Description and Characterization of the Terracotta Army Footwear

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Zásady pro vypracování:

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ABSTRACT

This diploma thesis was worked out under the topic: Description and Characterization of the Terracotta army Footwear. The aim of my diploma thesis is to process research findings about the First Emperor and his buried army formation with detailed information and description of the Terracotta army footwear.

Two pairs of replicas were made which represent the two main types of Terracotta army footwear. The replics were tested for biomechanical qualities and the values were compared with replicas of Oregon Indian sandals and Oetzi shoes.

From the results we can see that Terracotta army footwear reached maximum peek pressure values. In the graphic vizualisation of the plantar pressure distribution to a contact area; there is comletely missing load on inner sides of both feet in Terracotta army footwear.

Keywords: terracotta, army, emperor, China, 221- 207 B.C., military, biomechanics, history, qualities

ABSTRAKT

Diplomová práce byla vypracována na téma: Popis a charakteristika obuvi Terakotové armády. Cílem diplomové práce bylo zpracovat dostupné data o Prvním císaři a jeho pohřbené armádě s podrobným popisem tehdejší vojenské obuvi.

Byly zhotoveny dva páry replik reprezentující hlavní dva druhy obuvi používané čínskou terakotovou armádou. Byl vypracován test biomechanických vlastností obuvi a ty byly porovnány s replikami obuvi oregonských Indianů a Ötziho bot. Z výsledků můžeme konstatovat, že obuv terakotové armády vykazuje největší hodnoty tlaků a v grafickém vyobrazení plantarních tlaků vyhledem ke kontaktní ploše je patrná absence zátěže na vnitřních stranách chodidla.

Klíčová slova: terakota, armáda, císař, Čína, 221- 207 př.n.l., vojsko, bimechanika, historie, vlastnosti

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CONTENTS

INTRODUCTION

China is a cultural region and ancient civilization in East Asia. China is one of the world's oldest civilizations, consisting of states and cultures dating back more than six millennia. [1]

China is called Zhongguo in Mandarin Chinese. In ancient times the term referred to the "Central States" along the Yellow River valley. Ancient Chinese derived their country's name as "Middle Kingdom" because they believed they were in the middle of the world. English and many other languages use various forms of the name "China" and the prefix "Sino-" or "Sin-". These forms are thought to be probably derived from the name of the Qin Dynasty that first unified the country (221-206 BC) and established a centralized system of government. The Qin Dynasty unified the written language in China and gave the supreme ruler of China the title of "Emperor" instead of "King". The First Emperor of Qin, rules for a very short time but lays the foundation for China's imperial structure and begins construction of the Great Wall for defense to the north. [1]

Emperor Qin suffered a lifelong fear of death. He constantly searched for an elixir to guarantee his immortality. Having failed to find one, he decided to assure himself an easy passage into the hereafter by taking his legions with him. He amassed an army of artisans almost as large as his military. He commanded them to create a life-size clay duplicate of every soldier in his service. One by one his soldiers modeled for the sculptors. As each statue was finished, it was fired in a kiln, painted, and mounted in a giant pit, exactly where that man would stand in formation on a battlefield. When they finished, the emperor had a terra cotta duplicate of his entire army. [2]

In March 1974, several of China's leading archaeologists gathered at a place 1.5 kilometers east of Qin Shi Hung's Mausoleum in Lintong County, Shaanxi Province, to excavate a 14,000-square-meter vault in which thousands of terracotta warriors and horses had remained entombed for over 2,000 years. Thus, the terracotta army, known as another "Wonder of Ancient Civilization," was brought to light. [3]

The found speaks volumes about Qin military power. It provides an incredible amount of information of the distribution and information of ranks on the field, the use of weapons, and oveall tactics in ancient Chinese warfare. [4]

The buried army is one of the greatest archeological finds if all time, the terra-cotta army of China´s first emperor also has involved one of the biggest excavations ever carried out in that century.

The aim of my diploma thesis is to process research findings about the First Emperor and his buried army formation with a detailed information and description of the Terracotta army footwear.

I. THEORY

1 CHINA

China represents one of the earliest civilizations in the world and its history is detailed as far back as 16th century BC. China is one of the oldest continuous civilizations. The origins of Chinese civilization started with city-states in the Yellow River valley. The year 221 BC is commonly used as a date when China became unified under a large kingdom or empire. Successive dynasties developed systems of bureacratic control that would allow the Emperor of China to control the largest territory that would become known today as China. [5]

1.1 Shaanxi Province

Shaanxi Province is located in the very heart of China (Fig. 1.). With an area of over 200,000 square kilometers (about 77,225 square miles), Shaanxi includes most of the middle stretch of the Yellow River. It borders Inner Mongolia, Shanxi, Henan, Hubei, Sichuan, Gansu and Ningxia. [6]

Fig. 1. Shaanxi Province, China [6]

History of Shaanxi Province is one of the most important cradles of ancient Chinese civilization. As far back as one million years ago, some of China's earliest inhabitants lived in this region, and began spreading their culture along the life-sustaining Yellow River. Throughout the province's long history, there are 13 dynasties who established capitals here, including the Zhou, the Qin, the Han, and the Tang. Because of this rich history, cultural relics and ruins are plentiful, and may be found preserved both above- and underground. So Shaanxi is called the "authentic history museum" in China. [6]

1.1.1 The Capital Xian

Xian is the capital of Shaanxi province (Fig. 2.), located in the southern part of the GuanZhong Plain. With the Qinling Mountains to the north and the Weihe River to the south, it is in a favorable geographical location surrounded by water and hills. It has a semi-moist monsoon climate and there is a clear distinction between the four seasons. [6]

Xian, the eternal city, records the great changes of the Chinese nation just like a living history book. Called Chang'an in ancient times, Xian is one of the birthplaces of the ancient civilization in the Yellow River Basin area of the country. During Xian's 3,100 year development, 13 dynasties such as Zhou, Qin, Han and Tang placed their capitals here. So far, Xian enjoys equal fame with Athens, Cairo, and Rome as one of the four major ancient civilization capitals. [6]

Fig. 2. Shaanxi Province and the capital Xian [6]

2 QIN SHIHUANG – CREATOR OF TWO WORLD WONDERS

Many important men have crossed the Chinese historical stage during the last 5,000 years. One of the most important was to be known later as Emperor QinShihuang, the first Emperor of the Qin Dynasty (Fig. 3.). He inherited as a King of Qing State at the age of 13 and claimed as Emperor when he was 39. [7, 8]

Fig. 3. The First Emperor of Qin [7]

In order to consolidate his rule, he instituted a series of new policies. Probably his greatest contribution to the practice of government in China was his establishment of the centralized State and abolition of feudal system. To further unify the country, Emperor Qin standardized the system of weights, measures and handwriting. All these measures helped to establish a high centralization of politics, economy, military affairs and culture. He uniformed the law and strengthened the unity of the nation. [7, 9]

Ensuring the security of his new empire was a major concern of Emperor Qin. An imperial road network on an unprecedented scale was ordered to build and a highway was opened through Capital XiangYang to the northern border. Undoubtedly the First Emperor's greatest and most impressive achievement in this respect was his connecting and rebuilding of the defensive walls previously built by different states in the Warring States Period. This came into the Great Wall of China, one of the wonders in the world. [7]

Finally in 221 B.C., the King of Qin achieved his final victory and ruled until 207 B.C. No sooner did he become emperor, than he began preparing for his death. He ordered more than 700,000 workers to build his underground tomb. It took 40 years to finish. [5, 7]

In 210 B.C. the First Emperor of Qin died of illness at Shaqin (now Guanzong County, Hebei Province) at the age of 50 on his way of inspection through the Empire. The First Emperor of Qin was then buried in Qin Mausoleum in the north of Lishan Mountain, in the east of Lington County. The Emperor thought that he was the richest when alive, and should be the most luxurious after his death. Countless rare treasures were therefore buried with him. The Qin Shihuang Terracotta Warrior and Horse Figures were only a small part of the treasures buried with him. [8, 9]

In 209 B.C., a peasant rebellion on a large scale in Chinese history ended the Qin Empire. The Qin Empire only lasted for fifteen years, but its developement in various fields laid a foundation for exerted far-reaching influence on the development of various dynasties in Chinese history thereafter. [7]

Ancient China left the whole world two wonders – the Great Wall and the Qin Shihuang Terracotta Warriors and Horse Figures. [9]

2.1 Emperor Qin Shihuang´s Mausoluem

Burial mounds that conceal tombs below apperead early in the late Spring and Autumn Period (770 B.C.-476 B.C.), but none of them had been as huge as Emperor QinShihuang Mausoleum. [7]

The mausoleum is situated at the nothern foot of Mount Li, some 35 kilometres east from Xian city. The main reason why the emperor selected this place is due to its good FengShui. FengShui is the art of science of positioning man-made structures in harmony with the vital cosmic energy coursing through the earth. [7]

The mausoleum started to be under construction soon after QinShihuang became King of Qin. The contruction of Emperor Qin´s Mausoleum lasted near 40 years. Thousands and thousands of people were involved in this huge construction. There were at least 720,000 conscripts working there. [7]

2.1.1 Emperor Qin´s Mausoleum and The Satellite Pits and Tombs

The construction of the emperor´s tombs is recorded in the ShiJi (Records of the historian) as follows: „They dug through three subterranean streams and poured molten copper for outer coffin, and pavilions and officials, as well as fine vessels, precious stones and rarities. Artisans were ordered to fix up crossbows so that any thief breaking in would be shot. All the country´s streams, the Yellow River and Yangtze were reproduced in silver and by some mechanical means made to flow. The heavenly constellations were shown above and the regions of the earth below. The candles were made of whale oil to ensure their burning for eternity.“ [7]

