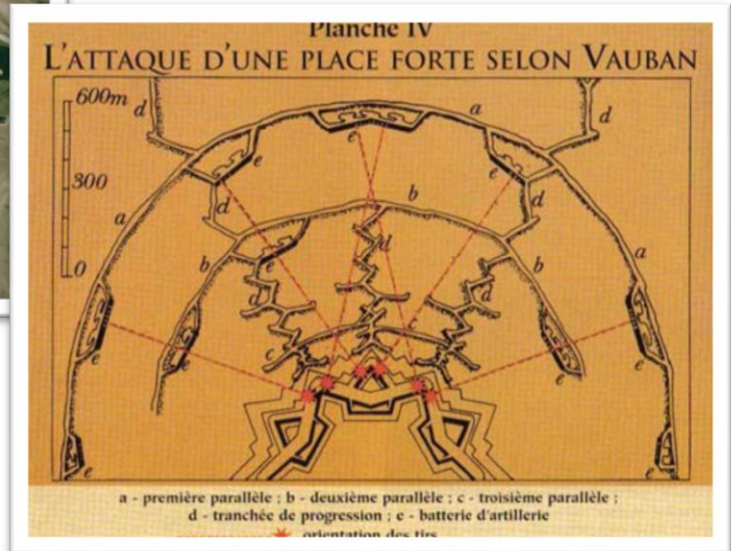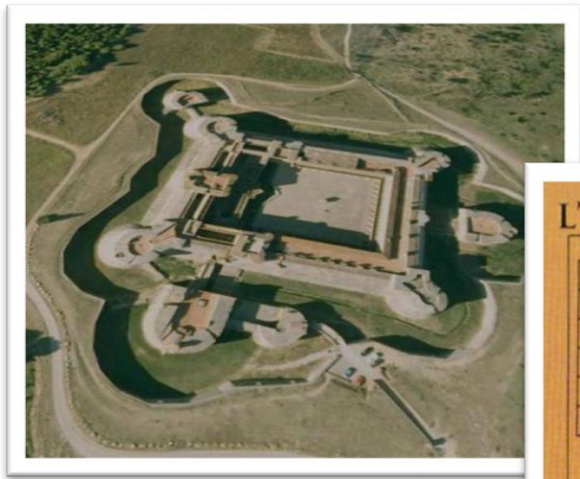# Evolution of siege techniques:

From the Catholic Monarchs to Vauban.

José Manuel Pañeda Ruiz

Cover images:
Salses Castle and diagram of the attack to a fortress.

CONTENTS

1. INTRODUCTION

Perhaps fortification is man's oldest job. From the beginning of their existence, men felt the need to keep from the many dangers facing him and what can be better than finding inaccessible places and improving them in different ways for better defense and safety.

In search of that safety many methods will emerge over time, from the simple protection of a cave to the building of the complex walled enclosures in bastion fortifications.

There is nowadays a great ignorance of most of the public about them, perhaps due to its complicated design and terminology. But even greater is the lack of dissemination of the techniques used in taking and capturing such defensive works. That is why the objective of this work is to analyze the evolution of the siege techniques of fortifications and their evolution before such threats, chronologically focused on the period from the Catholic Monarchs to Vauban.

Many studies have focused on the role of modern fortifications in Spain (Cámara, 1989; De la Fuente, 1994; Diaz, 2004), however, in relation to the topic presented in this paper, and particularly in the case we are dealing with, the treatment of modern poliorcetics has been reduced to a minimum (Saez, 2010).

For the writing of this study, as for its technical part, we have basically resort to the treaty of the 18th century Peter of Lucuze, "Principles of Fortification," which has been followed for the presentation of the most popular siege methods in its time. In that work we can find a summary of the necessary means to carry out each of these missions, as well as an exhaustive description of the practical implementation of it.

