Stonecutting in Maya Architecture: The Palace of the Governor at Uxmal (Yucatan, Mexico)

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Introduction

The ancient Maya civilisation developed in Mesoamerica between BC 1500 and AD 1500, the and reached an advanced understanding of various fields of knowledge, still visible today in its many architectural remains. Maya architecture has been studied from many disciplinary perspectives, including some architectural surveys, which have made it possible to identify regional differences in its architecture in terms of typological, aesthetic, and formal development. As a result, different architectural styles are currently associated with specific geographical areas, such as the Puuc architecture located in the Yucatan Peninsula, where a long building tradition has been revealed.

From the first Early Oxkintok architectural style to the last one, called Late Uxmal, the evolution of architecture in the Puuc region reveals the degree of sophistication achieved by Maya stonemasons, who developed great proficiency in stonecutting techniques, resulting in the skilful carving of the specialised pieces that make up the buildings erected during the Late Classic period (AD 750-1000).

Some of the most remarkable examples of stonemasonry can be seen in the later buildings of the ancient Maya city of Uxmal (Fig. 1), and yet there is still a lack of in-depth studies of their construction techniques and stereotomy. To address this issue, we have selected the Palace of the Governor, a Puuc palace in the Late Uxmal architectural style built around AD 900, for detailed study.

Figure 1: Geographic location of Uxmal within the Puuc Region of the Yucatan Peninsula, Mexico. Drawing: Laura Gilabert-Sansalvador and Riccardo Montuori, 2021

Based on the chart of specialised stones necessary for the construction of a Classic Puuc type building drawn up by George F. Andrews [1], a similar one has been created for the south façade of the South Wing of the Palace of the Governor, with the aim of both assessing the degree of standardisation attained in its erection, and outlining and implementing a new methodology for the study of stonecutting techniques within Maya architecture.

The results presented in this paper are part of ongoing research, so that the data presented below represents preliminary results of an analysis of the stonemasonry of this unique edifice. This work is part of a thesis that aims to introduce a novel line of research which studies Maya architecture from the point of view of stereotomy.

Puuc Architecture

There are significant differences in the architecture of each geographical zone of the Maya area, particularly in terms of construction technology. The characteristics of the stone material, the systems used for its extraction, the development of the quality of the mortars and the advances in stonecutting techniques in each geographical area determined the particularities of the architecture of each region and its evolution over time, conditioning in many cases the architectural and stylistic features of the buildings, which were often determined more by constructive than aesthetic issues. [2]

The architecture of some geographical areas of the Maya area has been the subject of more specific studies. Such is the case of the architecture of the Puuc region, in which the study of its construction technology has been specifically dealt with, above all in terms of stylistic classification and dating.

Unlike other Maya architecture, the construction of the Puuc is the reflection of a long construction tradition in which there is clear evidence of the evolution of its construction systems, going from the construction systems of the corbelled to the veneer type, which are finely carved specialised pieces that function as lost, and at the same time permanent, formwork for the resistant fillings of this architecture, elaborated in limestone. With this technological development, the Puuc Maya achieved ever wider and higher interior spaces and ever more refined stone surfaces, which required only a thin layer of stucco facing. In addition, Puuc architecture is well known for its builders' mastery of carved stone mosaic decoration and its characteristic geometric iconographic motifs.

Puuc Architectural Styles

The 1930s saw the emergence of an interest in multidisciplinary studies in the field of Mesoamerican architecture. The first architectural studies in the Puuc region of the Maya area were conducted [3]. Pollock was the first one to propose a stylistic classification in temporal phases using the architectural characteristics of the buildings he surveyed in the 1940s. For each proposed phase or style (Early Oxkintok, Proto-Puuc, Early Puuc and Classic Puuc) he defined the formal and constructive characteristics of the different parts of the building [4].

Pollock's research was later extended by George F. Andrews and Geraldine Andrews . On the basis of a field study conducted for between 1965 and 1990 in the Maya area, Andrews characterised and classified the buildings surveyed, based on 13 architectural elements: Base, Lower Wall, Wall Construction, Doorways, Doorjambs, Medial Mouldings, Upper Wall Zones, Cornice Mouldings, Roof Combs, Vaults and Beams, Vault Construction, Cordholders & Rodholders, and Decoration.