The description can provide us that Emperor QinShihuang´s tomb was actually an underground treasure-house (Fig. 4.). The tomb was a subteranean palace with a protective outer wall. Within this area was an inner wall that surrounded the burial mound, located in the southern half of overall compound. Both of the wall had gates leading out in all four directions and watch towers. The burial mound was 115 meters high 2,200 years ago, it´s reduced to a height of 76 meters today due to the passage of time. With the emperor´s tomb as the center, come 600 satellite pits and tombs have been found around within the area of 56,25 square kilometers. Some tombs contained bronze horse-drawn chariots, built in imitation of the Emperor´s chariots; in other pits there have been found terracotta birds and animals, symboliying the Emperor´s love for hunting; some other pits housed replicas if the imperial stable. Since the discovery of the pits of the Terra-cotta Warriors and Horses in 1974, more and more satellites and tombs began to be known and unearthed. [4, 7]

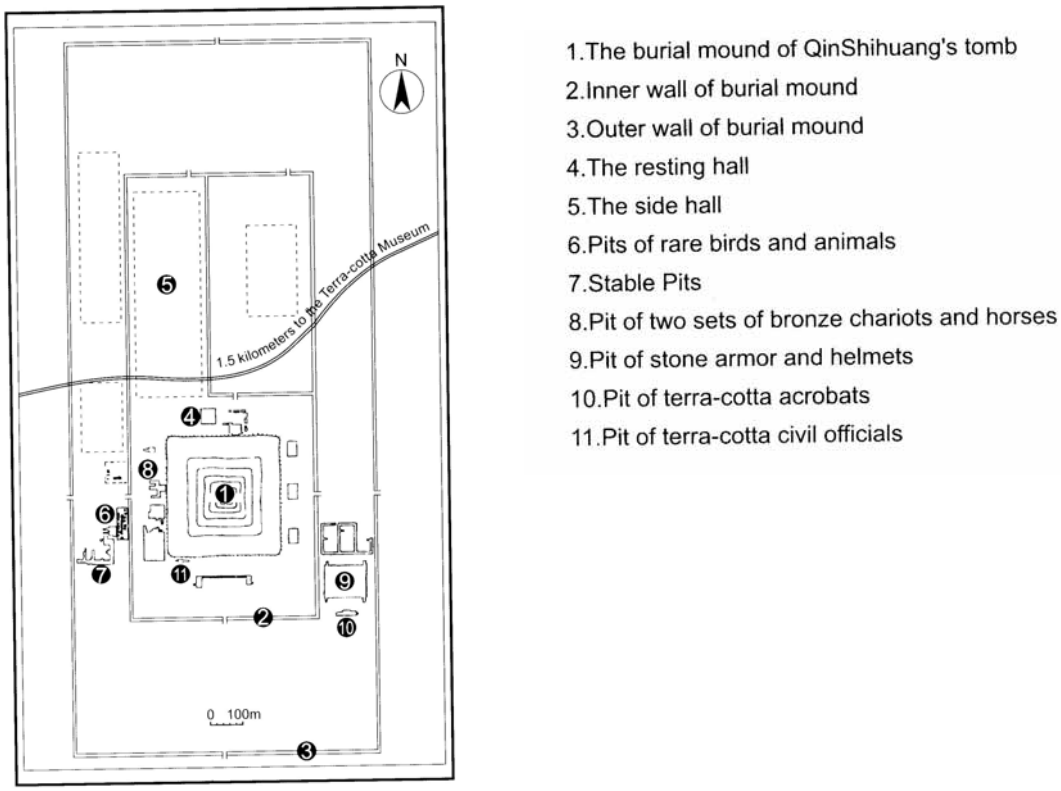


Fig. 4. Location map showing Emperor Qin´s Mausoleum and some discovered satellite pits and tombs [7]

3 DISCOVERY AND EXCAVATION OF TERRACOTTA ARMY

It was in March 1974, when local farmers were drilling a well in search of water, that large pottery fragments were discovered 1.5 kilometers east of Emperor Qin´s Mausoleum. This finds subsequently led to the revelation of one pit of the First Emperor´s buried army 2,200 years ago. Since then continual archeological work and excavation discovered another two pits successively (Fig. 5.). It has been revealed that three underground pits totally cover an area of 22,000 square meters, housing an estimated 8,000 life-size pottery warriors and horses. [7]

The three pits were built in similar basic construction. They are five to seven meters beneath the present ground level with the terra-cotta figures placed in corridors. The corridors, divided by earth-rammed partition walls, are paved with pottery bricks on which the figures were placed. The earth walls sustained a wood roof that was composed of huge and strong rafters. The roof was covered by layers of fiber mats, earth fill and tilled earth. All these were constructed to totally conceal the army. [7]

The three pits are independent of each other; not connected by any passage and vary in size and shape. Pit 1 is the largest one in rectangular shape, housing the main force of the army. Pit 2 is located some 20 meters north of Pit 1, which is a complex battle formation formed by charioteers, archers, cavalrymen and infantrymen. It is specially used for supporting the main force. Pit 3, located 25 meters to the north of Pit 1 and to the west of Pit 2, was evidently the headquarters. The total three pits are located to east of Emperor´s Mausoleum, determining that the army was facing east, with its back to the tomb, serving as guardians to protect the entrance of the Emperor´s burial. [4, 7]

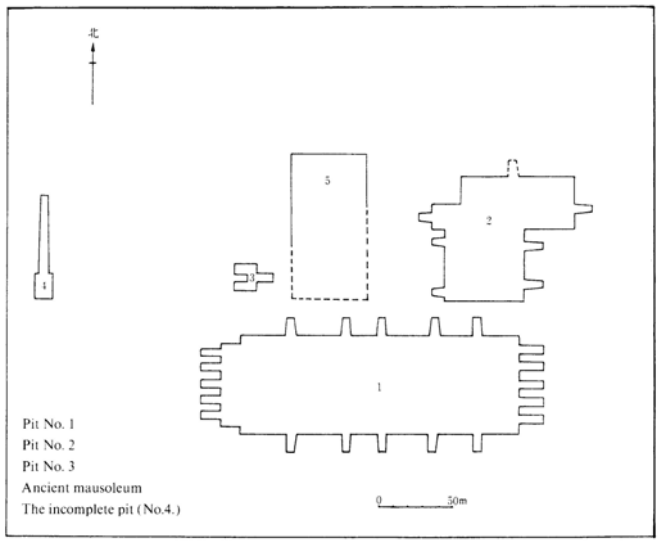


Fig. 5. Relative positions of Pits No. 1, 2 and 3 [4]

3.1 Pit 1

Pit 1, the largest pit, is in rectangular shape. It measures 230 meters long from east to west, 62 meters wide from north to south and 5 meters deep, covering an area of 14,260 square meters. Five sloping roadways into the pits were constructed on eastern and western sides of pits to permit access. [7]

Pit 1 contains the main fighting force of the underground army. The terra-cotta warriors and horses are arranged in a practical battle formation (Fig. 6.- 9.). At the eastern end of the pit there are three rows of vanguards, 68 in each, totaling 204 soldiers standing shoulder to shoulder who were originally equipped with genuine bows and crossbows. Immediately behind the vanguards is the main body of the battle formation containing 11 corridors with 30 chariots, each of which was drawn by four horses, armored and unarmored soldiers held weapons originally, such as spears, halberd etc. Around the outer edge, there is one row of soldiers with crossbows facing south, north and west respectively as the flanks to guard the sides and rear of the army. According to the density of each trial trench that has been excavated, it´s assumed that more than 6,000 pottery warriors and horses will be unearthed from Pit 1, most of which are infantrymen. [7, 10]

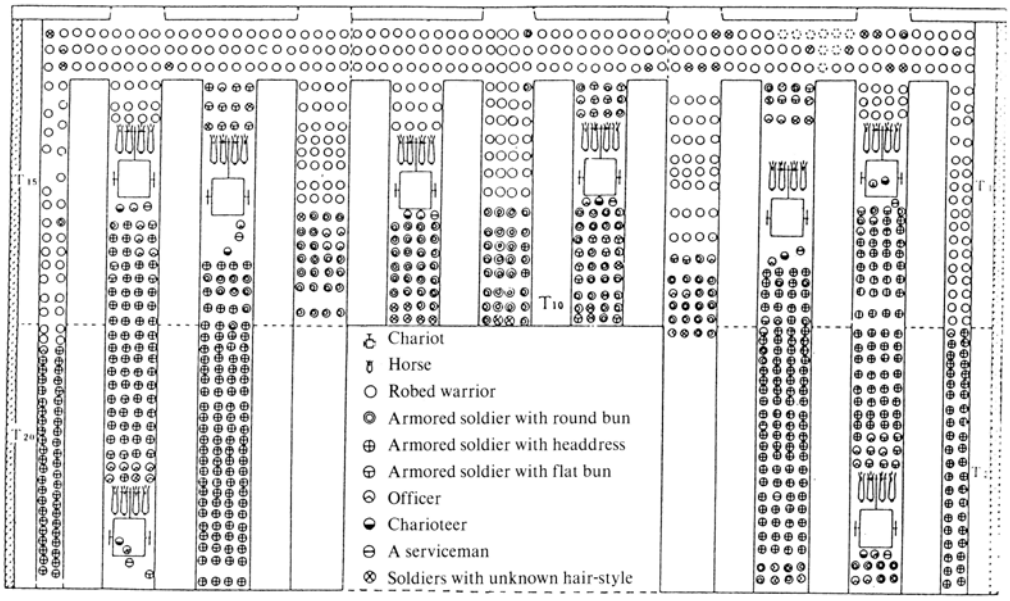


Fig. 6. Plan of the battle formation in Pit 1 [7]

Fig. 7. Inside view of Pit 1 [4]

Fig. 8. Battle formation in Pit 1 [11]

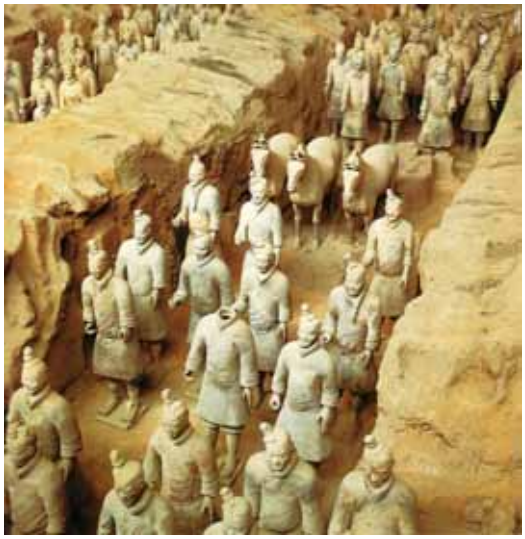


Fig. 9. Infantrymen and a war chariot in Pit 1 [4]

