The development of Hittite military architecture: "Kastenmauer" *and* "Casematte" *building techniques*

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Military architecture represents an essential component of the social and town-planning framework of Hittite Anatolia. The complex structure of the walls that made up the fortifications, thick walls subdivided by towers jutting out beyond the walls and overlooking the top of the walls themselves, and the building techniques used, in fact appear to indicate the presence of a so-called "*Hittite*" military architecture.

Said architectural technique is, in effect, divided into two main categories: "*Kastenmauer*" and "*Casematte*". The "*Kastenmauer*" building technique, as per current terminology, is a structure that has a series of internal divisions made with transversal parting walls, which form rectangular or square compartments[2]. The foundations are filled with earth and rubble. The "*Casematte*", on the other hand, in spite of having the same structure as the "*Kastenmauer*", had no filling in the foundations and was thus accessible from the side looking towards the city. The fact that it was accessible meant that it was possible to circulate within it and, in all likelihood, that it was also exploited for occupational purposes[3]. The hugely widespread use of the "*Kastenmauer*" and "*Casematte*" building techniques across the central and southern regions of Anatolia in the first half of the II millennium B.C. is one of the main reasons for which there is a standardization of "*Hittite*" military architecture. It does indeed seem to be the final product of a process of evolution of the different defence systems developed in Anatolia. A very important element concerning these fortification walls is in fact represented by the regular and continued use of the "*Kasten*" building technique for the walls, and, above all, the towers, in the settlements of the Hittite period.

The towers, in consideration of their architectural structure and their huge intrinsic defensive value, completely changed the meaning of defence proper to Anatolia in the III and II millennium B.C. and, at the same time, unequivocally represented one of the main innovations of "*Hittite*" military architecture, as well as one of its elements of standardization. The fortification walls of Hittite settlements such as Hattusha are in fact divided into walls of equal length and thickness, flanked by powerful independent foreparts jutting out beyond the line of the wall, divided up inside by transversal parting walls into rectangular compartments, not accessible at foundation level for the presence of an inner filling as shown by the city-walls of the Upper City of Hattusha[4] and Mersin VII – V[5].

[1] A special thank to Engineer Paolo Rinaldi for his contribution to the technical part of this study.

[2] S. Alp, *Zylinder und Stempelsiegel aus Karahöyük*, *Türk Tarih Kurumu*. Ankara 1968, p. 3; fig. 2; idem, "Eine *kārum*-zeitliche Gußform und die Siegel von Karahöyük", *Istanbuler Mitteilungen* 43 (1993), pp. 185-193.

[3] L. Woolley, *Carchemish. Report on the Excavations at Jerablus on Behalf of the British Museum. Part II. The Town Defences*. Oxford 1921, Pl. 6

[4] O. Puchstein, *Boghasköy. Die Bauwerke*. Leipzig 1912, pp. 38-45, 48-60, 62-81; fig. 38

[5] J. Garstang, *Prehistoric Mersin, Yümük Tepe*. Oxford 1953, pp. 236-241; fig. 153

A further and innovative element represented by the Hattusha Upper City fortification wall is the presence of rooms, within the towers themselves, without filling and thus accessible through a passage which opened onto the side facing the city. These rooms in fact must have included ladder-rooms through which it was possible to reach the upper levels of the towers and the walkway, which probably went around the whole of the fortified wall[6]. The presence of a second level inside the towers in fact implies that the towers had to be high enough to overlook the walls themselves, but that one could in any case walk the whole circumference of the walls passing through the towers themselves thanks to the ladder-rooms. A further element that indicates the total standardization of "*Hittite*" military architecture is represented by the architectural structure of the city-gates. These are composed of a central gate-room set between two powerful jutting towers that are divided up inside into multiple rectangular or square compartments filled with earth[7]. The increased partitioning of towers flanking city-gates as compared with those in other parts of the city walls seems to have been motivated by the need to increase their thickness so as to improve their stability and resistance, given their strategic importance. From studies till now carried out it would not seem possible to understand why the towers evolved the way they did. The towers along the walls of previous settlements, such as Karahöyük, in fact do not seem to be in any way linked to the development of the Hittite towers, because they are merely extended appendixes of the walls themselves, and not independent structures as shown by Karahöyük fortification wall[8].