In addition to narrowing the stylistic chronological dating previously proposed by Pollock, Andrews' studies added three sub-styles within Classic Puuc architecture (AD 770-1050). Thus, Andrews proposes the following classification of architectural styles: Early Oxkintok, Proto-Puuc, Early Puuc, Classic Puuc Junquillo, Classic Puuc Mosaic, and Late Uxmal [5].

The Palace of the Governor: A Masterpiece of Puuc Architecture

While Early Puuc architecture features rather crude stonework and simple ornamentation, the architecture of the Late Uxmal architectural style (AD 1000-1050) is the most advanced form of Puuc architecture, with finely-carved stonework and previously unseen architectural features: oversized medial and cornice mouldings; recessed jambs and lintels in all exterior doorways; and as higher vaults and upper wall zones, creating an increase in the monumentality of buildings. [6]

This is the case in the Palace of the Governor, a masterpiece of Puuc Architecture located in the ancient city of Uxmal. This building stands out from the rest because of the technical quality of the stonework of its ashlars, vault stones, and mosaic-type decorative pieces, which demonstrate exceptional advances in stonecutting techniques (Fig. 2). This fact is especially relevant, given that Maya stonemasons only had polished or carved stone tools made of lint, obsidian, and other hard stones to make chisels, axes and other tools [7] for carving all the blocks used in the construction of their buildings. The formal solutions of the House of the Governor have also been said to represent a final development in step-fret design in Puuc architecture [8]. The last construction stage of the Palace was built around AD 900, during the Late Classic Period (AD 750-1000) [9]. The quality of the limestone, the care and delicacy of its carving and the modular composition of its mosaic frieze make this building a striking example of the Puuc style in its final phase [10].

Figure 2: Northeast View of the Palace of the Governor at Uxmal, Mexico. Photo: Laura Gilabert Sansalvador, 2015

Floor Plan and Elevation of the Palace

Within the Palace of the Governor, many separate architectural forms are skilfully combined and adjusted by the architects of Uxmal [11]. The palace is a free-standing edifice of 98 m long, 12 m wide and 8.5 m high (Fig. 3). It consists of a central building and two side wings, unified by the two highest corbel-vaulted arches in Maya architecture. This structure stands on four platforms that contribute to its monumentality.

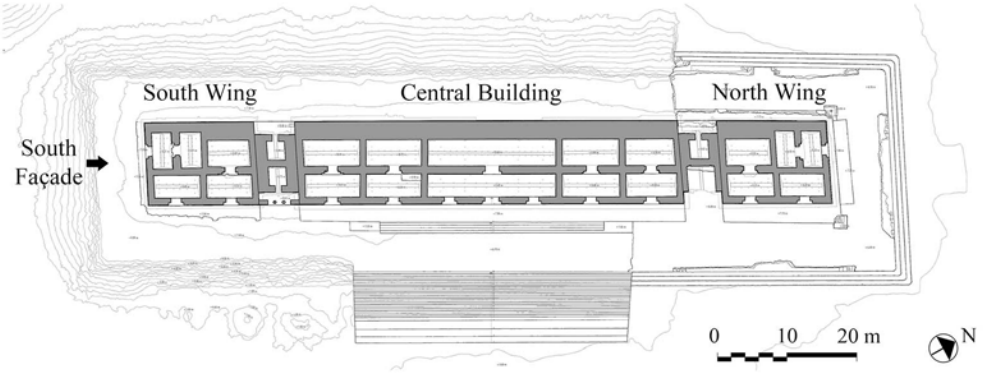

Figure 3: Floor plan of the Palace of the Governor at Uxmal, Mexico. Source: Modified from Muñoz Cosme & Vidal Lorenzo, 2020: Figure 9.

The South Wing is 16 m long, and has five rooms, two of them accessed by two doorways located on the eastern façade, while the other two are reached by a doorway on the south façade (Figs. 3-4). All its entrances have recessed jambs and lintels which are typical of the Late Uxmal architectural style.

Figure 4: South Façade of the Palace of the Governor. Photo: Ana Laura Rosado-Torres, 2013.

