LASER SCANNING OF STREETS IN POMPEII

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ABSTRACT:

During two seasons (2006 and 2007), the architectural investigation of street has been carried out at Pompeii. The evidence for following results is based on the preliminary analysis of more than 600 stations, which is subjected to detailed analysis of the structure. This paper aims to introduce recording methods of streets in Pompeii. The first part deal with measuring method by 3D scanning system and the second part deal with drawing methods of plan and section of rut. Streets in Pompeii have never been completely surveyed throughout the city, except for a couple of plans drawn by S. Tsujimura (1991). This is perhaps due to the fact that the streets might have been less regarded as worth recording, nonetheless the streets need to be examined as they are historical heritage as well. There is another reason that an old method, measuring cordage is unsuitable for measuring an irregular shape of ruts and paving stones. However it can be overcome by the most advanced method: 3D scanning system. The three-dimensional data of the streets includes not only the information on present condition but also on a secular change in Roman colonization era such as ruts. Drawing plans or sections of ruts could lead to a new finding, as Tsujimura could point out the presence of traffic system in final phase of Pompeii by recording ruts.

1. INTRODUCTION

The street in Pompeii consists of a roadway and a sidewalk. The roadway is almost paved and there are stepping stones placed between sidewalks. Compared with the other roman cities, a characteristic only found in Pompeii is ruts, which are sometimes 200 mm in depth in the principal road such as Via Stabiana. Ruts are synchronic evidence of Pompeii's final phase, and they can allow us to imagine the traffic circumstance in the past.

Focusing on these ruts, S. Tsujimura firstly approached traffic in Pompeii from researching ruts (Tsujimura, 1991). In her article, she recorded ruts of crossroads, and noticed that curved ruts survive around block's corners of obtuse angles. By remaining regular shapes of ruts at such corner, she said "it must be said that the regularity of the position of the curved traces at the many intersections involving a one-way street is city wide, therefore their directions are result of city-wide restricted traffic system". Thus she could shed light on a part of traffic system in Pompeii through her demonstrative approach.

There are 7 plans of streets in Tsujimura's article, it is all of the street plan detailed in ruts, paving stones and curbstones (Figure 1.). In Pompeii many researchers have drawn up plans of buildings or maps, however streets have been only hatched. This is perhaps due to the fact that the streets might have been less regarded as worth recording. Nonetheless, the streets need to be examined as they are historical heritage as well because they include not only the information on present condition but also on a secular change in Roman colonization era such as ruts.

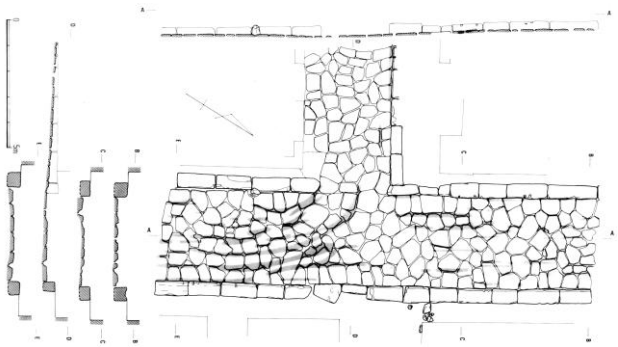

Figure 1. Street plan drawn by S. Tsujimura

Figure 2. Measured area in Pompeii

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The other reason could be a measuring method, cordage measuring mainly used in 20th century. It is not suitable for measuring street because ruts and paved stone have irregular shape. Hence this problem can be overcome by an advanced measuring method: 3D scanning system, in which the object can be described as the aggregation of dots having three dimensional coordinates. This enables us to new approach to the study of traffic system. By 3D scanning system, we can get not only plane coordinates but also vertical coordinates, and draw section of ruts, which have never been drawn. This could lead to new findings, as Tsujimura could point out the presence of traffic system by recording ruts.

This article deals with the recording methods of streets in Pompeii. The evidence for following results based on the result of our investigation carried out from 2006 to 2007 at Pompeii (Figure 2.). We introduce an advanced measuring method: 3D scanning system, in which more than 10,000 scannning laser beams can be emitted in one second and the object can be described as the aggregation of dots having three dimensional coordinates. The measurement of whole of streets and walls has been completed within two seasons (2006 and 2007). The city was separately measured into more than 600 aggregations. Each 3D model coming from the measuring system have each local coordinates to the global ones (longtitude and latitude). And some makers of which the longtitude and latitude measured by Arch. Rispoli in 2006 were included into our scanning data in order locate our data on the GPS.

2. MEASURING METHOD

The method generally used in the twentieth century such as cordage measuring was not suitable for ruts survey, whereas the laser technology can measure ruts automatically.