3.2 Pit 2

Located 20 meters to the north of Pit 1 at the eastern end, Pit 2 is in „L“ shape with a protruding rectangular area at the northeast corner. The pit was discovered in 1976, covering an area of 6,000 square meters. Different from Pit 1, over 1,300 pottery figures in Pit 2 were placed in four specialized military forces (Fig. 10.). [7]

The protruding northeast area houses 332 archers in all, 160 resting on their right knees were arrayed into four columns with 172 standing archers surrounding (Fig. 11.). All these archers, whatever kneeling or standing soldiers, face eastward. The south area is compoused of war chariots. Total 64 chariots were arrayed in 8 columns, also facing east, eight chariots with their chariot horses in each column. Originally made of wood. The chariots were completely deteriorated when unearthed. Each chariot in this group was accompanied with a charioteer, who was flanked by two attendant soldiers carrying long weapons. The middle area consists of war chariots in the front, immediately followed by infantrymen and the cavalry at the rear. The north area has only cavalry. There are totally 108 cavalrymen. Each of the cavalrymen stands in front of his saddled war-horse, holding the reins in right hand and a bow in left hand. [7, 10]

The four arrays seemed to exist independently, but could be assembled immediately to constitute a complete battle formation during the war times. This reflected the unique military strategy of the Qin army – army array within army array. [7]

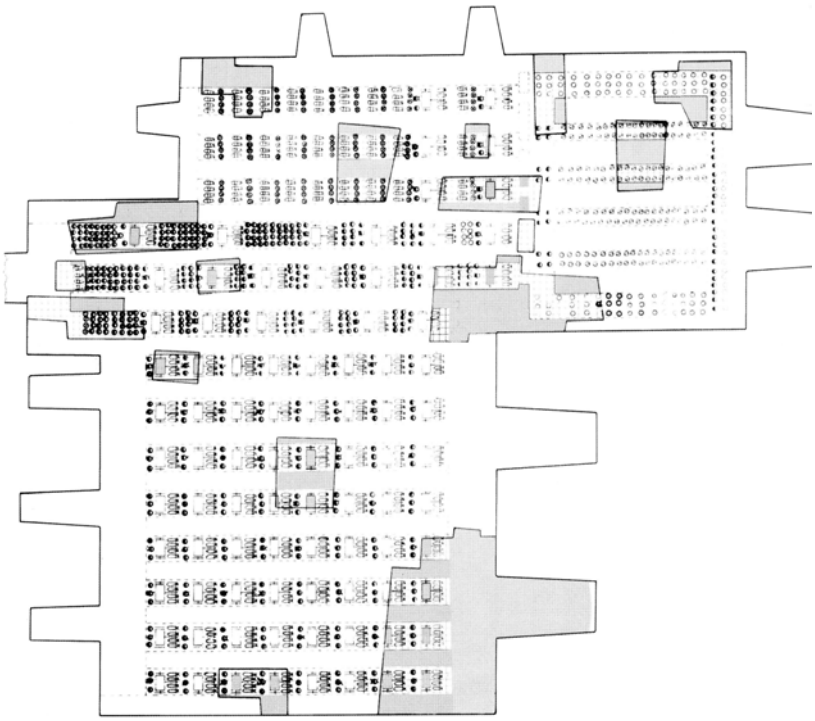
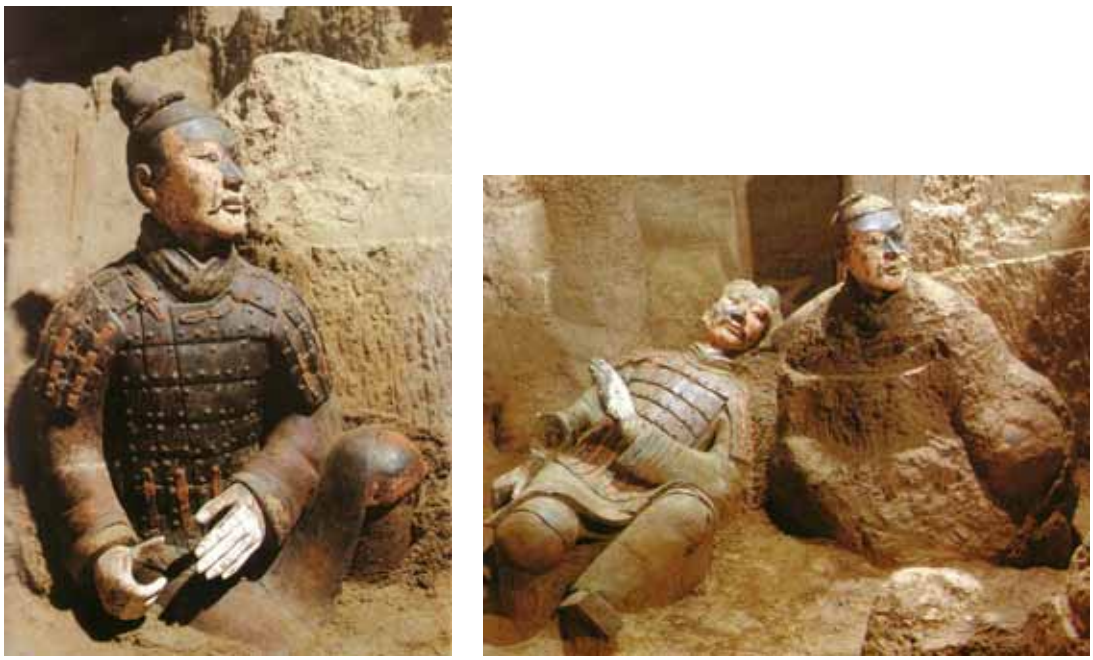


Fig. 10. Diagram of Pit 2 showing layout of pottery figures and chariots [12]



a) *b)*

Fig. 11. Excavated site of the kneeling archers in Pit 2

a) side view,

b) front view [7]

3.3 Pit 3

Is the smallest of the three pits and was discovered in 1976. Only 68 pottery figures and one chariot drawn by four horses were unearthed in the pit. It is of U-shape about 520 square meters (Fig. 12.). Pit 3 is now known as the command center of the entire army, because the following reasons. [7]

Its position in the far northwest corner of the overall plan ensured that is well protected by the armies of two larger pits. At the eastern end of the pit, there is a sloping road served as the entrance, then followed by an ornate canopied chariot with four armored officers. The chariot with canopy was colourful painted, representing higher rank (Fig. 13.). [7]

In the north and side chambers, 64 fully armored figures were found. Unlike the soldiers in Pit 1 and Pit 2, these figures were arrayed face-to face with their backs to the wall, suggest that they were the guards (Figure 14., 15.). Even the weapons held by these guards are different from those in another two pits. [7]

Once the terra-cotta warriors and horses were all arrayed inside the corridors, the entrance were closed. It meant a sealed united army was formed to guard Emperor Qin´s underground palace. [7]

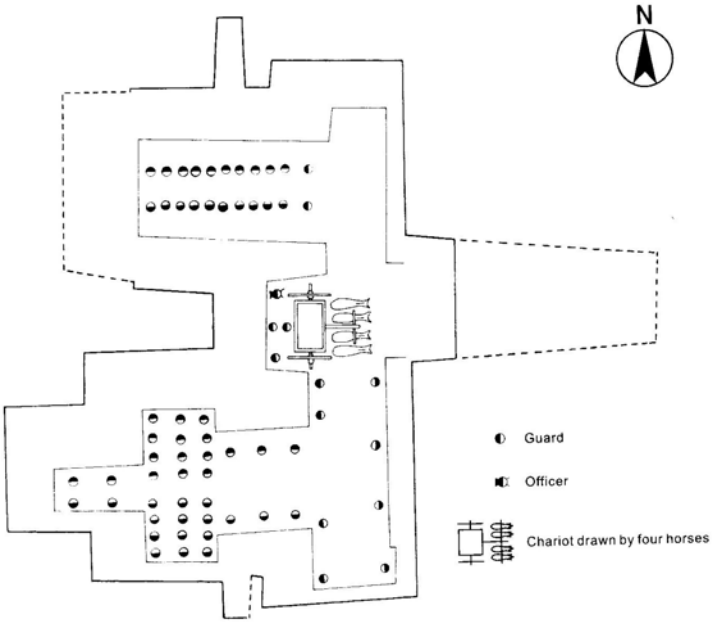


Fig. 12. Plan of the battle formation in Pit 3 [7]

Fig. 13. Chariot section of Pit 3 [7]

Fig. 14. Pottery figures in the south section of Pit 3 [7]

Fig. 15. South section of Pit 3 [12]

4 TERRACOTTA FIGURES

Watching the Qin Figures in the Museum, we can easily draw a conclusion that most of the Qin Figures are young, a small part are middle-aged and only a few are old warriors. The moderate type of the Figure is about 175 cm tall. The height of the tallest one is over 190 cm. [9]

There are ten facial types. Some are oval, some are round and some square. Most excellent is that, each face is more or less different from the other. Facial expressions can be divided into eight basic types: majest, earnest, pondering, constientious, childish, happy, sad and dissatisfied. The shape and structure of Qin Figures´ noses, eyes, mouths and ears are portrayed perfectly. Ancient Chinese men wore long hair and they were fastidious to their hair style. [9]

Except the faces and hands, the figures are mainly covered with clothes. They have caps on head, shoes on feet, war-robes or armor on bodies and collars around necks and gaiter bind feet. [9]

The general Terracottas are leaning on the sword. The cavalryman Terracottas are leading the horse, the infantryman Terracottas have weapon and the driver Terracottas are holding the halter tightly. Some archer Terracottas are standing and some are kneeling. The whole army are ready for war as soon as Qing Shihuang issures an order, a large number of mounted and foot soldiers will run to the battlefield. [9]

Over all, the Qin Figures are made absolutely lifelike.