Methodology

In order to study in depth the Palace of the Governor, we took as a starting point the classification of pieces required for the construction of a typical Classic Puuc building, according to the proposal made by George F. Andrews. In this list, he identifies 24 specialised type pieces, both interior and exterior, for the following architectural elements: Basal Moulding (A), Perimeter Wall (B), Middle Moulding (C), Upper Walls, Exterior (D), Cornice (E), Upper Walls, Interior (F), and Vaults (G) [12].

Then, by means of the data surveyed in the field in April 2018 [13], the graphic restitution of the south façade of the South Wing of the Palace was carried out, distinguishing the following architectural elements on its façade: Basal Moulding (A), Lower Wall (B), Medial Moulding (C), Frieze (D), and Cornice (E). Subsequently, the study of the frieze was discarded since, in order to study the stone mosaic pieces located in this element, it would be necessary to address the architectural sculpture of the Palace as a whole, and not only in this façade. Thus, we have focused on the architectural elements in which carved pieces with a mainly constructive function are concentrated.

Hence, 18 of the 24 specialised pieces identified by Andrews were found on the façade, in addition to five new pieces, making a total of 23 specialised constructive pieces for the south façade of the South Wing of the Palace of the Governor. (Fig. 5)

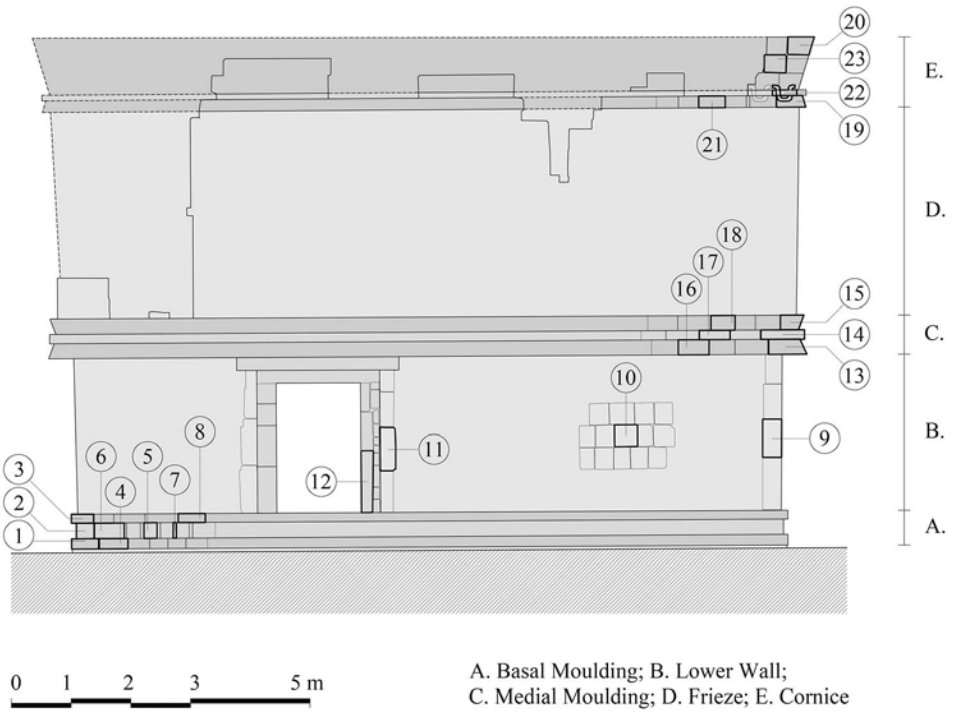

Figure 5: Schema of the South Façade of the Palace of the Governor: architectural elements and identification of specialised constructive pieces. Drawing: Riccardo Montuori, 2021

The South Façade of the Palace of the Governor: specialised stonemasonry pieces

The following table (Table 01) shows the 23 types of specialised constructive pieces identified on the south façade of the South Wing of the Palace of the Governor (1 to 23), organised according to the architectural element to which they belong (A, B, C, E). The table also includes the following data: number of pieces per type and their average dimensions in Width (W), Height (H) and Depth (D), as well as the carved surfaces identified (Visible or Partially Visible, Hidden, Total). The analysis of the total of 518 pieces identified allows us to present the results below.