In order to make a street plan including the information about ruts in a three dimensional picture, clouds measured by long range scanning, whose laser ray can reach from as far as 700 m, are merged into the framework of main streets. After that, clouds measured by short range scanning are attached to the framework. And thus, it is able to compose clouds without considerable divergences. The clouds of long range scanning should not include information about ruts but benchmarks such as curbstones or frontages of buildings, because it is needed to merge into one model from the clouds of short range scanning. Whereas the clouds of short range scanning should include information about ruts in detail. To capture ruts simultaneously, laser ray have to be emitted to the objects at an angle of depression. Therefore it is the best to set the machine at high place (Figure 3.).

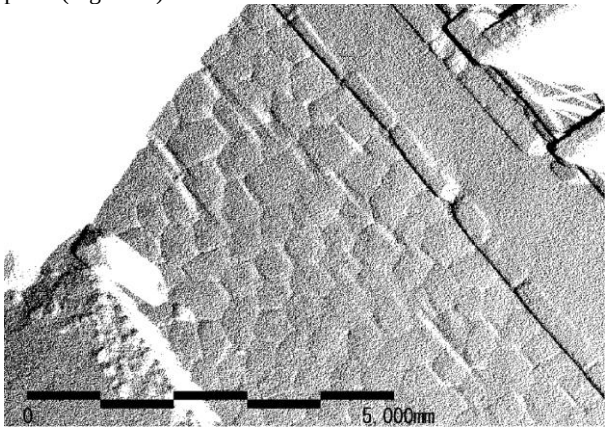

Figure 3. Via stabiana measured from a top of the small theatre

However, it is usually difficult to find such high places, and even if we found such places, it should be better to set the machine on the ground. When the distance between the machine and ruts is within about 10 m, it can be scanned at once because of an angle of relative depression. However, when the distance was between 10 m and 20 m, laser ray only can reach to one side of depressions of ruts. Therefore to avoid the deficiency and complete the data, scanning from the opposite side of the objects is required (Figure 4.). It is also required when there are stepping stones, and its occultation cannot be measured.

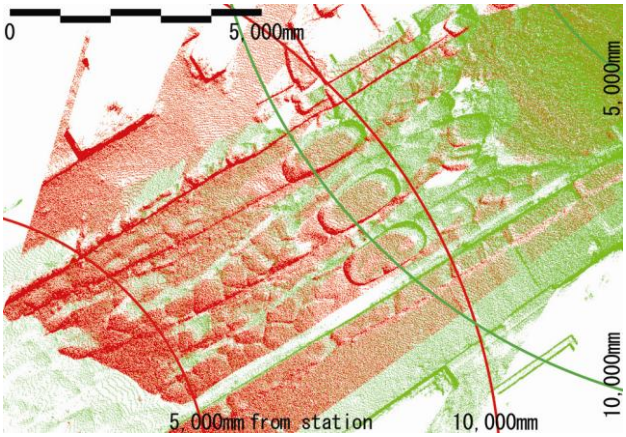

Figure 4. Via della Fortuna measured from west (red in colour) and east (green in colour)

3. PLAN IN BMP FORMAT AND ORTHOGRAPHIC PHOTO

To record streets, firstly the 3D mesh can be created from the collected data by the computer software, and then laser data can be used for making plans. To make a drawing without any tracing, we introduce two methods; bmp format picture and orthographic photo.

The area enclosed by the city wall measures 63.5ha, so it is massive works to draw entire streets plan. Hence from 3D mesh, plans, elevations and sections can be directly created in CAD by writing by bmp format, it can simplify the process of making plans.

To use the picture drawn in clouds of dots as plans, a density of dots should be taken into consideration. There are three figures whose density of dots are different from each other: 1,500 points , 5,000 points, 20,000 points per 1 ㎡ (Figure 5.). According to these figures, about 5,000 points per 1 ㎡ are required at the minimum to distinguish each stepping stone and locations of ruts. A picture including 20,000 points per 1 ㎡ provides also image of depth of ruts.

From 3D mesh model, an orthographic photo can be created. To create an orthographic photo, firstly control points selected from the aggregation of dots are correlated to picture, and triangulation is composed. Paving stones having irregular shape are not suitable for control point, because it tends to correlate different point between picture and 3D mesh model. Therefore it is better to select curbstones as control points, and this make an orthographic photo having accurate information about width of street. The orthographic photo including colour information has an advantage to see locations and depth of ruts at a glance. Therefore it is not required to hatch a plan as ruts in tracing plan (Figure 7.).