4.1 The types of Figures, identity, clothes and personal adornments of the Terracottas

In the feudal Qin Dynasty, the hierarchy is very rigorous, which we can find out clearly from the clothes of Qin Figures. On the heads, hats and hair styles are different. The upper outer garments and armors on upper bodies, the trousers and shoes on the lower bodies are not the same. [9]

There are six levels. The first level is Terracotta of high-ranking officer. He has a general cap whose appereance is handsome and elegant on head and wears the general armor which is made of leather and has knots on chest, back and shoulders and scale-like armor on abdomen and waist. Under the armor there is a double-thick long coat that is the general´s characteristic. The outer coat is very short and the inner coat very long. His trousers are long enough till the ankle joint and cover the whole legs. And there is a pair of raise point shoes on his feet. [9]

The second level is the Terracotta of middle-ranking officer, on whose head there is a long hat of two boards form, the basic symbol. [9]

A third level is the lower-ranking officer, on whose head there is a long hat of one board form and the armor is joined by armor pieces directly. There are some pads under armor and armor piece is big. [9]

The officer class is identified by their greater size and more ornate armor including headgear and small tabs or sashes which may be emblems of rank. [7]

The fourth level is Terracotta of armored warrior, on whose head there is a scarf, a kind of taper-like hat. And his armor is bigger and fewer in number. [9]

The fifth level is Terracotta of war robe warrior wearing a long robe without any hat and armor protecting body. [9]

The last level is cavalryman Terracotta whose clothes are portable for riding and shooting. The cavalryman is immediately identifiable by the tight fitting helmet tied under the chin, together with tight fitting armor to the waist and flared robe. [7, 9]

From those, we can see clearly that the clothes, and personal adornments, especially the hats and armors show the levels of the army, noble or lower. [9]

4.2 The Terracotta Figures´ Construction

In China the pottery figures could be dated back long time ago. But the pottery figures before the Qin Dynasty were roughly made in small size and the temperature for baking in the kiln was low, too. The Qin Terra-cotta Warriors and Horses were big in life-size and exquisitely made with high technology. The hardness of their bodies indicates that they might be fired at a temperature between 950 °C and 1,050 °C. [7]

All of the soldiers and horses were made of coils of coarse gray terra cotta, a kind of clay. The weight of the Terra-cotta Warriors varies from 110 kg to 300 kg. The average height is 1,8 m. How these large and heavy statues were made 2,200 years ago? Investigations into the construction of the figures have shown that the same method was used throughout the entire production. In general the bodies, heads and arms of human figures are hollow and legs solid. Clearly such large figures could not have been produced from single mold and it seemed they were constructed from a number of separately molded or modeled segments that were glued together before firing. First, the coils were coated with finer clay. The feet and the pedestal on which they stood were hand made or molded with the legs. The torso was either sculpted from strips of clay or cast prior to the attachment of the arms. Next, the warriors' heads and hands were attached. The heads were made of two-piece molds that were joined together later. Ears, noses, hairstyle, mouth, moustache and beard were hand made independently and then added on. No two figures unearthed so far have the same feature or expression. Some experts think that the real soldiers served as models when Terra-cotta Warriors were made. Besides different faces, features as the armor plates with fixings, belt hooks, shoe ties and costume details were precisely sculpted. Then the bodies were painted and fired. [5, 7]

These clay soldiers, chariots, and horses are the earliest known examples of large sculpture by Chinese artists. The site is considered one of the most important archaeological finds of the twentieth century. [5]

4.2.1 The Colorful Uniform of Qin Terracotta Figures

Archaeologists have determined that originally the figures were completed with painted detail, but ravages of floods, fire and time have erased original paint from statues. However, guided by flakes of paint remained on the figures; an approximation of the figures´ original appearances can be modified as follows. Two new points can be known from them: Qin army had no standardized colors for uniforms and various colors can not help distinguish different ranks. It means that warriors of different ranks sometimes wore same color of clothing homemade.

5 DESCRIPTIONS OF INDIVIDUAL RANKS

The pits containing the terra-cotta pieces are more than a tresure trove for historians. The legions remain the only discovery of so great a number of life-sized sculptures in the history of Chinese archeology. The three pits include nearly 8,000 pottery soldiers and horses, still waiting for the command to attack. There lies the essence of the art of the terra-cotta warriors, which are combination of realistic style and individual characteristics. [4]

5.1 High Ranking Officer, Possibly a General

One of the tallest clay figures with the height of 197 cm and it was found in Pit 2. The officer's gestures and size give him a majestic presence (Fig. 16.). He is wearing double-layered robes covered by shoulder plates. Evidence suggests that his outer robes were painted dark purple. His trousers were in green and his square. The headgear he is wearing was painted brown. The colorful fish-scaled armor protected the chest, back and shoulders. The armor was usually painted brown and dotted with vermilion thread for linking the pieces. [7, 10]

The collar, chest, shoulders and edges of the armor were decorated with colorful patterns. There are eight knots made of ribbon to decorate the armor, three knots on the front plate, three on the back and one knot each on the shoulders. His carefully groomed moustache and sideburns convey a sense of authority, solemnity and dignity. [7]

Fig. 16. High ranking officer [7]

5.2 Officer

The officer, found in Pit 2, was wearing red trousers and a high-collar robe in green and under an armor cape originally (Fig. 17.). The collar and cuff were decorated by white and red patterns. Both his flat hat and square-toed shoes should be in black color. The figure wears chest armor, which is fastened by cross-straps on the back, over a flared battle robe. The ornate scarves around the neck possibly signify his commissioned rank. [7]

From position of the hands and arms, it is clear that this figure held weapons. [7]

a) *b)*

Fig. 17. An officer

a) front view,

b) color restoration [7]

5.3 The Armored and Unarmored Soldiers

A large quantity of soldiers has been discovered from the terra-cotta pits. Some of them wear armor, some do not. The colors of their uniform were much different when they were painted. But he armors were all painted brown, without the colorful patterns on. The robe varied in colors such as vermilion, green or blue, and the trousers green, white or pink. [7]

5.3.1 Unarmored Soldier

The figure, found in Pit 2, wears a knee-length robe without armor-plated uniform (Fig. 18.). Around the waist of the robe is a belt linked with a distinctive belt hook. The soldier also wears the short trousers and his shoe curved upward. The hair is tightly coiled into a neat bun on the right top of his head. The fact that he wears no armor allows for unrestricted movement. [7]

Fig. 18. Un-armored soldier [7]

5.3.2 Armored Soldier

The figure found in Pit 3 is 182 cm height and wears a battle robe with full body armor including shoulder pieces (Fig. 19.). He also wears short trousers, curve-toed shoes. The right arm is raised and would evidently have held spear. [7]

Fig. 19. Armored officer [7]

5.4 Charioteer with His Attendant Soldiers

The figure from Pit 2 was provided with a special uniform and extra armor to protect his arm, hand, neck and upper body. This was necessary because he needed to use both hands to hold the reins, and thus could not defend himself. His hands held firmly out in front to hold the reins. [7]

The attendant soldiers, who flank the charioteer, wear long robes in different colors; one is in red, another in green. Both soldiers carry long weapons in one hand while grasping the chariot with the other (Fig. 20., 21.). [7]

Fig. 20. Charioteer flanked by two soldiers [7]

Fig. 21. Painted reconstruction of the right and left flanking soldiers [7]

5.5 Cavalryman with His Saddled War-Horse

The cavalryman was an important element of Emperor Qin's Army, providing it with speed and agility. The figures of cavalryman so far discovered in Pit 2 were accompanied by a horse (Fig. 22.). [7]

The figure wears the short brown dark tight-fitting armor, green narrow-sleeved knee-length robe originally. Beneath the belted waist the robe appears full with pleats and folds. The small tight-fitting cap fastened under the chin was originally painted reddish brown, suggesting leather. The stitched leather shoes are represented in some detail with laces and ties. The figure holds the reins in one hand and a crossbow in the other. These horsemen were thought to serve as messengers during a battle. [7, 13, 14]

Fig. 22. Cavalryman with his horse [7]

5.6 Kneeling Archer

The figures of kneeling archers were discovered from Pit 2, their height is 120 cm. They own quite similar characteristics. The figure wears green battle robe covered by armor together with shoulder pieces. The battle robe was distinguished by the series of plates and folds as it rest over the legs. As with all of the terra-cotta figures, the archer was highly detailed, even showing the pebbled texture on the soles of his shoes. The hair was plaited on the back of the head and then coiled into a bun tied with vermilion

ribbons. [7]

He kneels on the right knee with the left knee raised. The right arm is held with the hand open, the left arm rests on the raised left knee and the hand extends across the chest. The pose of both hands evidences that this figure held one crossbow originally. The head is held firm and the eyes look directly ahead. The straight back emphasizes the impressions of concentration and discipline (Fig. 23., 24.). There have been 160 archers unearthed in Pit 2. [7, 13, 14]

Fig. 23. Kneeling archer [7]

Fig. 24. Painted reconstruction of the kneeling archer [7]

5.7 Standing Archer

There is a large number of standing archers discovered in Pit 2; their average height is 178 cm. Their uniforms were colorful painted when made (Fig. 25.). [7]

The figure was dressed in an unarmored red robe fastened around the waist with a belt, short green trousers, with shin guards and short boots. His hair was coiled into a neat bun on the right top of his head. The archer displays a posture: the feet stand apart with the right foot turned outwards and the left foot forward. His body is carefully tilted to the left with his pedant left arm and raised right arm in front of the chest as if to hold a crossbow. This is a position from which they are primed for an assault on the enemy. [7, 13, 14]

Fig. 25. Standing archer [7]

II. PROJECT

6 SURVEY

6.1 The Aim

According to Zhang Wembi, research fellow and director of Research Office of the Museum of the Terra-cotta Warriors and Horses of Emperor QinShihuang, there has not been found an evidence of the footwear in China before 300 B.C. To compare it with findings in Europe, Oetzi shoes found in the Alps have been claimed to be worn 5000 B.C. [15]

It is considered that textile binding was found in China around 200- 300 B.C. There has not been found any old shoes in China from ancient times. We know that three kinds of materials were common for shoe production- leather and silk by wealthy people and plant by poor ones.