Table 1: Specialised constructive pieces required for the construction of south façade of the Palace of the Governor.

PALACE OF THE GOVERNOR: SOUTH FAÇADE OF SOUTH WING								
	Specialised Constructive Pieces	Pieces per type	Average dimensions (cm)			Carved surfaces		
			W	H	D	Visible / Partially Visible	Hidden	Total
A. BASAL MOULDING		**120**						
1	Corner piece, lower member	2	42	17	36	3	3	6
2	Corner piece, central member	2	34	25	42	2	4	6
3	Corner piece, upper member	2	44	15	59	4	2	6
4	Typical lower member	30	35	17	(45)	1	4	5
5	Typical central member: colonnette	20	22	25	(25)	1	-	1*
6	*Typical central member: squared*	14	38	25	(25)	1	4	5
7	*Intermediate piece*	25	6	25	(10)	1	-	1
8	Typical upper member	25	52	15	(45)	3	2	5
B. LOWER WALLS		**256**						
9	Outside corner block	10	32	54	34	2	2	4
10	Typical wall facing block	232	29	32	(15)	1	-	1
11	*Outer Doorjamb*	7	25	65	30	2	2	4
12	*Inner Doorjamb*	7	33	63	60	3	2	5
C. MEDIAL MOULDING		**81**						
13	Corner block, lower member	2	65	25	86	3	3	6
14	Corner block, central member	2	50	18	(40)	3	2	5
15	Corner block, upper member	2	38	24	37	3	1	4
16	Typical lower member	24	46	25	(80)	2	3	5
17	Typical central member	24	46	18	(40)	3	2	5
18	Typical upper member	27	43	24	(45)	2	3	5
E. CORNICE		**61**						
19	Corner block, lower member	1	47	19	(40)	3	3	6
20	Corner block, upper member	3	35	29	(25)	2	1	3
21	Typical lower member	20	41	19	(40)	2	4	6
22	*Typical guilloche member*	13	38	26	35	1	4	5
23	Typical upper member	24	29	29	(25)	1	1	2
		518	**TOTAL NUMBER OF COMPONENTS**					
		*Stonemasonry piece with a semi-cylindrical outer surface.						
		(x) Source: Kowalski, 1987, Fig. 64 (p. 101).						

Basal Moulding (A)

The basal moulding of the south façade is composed of 120 pieces. Eight types of specialised construction stones that have been identified within this architectural element. These are: Corner piece, lower member (1); Corner piece, central member (2); Corner piece, upper member (3); Typical lower member (4); Typical central member: colonnette (5); Typical central member: squared (6); Intermediate piece, central member (7); and Typical upper member (8) (Table 02). Two of these types (6 & 7) are additional to the list of specialised stones in the basal moulding of a Classic Puuc building type previously proposed by Andrews.

Having carefully studied each type of stone block that makes up this architectural element, some interesting data can be extracted regarding the work required to achieve its final form. While in the typical intermediate pieces (4, 6-8) only one of their faces is completely visible on the façade, two of the surfaces that make up the corner pieces (1-3) are on the façade, requiring much more refined carving work than in the case of the former. In addition to the surfaces that make up the façade, it should be noted that there are other surfaces that are partially visible, either on their front or back side, so that the refined carving work is not limited to the visible side only. Thus, the pieces that make up the basal moulding have up to four carved surfaces that are visible or partially visible, while the rest remain embedded in the solid core of the wall.

The typical lower (4) and upper (8) intermediate pieces are in both cases quadrangular in their front elevation, with well-defined corners, with a constant average height —17 cm for the former and 15 cm for the latter—although their width varies. In the case of the lower intermediate piece (4), it ranges from 26 to 52 cm wide, although it is usually between 30 and 40 cm wide (the arithmetic mode is 35 cm). With regard to the upper intermediate piece (8), there are cases ranging from 19 to 58 cm wide, although they are usually 52 cm wide.

From the above it can be deduced that, although each piece of stonework was in principle designed to be executed according to standardised measurements that would allow them to be integrated into the architectural element for which they were conceived, with regard to the width of each piece there is great flexibility to adjust tothe dimensions of the blocks extracted from the quarry. The width of the piece was not really relevant in achieving the final result as, after all, these intermediate elements were not intended to stand out.