A first evolutionary stage of the towers seems to be represented, even if entirely hypothetically, by the "*Poternenmauer*" level BK IV c at Büyükkale[9] (fig. 1). The sides of the towers in this fortification wall, built according to the "*Kasten*" building technique and which jut above and over the inner line of the walls, go right through to the ground and are thus independently built structures inside a compact surrounding wall. On the basis of these elements, then, it seems possible to suppose that the first evolutionary stage of the towers is a by-product of the structure and the intrinsic defensive value of the "*Kastenmauer*" building technique. The reasons why the "*Kasten*" building technique was so widely employed in "*Hittite*" military architecture, as moreover during the *kārum* period, are, from a wholly hypothetical point of view, to be sought for in the military characteristics typical to this typology, characterised by its filling technique and the architectural structure[10]. The subdivision of the inner space into rectangular or square compartments, filled with soil and clay, in fact allowed for the building of an extremely solid construction against frontal impact. The demolition of the external wall didn't in fact produce the total collapse of the

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[6] K. Bittel – R. Naumann, *Hattuša, Ergebnisse der Ausgrabungen des Archäologischen Instituts und der Deutschen Orient-Gesellschaft in den Jahren 1931-1939*. Stuttgart 1952, pp. 82-98; fig. 20

[7] A. Müller-Karpe, "Untersuchungen in Kuşaklı 1998", *Mitteilungen der Deutschen Orient-Gesellschaft* 131. Berlin 1999, pp. 69-76; fig. 12

[8] Alp, *op. cit.* note 2; fig. 2

[9] R. Naumann, *Architektur Kleinasiens, von ihren Anfängen bis zum Ende der hethitischen Zeit*. Tübingen 1971, pp. 64-108, 212-213, 236-335; fig. 342

[10] G. M. Di Nocera, "Arslantepe und die Befestigungsanlage vom Beginn des zweiten Jahrtausends am oberen Euphrat", in *Festschrift aus Anlass des 65. Geburtstages von Harald Hauptmann*. Berlin 2001, pp. 85-96.

structure, but only a part of it, thanks to the presence of the second inner wall[11]. A further reason for the widespread diffusion of the "*Kastenmauer*" building technique would, moreover, seem to be represented by the relative ease with which this type of structure can be built and by savings in building materials. The architectural principle at the basis of the "*Kasten*" building technique is in fact that of building two parallel walls the space within which is then filled with earth and rubble, a technique that allowed for a large saving of materials whilst at the same time giving powerful and solid city-walls. One of the main issues of debate related to the "*Kasten*" building technique however concerns the need to determine to what level the space between the two walls was in effect filled. Was the intramural space completely filled, in other words, up to the top of walls themselves, or was it limited only to the foundation level (fig. 2). There is no general agreement as concerns this point. From an analytical study on the fortification walls of the settlements of the first and second half of II millennium B.C., constructed with the "*Kastenmauer*" building technique, it appears that there are large differences relative to the thickness of the walls and to the depth of the compartments (Tab. 1 and 2). For the fortification walls of the Late Bronze Age it is possible to note a reduction of the size of the compartments and an enlargement of the foundation walls through the use of medium-sized and large roughly hewn stones.

	Total thickness	Front hanging wall	Back hanging wall	Intramural space
Karahöyük	9.50 m	1.50 m	1.50 m	6.50 m
Alişar Hüyük 11T10 T	5.00 - 6.00 m	1.00 m	1.00 m	3.00 – 4.00 m
Tilmen Höyük II c	8.00 m	1.25 m	1.25 m	5.50 m

(Tab. 1. Total thickness of "Kastenmauer" fortification walls in the first half of II millennium B.C.).

	Total thickness	Front hanging wall	Back hanging wall	Intramural space
Hattusha U. C. 3 from King's Gate to Tower 25th	4.40 m	2.10 m	1.00 m	1.30 m
Büyükkaya	7.50 – 8.00 m	2.50 m	1.80 – 2.00m	3.50 m
Korocutepe	5.50 m	1.40 – 1.60 m	1.40 – 1.60 m	2.40 m
Büyükkale/Südmauer	7.00 m	2.00 – 2.20 m	2.00 –2.20 m	3.00 m

(Tab. 2. Total thickness of "Kastenmauer" fortification walls in the second half of II millennium B.C.).

