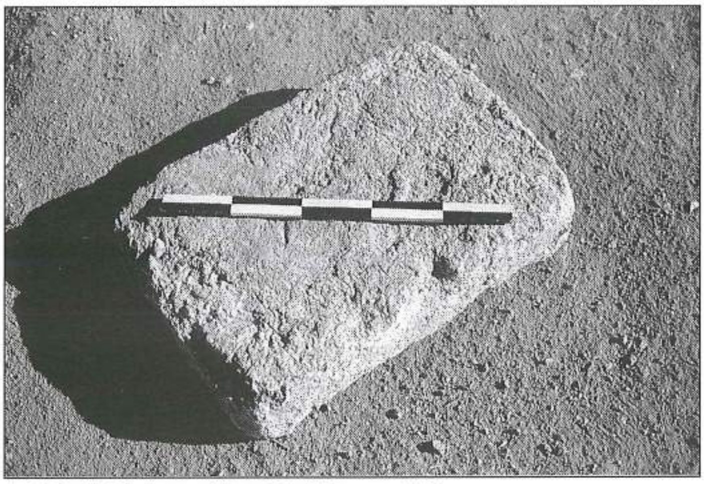
12. Local lime kiln.



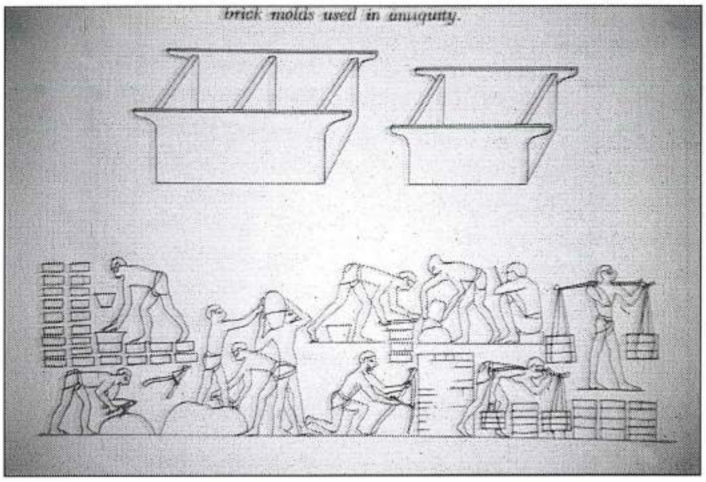
13. Wooden ceiling at Tall Marisha.

made in Mesopotamia or Egypt (FIG. 15), although sources of clay were not as plentiful locally as along the Nile and Euphrates or Tigris Rivers. Measuring approximately 0.5 m long, 0.4 m wide and 0.15 m thick, these were laid with mortar and evidently plastered over to form smoothly finished surfaces (FIG. 16). Thus, the labor-intensive processes involved in the production of quicklime (for mortar) and slaked lime (for plaster) added to the heavy work loads of those involved in this aspect of the construction of domestic buildings.

Mesopotamian brick-making with sun-baked mudbricks, while time- and labor-intensive, demanded little native talent or skill. Likely every villager was engaged in the practice at one time or another (Moorey 1994: 305). The process involved three major operations: digging out and collecting the raw material, mixing the mud with straw or dung and molding the bricks. Firing, of course, would be added to the job description of laborers in the case of kiln-baked bricks. "The preferred brick manufacturing month was the 'third' (May-June), immediately



14. Mudbrick from pillared building at al-'Umayrī.



15. Brick making according to Egyptian tomb relief.

after the spring rains, when water would be plentiful and the whole summer lay ahead, if necessary, for drying. Chaff or straw was easily available at this time" (Moorey 1994: 304). On the basis of recent calculations by Oates,[3] 100 bricks would require about 60 kg of straw or the amount harvested from one eighth of a hectare of barley. Thus, in addition to collecting available clay, huge amounts of straw were also needed.

The temper and clay are then thoroughly mixed in large puddling basins, from which the combined materials are taken and "shaped, usually two at a time, in a rectangular wooden mould with no top or bottom; and were afterwards left to dry, being turned over from time to time" (Derry and Williams 1961: 158).[4]

Laborers on the four-room house also raised another roof of similar construction to the one mentioned above for the second story, with concomitant demands on labor and material. As well, people accessing the upper story appear to have constructed and utilized a stone platform supporting a wooden ladder.

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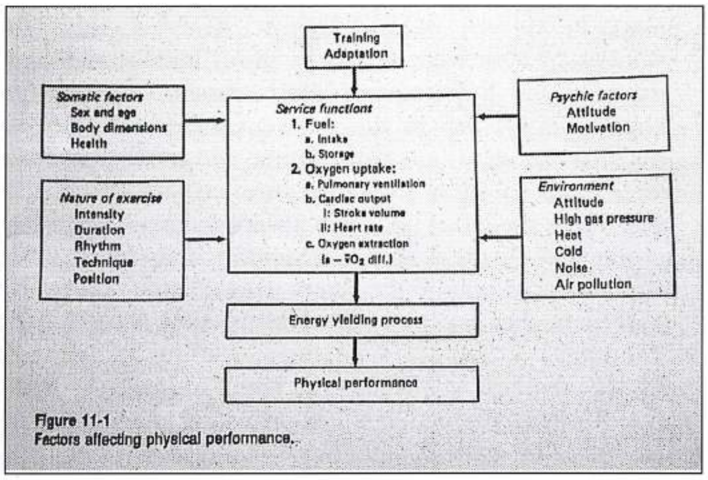
[3] See Oates, D. Innovations in Mud-Brick: Decorative and Structural Techniques in Ancient Mesopotamia. *World Archaeology* 21: 388-406 as cited in Moorey 1994: 305.