Another interesting observation is that, for the harmonious decorative conformation of certain architectural elements, it was not so important that all the pieces had the same length, but that all of them conformed to the required module according to the design of the compositional rhythms on the façade. That is the case of the typical central members of the basal moulding (5-7), as seen in the following figure. (Fig. 6)

Lower Wall (B)

There are 256 pieces that make up this architectural element, in which we find four types of specialised stones: Outside corner block (9), Typical wall facing block (10), Outer doorjamb (11), and Inner doorjamb (12) (Table 02). The latter two had not been included in Andrews' list, as these architectural features only appear in buildings of the Late Uxmal architectural style. Lintels previously included in Andrew's list have been removed from ours, as they would have been made of wood rather than stone at the Palace of the Governor [14].

Thus, on the south façade there are a total of 10 outside corner blocks: four on the east side and six on the west side. These pieces have two finely carved faces, one facing the south façade and the other facing the east or west façade, respectively. It is observed that the number of pieces and their height is variable, although there are some cases where the corner pieces correspond or conform to the courses of facing stones. To give some general numbers, their width ranges from 26 to 38 cm, while their height ranges from 21 to 87 cm. Their average depth is around 34 cm.

The wall facing blocks (10) are by far the most numerous elements of the lower walls of the Palace of the Governor: there are 232 of them in total. These specialised stones are well squared, pecked and ground smooth. This type of masonry has been referred to as a veneer, given its appearance, but technically it is formwork masonry, as the facing stones must be set in place before the concrete core can set [15]. All the pieces are arranged very tightly, so that the joint between them is only a few millimetres. Because of the even surface, little stucco was required to cover the façades.

The lower wall of the south façade measures a total of 2.60 m in height and is composed of a total of 8 courses of facing stones, ranging in size from 36 cm high for the first course just above the basal moulding to 23 cm high for the eighth course below the medial moulding. The width of the facing stones also varies, ranging from 12 to 49 cm wide, although the standard piece is normally 29 cm wide (Fig. 7a). In terms of depth, these blocks are usually only half the size of their height and width, so that the back is usually about 15 cm deep.

In this standardised piece, however, there are some peculiarities: in some cases, the facing stones have a special geometry because they have been adapted to their relative position in the wall. Two examples are provided here to illustrate this: a piece that has been adapted to fit the dimensions of the corner piece (Fig. 7b), and another that has been adapted to form a constructive hole in the eighth course of the wall. (Fig. 7c).

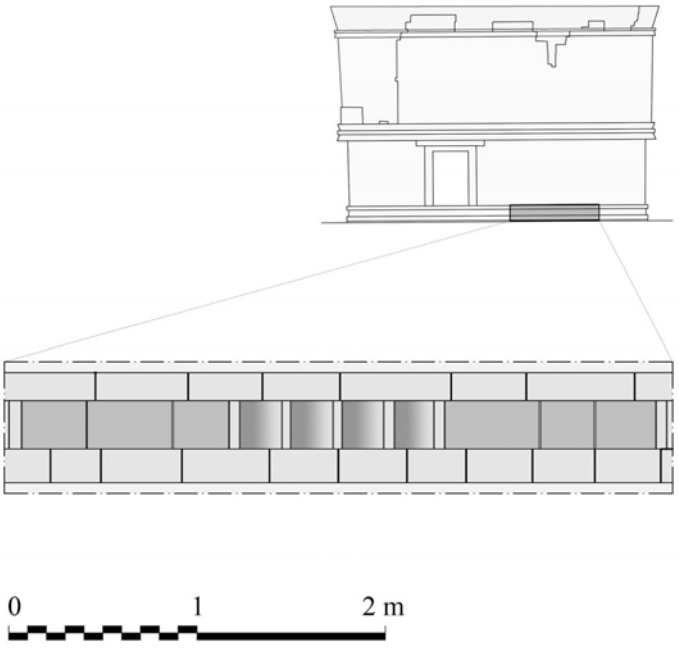

Figure 6: Scheme of Basal moulding showing different measures of specialised stones within Typical central member: squared. Drawing: Riccardo Montuori, 2021