The Terracotta army excavation provides an incredible amount of information on the clothing and footwear from ancient China. We can distinguish five different shoe types and two types visibly of different materials used for production.

There is an interesting point, Zhang Wembi was saying. He said there was no difference between male and female footwear. Although there has not been found a female statue in any of the excavated pits for proving this fact.

The Terracotta army shoes differ mainly in construction of shoe tips. We can find square and flat front parts of the shoes and most of the square shaped shoes have a turn up tip.

The design of the shoes correspond to a personal social status. The more the tip was curved up the higher rank it meant. Even a height of a shoe or thickness of soles put a wearer to a certain social group.

An exciting fact is that a color of Terracotta army shoes was not chosen according to a sex or a social status. While excavation there have been found rests of mostly brown and black shoe coloration on the statues. There is a binding at the upper peripheral edge of some shoes and we can notice that redish colors of this binding appears on statues with higher ranks up to the general. We can see various types of lacing up on leather boots which were supposed to be also colorful and remains of orange and green were found. The higher types of boots were probably made of materials of purple colors.

We can clearly see, especially on soldiers wearing knickerbockers (Fig. 21.), that they binded their calves. The infantry velites protected their thighs by cloth putees and infantry hoplites by girdles likely to be made of felt or even metal.

The aim of my diploma thesis is to process research findings about the First Emperor and his buried army formation with a detailed information and description of the Terracotta army footwear. As a part of the thesis there will be production of shoe replics of the Terracotta Army, description, mutual comparison and testing their biomechanical qualities.

6.2 Analysis of the Footwear of the Terracotta Soldiers

6.2.1 Square-shaped mocasins

A square-shaped type of shoe (Fig. 26., 27.) occurs through almost all ranks, especially by higher ranks like general, officer, armored soldier and kneeling archer. It is concerned the shoes might have been made from woolen felt.

The shoe is similar to a moccasin in a shape. It has square bottom, squared-off opening and turned-up tip of the shoe.

If the shoes are made from some type of hard material the wearer would have to wear some type of padding or socks to prevent the feet from hurting on sharp edges of the shoes and for all day comfort.

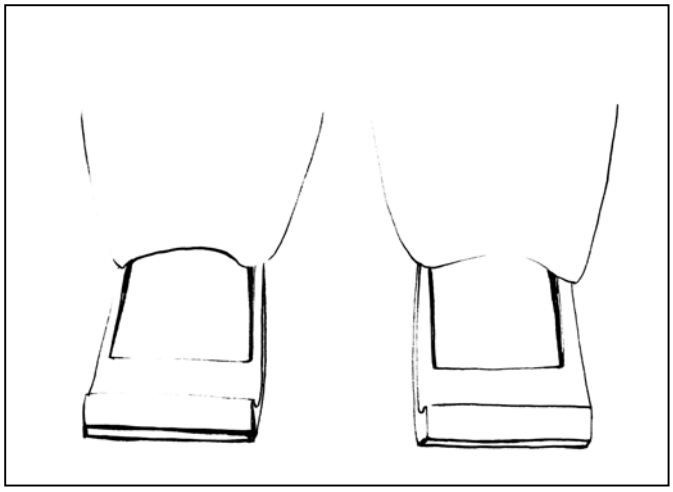


Fig. 26. Front view of square-shaped moccasins [16]

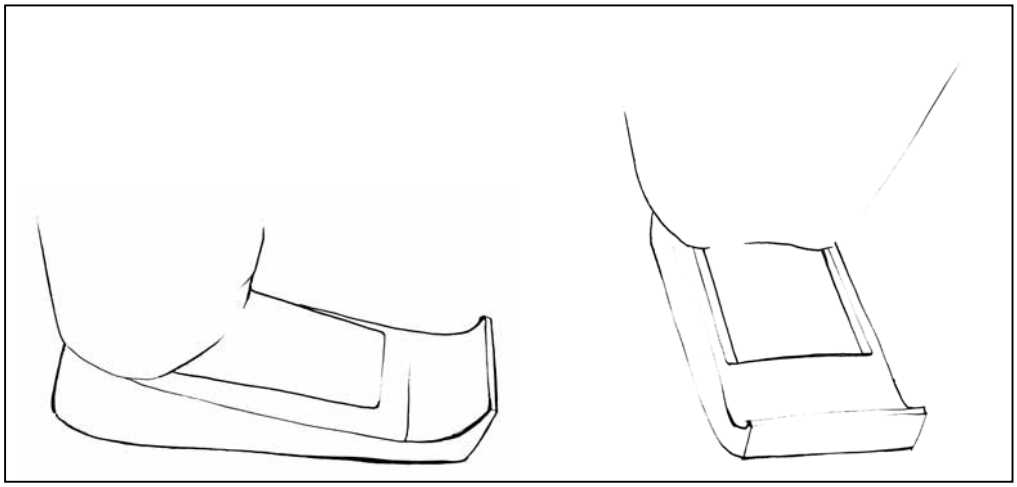
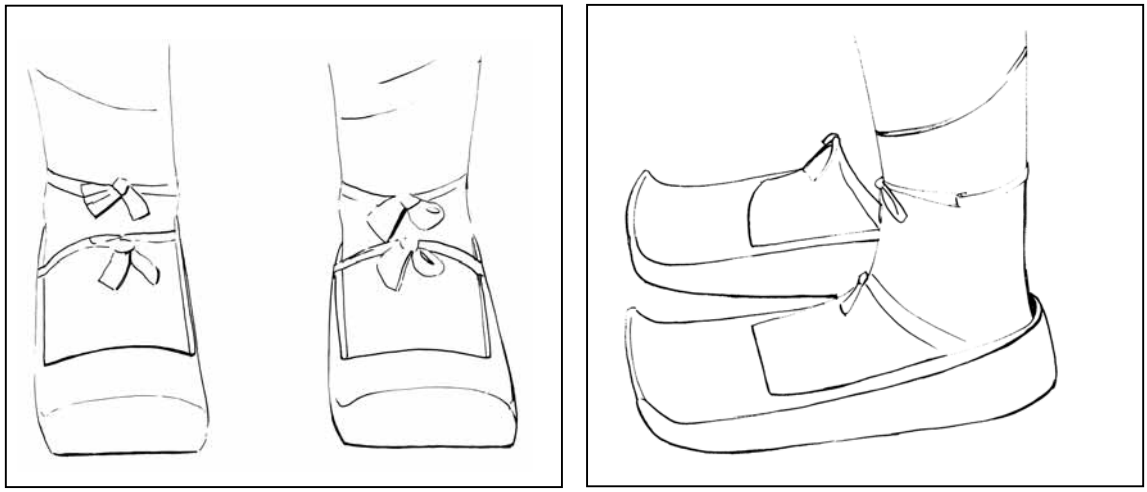


Fig. 27. Other views of square-shaped moccasins [16]

6.2.2 Square-shaped mocasins with shoe-string

Shoes with laces were discovered on officers, and both armored and unarmored soldiers. There are two groups of soldiers having this type of shoes. Soldiers dressed in long trousers and soldiers dressed in knickerbockers (Fig. 28., 29.). This type of squared upward curving shoe is built for outdoor terrain.



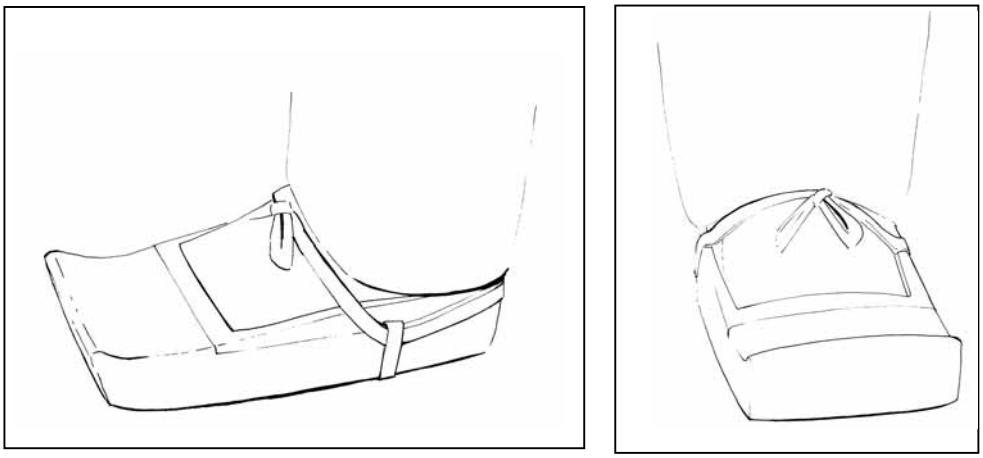
a) *b)*

Fig. 28. Square-shaped moccasins with shoe-strings on soldiers wearing knickerbockers

a) front view,

b)side view [16]

There is a flat shoe string, on a soldier dressed in trousers, probably made of leather, going over the top of the shoe, behind the heel and under the back of the shoe holding the wearer's foot safely into the shoe. A soldier dressed in shorts has the lacings crossed twice on his thigh.



a) *b)*

Fig. 29. Square-shaped moccasins with shoe-laces on soldiers dressed in trousers

a) front view,

b) side view [16]

6.2.3 Round-shaped mocasins with round shoe tip and shoe-strings

This is a rare type of shoe found only on a couple kneeling archers. It is probably a round version of squared-shaped mocasins (Fig. 30.). They are thought to have been made of felt.

They have simple shoe lace. The string is going under the heel part of the shoe and ends with a knot on a top of a foot instep.