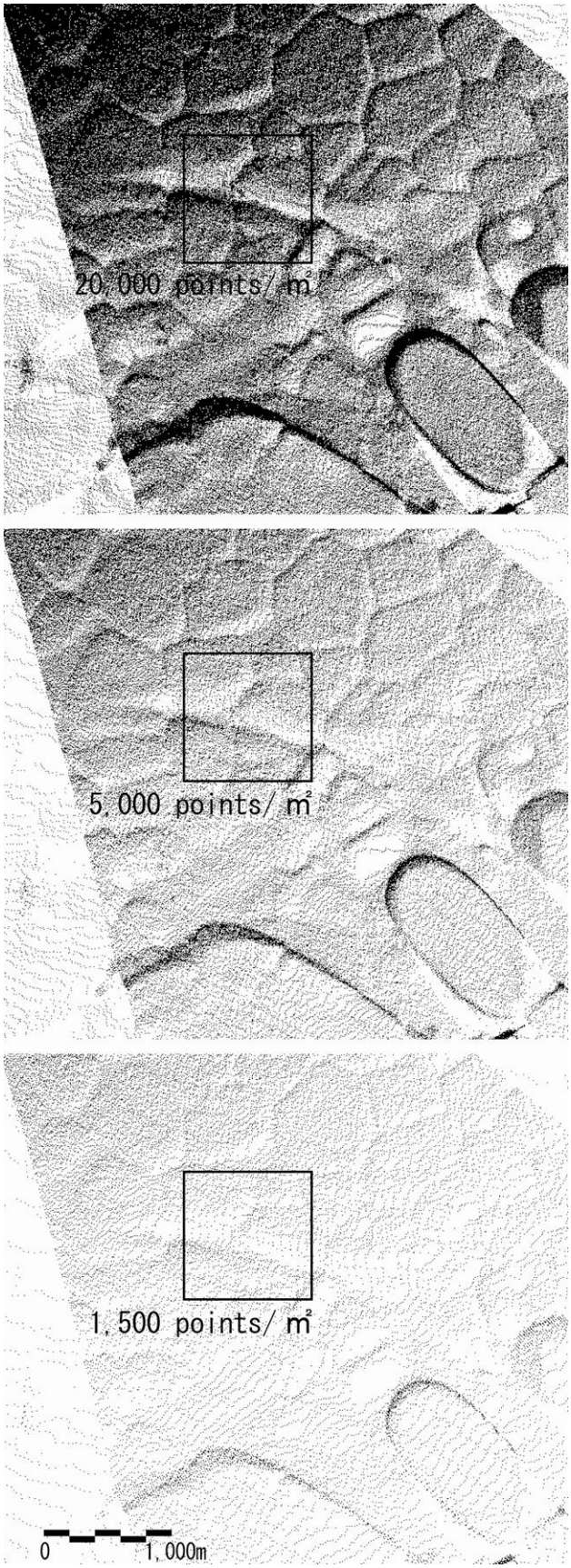

Figure 5. A comparison of each density of dots: 20,000, 5,000, 1,500 points/㎡ (north-east corner of the Central Baths)

From the triangulation, section of street can be created automatically by determining a line of section, so it is able to record sections of numberless ruts in Pompeii (Figure 7.).

Figure 6. An orthographic photo of street (the Herculaneum gate)

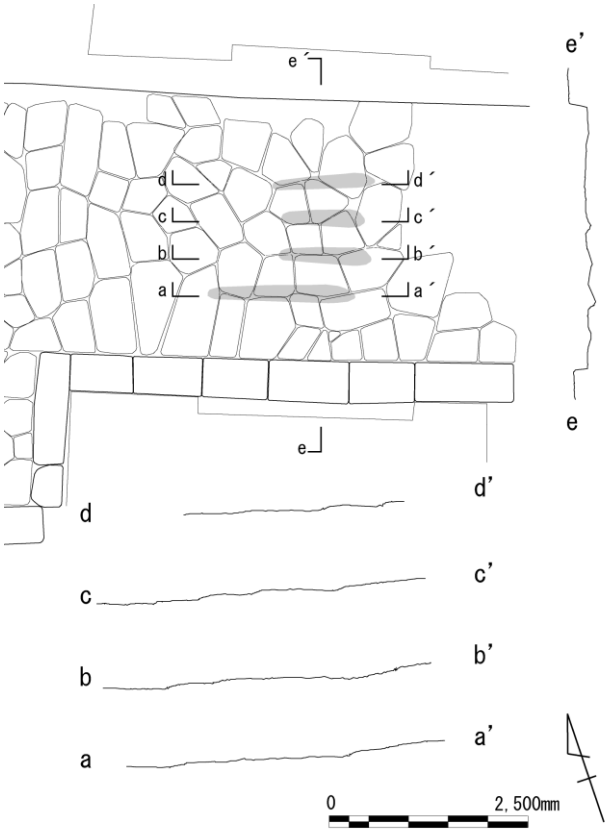

Figure 7. A plan traced from dots and sections created automatically (the Herculaneum gate)

4. CONCLUSION

Erosion of streets in Pompeii has progressed considerably from excavation in eighteen century. In addition, it has been aggravated the problem of the streets worn by many tourists. If this situation continues, a precious historical heritage, which tells us the life of the Roman era, would be lost in the future. Therefore countermeasures are necessary to avoid these damages. In this point, 3D laser scanning system can contribute as an efficient and simplified recording method of streets.

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