[4] Brick-making in Egypt is well illustrated on tomb reliefs and ethnographically. The process was extensive, extremely exhausting and seemingly eternal. It included the following stages: locating, collecting and preparing materials (water, clay and temper-straw was steeped for several days in order to distribute the cellulose uniformly throughout the mud [Goyon: 153]), mixing the materials thoroughly, shaping the bricks in molds and drying them for a week or so, turning them midway through. Of course they then had to be transported to the construction site. All of this activity took place in the Nile delta where heat; humidity; endless hours of backbreaking, repetitive labor; and insect-borne diseases and other health hazards added to the affliction of conscripted laborers. A modern description of brick-making captures the process well:

The brick maker, called *ṭawwāb* in Arabic, searches for a deposit of Nile mud of a suitable consistency for his purpose, and clears as large and flat a space as possible. His assistants dig up the mud and put it into a smallish hole in the ground (*ma'gana or makhmara*), where water is added to it until it has the consistency of a very thick paste. The mixing is done with the aid of a cultivator's hoe (*fās* or *ṭūria*), the feet assisting in the operation. If chaff (*tibn*) is available, it is mixed in varying quantities with the mud paste; if there is no *tibn* the bricks are made without it, but sand is often added with good effect. Having thoroughly mixed up the paste, an assistant takes a round or oval mat (*bursh*) made of strips of palm leaf (*khawṣ*), having handles on either side, and, having dusted it over with fine mud to prevent sticking, he puts as much of the paste on it as he can carry and leaves it beside the brick maker. The brick maker squats down, holding an oblong wooden mould fitted with a handle—of which examples are known in the XIIth and the XVIIIth dynasties—the mould being of the size of the bricks he wishes to "strike" (*ḍarab*). Having filled the mould with the mud paste, the brick maker scrapes off the surplus and lifts off the mould, leaving a sticky mud brick, just sufficiently hard to retain its form. He continues "striking" a series of such bricks, one alongside the other, until all his available space is filled. The bricks must then be left to dry until they are hard enough to be stacked and a new series made. In ancient Egypt the method was identical with that used to-day, the only difference being that in the old scenes the mud is carried in a pot instead of on a mat (Clarke and Englebach 1990: 208-209).

16. Brick with plaster and mortar.



17. Physiology chart.

The Physiology of Human Labor

Assessing the physiological investment of human energy in a task like building a house of stone, wood, plaster and clay requires the expertise of a variety of people in a wide range of disciplines. I lay no claims here beyond mere acquaintance with areas worth investigation if we are to study and understand this important aspect of human endeavor which occupied the time and attention of ancient tribal groups in the hill country of Jordan and Palestine during Iron I. However, a few notes to supplement what the archaeological data have suggested to this point might prove useful, if not in providing answers to our questions, at least in proposing avenues for further research.

The chart on training adaptation, drawn from one of the standard textbooks in the field on work physiology, that by Åstrand and Rodahl (1986: 489), demonstrates the range of considerations one must keep in mind (FIG. 17). Factors involving the body and the nature of the exercise (on the left), the mind and the environment (on the right), and the functions of fuel and oxygen utilization (center) all contribute to an assessment of energy invested and performance realized.

With the aid of these lines of research into the physiology of human labor, we should be able to calculate more precisely the time and human effort invested in the construction of houses, the nutritional drain and oxygen uptake of builders, and, from these, say something about dietary needs and aerobic demands. Current measuring technologies allow us to evaluate all kinds of chemical changes during work, heart rate, loads on single muscles or groups of muscles, hormonal responses to stresses, emotional engagement. Energy output estimates derive from monitoring heart rate, time-activity measurements of all types of activities, and assessments of food intake necessary to maintain body weight.

Beyond the basic energy needs for basal metabolism, eating and the necessary expenditures of energy, the body, by the estimates of some physiologists, needs around 2000 kilocalories per day to support hard labor like construction. The expenditure, however, will vary depending on all the factors noted above—internal and environmental.

Hopefully, by comparing these data with what we know archaeologically (the results of human labor and the evidences for the dietary makeup of the Iron Age hill-country populations of Palestine and Jordan), we may be in a position to explain further human endeavors in antiquity, especially those involving investments in the construction of buildings. Clearly, further study awaits our attention.

Conclusion

The construction of stone four-room houses in the Iron I period was a labor-intensive endeavor, involving a variety of tasks. Earth, stone, wood, lime and clay all demanded significant effort and time in their collection, preparation/production, transportation and application to house building. This was especially demanding for villagers whose subsistence-level income forced them to do most of the work themselves in addition to the tasks they performed simply to stay alive and feed their families. For the most part, building construction was difficult, dangerous and demanding for the ancients. Theirs was a hard lot and only remnants of their work remain. At the same time, this human investment was not only essential for their survival, but exemplary in demonstrating the persistence and perseverance, the ingenuity and innovation, the strength and stamina of our forebearers in this region.

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