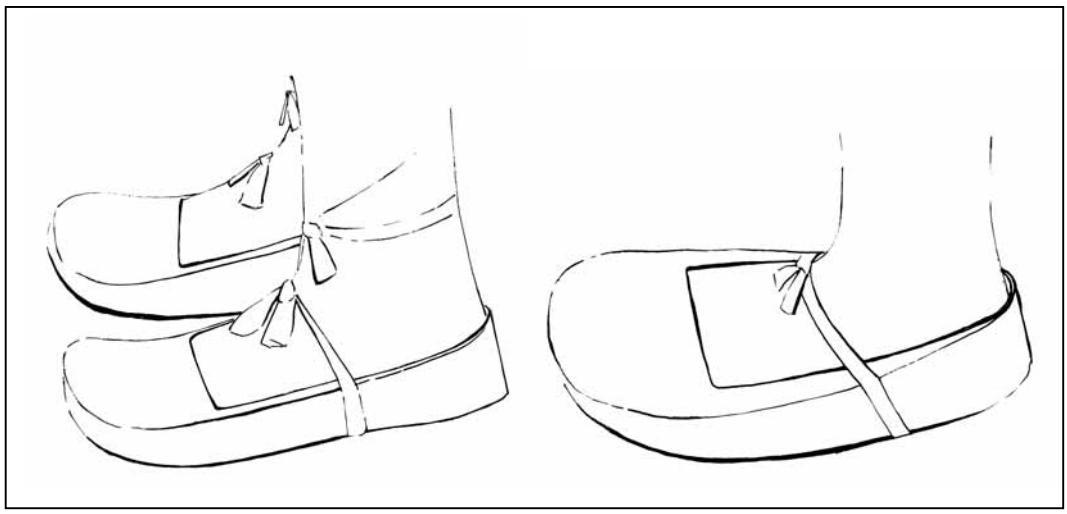


Fig. 30. Round-shaped moccasins [16]

6.2.4 Shoes made of leather

Shoes (Fig. 31.), probably made of leather, were discovered on statues of standing archer, charioteer and cavalryman. The light and soft material enabled the warrior to move quickly through the battlefield.

From preliminary observations we would assume the shoe is made of light leather.

Three types of decorative seams were found (Fig. 32.). Some of them end with a knot. There is a same type of binding the shoe with a strip going around the heel that holds the the foot tight.

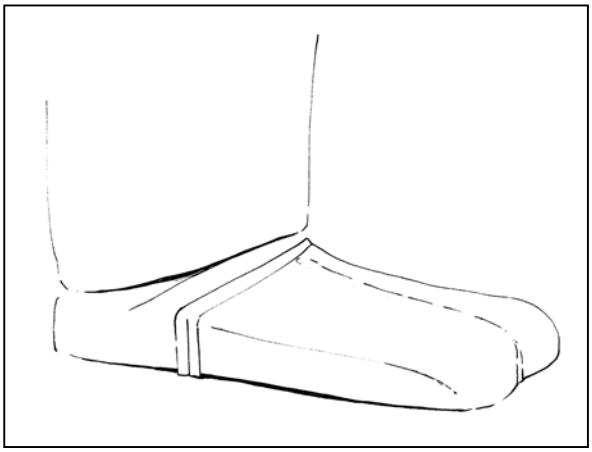


Fig. 31. Side view of a leather shoe [16]

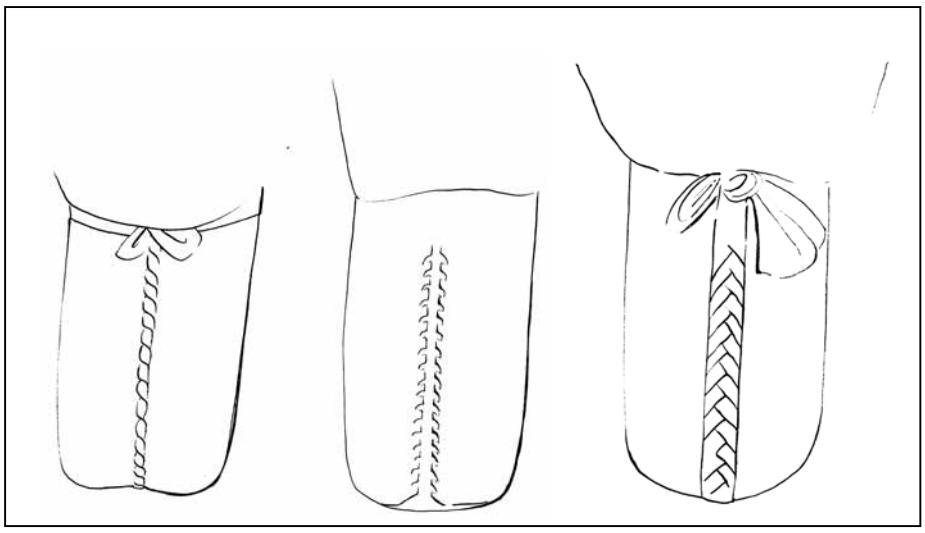


Fig. 32. Different seams on leather shoes [16]

6.2.5 Boots made of leather

We can find boots (Fig. 33.) only by a couple armored and un-armored soldiers dressed in shorts.

It is a kind of lighter high-top shoe which allows stepping easily and was probably made of leather. The shoes were light weight and must still have provided long durability.

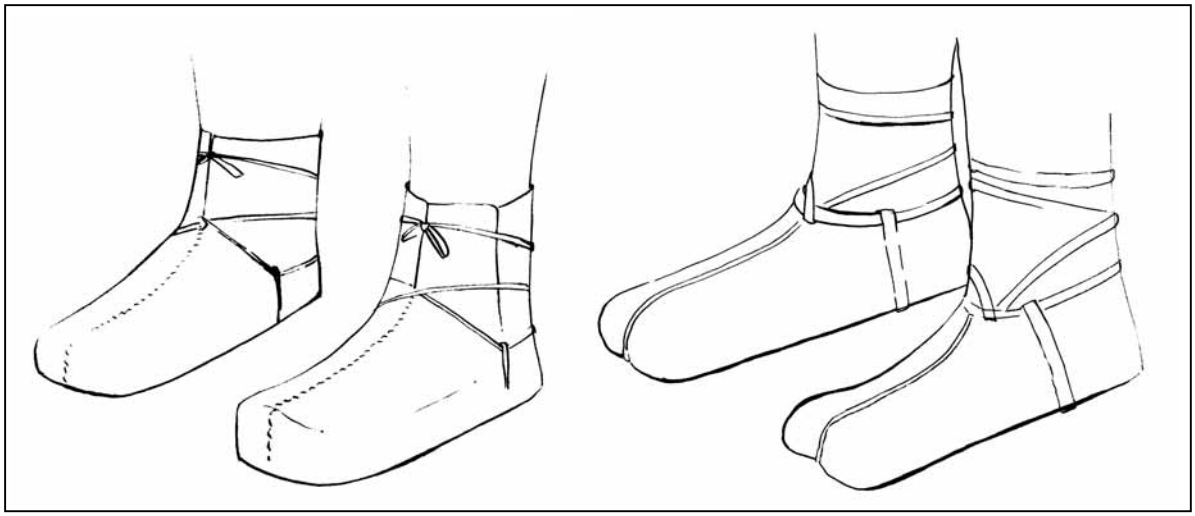


Fig. 33. Leather boots [16]

It is a simple cut and the shoe is probably sewn from one piece of material. There appears a cut at the outer side of the shoe, going from the ankle point to upper peripheral edge, to make the opening larger to facilitate the foot entry into the shoe. The same kind of open cut goes from the top of a foot instep to the upper edge of the shoe.

The lacing is a significant feature of this particular type of shoes. The leather shoe-lace goes behind the heel through a springe and under the sole at the back part of the shoe. Then, it is crossed on the vamp and ends with a bendup.

There is a seam on the top of the shoe having also a decorative function.

6.2.6 Finall analysis common for all types of terracotta warriors´ shoes

All types of terracotta shoes are symetric.

The material used for production is deducted from the thickness of the material shown on the statues. We can clearly see a thicker material on statues with square- and round shaped mocasins on and much thinner layer of clay is used for the demostration of shoes on soldiers in most cases accompanied by a horse. Generally, thinner material is used

on boots. A felt was probably chosen for the mocasin types for its insulating quality because these shoes are shown mostly on leaders and infantrymen. We assume that the thiner material is leather, not only for not hurting the horses but it was also worn by archers probably because of more comfort when they were running.

In the Fig. 34. we can see the design of a sole. The picture suggests that the sole may have been made of leather and to make the surface harder and rougher kind of riveting were used which causes a grainy look.

Fig. 34. Sole of archer´s shoe [4]

There were found two types of fixing the shoe string on the shoes. One type of a fastener is made as an eyelet and the shoestring goes through (Fig. 35.). Other example (Fig. 36.) shows a fastener sewn with missing sections of stitching for pulling the shoe string through. We are not able to tell if the strings were sewn separately on both sides of a shoe or if it was one string going under the sole or in between the upper part of the shoe and the sole.

a) *b)*

Fig. 35. Evidence of an eyelet for pulling a shoe string through

a) the whole shoe,

b) in a detail [12]

a) *b)*

Fig. 36. Evidence of a sewn on string for pulling the shoe string through

a) the wholw shoe,

b)in a detail [4]

We can find two types of stiffeners on the square-shaped types of shoes. In most cases there is only one stiffenig string stitched on the inner edge of a vamp on mocasins with a shoe string (Fig. 37). A shoe without a shoe string has significantly more reinforcing elements to make the shoe more stable and wearable. It has not only a string on the vamp but it has also a leather hem around the whole opening of the shoe (Fig. 38). Of course, there are also simple types of shoes without any stiffening (Fig. 39).