In order to get a complete view of the stages and development of the fortifications that were produced over the years, we have consulted the works of Diaz, "The bastion fortification" and Professor Cámara, "Fortifications of Philip II"; for the study of the earliest uses of artillery and the means of attack, we have followed the work "Artillery and Fortifications in the Kingdom of Castile during the reign of Isabel the Catholic" published by the Ministry of Defense.

The paper is structured in two parts. The first is dedicated to those threats that fortifications had to face from the employment of artillery in the field and their evolution.

In the second part, there is a presentation of the bastion fortification, finishing this section with the analysis of the siege techniques used against such defenses.

2. FORTIFICATIONS. MIDDLE AGE AND TRANSITION.

The bastion fortification is formed by the set of defenses built form the sixteenth century to the early nineteenth century. Designed and built to face the destructive effects of artillery, this fortification proved necessary since it adopted the material of bronze, metallic spherical shells, until the moment when it evolved to the use of steel parts with rifled barrels and high explosive projectiles, with warheads provided with fuses[1].

The evolution of fortification was the result of the aforementioned weapon progress and improvements in construction techniques. There has always been a close relationship between the artillery and defenses; the progress of the former was always followed by a replica from the latter. If, in the Middle Ages, the walls of castles and cities were unassailable until the appearance of gunpowder in the battlefield, the defenses of the bastion fortification were easily attacked by the siege artillery of the time.

2.1. Castles

The castle is the most characteristic medieval fortification. A medieval castle is "*a building of regular proportions, exempt, where safety prevails over the mere occupancy, presenting a profusion of defensive elements, active and passive, which holds no strictly military domestic life*" (translated from De Mora, 1996: 74).

The typical defensive elements include: an outer walled enclosure adapted to the ground, a moat, and inside these two elements, or one of them, the castle itself formed by tall and narrow walls, and flanking tower (Díaz, 2004: 98).

To facilitate the defense, and hinder the approach of the enemy to the walls, these were reinforced with: machicolations, battlements and loopholes[2]. Given the limitations of the offensive means many of the castles were almost impregnable, much more if they were located in abrupt places. The purpose of these defensive elements was to protect the people and properties from any enemy, who, in order to seize them, was forced to fight and meet the challenge of the castle walls.

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[1] The discovery in 1885 of a new explosive called melanite, which was adopted as load in artillery shells, caused a crisis in the fortifications of the old bastion system because they were vulnerable to new shells fitted with fuses and ogival shaped, thus improving its performance. Due to its shape, similar to a torpedo, it was given the name of "the crisis of the torpedo shell".

[2] Machicolation: sill overhanging on the parapet of a canvas or a tower, supported on brackets or buttresses and with holed floor to control wall (translated from De Mora, 1996: 128).
Battlement: open vain between battlements, on the parapets and towers (translated from De Mora, 1996: 40).
Loopholes: long, narrow opening in a wall to shoot through. It is a generic word that includes both the neurobalistic and the loophole for riflemen on the forts of the nineteenth century (translated from De Mora, 1996:45).

As we will discuss in more detail later, this attack was done by assaulting, using sapping mines or war machines. However, neither the use of shooting machines such as catapults, lathe crossbows or stone shooting machines were unable to breach most the walls they faced, so the castles held supremacy over the attacker until the 14th century.

The discovery of gunpowder and the subsequent invention of firearms opened a new page in the history of warfare. The castle, which was the quintessential defense, almost impregnable, approached its end and artillery began to take its first steps.

We can say that gunpowder revolutionized warfare, closing a stage characterized by the use of war machines in use for many years and questioning the art of fortification. It thereafter began a long period characterized by experimentation in both fields, which would end, in the field of fortification, with the bastion fortification.

2.2. The fortifications in the transition period

The transformation suffered by fortification at the end of the Middle Ages can be attribute to three main causes:

First, the emergence and different progress of powder artillery. In the mid-fifteenth century artillery was improved, and the old bombard was followed by other cast pieces; the stone bullet was replaced by a heavier iron one, gunpowder was grained, and faster projectiles could breach the walls which always mouldered after a few shots.

