The Documentation of Stonework in the Ancient World

John Gelder
University of South Australia

Introduction

Stone has been used as a construction material since humanity first started to build. Its properties have not changed – granite quarried today is the same material as granite quarried in the ancient world. Indeed some ancient quarries are still in use, such as the marble quarries of the Apuan Alps in Italy, and the Greek rosso antico quarries [1]. On the other hand, the way stonework is designed and documented has changed somewhat over the centuries, an example being the development of stereotomy from the 13th century [2]. But there are some continuities, such as the preparation of full-scale drawings of stonework. This has been the norm since antiquity, from drawings inscribed on unfinished in situ stonework for the Greek temple of Apollo at Didyma (below), to those inscribed on medieval tracing floors (as at York Minster and Wells Cathedral), [3] to rolls of full-scale details provided for a stonework elevation in London in the 1980s, [4] to contemporary 1:1 BIM documentation.

Most of the extant construction documents from ancient Egypt, Greece and Rome concern stonework for monumental buildings. The documents include written descriptions (notably the Greek syggraphai), full-scale in situ drawings, and small-scale stone models. On a given project, all three will have been read together, but unfortunately, we do not have a 'set' of this kind. This paper outlines the nature of this documentation using some examples – it is not comprehensive.

Pharaonic to Greco-Roman Egypt

Construction stone was readily available in ancient Egypt. Harrell & Storemyr list 39 miscellaneous hardstone quarries (basalt, granite, diorite, porphyry etc), nine travertine quarries, 99 limestone quarries, and 38 sandstone quarries in Egypt, used from the prehistoric to Islamic periods. Hardstone was sourced from quarries mostly in the Red Sea Hills, requiring land transport, but travertines and limestones were extracted along the Lower Nile and sandstone along the Upper Nile, enabling river transport. Preference varied with time. For example, most of the hardstone quarries were used primarily in the Greco-Roman period (with the stone often exported?), whereas travertine usage was mostly Pharaonic [5].

Two written descriptions of stonework from ancient Egypt are in the form of annotations on a drawing and a model. One is below-ground, one is above-ground. From the floor plan on an ostrakon of the Tomb for Ramesses IV, KV 2, Valley of the Kings (1155-1149 BCE) is a description of the stonework that is repeated four times, describing the execution of the relief murals (unfinished in many tombs): '[The room] … being drawn with outlines, graven with the chisel, filled with colours, and completed [6].' From the stone base of a model for the temple gateway at Heliopolis, Seti I (1323-1279 BCE), made after the temple was completed:

> The good god is making foundations for his father, Ra Horakhty. He made in the temple, which is of good quartzite, two pylon towers of white crystalline limestone, doors of bronze, a pair of flagstaffs of msdt stone, a pair of obelisks of bkhn stone established in Iunu, the horizon of heaven. The souls of Iunu exult at seeing them [7].

Many construction drawings of stonework survive from ancient Egypt [8]. Small-scale drawings for below-ground projects include sketches for the tomb of Ramesses IV, KV2 in the Valley of the Kings (Turin Papyrus 1885 recto), and the tomb of Ramesses IX, KV6 (Cairo CG 25184) on an ostrakon, [9] a pillared chapel (London BM 41228), and ceiling patterns (Cairo CG 66260, 66261, 66263, 66265), all on ostraka [10]. For above-ground projects, the oldest drawing is a vault section on an ostrakon (Imhotep Museum, Saqqara, JE 50036) [11]. Otherwise above-ground project drawings all concern columns and include small-scale column sketches (Paris Louvre 3043 & E25334, New York Metropolitan Museum of Art MMA 23.3.34 & 35), on ostraka, and later (perhaps following Greek practice – below) full-scale in situ inscribed drawings of columns, capitals and cornices at the temple of Horus, Edfu, the temple of Isis, Philae, the temple of Mandulis, Kalabsha, and the quarry at Gebel Abu Fodah.

Small-scale models of stone columns and capitals from Egypt were common, with examples held in the Ägyptisches Museum und Papyrussammlung, Staatlichen Museen, Berlin (Saqqara, ÄM 1627 & 1629; Tuna el-Gebel, ÄM 20351 & 20351), the Metropolitan Museum of Art, New York (MMA 12.182.6), the Petrie Museum, London (UC69263, UC33425, UC28720, UC28721), Strasbourg (Philae, 1388), and Cairo (33.395, 33.396, 33.397) for example. Some are ceramic and crude and some are stone and precise. These models range in date from Pharaonic to Roman Egypt and indicate a consistent tradition in Egypt down the timeline. The Greek tradition of full-scale paradeigma (below) does not seem to have been adopted in the Hellenic and Roman periods.