Fig. 37. Shoe with a vamp string [10]

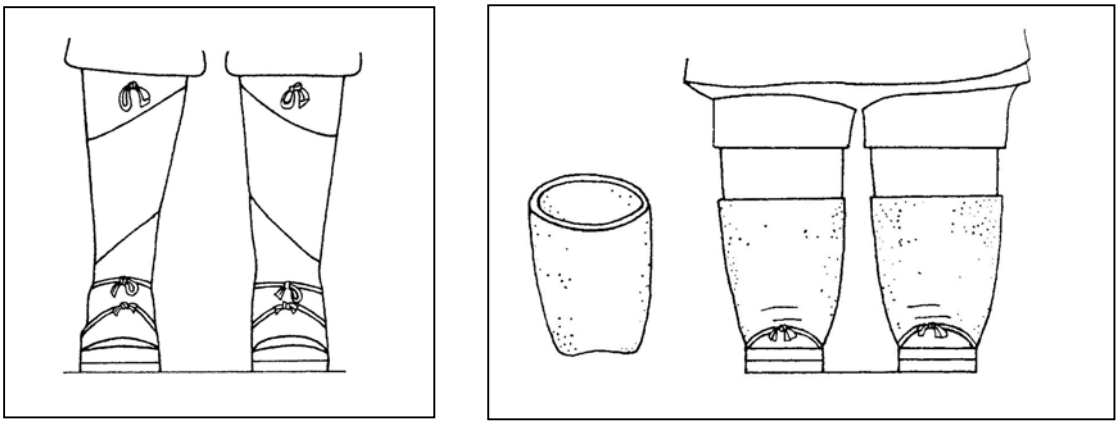
Fig. 38. Shoe with a stiffening hem [14]

Fig. 39. Shoe without stiffening [4]

There is a seem at the back at the back side of square-shaped shoes which we can clearly see in the figure 40. It can suggest that there are slight differences in pattern cutting and shoemaking and that probably every shoemaker had his own way of production.

Fig. 40. Evidence of a heel seam [14]

Mr. Jaroslav Malina describes in his book methods of binding calves the chinese soldiers were probably using (Fig. 41.). The infantry velites have cloth putees and infantry hoplites have girdles likely to be made of felt on their thigs. *[17]*



a) *b)*

Fig. 41. Two types of gear design

a) putees,

b) gridles [17]

7 PRODUCTIONS OF THE REPLICAS

7.1 Replicas of square-shaped mocasins with shoe strings

7.1.1 Material, pattern and last preparation

A woolen felt 5 mm thick in a natural colour was chosen as an upper material (Fig. 42.). A special wooden last must have been produced and from its shape a pattern of the main part was made (Fig. 43., 44.). The shoe is actually made from 1 piece of material.

Fig. 42. Pattern of the main upper part

Fig. 43. Wooden last

Fig. 44. Special wooden last and upper material

7.1.2 Forming

After the attachment of the main piece on the sides of the last with nails (Fig. 45.), the felt was steamed over a wet piece of cloth with a help of an hot electric iron. The material became soft and workable within a couple seconds and was pulled step by step and attached to the last by nails (Fig. 46.). When the forming was finished the last with the felt was let to dry and fix the form of the upper.

Fig. 45. Upper material attached to the last

Fig. 46. Formed upper fixed on the last by nails

7.1.3 Sole construction and its attachement to the upper

There was need to produce brassed pegs for the contact side of the sole. We were trying to simulate as much as possible the production methods at ancient chinese time. After cutting off a required length of a brassed rod, the piece was anchore and the head of the rod was beat and formed with a hammer (Fig. 47).

The sole is made of buff hide 2 mm thick and vegetable tanned. It was cut with a help of a pattern matching to the bottom of the shoe. It consists of front contact, sole waist and heel part. According to the fig. 48. a system of holes was made for fitting the pegs. Individual pegs were put into the holes and buffered and hammered into the desired shape from the outside (Fig. 49., 50.). There is approximately 420 pegs at each sole and it took 7 hours of work for a skilled shoemaker to make a pair of soles.

The sole is mounted to the upper by the marginal line of pegs on the sole (Fig. 51.) and the pegs are formed and shaped as the previous ones (Fig. 52.- 54.). They go through the upper and are visible inside the shoe.

a)

b)

c)

d)

Fig. 47. Peg production a) a brassed rod

b) a brassed rod attached in pliers

c) hammering a head of a peg

d) two types of pegs

Fig. 48. Fitting the pegs into the holes on the sole

Fig. 49. Forming the pegs on the sole

Fig. 50. Hammering a head of a peg

Fig. 51. Attaching the sole to an upper

Fig. 52. Shortening the length of a peg

Fig. 53. Forming a head of a peg

Fig. 54. Forming a head of a peg with a hammer

7.1.4 Stitching the vamp to the upper and finishing operations

The turned-up tip of the sole was stitched to the upper with one line of simple hand stitching (Fig. 55.). The rest of the felt material was bent back and stitched together with the sides of the shoe (Fig. 56.). The stitch formed a clear edge of a vamp (Fig. 57.).

Fig. 55. Stitching the sole to the upper

Fig. 56. Sewing the vamp to the upper

Fig. 57. Half-finished felt mocasins

The edge of the upper around the foot was hemmed with a bend of leather in a contrast brown colour and stitched through with a line of hand stitching. Also, the edge of the vamp was firmed up with a strip of leather (Fig. 58., 59.).

According to figure 60 both types of sewing on of strips for lacing through were made. One is made as an eyelet and the other one has missing stitches for pulling the shoe string through.

a) *b)*

Fig. 58. Finished felt mocasins with the stiffening elements

a) front view,

b) side view

a) *b)*

Fig. 59. Sole of the felt mocasin

a) side view,

b) back view

Fig. 60. Two types of string for lacing

a) *b)*

Fig. 61. Finished square-shaped felt mocasin

a) aerial view,

b) front view

7.2 Replicas of leather boots

7.2.1 Material, pattern and last preparation

A special type of wooden last must have been made to imitate the production at ancient chinese time. Then, a pattern was made. The main part of the upper is made from one piece of material, same as the previous example. The material must be able to form easy and therefore thin buff hide was chosen as an upper material (Fig. 62.)

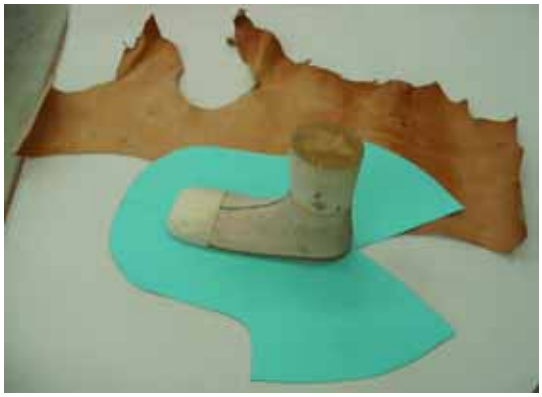


Fig. 62. Wooden last, paper pattern and leather for leather boot production

Fig. 63. Formed upper of a leather boot

7.2.2 Forming, sole construction and finishing operations

Even for a skillfull shoemaker, it was quite complicated to give the one piece of leather desired form of the last (Fig. 63.). The shoe can be practically divided into two parts by the main cutting lines going from the tip and from the bottom of the heel to the upper peripheral edge (Fig. 64). Afterwards, the rests of the leather on all hems were cut off (Fig. 65.). Sole construction and its attachement to the upper is identical to the felt shoe sole (Fig. 66.).

Fig. 64. The main cut lines on a boot and leather rests

a) *b)*

Fig. 65. Formed leather boot

a) front view,

b) back view

The decorative stitching on the vamp and at the back of the shoe was made. The zig-zag stiches, made of thin leather strap, bindes together two halves of the upper together. They reach to the top of a foot instep and to the upper end of the heel at the back. The rests of the cuts are open and enable to put the shoe on (Fig. 68., 69).

Fig. 66. Formed leather boot with a finished sole

Fig. 67. Front view of the half-finished leather boot

Fig. 68. Back view of the half-finished leather boot

Fig. 69. String for lacing attached on the sole by pegs

Fig. 70. Side view of the finished leather boots

Fig. 71. Back view of the finished leather boots

There is a string of leather attached to the sole by 2 pegs on each shoe. The string is intented for lacing the shoe. It has holes at the ends for pulling a shoe-string through and tighting the shoe (Fig. 70.- 72.).

Fig. 72. Front view of the finished leather boots

8 TESTS OF THE REPLICAS

Testing biomechanical qualities of the Terracotta army shoe replicas has been broadened for a comparison of these qualities with other shoe replicas made at the Tomas Bata University; Oetzi shoes and Oregon sandals.

8.1 Measuring device and evaluation description

Measuring was done with the PEDAR® device provided by Novel GmbH company from Munich. The pedar system is an accurate and reliable pressure distribution measuring system for monitoring local loads between the foot and the shoe. It consists of highly conforming, elastic sensor insoles, equipment for information transfer into a computer and a software. Measuring insoles are equiped with a matrix of scaning pressure measuring sensors (maximum 256 sensors on an insole – according to a size of the insole). The insoles are 2,6 mm thick and can be compress to l mm. The device measures contact pressure in a range 3-120 N/cm^2. Scaning the pressure runs in a frequency of 10 000 impulses in a second. While measuring the contact pressure the insole is fit in a shoe and is in a direct contact with a foot. We can get information from a multi-step with this type of measuring.

The data are recorded in the program Novel – PEDAR and then analysed. This program enables us to get data of maximum force and peek pressure. The values are processed by statistic methods and then visualized in tables and graphs. [18]

8.2 Replicas used in the tests

Two other pairs of replicas were used for comparison of data from the PEDAR® device. The first ones are Oetzi shoes (Fig. 73.). In 1991 there was found, in the Oetzital Alpes a body of a man mummified by frost (around 5 300 years B.C.). His right foot was shod with a heavily damaged shoe of unusual construction. The left halfpair of these shoes was found a year later. The construction of these shoes, the used material and the state of wear have crucially changed the views concerning the beginnings of shoeing of the man. [19]

The soles were made of the hide of the brown bear, the leather therefor was very fine (under 1 mm). The vamp part was made of red deer hide. The strap, which connected the netting with the sole was made of calfskin. [19]

Fig. 73. Oetzi shoes

Then, Indian Oregon sandals (Fig. 74.) were used in the tests. The sandals are made of fibres originated in a plant called Arthemisia Vulgaris. They have been considered as the oldest found shoes in the world (7 500 years B.C.). Shoes were found in 1938 while archaeological excavations by the Fort Rock cave, Oregon, USA. [20]

Fig. 74. Oregon Indian sandals

8.3 Organization of the experiment

According to different sizes of the replicas 2 probands were doing the tests. A male proband 180 cm tall and 78 kg heavy was walking in felt shoes and Oregon sandals. A female proband 170 cm tall and 57 kg heavy was walking in leather boots and Oetzi shoes.