These differences, in addition to indicating the absence of any kind of fixed unit of measure, indicate a significant process of evolution in the "*Kastenmauer*" building technique, because the enlargement of the containment walls seems to have been aimed at an increment in the filling.

This hypothesis is in fact based on the unlikely development of the inner filling above the level of the foundation walls, unlikely due to the scant thickness and structural instability

[11] H. H. von der Osten, "The Alishar Hüyük, Seasons of 1930-1932", *OIP* 28, Chicago 1937, pp. 110-135, 210-223; idem, "The Alishar Hüyük, Seasons of 1930-1932 II", *Vol. I*, *OIP* 29, Chicago 1938, pp. 4-10.

of the superstructure in bricks, which would not have been able to bear the pressure of a filling extended up to that level.

According to these elements, then, it has been attempted to analyse the hypothetical extension that could have been reached by the fortification wall, built with the "*Kasten*" building technique, of Büyükkale level BK IV c: the so-called "*Poternenmauer*".

According to an analytical study relative to this structure it in fact appears that, on the basis of the thickness of the foundation walls and given a safety coefficient of 1.5, as well as combining the results for clay with those for earth, the greatest possible average height of the inner filling, and so of the foundation, must have been of 7.89 m, because over this limit the whole structure would have toppled (Tab. 3).

Soil	Density (kg/m^3)	Material internal friction angle (°)
Packed sand	1800 ÷ 2300	32.5 ÷ 33.5
Packed gravel	2200 ÷ 2400	33.5
Sandy clay	1800 ÷ 2200	16.5 ÷ 22
Rich clay	1500 ÷ 2000	11.5 ÷ 16.5
Soil	1400 ÷ 1800	28 ÷ 45
Soil and pebbles	1700 ÷ 1900	35 ÷ 45

Material walls	Clay or Bricks	Granite/Limestone	Rocks
Density (kg/m^3)	1800	2700	2000

Safety coefficient of 1.5	Sandy clay	Rich clay	Soil and pebbles
Limestone	5.97 m	6.08 m	11.64 m

(Tab. 3. Büyükkale "Südmauer": hypothetical height "Kastenmauer" inner filling and foundation walls).

This hypothesis seems to be confirmed by a further study made on the later fortification wall of Büyükkale BK III b: the so-called "*Südmauer*".

In fact, on the basis of the thickness of the retaining walls and with a safety coefficient of 1.5, the greatest average height possible of the superstructure in stone seems to have been of 5.85 m, while with a coefficient of 1.2 it goes down to 6.93 m (Tab. 4).

Soil	Density (kg/m^3)	Material internal friction angle (°)
Packed sand	1800 ÷ 2300	32.5 ÷ 33.5
Packed gravel	2200 ÷ 2400	33.5
Sandy clay	1800 ÷ 2200	16.5 ÷ 22
Rich clay	1500 ÷ 2000	11.5 ÷ 16.5
Soil	1400 ÷ 1800	28 ÷ 45
Soil and pebbles	1700 ÷ 1900	35 ÷ 45

Material walls	Clay or Bricks	Granite/Limestone	Rocks
Density (kg/m^3)	1800	2700	2000

Safety coefficient of 1.5	Sandy clay	Rich clay	Soil and pebbles
Limestone	4.43 m	4.50 m	8.62 m

(Tab. 4. Büyükkale "Südmauer": hypothetical height "Kastenmauer" inner filling and foundation walls).

On the contrary the elevation of the foundations of the main fortification walls of the Upper City, from the King's Gate to the Lion's Gate, is clearly lower. It has indeed been calculated that, on the basis of a coefficient of 1.5, the greatest average height possible in the section between the King's Gate and the 25^{th} Tower was of 2.92 m (Tab. 5), and of 4.09 m between the 25^{th} tower and the Lion's Gate (Tab. 6).