Small-scale stone construction models from Egypt of buildings or parts of buildings were less common (unlike votive models) and include an underground tomb at the pyramid of Hawara, Dahshur [12] and another small tomb (Petrie UC57155). Above ground we have two pyramids from Memphis and Dahshur (Petrie UC16519 & UC14793), the floor of a columned hall at Tod near Luxor (Louvre E 14762), a multi-part model of the contra-temple of Soknopaiou Nesos, Dime es-Seba, Fayyum [13], a water tank (Petrie UC14530), a hydreuma (Petrie UC75646), and altar steps (Cairo 33.401).

Greece

Construction stone was widely available and widely used across Greece, from the red marble used at Minos (Crete) onwards. In the Greek period, construction projects used local stone as much as possible, given difficulties of transport. While the white marbles of Penteleikon (at least 30 quarries active in antiquity) and Hymettos are perhaps best known, and convenient to Athens (an ancient road linking them was found in 2009), white marble was also available on Naxos, Paros and Thasos. Polychromic (grey, green, pink and so on) stones were available, but their use peaked for export in the Roman Imperial period as more exotic materials were sought by architects. However, the most widely used construction stones were the less glamorous limestone – ‘the bread and butter of construction activities through Antiquity’ – and sandstone [14].

At least 40 written Greek construction contracts survive, in whole or in part, in the form of inscribed texts (syggraphai) on stone steles, describing the required work in some detail [15]. They included contractual material (the parties, payments, penalties and so on), quantities, layout, and specifications. Five specified the stone quarries to be used most in Attica (Table 1). These were IG II2 1666 A&B for the Prostoon at Eleusis, IG II2 1685 for the sanctuary of Asclepius at Athens, IG II2 1668 for the naval tackle store at Zeia, IG II2 1665 for tripod plinths at Kynosarges, a suburb of Athens, and IG II2 1680 for the Prostoon at Eleusis. The marble from the Penteleikon quarries was favoured for column capitals, which entailed intricate carving.

One of these, IG II2 1666 A&B, is complete but was never let, being replaced by a series of subsequent contracts. Nevertheless, the inscription is very informative about the prescriptive nature of Greek stone specifications (Table 2). This inscription covered separately the quarrying, rough cutting, storage, transport to site, carving, hoisting and laying of 19 different stone units: kanonides, triglyphs, metopes, cornices, plinths, capitals, thresholds, gable blocks, roof tiles, foundation stones, paving, and stylobates. As Table 2 indicates, common requirements were that stones be sound, white, stainless and unbroken. Workmanship is repeatedly specified in terms of tight, unbroken and flush joints and straight level tops, with the stones generally clamped, dowelled, and lead poured around. The apergon referred to was a temporary protective skin of stone. For some units cutting and carving relied on an anagraphe provided by the architect. Excavation for the foundations was also included. For this project, the city was to provide the lead, iron clamps and hoists. Some quantities and sizes were left unresolved (for larger foundation stones), but generally quantities and sizes were given throughout. The repetitive nature of the inscriptions resulted in some internal conflict, in terms of the quantities given and the work to be done. For example, two capitals are to be quarried but three were to be carved and installed, 42 stylobates are quarried and 44 are carved and installed, two corner stones are transported, carved and installed but not quarried, and four capitals are quarried and transported but not carved or installed. No doubt these errors would have been resolved during execution.

Table 1: Stone types specified in 5 syggraphai

	Location, date BCE	**Penteleikon**	**Hymettos**	**Eleusis**	**Megaris**	**Aktitēs**	**Agryleikon**	**Aegina, Saronic Gulf**
IG II2 1665	Athens, 400-350	Capitals	-	Orthostats, ‘grasping stones’			Found ations	-
IG II2 1666 A&B	Eleusis, 356	Capitals, metopes, cornices, pilasters, gables, roof tiles	-	Stylobates, corners	-	Foundations, euthynteria	-	Kanonides, triglyphs
IG II2 1668	Piraeus, 347-6	Capitals, lintels, pilasters, columns	Pilasters, thresholds	-	-	-	-	-
IG II2 1680	Eleusis, 350-300	Capitals	-	-	-	-	-	-
IG II2 1685	Athens, c.300	Capitals	Columns, pilasters	-	-	-	-	-