These facts greatly increased the importance of artillery, so that cities and castles so far impregnable were considered defenseless. Because of its excessive height and thinness, medieval walls were unable to resist the effects of enemy artillery. The first idea considered, in order to attend the new defensive needs was to lower the walls to provide a more difficult target to enemy fire, and their slope was increased to make them more resistant (Díaz, 2004: 101).

Since the walls of medieval fortifications were thin, they were not suitable for installing on them the artillery pieces needed for defensive artillery fire against the siege artillery. To get such space, platforms were set behind the curtain walls by means of embankments. By placing artillery on the parapet, the battlements were replaced with loopholes that protected both pieces and servants.

One of the aspects they should most fear from the new artillery was the doors, since, however strong they were immediately shot down by the besieging. To cover the main entrance of the premises, an external defense shorter than the walls was used. This element, called barbican, was called *baluarte* in Castile, with semicircular or pentagonal shape (Díaz, 2004: 102). All these elements appear in the fortress of Salses in Roussillon, built by Ramiro Lopez between 1497 and 1503.

Another cause of this transformation was the introduction of permanent armies. Undoubtedly, the fortification was always linked to power, while during the Middle Ages, the nobility was the great dominator of that period, the Europe of the Renaissance was characterized by the establishment of authoritarian national monarchies. The monarchs of the time aspired to submit to their authority the institutions of each

country. One of the most outstanding features of the new system was the presence of a permanent army to service of the monarchy.

With the help of these troops, the monarchs held a policy of territorial expansion, strongholds would become a very important part of their policy since, on the one hand, they were used to delimit boundaries between states, and, on the other hand, they had a deterrent effect against possible attacks from rival powers.

Logically the development, construction, maintenance and defense of such strongholds, were so high that only a strong state could afford it. In this way there was a dependence and mutual need between power and architecture. The monarch needed fortifications to develop his policy and maintain his political power and the defense works required a huge expense that could only be made by a strong power (Díaz, 2004: 17).

The arrival in Rome, following the fall of Constantinople to the Turks in 1453, of Byzantine engineers experts in fortifying against the techniques and methods of use of weapons and devices used by their enemies, together with the rediscovery of works and themes of classical Greek and Roman antiquity, created in Italy a favorable environment for the development of the sciences related to military engineering, as happened in other fields of knowledge. This can be considered as the third cause that triggered the evolution of the medieval fortifications to modern defenses (Díaz, 2004: 104).

This was the breeding ground in which the transition of the fortifications would develop as mention above. In the origin of the new defensive systems concurred, more or less decisively, the three causes mentioned above, of which undoubtedly the first is the main and predominant one.

3. SIEGE TECHNIQUES UNTIL THE SIXTEENTH CENTURY

Towers, walls, moats and castles are various forms of medieval fortifications, which appear either in isolation or combined together to hinder the action of the enemy.

As mentioned in previous sections, these constructions were also reinforced with other defensive elements, in order to protect the lives and properties of people. To seize these walled enclosures the attacker had to fight; before the use of firearms, and even long after their appearance, this fight involved some of the following, which will be expanded later: climbing, breaching, sapping mines, war machines, and if all this failed, one last resort, the siege.

3.1. Sieges and assaults

The assault by means of ladders was a procedure followed since ancient times, and continued to be practiced for many centuries, whenever it could be used. This technique was used to try to buy time, trying to put aside the hard work of digging trenches, laying the batteries or even digging mines.

The conditions for the use of climbing against a fortification had to be clearly defined before the attack, as it was very difficult to finish the task successfully. Among them we can mention that the fortification to be seized was poorly watched, as in the capture of Alhama during the campaign of 1482 by the troops of the Marquis of Cadiz, where after the climbing of the walls at dawn, on 27th February and after a day of fighting, the population capitulated (Ministry of Defence [MDEF], 2004: 76) (Fig. 1)

Fig. 1. Board under the low chair in the cathedral of Toledo showing the assault and conquest of Alhama (1482). The scene presents the royalist army at the time of the attack on the city. In the foreground we can see a gunner firing a bombard while on three ladders, the assailants climb the wall (as A. Franco Mata, 2010).