Soil	Density (kg/m³)	Material internal friction angle (°)
Packed sand	1800 ÷ 2300	32.5 ÷ 33.5
Packed gravel	2200 ÷ 2400	33.5
Sandy clay	1800 ÷ 2200	16.5 ÷ 22
Rich clay	1500 ÷ 2000	11.5 ÷ 16.5
Soil	1400 ÷ 1800	28 ÷ 45
Soil and pebbles	1700 ÷ 1900	35 ÷ 45

Material walls	Clay or Bricks	Granite/Limestone	Rocks
Density (kg/m³)	1800	2700	2000

Safety coefficient of 1.5	Sandy clay	Rich clay	Soil and pebbles
Limestone	2.21 m	2.25 m	4.31 m

(Tab. 5. Hattusha Upper City 3 main fortification wall from King's Gate to 25^{th} Tower: hypothetical height "Kastenmauer" inner filling and foundation walls).

Soil	Density (kg/m³)	Material internal friction angle (°)
Packed sand	1800 ÷ 2300	32.5 ÷ 33.5
Packed gravel	2200 ÷ 2400	33.5
Sandy clay	1800 ÷ 2200	16.5 ÷ 22
Rich clay	1500 ÷ 2000	11.5 ÷ 16.5
Soil	1400 ÷ 1800	28 ÷ 45
Soil and pebbles	1700 ÷ 1900	35 ÷ 45

Material walls	Clay or Bricks	Granite/Limestone	Rocks
Density (kg/m³)	1800	2700	2000

Safety coefficient of 1.5	Sandy clay	Rich clay	Soil and pebbles
Limestone	3.10 m	3.15 m	6.03 m

(Tab. 6. Hattusha Upper City 3 main fortification wall from Tower 25^{th} to Lion's Gate: hypothetical height "Kastenmauer" inner filling and foundation walls).

The scant thickness of the main fortification wall, as compared to the Büyükkale fortification walls, could, from a wholly hypothetical point of view, explain the outer fortification wall, that, it is supposed, ran parallel to and outside the main walls from the King's Gate to the Lion's Gate. The large difference in thickness between these two structures could be due also to the strong irregularities in the terrain, which is undulating.

A further element relative to the stability and extent of fillings in the "*Kastenmauer*" structure is represented by the different materials used in this type of construction as, depending on which material was used there was greater or lesser cohesion and consequent pressure on the containment walls. In fact, according to an analytical study conducted on materials used for filling, it turns out that in a majority of cases clay of various types mixed with compacted earth was used, given the high level of cohesion offered by these materials when combined. The use of these components, such as clay and earth for the filling and of limestone for the containment walls, thus seems to indicate a careful choice aimed at a greater extension and stability of the structure.

This study would thus appear to show that the extent of the filling was directly proportional to the thickness of the stone foundation walls.

The fact that the filling was limited to the top of the containment walls in no way represents a reduction of solidity and efficacy, for defensive purposes, of the "*Kastenmauer*" structure. The hypothetical height of the superstructure in stone and the solidity represented by the filling in fact make up an architecturally solid and militarily versatile structure.

In fact, from this analytical study concerning the extension of the superstructure has emerged an extremely significant aspect relative to the height of the superstructure; it would indeed seem that the weight of the superstructure in bricks could in no way have had repercussions on the stability of the wall beneath, and so, on the basis of this hypothesis, the superstructure could have been extended without any effective limit.

Further, the absence of filling seems to indicate that this, eventual, intramural space could have been used by the defenders to go along the fortification wall without being seen by the enemy.

Nevertheless, this hypothetical inner circulation area didn't necessarily involve the presence of access points placed above the filling in the side walls of the towers, because they could have reduced the structural stability of the forepart, preventing its extension over the top of the walls, and, above all, it was not used for any occupational purpose, both because of the narrowness of the compartments and for the absence of objects in the rooms themselves, making it de facto impossible to assimilate the "*Kastenmauer*" structure and the "*Casematte*".

The similar architectonical structure, with a partition of the intramural space in compartments, in fact seems to have been at the heart, as concerns studies comparing the "*Kastenmauer*" to the "*Casematte*", of the idea of communing these two techniques.