This prescriptive approach to stonework quality was the norm. But another syggraphai, IG II2 3073, for a temple at Lebadeia (no later than 220 BCE), specified the stonework for the steles and foundations both prescriptively and in terms of processes – the specific tools and ephemerals to be used. It may have only been describing normal practice, but no other syggraphai did this. The first part of the inscription described the inscription of the syggraphai themselves, and related processes such as cleaning the steles with nitron (also used as flux in glass production, according to Pliny the Elder [16]) and painting and washing out the letters. Other syggraphai mention the preparation of inscriptions (e.g. IG XII, 9 191, for draining a swamp at Ptechai), but rightly left the processes to the contractor. The second part described the processes of levelling and smoothing stonework in detail, specifying chisels of several kinds, and olive oil and the mineral miltos, or red lead, for levelling. Again, other contracts left these matters to the contractor. The specification of processes is deprecated today and was not usual then [17]. This technique may have been used here as skill sets had been lost due to long-running wars in the region, between Rome and Macedonia, and so could not be assumed for the contracting teams as they are in conventional prescriptive specifications.

Stonework did not comprise just stone. A contract for bronze empolia and tenons, IG II2 1675, described them in some detail:

> For the sanctuary at Eleusis, for the column-drums of the columns of the Prostoon, for the joints provide bronze tenons and empolia, two empolia for each joint and, inside, (a) tenon. The lower ones, the first (i.e. the empolia): six dactyl each way, square, then the uppermost five dactyl each way, the remainder changing equally from the biggest to the smallest. The latter, tenons: cylindrical, the lower ones length five daktyl, but thickness two daktyl, the upper ones length on one hand (a) palastai, thickness on the other hand daktyl and half daktyl, the remainder changing, for length and for thickness, equally from the biggest to the smallest. Then work of copper from Marion, mixing twelve parts, eleven of copper, but the twelfth of tin. And deliver the former, empolia, straight and immovable and equal-angled. The latter, tenons, turn with a lathe, cylindrical to match the paradeigma, and fit into the empolia tightly and straight and turned with a lathe each way such that it can be rotated. (author's translation)

Full-scale drawings of stonework were prepared during the construction process and inscribed in situ. Some that survive are plan views of columns – two for the temple of Aphaia at Aegina, [18] and two for the temple of Apollo at Didyma. Others are vertical drawings of columns – a column base, a drawing showing column entasis (vertical scale is 1:16), and a full section, for the temple of Apollo at Didyma. The setout of a volute is inscribed onto a column base at the Prytaneion at Ephesos [19], and the plan of a ceiling panel on the walls at the temple of Apollo at Didyma. The Didyma drawings were inscribed into the apergon which, as the temple was never finished, was never removed as specified for the Prostoon at Eleusis, above.

Table 2: Requirements for the 19 stone units, by frequency, in IG II2 1666 A&B

Dimensions & quantities																			
• Item identification	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
• Length x width x thickness (palaste)	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
• Number	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Quarrying																			
• Quarry	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
• With *apergon* all over	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
• Straight in every direction	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■			
• Square in every direction	■	■	■	■	■	■	■												
• According to the *anagraphe* provided by the architect	■	■	■	■	■	■													
Transport and delivery																			
• Transport from quarry or storage to Eleusis sanctuary	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
• Deliver sound and unbroken	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
• Deliver to storage sound	■	■	■	■	■	■	■	■	■	■	■	■	■	■					
• Deliver to storage white and stainless	■	■	■	■	■	■	■	■	■	■									
Carving																			
• According to the *anagraphe* provided by the architect	■	■	■	■	■														
• Match existing	■	■																	

• Doric or Ionic
• Remove *apergon*
• Straight and square in every direction
• Trim smooth
• Carve the lion heads
• At the corners also dress the sides, along all the walls
Installation
• Fit together with joints tight-fitting in every direction
• Level the tops [straight]
• Clamp and pour lead around
• Hoist
• Lay unbroken
• Dowel
• Fit flush
• Joints 1 palastai wide
• Level each course throughout, lengthwise and crosswise
• Level according to the *periteneian* provided by the architect
• Under the columns, dowel and pour lead around
• Tight-fitting joints [unqualified]
• Remove *apergon* to 3 palastai high where visible
• Erect on foundations
• Erect upon beds in the rock on solid ground
• Trim edges to 2 palastai high
• Smooth at the required height and dress upper surface leaving raised panels
• Lay and bed overlapping 0.5 palastai
• Square in every direction
• Fix *as directed* by the architect
• Hoist at the proper place
• Width of 3 pilasters according to the *measurements* provided by the architect
• Erect on pilasters
• Erect on thresholds
• Use as many as necessary where needed