Another reason to use the ladder could be the fact that the attacking army might not have enough troops to establish a siege because of its limited material and human resources. However, this technique was almost useless against large fortifications, because even if they succeeded in reaching the walls, due to poor organization of the assaulting units, they could be at the mercy of the garrison that protected them, usually in a higher number than the attackers, with obvious result from these forces.

If the scale was failed, they resorted to the breaching, and if all the methods failed or was not reasonable to try them, the preparations for a siege, long, expensive and uncertain, started.

Blocking always developed in the same way. When an army reached the walls of the target place tried to isolate the besieged cutting off every communication with the outside. It was vital for the besiegers to deprive the besieged of food and water, preventing the entry of supplies once the siege had been completed. At the same time, it was also necessary to prevent troop reinforcements to strengthen the garrison defending the place. If these goals were not reached, the resistance of any fortress could last indefinitely (Sáez, 2010: 23).

However, the siege imposed a considerable human and material effort to the besieger, which still did not guarantee the capture of a fortress. So in most cases it involved an active lock, that is, time was shorten by attacking the walls either to force the surrender of the city or to take it by assaulting it, after having breached its walls. In these cases, the use of mines or war machines was preferred, which is discussed in the following section.

3.2. Mines and war machines

As mentioned above, if the climbing was frustrated or it was not practicable, or, due to their robustness, they were able to resist shooting machines, they were obliged to use

the mining, slow but certain, whose effectiveness required the permanence of the besieging at foot of the wall, which was not always possible. This means of attack, of difficult implementation, could be developed in two main ways. The first consisted in opening an underground way down to the foundations of the walls, which weakened with the subsequent excavation being secured by wooden props which were set fire at the right time, the wall failing and allowing the assault of the besieging troops.

The mine with burnt props was still used after the invention of gunpowder; what is more, the first use of it in mines was in order to burn these rigs more easily, since, due to the lack of air, they did not burn completely sometimes.

The second method was for the explosive mines, the first use of which took place in the second half of the 15th century (Fig. 2). They are referred to by the architect of Siena, Francis of Giorgio, who proposes the use of gunpowder to breach the walls; however, the priority of its use has been granted to Pedro Navarro (Estado Mayor Central del Ejército, 1948: 7) implementing this technique during the siege of the castle of St. George in Cephalonia with several mines that helped to conquer the fortress.

It is a historical fact that in the order of human progress, no innovation has suddenly banished the existing elements of the same gender. This principle, confirmed by the experience of all times, could not fail in the case of the cannon, whose first results were far from satisfying. Until about 1480, the combined attacks of artillery and heavy medieval machine, such as catapults, coexisted in the many conflicts that occurred in the Kingdom of Spain[3].
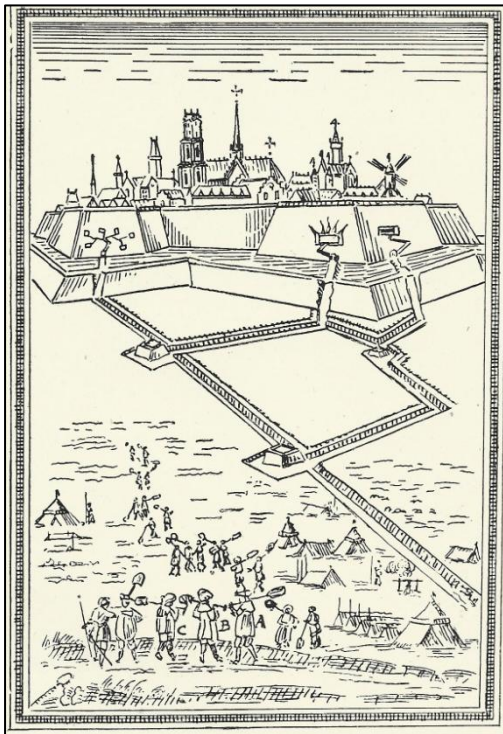

Fig. 2. Attack to a place with mines, as shown in an old fortification treaty.