When the device was ready, the electric insoles were put in the shoes and a proband had to walk around 20 steps pretending a regular straight walk.

8.4 Evaluations of the tests

The table I contains data from testing felt shoes. The contact area is 131,463 cm^2 for left foot and 133,400 cm^2 for right foot with an average of 132,432 cm^2 for both feet. The maximum force reached the point of 702,838 N for left foot and 671,088 N for right foot which makes an average of 686,963 N. The peek pressure is 351,550 kPa for left foot and 288,550 kPa for right foot with an average of 320,05 kPa. In the figure 75 we can see the matrix of pressure values for felt shoes.

Contact area [cm^2]		**Maximum force [N]**		**Peek pressure [kPa]**	
LF	RF	LF	RF	LF	RF
131,463	133,400	702,838	671,088	351,550	288,550

Tab. I. Values for felt shoes from the PEDAR® device (LF-left foot, RF-right foot)

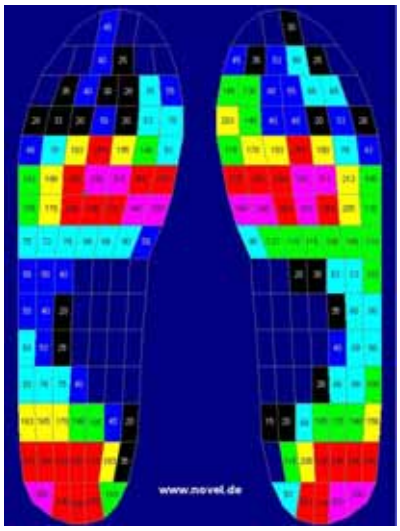


Fig. 75. Matrix of pressure values for the felt shoe from the PEDAR® device

The table II gives us information on measured values for the leather boots. The contact area for left foot is 129, 413 cm^2 and 141,403 cm^2 for right foot. The maximum force values ascended to 873,123 N for left foot and 880,350 N for right foot. The peek pressure reached 354,575 kPa for left foot and 325,200 N for right foot. The average values are 135,408 cm^2 for contact area, 876,737 N for maximum force and 339,888 kPa for peek pressure. The figure 76 shows matrix of pressure values for leather boots.

Contact area [cm^2]		**Maximum force [N]**		**Peek pressure [kPa]**	
LF	RF	LF	RF	LF	RF
129,413	141,403	873,123	880,350	354,575	325,200

Tab. II. Values from the PEDAR® device for leather boots (LF-left foot, RF-right foot)

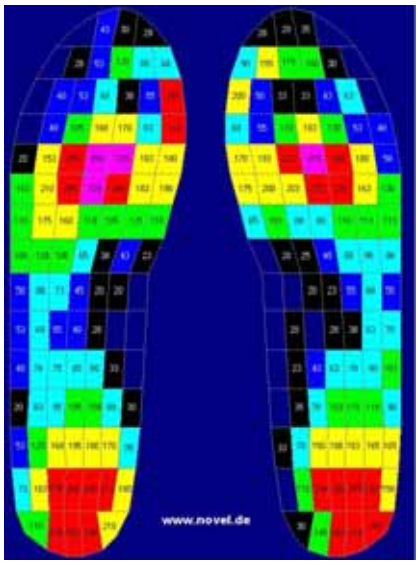


Fig. 76. Matrix of pressure values for the leather boots from the PEDAR® device

The table III informs us about values the device measured while a proband was walking in Oetzi shoes. The contact area for left foot is 146,328 cm^2 and 151,29 for right foot which makes an average of 148,809 N. Maximum force reached 718,848 N for left foot and 700,97 N for right foot. Peek pressure got to a point of 266,3 kPa for left foot and 196,025 kPa for right foot. The average value for maximum force is 709,909 N and 231,163 kPa for pressure peek. We can see the pressure spreading in Indian sandals in the figure 77.

Contact area [cm^2]	**Maximum force [N]**	**Peek pressure [kPa]**

LF	RF	LF	RF	LF	RF
146,328	151,29	718,848	700,97	266,3	196,025

Tab. III. Values for Oetzi shoes from the PEDAR® device (LF-left foot, RF-right foot)

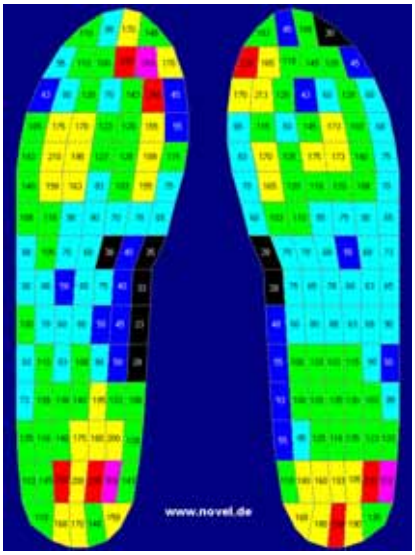


Fig. 77. Matrix of pressure values for Oetzi shoe from the PEDAR® device

Contact area [cm^2]		**Maximum force [N]**		**Peek pressure [kPa]**	
LF	RF	LF	RF	LF	RF
139,593	135,34	751,978	706,02	313,15	255,25

Tab. IV. Values for Indian sandals from the PEDAR® device (LF-left foot, RF-right foot)

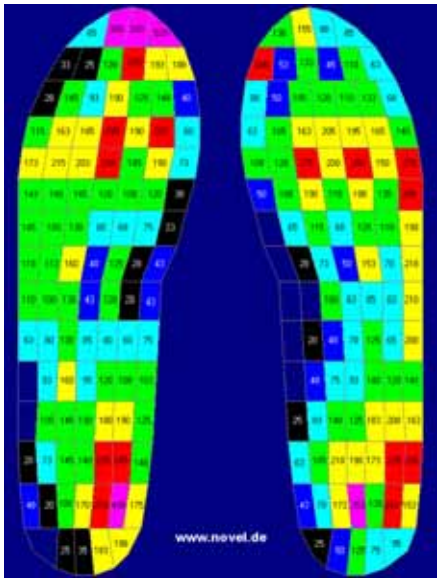


Fig. 78. Matrix of pressure values for Indian sandals from the PEDAR® device

Table IV contains data from measuring Indian sandals. The contact area for left foot reached 139,593 cm^2 and right foot 135,34 cm^2.

The maximum force is 751, 978 N for left foot and 706,02 N for right foot. The pressure peaked to 313,15 kPa for left foot and 255,25 kPa for right foot. The average values are 137,467 cm^2 for contact area, 728,999 N for maximum force and 284,2 kPa for peek pressure. The figure 78 shows matrix of pressure values for Indian sandals.

From the tables we can consider that, from biomechanical foot comfort, the best material and even a construction has been used on Oetzi shoes made of bear and deer hide and calfskin filled with hay. The values of peek pressure are nearly about 100 kPa lower than by the felt and leather footwear of the Terracotta army and even 140 kPa lower by Oregon Indian sandals.

According to a graphic vizualisation of the plantar pressure distribution to a contact area we can see interesting facts. If we compare Terracotta army footwear and Oetzi shoes with Oregon sandals an interesting way of pressure load is noticable. There is a significantly heavier load on inner sides of both feet in Oregon sandals and this pressure is completely missing in Terracotta army footwear.

The inner foot arch was supported by the hay in Oetzi shoes and by the Artemisia Vulgaris fibres in Oregon Indian sandals but there is nothing that supports the foot arch in Terracotta army footwear. It is possible that the soldiers were using some kind of padding or insoles for making the walking more comfortable.

CONCLUSION

China has the longest period of continuous development of military culture of any civilization in world history. It has diverse customs and styles as regards its traditional dress culture, and the abundance and variety of Chinese footwear justifies its being singled out from other items of apparel to be studied separately as "shoe culture". Footwear is an interesting facet of the many aspects of Chinese culture. The finding of Terracotta army statues gives us incredible amount of detailed facts on chinese military footwear at those early times.

Warefare is rough on shoes. Army shoes must stand up under hard marching, mud, snow and severties of the weather. Warefare requires a lot of shoes and it requires stout shoes. The shoes have always been one of the most important equipment of a soldier.

The materials used for production of shoe replics were deducted from the thickness of the material shown on the statues. We can clearly see different material thickness for example in pictures 36 and 37 where obviously thicker material is used on square and round shaped mocasins and much thinner layer of clay is used on boots. A felt was chosen for its insulating qualities and leather as the thinner material for it softness, comfort and because it is easy to form.

All types of terracotta shoes are symetric, having simple cuts with not many seams. We can divide all the types of shoes that have been found on statues into two main groups. Mocasins have been found mainly on officers, leading soldiers, archers and infantrymen while in boots were charioteers and cavalrymen.

Mocasins differ in designs of the front part from square-shaped with a turn up tip to round and flat ones. We can find a border on some of the mocasins. Mocasins without laces (Fig. 38.) have a border all around the upper edge and a vamp, while the ones with laces (Fig. 37.) have a border mainly on a vamp. The border, made probably of leather, helps to keep the form of a shoe. The lace thightens the shoe and keeps the heel part stabile.

Boots are similar in shape, with very slight differences in tighting.

A simple wooden pair of symetric lasts were used for the replic production.

Fig. 34. is a detailed picture of a sole which provided an evidence for its construction. The picture suggests that the sole may have been made of leather with rivets placed more dense in front and heel part.

The footwear found on Terracotta army statues differ within the ranks and it corresponds to a social status of a soldier.

Testing biomechanical qualities of the Terracotta army shoe replicas were done on the PEDAR® device which measures pressure distribution between the foot and the shoe. As a comparison Oetzi shoes and Oregon sandals were used for the test. The Oetzi shoes shows the highest biomechanical foot comfort. The maximum force and the peek pressure reached the highest values by Terracotta army footwear. It concludes that the soldiers were probably using some kind of padding or insoles for making the walking more comfortable and to support the foot arch.

I hope my diploima thesis would help to understand and to get to know more about chinese history and history of chinese military footwear.

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LIST OF ABBREVIATIONS

LF left foot

RF right foot

USA United States of America

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