Just a few construction models survive from ancient Greece. One reason is that, for complex objects such as capitals, full-size paradeigma were prepared and, after being copied, were incorporated into the works. These 'models' are not distinguishable from the copies [20]. Tile standards were prepared at full-scale in stone, but not incorporated into the works. Three are extant, for Messene, Athens and Assos [21]. Small-scale models that might have been used for construction include an Argive roof at the Acropolis, Athens, [22] and triglyphs and metopes for the temple of Aphaia at Aegina [23].

Rome

In the early period, Rome sourced its stone locally, [24] but as the Empire grew, so did the range of quarries used. Stone was imported by sea from Egypt, for example, even at the risk of losing a cargo of 50-foot (14.8 m) columns for the Pantheon in Rome [25]. The online Stone Quarries Database lists 792 quarries across the Empire but notes that 'there must have been hundreds if not thousands of other quarries that have yet to be documented in any way [26]'. Stone types listed include marble, limestone, sandstone, granite, gypsum, travertine, alabaster, schist, basalt, porphyry, volcanic tuff, quartzite, conglomerate and lava.

Only one construction specification survives from Rome. For a porch in an existing wall at Puteoli, 105 BCE, this describes prescriptively a range of materials and work, including stones and stonework, albeit briefly. The relevant extracts are as follows [CIL 12.698 (author's translation)]:

… Make the width p 6, height p 7. From this wall, project two antae towards the sea forwards, length p 2, thickness p 1 ¼. … For the same, make the furthest garden-wall, the existing wall, (and) the (new) wall with coping of height p 10.

For the same, the existing entrance-door entering into the site and the windows which (are) in the wall near that site are (now) wall, (and) must be filled in.

And place upon the existing wall near the road an uninterrupted coping. And all the walls and copings which (are) not (coated) with beach-sand will be rendered with lime (plaster). … No heavier rough quarry stones may be laid than rough quarry stones (of) dry weight p 15, nor make corner stones higher (than) [4.5 unciae]. …

As for Greece, full-scale drawings of stonework were prepared during the construction process. Likewise, most were inscribed into the architectural fabric, in situ. Examples include a drawing of entasis and another of a column profile at the theatre of Aphrodisias in Asia Minor; a pediment elevation, an arc elevation, a plan of the orchestra and cavea, a courtyard plan and an arch elevation at the temple of Jupiter at Baalbek, Lebanon; [27] details of the Pantheon at Rome, inscribed in the paving near the Mausoleum of Augustus; an elevation of an arch and a rosette and other patterns now at Santa Maria di Capua Vetere; elevations of a pediment and entablature at Bziza, Lebanon; elevations of entablature and a column at Pergamon; and elevations of a roof crown and arch and pediment at the temple of Bacchus, Baalbek. We also have a portable inscribed drawing of a volute, from Thysdrus, Tunisia [28].

Stone construction models from around the Roman Empire dealt with whole buildings, and so were small-scale. They include a model of the temple of Luna at Ostia (Museo d'Ostica Antica 189), a thermal bath at Taormina (Akademischen Kunstmuseums der Universität Bonn, B 298), the adyton for Temple A at Niha, Lebanon, [29] the stairs of the Great Altar at Baalbek, Lebanon, [30] the stadium at Villa Adriana, Tivoli (Museo Didattico di Villa Adriana, Tivoli, 4714/A&B), and the open-air theatre at Baalbek [31]. It can be assumed that the Romans followed the Greek practice of built-in full-scale paradeigma for column capitals and the like.

Conclusion

The documentation of stonework for prestige buildings in the ancient world came in the form of written descriptions, drawings and models. All could have been prepared for a project and will have been read together. The initial contractual document was typically a written description, for Greece at least. They will have been prepared on portable but ephemeral materials such as papyrus but, from Greece, copies of the syggraphai inscribed in stone for public display survive (along with many other kinds of inscriptions).