However, despite the difficulties of this primitive artillery, heaviness, lack of precision and power, as time went by, it overshadowed and replaced the old war machines. The final victory of the cannon on the catapult, in the fifteenth century, was mainly due to its technical development.

The artillery was also a real germ of modernism and it would gradually create an art, science and spirit, typical of the artillery.

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[3] We can name, as examples of this combined use, the war of Succession to Henry IV, later during the war of Granada, as well as by the Turks during the siege of Rhodes. (MDEF, 2004: 209).

Just as the above-mentioned construction, development and maintenance of modern fortifications needed huge capital investments, the artillery was also, from the beginning, an expensive and difficult to obtain and use weapon. For this reason, the new weapon will be used exclusively by the new national monarchies, able to hire and keep permanent armies that would be the main users of such pieces of artillery.

The first artillery pieces were made of forged iron, shooting limestone projectiles, called *bolaños*. These guns lacked the destructive power to breach the walls of the defenses they faced, so until the mid-fifteenth century when improvements were made in the materials used in the manufacture of the pieces, in the projectiles replacing stone bullets with some made of lead or forged iron, and, especially, with the improvements in the manufacture of gunpowder, artillery became a serious rival to the fortresses.

The use of such materials in sieges needed considerable logistical preparation, since the equipment needed by a full train of artillery consisted of not only the piece itself but also the carriages, wagons for ammunition and gunpowder, horses, ... Once in the vicinity of the besieged place, it was located at the position which was more appropriate for the shots; due to the low precision and number of them, the pieces available were placed as close as possible to increase the destructive effects on defenses. The priority was to suppress the fire from the defender artillery, so they could then move the settlements forward and begin the real bombing of the walls to breach them and allow assault (MDEF, 2004: pp. 137-140).

The superiority acquired by the artillery over the defenses since the mid-fifteenth century will provoke a series of adaptations to the new threats in order to try to rebalance the equation between protection and projectile.

4. EVOLUTION OF FORTIFICATIONS

The vulnerability of the fortifications when facing artillery from the mid-fifteenth century was the cause for a renewal in both their construction elements and their design.

Concerning the former, from the late fifteenth and early sixteenth centuries, the stone walls of medieval fortifications, which were weak to resist the impact of the cannon balls, were progressively replaced by embankments, because they realized that slightly compacted soil absorbed the cannon balls and counteracted its effects[4].

In the field of design, the artillery threat meant that the old medieval towers generated numerous blind spots in defensive fire, which would result in the construction of pentagonal towers with an apex directed outwards, conveniently stationed to remove the adjacent dead angles and facilitate flanking fires. This would be the origin of the bastion, which gave its name to a whole system of permanent fortifications that were used from the second half of the sixteenth century to the late eighteenth (Díaz, 2004: 25).

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[4] Later these walls were revetment. The brick was the material chosen for the same, in the case of impact, due to be made of small pieces, which broke only hit and not transmitting cracks in the wall. However, walls made of blocks of stone, the impact on one of them, not only break it, but also affecting the closed ones.

Fig. 3. Plant of the citadel of Antwerp. Square built following a new design by order of Emperor Charles V and under the direction of Italian architect Donato Buoni. It had very long curtains of 300 to 400 meters with very small and very distant bastions flanking and therefore were not properly secured by the short effective reach of muskets.

During the second half of the century, the bastion fortification was consolidated as a system. As a result of the experience, some modifications and improvements were introduced as well as improvements favored by the progress of the whole architecture. However, the progress was slow. The first defenses were small in size, so artillery and troop maneuvers were difficult in them. The curtains, which were very long, forced to build platforms between bastion and bulwark to facilitate long shots, or break his rectilinear direction to improve the flanking (see figure 3).