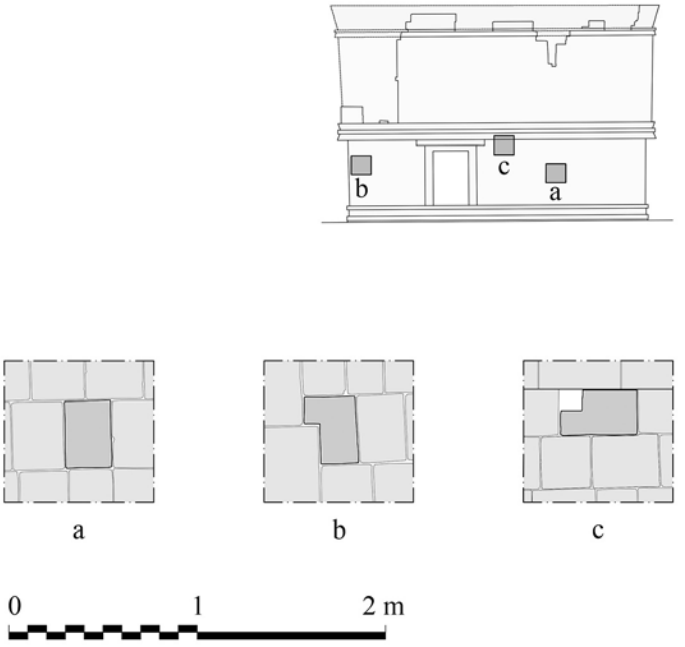

Figure 7: (a) Typical wall facing stone; (b) Modified wall facing stone to fit with corner block; (c) Facing stone modified to form a constructive hole. Drawing: Riccardo Montuori, 2021

This shows that although there were premeditated processes of carving that allowed the facing stones to be made of the same height to fit in their courses, in some cases it was also necessary to make adjustments according to the specific position they would occupy.

Lastly, we will briefly describe the pieces that make up the recessed entrances, which, as mentioned above, are a constructive novelty of this architectural style. On the south façade there are a total of 7 pieces of Outer doorjamb (11) and 7 pieces of Inner Doorjamb (12).

As seen in the façade diagram (Fig. 5), there are four outer doorjambs on the east (right) and three on the west (left) side of the entrance. They range size from 22 to 32 cm wide and from 32 to 80 cm high. Their depth constant. It is 30 cm, which is one third of the thickness of the wall. These pieces have two finely carved faces, one facing the south façade and the other facing the interior of the entrance.

As for the inner doorjambs, these are also seven in total: three on the east (right) side and four on the west (left) side. Unfortunately, their state of preservation is rather poor, as the pieces are fragmented and joined together with concrete. Nevertheless, it was possible to take the general measurements of the pieces. Their width varies between 19 and 32 cm, while their height ranges from 34 cm to 104 cm. These pieces are generally narrower in comparison with the outer jambs, but considerably wider: 60 cm in total, which corresponds to two thirds of the total thickness of the wall. These pieces have three finely-carved faces: one facing the south façade, one facing the entrance and one facing the interior of the room.

Medial Moulding (C)

This architectural element consists of two bevelled members separated by a rectangular course, which is also known as *atadura* or binder moulding. In the south façade of the Palace of the Governor, we have identified a total of 81 pieces within the same six types of specialised pieces referred to by Andrews, namely: Corner block, lower member (13); Corner block, central member (14); Corner block, upper member (15); Typical lower member (16); Typical central member (17); and Typical upper member (18). (Fig. 8)

Figure 8: Typical lower member on Medial moulding, finely carved and protruded from Lower wall. Photo: Riccardo Montuori, 2018

As for the lower members, both the corner and the typical ones (13 & 16) protrude some 40 to 42 cm from the inferior wall, which protects the typical wall facing blocks from deterioration caused by rain runoff (Fig. 8). The typical lower member (16) has only one bevel, with an angle of 64-65º, and has two finely carved and visible faces. Its average dimensions are 46 cm wide (with a minimum value of 34 cm and a maximum of 75 cm), 25 cm high and about 80 cm deep.

The Corner block, lower member (13), has three visible carved faces and two bevels (about 60-65º on both sides). It is 65 cm wide, 25 cm high and 86 cm deep. This piece is the largest of the lower pieces of the Medial moulding.