Some of the drawings were small-scale and some were full-size. Small-scale drawings were not to scale, often in the form of sketches, and were drawn on ostraka, which have survived, and on ephemeral materials, which generally have not. Full-size drawings were inscribed in stone on or near the site, during the construction process. Those on site were often inscribed on the walls in a temporary protective layer of stone which was removed in the finished project – those that survive do so only because some projects were unfinished.

Some of the models were small-scale and some were full-size. In the Egyptian tradition, small-scale models of capitals were also often 'sketches', roughly made, often in clay, but some were very precise, to scale, and durable being carved in stone. Sculptors could have enlarged them using callipers or grids without too much difficulty. In the Greek tradition, full-size models of stone capitals and the like were prepared by the architect or master carver, and subsequently copied and then incorporated into the works.

Today stone masonry is one product in thousands used in the construction of a modern building, but the element of prestige remains. Recently it has rarely been used structurally, being largely reserved for non-loadbearing lining, flooring, cladding and benchtops. Fixings are phosphor bronze or stainless steel, rather than brass, iron and lead, and the design and specification of stone and stonework is scientific, referencing international standards such as EN 771-6 and Eurocode 6 [32]. But interestingly, loadbearing stonework might be making a comeback [33].

References

[1] P. Warren, 'The rediscovery of Greek rosso antico marble and its use in Britain in the nineteenth and twentieth centuries', Annual of the British School at Athens 107, 2012; 341-386.
[2] J. Calvo-Lopéz, Stereotomy: Stone construction and geometry in Western Europe 1200-1900, Basel: Birkhäuser, 2020.
[3] A.B. Holton, 'The working space of the medieval master mason: The tracing houses of York Minster and Wells Cathedral', in Proceedings of the Second International Congress on Construction History, Volume II, 2006; 1579-1597.
[4] At 1 St Paul's Churchyard, London. The stone was from Portland, Dorset. The author was the site architect for this project over 1986.
[5] J.A. Harrell & P. Storenyr, 'Ancient Egyptian quarries – an illustrated overview', in N. Abu-Jaber, E.G. Bloxam, P. Degryse & T. Heldal (eds.) QuarryScapes: ancient stone quarry landscapes in the eastern Mediterranean, Geological Survey of Norway, 2009; 7-50.
[6] H. Carter & A.H. Gardiner, 'The tomb of Ramesses IV and the Turin plan of a royal tomb', Journal of Egyptian Archaeology 4, 1917; 134, 136-37.
[7] A. Badawy, A monumental gateway for a temple of King Sety I: An ancient model restored, Miscellanea Wilbouriana 1, New York: Brooklyn Museum, 1972; 15.
[8] Many of the construction drawings listed in this paper are collected in J.P. Heisel, Antike Bauzeichnungen, Darmstadt: Wissenschaftliche Buchgesellschaft, 1993.
[9] For the accuracy of this and other documents for three tombs, see J. Gelder, 'Comparing 'as documented' with 'as constructed' in Ancient Egypt', in J.W.P. Campbell et al (eds.), Building histories: The proceedings of the fourth conference of the Construction History Society, Queen's College Cambridge, 7-9 April 2017, Cambridge: Construction History Society, 2017; 55-66.
[10] W.C. Hayes, Ostraka and name stones from the tomb of Sen-Mūt (No. 71) at Thebes, Publications of the Metropolitan Museum of Art Egyptian Expedition 15, New York: Metropolitan Museum of Art, 1942.
[11] For the set-out and accuracy of this and another vault curve, see J. Gelder, 'Two Egyptian curves revisited', in J.W.P. Campbell et al (eds.), Proceedings of the First Conference of the Construction History Society, Queens' College, Cambridge, April 2014, Cambridge: Construction History Society, 2014; 145-156.
[12] D. Arnold, 'Der Pyramidenbezirk des Königs Amenemhet III in Dahschur: Band 1: Die Pyramide', Archäologische Veröffentlichungen 53, 1987; 86-88, taf 35, 66-68.