The construction of fortifications was generally closely related to the political situation. The center of gravity of the construction of new defenses was found, in the early years, in the Italian territory, belonging to the Spanish monarchy. In the second half of the sixteenth century, the bulk of this activity came to the Netherlands, since the conflict had basically moved there. The efforts of the Emperor Charles V to prevent serious religious confrontations in Europe had failed and his son Philip II had to deal with bloody civil fights ignited by Calvinism (Díaz, 2004: 16).

Precisely these struggles of religion that will clearly mark a religious boundary in which the fortifications would be one of the key elements for control. During the monarchy of Philip II large fortresses or fortified cities with the names that the defenses received, were named after San Felipe, San Jorge…, and became the hallmark against Counter-reform mentality[5] (Cámara, 1998: pp. 77-78).

With the sixteenth century the long period of struggle during the time of King Philip II came to an end. The next century began with a state of relative peace throughout Europe, with the exception of the war that Spain still held against the Netherlands. It is precisely in this area where fortifications will be more exposed because of the many conflicts which evolved faster than in other countries.

So in addition to using the many possibilities that water offered them as an obstacle to an enemy attack, the Dutch developed a series of defensive lines capable of successfully facing the attacks of the besiegers. The Dutch system progressively built a complex system of defenses in depth, composed of multiple external works such as

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[5] A clear example of this, it is the San Fernando fortress in Figueras, all defensive elements were named as saints: Saint Bárbara, Saint Dalmacio, Saint Narciso, Saint Tecla, Santiago and Saint Felipe bastions; Saint Antonio, Rosario, Ánimas and Saint José ravelins; Saint Zenón, Saint Roque and Saint Miguel hornworks; Saint Juan and Saint Pedro counterguards.

ravelins, hornworks, crowns and others. This had a particular influence on the subsequent development of fortification bastion in the remaining countries (Díaz, 2004: 168).

The characteristic mark of the second half of the seventeenth century in the field of fortifications is the figure of Marshal Vauban, not only for the large number of fortifications built under his direction, but also on the level of perfection reached. The principles of adaptation and staging ground ball defense were consolidated in his constructions.

If a section of the fortress was little attackable, they used large external sides to reduce construction spending and obtained long defense lines, that considered sufficient, because in such conditions could be satisfied with the flanking by the cannon. Vauban wrote much, but almost everything were individual reports on the properties of certain places. As for fortification treaties refers where they could find the rules constituting tracing system, Vauban said nothing in that respect. However, in teaching is traditional fortification of Vauban considered three systems, you really should reduce them in two, since both second and third calls are merely variations of the first (Fig. 4).
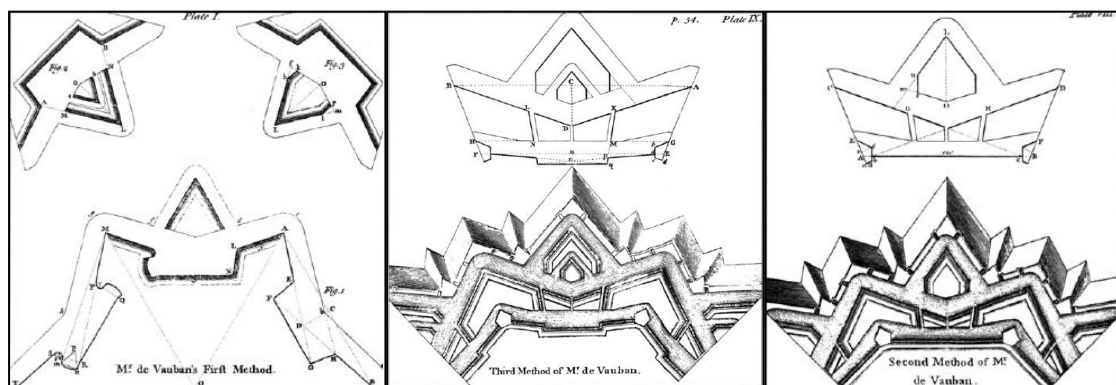

Fig. 4. Vauban never intended to expose their systems, but others felt they would be unable to understand their work unless it was reduced to a series of systems. The three systems Vauban by Müller, 1746 (as P. Griffith, 2006).