According to an analytical study of these two methods of construction, it nevertheless appears that there is a substantial difference that highlights structural diversity and, apparently, also functional, between the "*Kastenmauer*" and the "*Casematte*" technique: the filling. The filling, in fact, is the main distinguishing factor between the two military typologies, because it prevents access and use, apparently only at foundation level, of the intramural space, underlining a clear difference with the "*Casematte*". The distinguishing feature of the "*Casematte*" building technique is in fact represented by the possibility of delimited circulation within the compartments, accessible at foundation level, and by their exploitation for occupational purposes. The filling, on the contrary, unequivocally prevents this accessibility to the intramural space, and, if the filling was really limited to the top of the foundation wall, and it did not therefore extend to the summit of the walls, leaving a practicable space inside the superstructure in bricks, would represent a clear difference between these two typologies, because the filling didn't simply strengthen and increase the thickness of the city-wall but was the "*essence*" of the "*Kastenmauer*" itself. According to this study, in fact, I believe that it cannot be considered as a "*variant*" of the "*Casematte*" building technique, but must be thought of as an independent and autonomous structure.

A further element that seems to indicate the total difference between these two building techniques is represented by the coexistence, in the Tilmen Höyük II c fortification wall, of the "*Kastenmauer*" and "*Casematte*" techniques[12]: the double fortification wall divided up into long stretches split up into compartments without inner filling, which were accessible at foundation level, and linked by narrow passages, from which it was maybe possible to reach the walkway, and others which were made according to the "*Kastenmauer*" building technique and so certainly not passable at foundation level.

The selfsame subdivision of the Tilmen Höyük city-wall in compartments without a filling and others built according to the "*Kasten*" building technique in fact seems to underline the structural and functional differences between these defensive typologies. From an analytical study of the sections made with the "*Kastenmauer*" technique, it appears that, with a safety coefficient of 1.5, the greatest average height of the superstructure in stone could have been of 3.96 m (Tab. 7).

Soil	**Density (kg/m^3)**	**Material internal friction angle (°)**
Packed sand	1800 ÷ 2300	32.5 ÷ 33.5
Packed gravel	2200 ÷ 2400	33.5
Sandy clay	1800 ÷ 2200	16.5 ÷ 22
Rich clay	1500 ÷ 2000	11.5 ÷ 16.5
Soil	1400 ÷ 1800	28 ÷ 45
Soil and pebbles	1700 ÷ 1900	35 ÷ 45

Material walls	**Clay or Bricks**	**Granite/Limestone**	**Rocks**
Density (kg/m^3)	1800	2700	2000

Safety coefficient of 1.5	**Packed gravel**	**Soil and pebbles**
Limestone	3.18 m	4.74 m

(Tab. 7. Tilmen Höyük II c: hypothetical height "Kastenmauer" inner filling and foundation walls).

This then indicates that, for purely military purposes, there was a difference of level between the passageways of the compartments. The vast dimensions of the compartments without the filling, and the fact that they were linked by passages 90 cm wide in fact indicate that the defenders could stay inside these compartments and, in case of attack, carry out an efficient defence passing from one compartment to another using the various passages.

The presence, moreover, in room C 7 of a ladder, seems to indicate that this compartment was used as a ladder-room to go up onto the top of the compartments filled with soil and rubble.[13] These, in fact, due to the height of the hanging walls, represented really solid bastions, from the top of which, the defenders, very likely sheltered by the superstructure in bricks, were able to have a complete view of the "*space*" in front of the walls and to use the increased height to attack the enemy (fig. 3).