[13] P. Davoli, 'The contra-temple of Soknopaios and its architectural model', Egyptian Archaeology 55, 2019; 40-43.
[14] B.J. Russell, ‘Stone quarrying in Greece: ten years of research’, Archaeological Reports 63, 2017; 77-78.
[15] For an analysis of 36 syggraphai see J. Gelder, ‘Professional roles in Greek construction contracts’, in this volume. The article explores the nature and roles of syggraphai, paradeigma, anagraphe, periteneian, measurements and site directions by the architect.
[16] Pliny the Elder, Natural history, Book 36.65; I. Despina et al, ‘Nitrum Chalestricum: The natron of Macedonia’, Annales du 16e Congrès de l'Association Internationale pour l'Histoire du Verre, AIHV, 2008; 64-67.
[17] J. Gelder, ‘Specifying construction processes’, NBS Journal 01, November 2002; 3-4; J. Gelder, ‘Process clarification’, NBS Journal 02, May 2003; 3.
[18] E-L. Schwandner, ‘Zu Entwurf, Zeichnung und Maszsystem des Älteren Aphaiatempels von Aegina’, in J. Frézouls, C. Margueron, G. Siebert & J.M. Spieser (eds.), Le dessin d’architecture dans les sociétés antiques, Actes du Colloque de Strasbourg, 26-28 January 1984, Leiden: EJ Brill, 1985; 277-281; 80-81, Abb 3&4.
[19] M. Steskal, ‘Konstruktionszeichnungen zweier Voluten aus dem Prytaneion in Ephesos’, Jahreshefte des Ŏsterreichischen Archäologischen Institutes in Wien 76, 2007; 374, 378.
[20] J. Gelder, ‘Professional roles in Greek construction contracts’, in this volume.
[21] J.T. Clarke, F.H. Bacon & R. Koldewey, Investigations at Assos, Cambridge MA: Archaeological Institute of America, 1902; 71, fig.2; G.P. Stevens, ‘A tile standard in the Agora of ancient Athens’, Hesperia 19/3, 1949; 174-188, plate 82/1; P. Themelis, ‘Hellenistic architectural terracottas from Messene’, Hesperia Supplements 27, 1994, 141-169, 390-398, plate 48d.
[22] N. Winter, Greek architectural terracottas, Oxford: Oxford University Press, 1993; 155-157, figs 16-17, plates 60-2.
[23] L. Haselberger, ‘Architectural likenesses: models and plans of architecture in classical antiquity’, Journal of Roman Archaeology 10, 1997; 80, fig 16.
[24] M. Jackson & F. Marra, ‘Roman stone masonry: Volcanic foundations of the ancient city’, American Journal of Archaeology 110/3; 403-436.
[25] T.A. Marder & M. Wilson-Jones (eds.), The Pantheon: From antiquity to the present, Cambridge: Cambridge University Press, 2015; 214ff.
[26] B.J. Russell, Gazetteer of stone quarries in the Roman world, Version 1.0, 2013, online at: www.romaneconomy.ox.ac.uk/databases/stone_quarries_database/ (accessed 2 June 2021).
[27] D. Lohmann, ‘Drafting and design: Roman architectural drawings and their meaning for the construction of Heliopolis/Baalbek, Lebanon’, in K-E. Kurrer, W. Lorenz & V. Wetzk (eds.) Proceedings of the third international congress on construction history, BUT, Cottbus, Germany, 20-24 May 2009, volume 2, Berlin: Neunplus 1, 2009; 959-966.
[28] T. Loertscher, ‘Voluta constructa: Zu einem kaiserzeitlichen Volutenkonstruktionsmodell aus Nordafrika’, Antike Kunst 32, 1989; 82-103.
[29] E. Will, ‘La maquette de l’adyton du Temple A de Niha (Beqa)’, in Frézouls et al, Le dessin d’architecture; 277-281; figs 1, 3, 4, plate 4. [Note 18]
[30] R. Taylor, Roman builders: A study in architectural process, Cambridge: Cambridge University Press, 2003; 33 fig 8
[31] A. Ghadban, ‘Maqueta d'un teatre procedent d'Heliopolis-Baalbek', in P. Azara (ed.), Les cases de l'ànima: Maquetes arquitectòniques de l'antiguitat (5500 AC/300 DC), Barcelona: Centre de Cultura Contemporania de Barcelona & Institut d'Edicions de la Disputacio de Barcelona, 1997; 239-40. Several of the Roman construction models listed here are included in this catalogue.
[32] EN 771-6:2011 Specification for masonry units. Natural stone masonry units; EN 1996-2:2006 Eurocode 6. Design of masonry structures, Design considerations, selection of materials and execution of masonry.
[33] T. Ravenscroft, ‘Groupwork designs 30-storey stone skyscraper’, Dezeen, 10 March 2020; online at: www.dezeen.com/2020/03/10/stone-skyscraper-groupwork-amin-taha/ (accessed 2 June 2021).