Despite all the technical innovations applied to the fortifications after the Vauban period, the bastion fortification was coming to an end. The eighteenth century was not fruitful in fortification constructions in Europe. While at the beginning of this century, the bastion fortification had reached its heyday, shortly after, its evolution had stopped. Although the bulwark would maintain its role until the mid-nineteenth century, but only in a languid and routine way. Meanwhile the artillery, from the middle of the eighteenth century, began a new period of modernization, increasing mobility, range, accuracy and rate of fire (Díaz, 2004: 199).

5. SIEGE TECHNIQUES OF THE SIXTEENTH TO THE SEVENTEENTH CENTURY

As mentioned previously, improvements in the methods of attack accelerated the evolution of bastion fortification, so it seems appropriate to make a reference to this issue.

As it had happened before during the Middle Ages, throughout the sixteenth and seventeenth centuries battles in open field were still exceptional events while sieges of fortresses were much more important and numerous. Such was the importance of this type of operation that an entire campaign, or even more than one, could be devoted to the execution of a single siege. Take as example La Rochelle, whose siege lasted from 1627 to 1628[6] (Sáez, 2010: 18).

The art of the siege and defense of fortified places suffered a considerable leap in the sixteenth century onwards. However, the techniques and strategies to yield a stronghold remained basically the same as during the medieval period, with the only exception that the guns and walled enclosures were considerably modified.

The attack procedures prior to Vauban were based on the construction of the correct safe distance, taking advantage of the strong points of the terrain, heavy batteries intended to be pulling on the fortress and protect the trenches, zigzags, headed towards a covered way through defiladed areas (Fig. 5). Upon reaching this location, the troops had to occupy it by force, and from there, breach the walls with mines or batteries gap. The disadvantage of this system was that the attacking artillery pieces were placed in fixed positions so that they could not adequately protect the assaulting troops, so the assault to the covered way and fortified place caused a large number of casualties.

Fig. 5. A comparison of siege-works before and after Vauban.

If the paths and principles of Vauban had influence in every nation, the field in which it truly innovated was in the art of the siege, for which he applied new rules and

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[6] Reducción de la ciudad de La Rochela, y relación de su cerco, con las varias victorias alcanzadas del Ingles, por el Christianisimo Rey de Francia Luis el Justo XIII, 1627: National Library, Madrid, R.Micro/32647.

precepts, perfecting the execution of the work of undermining and employment of artillery. His innovations consisted of:

- In the construction of parallel, extensive trench lines with a broad front heading the fortress to receive fire from higher positions and reject them afterwards (Fig. 5).
- With the shot to bounce when loading the guns with less amount of shooting powder, a more curved shot was obtained, which made bullets cross over the parapets after several rebounds in their successive collisions on the floor.
- Trench knights, dominant works created to send out the defender covered way. Vauban gave them the aforementioned implementation, reducing them to a realistic size avoiding loss of lives and time (Fig. 6).
- In the dogmatic character printed Vauban to the direction of the work, the structuring the number of parallel lines, its length and distances, zigzag branches, the placing of batteries and generally all the work and in his clear preference for the slow advance through mining, preventing the actions of force, brilliant but expensive.
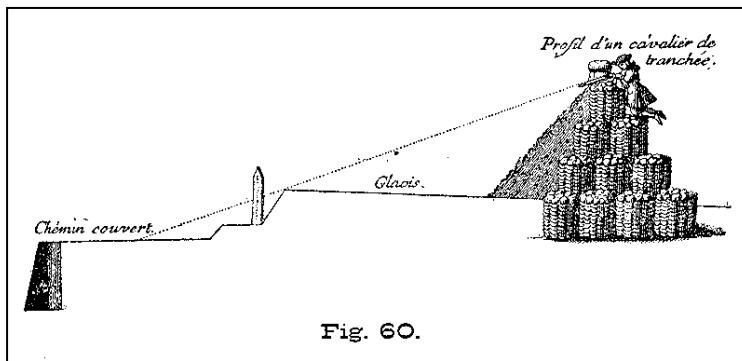

Fig. 6. Profile of a trench knight.