With respect to the Typical central member (17), it is a rectangular block with a finely carved face entirely visible, as well as two other carved faces, the upper and lower ones, which are only partially visible (7-8 cm), given that the rest of

the piece is inserted into the core. There are 24 pieces in total, whose average dimensions are 46 cm wide (with values ranging from 22 to 59 cm), 18 cm high and 40 cm deep.

Finally, the upper members, like the lower ones, have two finely carved faces on their typical members (18) and three in the case of the corner members (15). In this case, the angle of the bevel is somewhat more obtuse: around 70º on both sides.

The upper typical member is on average 43 cm wide, 24 cm high and 40 cm deep, while the corner pieces have the same height, but are 38 cm wide and 37 cm deep. In other words, they all seem to come from roughly equilateral quadrangular quarry blocks.

Cornice (E)

With regard to the cornice, this architectural element is made up of 61 elements belonging to five types of specialised constructive pieces: Corner block, lower member (19); Corner block, upper member (20); Typical lower member (21); Typical guilloche member (22); and Typical upper member (23).

With a total height of 1.15 m, the cornice of the Governor's Palace presents three new pieces to be added to those in Andrews' classification. While the lower piece (21) is quite similar to the corresponding piece in the middle moulding (lower height and a less acute bevel angle), the central piece is a completely different element: the guilloche piece (22) (Fig. 9). This specialised stone, which as well as being a constructive element also serves as a decorative element, has a novel design not found so far in any other building in the Puuc region, making it a distinctive feature of this building. Although only 13 guilloches remain *in situ* on the south façade, the rest of the building's façades are surrounded by this rhythmic element. A detailed analysis of this element is beyond the scope of this paper, but we think it is worthy of in-depth analysis in order hypotheses can be developed about the process of tracing and cutting that would be necessary to achieve the standardised final result of this carved piece.

Figure 9: Cornice of the South Façade on the PG, with five specialised constructive pieces. Photo: Riccardo Montuori, 2018

Conclusions

The study of Maya architecture from a perspective of its construction techniques has been scarcely addressed so far, despite the importance of this subject for historical and constructive knowledge and for the preservation of these buildings.

Based on the identification and analysis of the different stone blocks that make up the south façade of the Palace of the Governor, it has been possible to classify and distinguish the different types of specialised pieces that make up the south façade of the South Wing of this building. These pieces have been characterised individually, analysing their measurements and final geometry, with special emphasis on the quality of the carved work required for their formal definition, which was designed in each case to fulfil a specific constructive function.

From the analysis of the above data, it has been possible to study the geometric and cutting solutions achieved, finding some examples of pieces that reflect very precise carving work, which leads us to believe that measuring, aligning and cutting tools would undoubtedly have been used in their manufacture.

It should be noted that, although specialised types of pieces have been detected, not all of them have been made with the exact same dimensions. One of the observations that can be drawn from this analysis is that the carving work conducted by the Puuc Maya stonemasons left a wide margin of flexibility for the execution of each of their stonework pieces, sometimes adjusting them to the dimensions of the exact position in which they were to be finally placed.

Another interesting observation is that, given that the building would have been covered with a thin layer of stucco, it is clear that the various pieces of specialised stonework that make up the building were not actually carved to be visible. For Maya stonemasons and architects, the most important thing was the overall view of the building and not the geometric precision of each individual piece.

Future research will address the characterisation of the stonemasonry pieces corresponding to the rest of the buildings that make up the whole palace: the three buildings and the two corbel-vaulted arches that join them together. From the total number of carved stones to be analysed, those of greatest interest in terms of their stereotomy will be selected and subsequently examined in detail, with the aim of developing hypotheses on the processes of tracing and carving necessary to achieve their final geometric shape.

Acknowledgments

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[11] Kowalski, (Note 8), p. 113.
[12] Andrews, (Note 1), p. 126.
[13] Muñoz Cosme, (Note 10) p. 400.
[14] This modification is a constructive evolution, given that stone lintels have a limited length, both because of the weight of the material and the size of the entrances they allow.
[15] Kowalski, (Note 8), p. 103.