[12] R. Duru, "İslâhiye Bölgesinde M. Ö. 2. Binyılına Ait Önemli Bir Kent: Tilmen Höyük", *Anadolu* 21 (1979-1980). Ankara 1987, pp. 37-46, fig. 1

[13] U. B. Alkım, *Anatolien I*. Ankara 1968, pp. 86-102; idem, "Tilmen Höyük", *Anatolica* 5 (1973/1976), pp. 33-37

In conclusion, a very interesting result that has emerged from this analytical study is the apparent existence of a so-called "*Hittite*" architectural typology. This typology is reflected also in the installation of city-gates and walls, along two different lines of development but that are nevertheless linked once more by one common element: the tower. In line with the military potential intrinsic to this structure, the possibility of having access to the compartments of walls built with the "*Kastenmauer*" technique completely changed the concept of defence thanks to the coexistence of two structures, such as the "*Kastenmauer*" and the "*Casematte*", complementary from a structural point of view, but different in their functional purpose. The main innovation of "*Hittite*" military architecture is in fact the existence of these two building technique in a single structure. The "*Kastenmauer*", nevertheless, in spite of the limited extension of the filling to the top of the foundation walls, must be considered as a completely different structure to the "*Casematte*", because this difference in filling method makes of the "*Kastenmauer*" structure a typically Anatolian building technique.

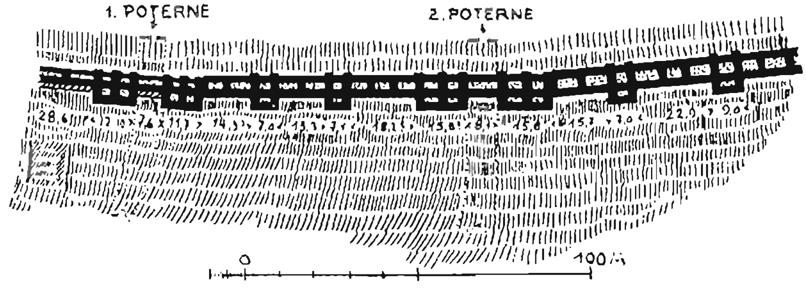

Fig. 1. Büyükkale BK IV c. "Poternenmauer" (Naumann, *Architektur Kleinasiens*. Tübingen 1971, fig. 342).

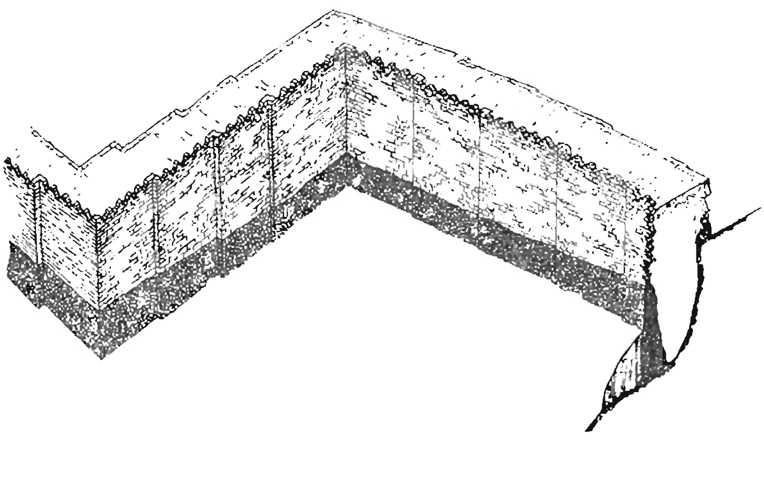

Fig. 2. Alişar Hüyük 11 T – 10 T. Fortification Wall. Tentative of Rebuilding (von der Osten, *OIP* 28. Chicago 1937, fig. 112).

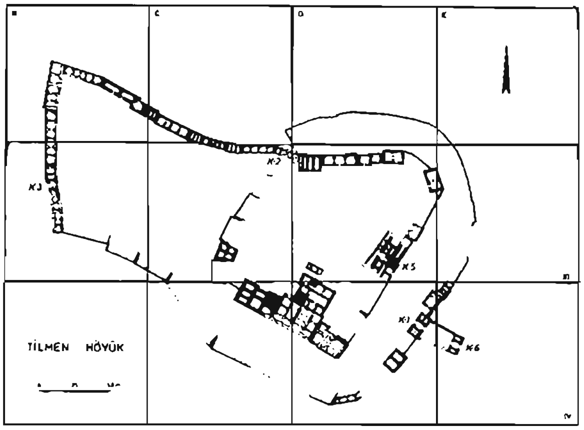

Fig. 3. Tilmen Höyük II c. Fortification Wall (Duru 1987, in note 12; fig. 1).