After this brief analysis of these siege techniques you can see some degree of analogy with its fortified counterpart, having both evolved hand in hand with the art and science of the time, both becoming an exact science, since they had in their origin complicated geometrical analyses, both in their tracing as well for the attack.

6. CONCLUSIONS

In this paper we have briefly summarized those defensive elements that evolved from medieval castles to face the new threats had to face.

As previously indicated, the walls, towers and other defensive elements of the castles, which were effective for many years against the primitive war machines used against them, will suffer, with the use of gunpowder on the battlefield in the form of a primitive artillery, an unexpected and necessary transformation to survive in the new war technology.

This transition will merge as a result of a series of political, social and technical factors. The first of them would be the establishment of European authoritarian monarchies, which would be the only power capable of financing the construction of such defenses to maintain their territorial interests; the second arises from the new

thinking emerging from the Italian Renaissance, tending to restore classical civilization and arts, through which numerous treaties on fortification were recovered and its ideas applied to the new situation. And the last point would be the practical application of new ideas arising from the two points above to the technical field. The old medieval walls, ineffective against artillery, had to be transformed, changed in its design and materials, thus trying to restore the balance between defense and attack.

We also analyzed the threats suffered by these fortifications and their effectiveness when taking besieged places. Fixing the timeline at the end of the fitheenth century, the different ways of attacking a fortress are studied, from the simplest like the use of ladders, to the most complex and expensive such as the sieges of places.

Although there was no method to guarantee a hundred percent the capture of a fortress, some of them seemed almost childish[7], while others were of a praiseworthy technical perfection. The problem with most of them was their dependency on many factors unrelated to its planning for a satisfactory end, because firearms in this period had a limited range and accuracy, which required a fight close to the enemy with a high number of casualties in most cases.

The second part of the text deals with the evolution of bastion fortification, its origins, expansion and, finally, its decline due to the paralysis of their outlines and especially the technical development of the artillery. The presence of these walled enclosures meant that major military operations should focus on the siege of such defenses, as an enemy army could not afford to leave behind them a fortress with an intact garrison, since there was the possibility that it could attack their supply lines.

While, initially, the bastion fortification was able to balance the situation between defense and attack, mainly due to the implementation of complex designs and mathematical calculations to turn their outlines into works of art and engineering, gradually applying the same principles to attacking them turned their survival into a matter of time.

So, in conclusion, we can say that the art of poliorcetics experienced a steady process of refining since the late sixteenth century, beginning, as mentioned above, by applying mathematical parameters. The siege artillery was equipped with enough power to breach the walls within a period of time that could be calculated. With these data, it was possible to quantify the resilience of a fortress in time, in the case of not getting backup from the outside; Vauban was proud of being able to calculate the exact duration of a siege (Griffith, 2006: 5). In the case of using an appropriate train of artillery and a blocking tactic, victory could be taken for sure.

As mentioned in the introduction, the historical heritage of the fortification still remains largely unknown to most of the general public, the scarcity of literature regarding sieges and attacks on those defenses being even higher; thus, it would be desirable that in addition to the ancient treaties on fortification, some initiatives might appear that would lead to the divulging of such poliorcetics techniques.

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[7] Among these we may mention the feint and the intelligence or treason, cited in the Treaty of Peter of Lucuze "*Principles of Fortification*", 1772, pp. 110-111; where their skills in succeeding in attacking a place are positively valued.

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