

## Resistivity Value as Characteristics Of Majapahit Kingdom Era Red Bricks

Supriyadi <sup>1</sup>, Priyantari, N. <sup>1</sup>, Sukmadewi, R. D<sup>2</sup>

<sup>1</sup> (lecturer): dept. of physics , mathematics and natural science, Jember University, Jember, Indonesia, supriyadi@unej.ac.id

<sup>2</sup> (student): dept. of physics , mathematics and natural science, Jember University, Jember, Indonesia

Email: supriyadi@unej.ac.id

**Abstract**— The era of Majapahit kingdom is the most famous kingdom era in Indonesia. This is shown by many heritage sites in Indonesia, including some of the temples that have been found. generally, the temples consists of red brick is visually the same as the other red brick. Contrain in identification of heritage site era is frequently faced in escavation. In this research, red brick of Majapahit kingdom era will be characterise using resistivity value and compare to recent red brick. The red brick samples were taken from two temples in Jember, the Deres temple (the Beteng Site) and the temple in Wuluhan country. The research result that Majapahit kingdom era red brick has resistivity lower than recent red brick, 15,73  $\Omega\text{m}$  for the Beteng Site and 17,5  $\Omega\text{m}$  for the temple in Wuluhan country, whereas 22,56  $\Omega\text{m}$  for recent red brick. Therefore, red brick resistivity value can be use as characteristics to identify era of a heritage site, especially Majapahit kingdom era.

**Keywords:** Red Bricks, Majapahit Kingdom, Resistivity

### INTRODUCTION

Majapahit kingdoms era is most famous kingdom in Indonesia, under reign Hayam Wuruk as king and Mahapatih Gajah Mada as prime minister, this kingdom possess an area of almost the entire territory of Indonesia. Majapahit able to dominate the other kingdoms in the Malay Peninsula, Borneo, Sumatra, Bali, and the Philippines [1]. Majapahit was the last Hindu kingdom and to be the greatest kingdom in the history of Indonesia. At the early 14th century, the Majapahit kingdom power gradually weaken and eventually collapse [1]. The Majapahit kingdom was known as a great kingdom which bring many changes, evidenced by the new discovery of the enshrinement sites in some areas such as Mojokerto, Madiun, Probolinggo, Jember, etc.

The southern Jember like Puger, Kencong and Gumukmas become the expedition route King Hayam Wuruk. One heritage of this era is the temple, precisely located in Gumuk Mas and Kencong. In Gumuk mas, there is Deres temple that located at dune in the center of rice field. This temple mostly constucted from red brick with certain shape and size. The physical condition of the temple are already crumbling and separated by a large tree into two parts [2]. The other Majapahit heritage were discovered in Gondosari, Tamansari Village, District Wuluhan on November 4, 2008. In this site, the conditions of red brick with large zise seemed straggle. Earlier, at a location around this site also found buildings like temple constructed from red brick having large size [3]. In addition to temples, there are some relics of the Majapahit kingdom era such as artifacts and other heirlooms. In 2013, there are discovery Beteng site in Semboro sub-district, Jember. Beteng site store some relics found since 1965-1995 as artifact, vestige of building at majapahit era, and other heirlooms[4].

Relics that have been found, generally consist of same type rock. From several temple of majapahit era, it is known that rock type similarly to the others. Relics building majapahit era have same type of rock that is red brick. Every rock have physical characteristics especially electric properties. Resistivity as electric properties of rock shows capability of material to conduct electricity [5]. The greater resistivity of a material, the more difficult these material conduct electricity, and vice versa. Resistivity value of red brick(sandy silt soil) as 15-150  $\Omega\text{m}$  [6].

Based on this problem, we will identify the characteristic of the rock making up the relic temple of majapahit era from their resistivity value. Result of this research can be use as preliminary study to determine the era of a relics in a escavation through red brick resistivity value.

### Method

Red brick sample have size 3,5 x 1,5 x 5,5  $\text{cm}^3$ , used as measured object. Red brick sample are taken from 3 location as Beteng site located in Sidomekar sub village, Semboro-Jember, Wuluhan temple in Tamansari village, Wuluhan-Jember and recent red brick. Recent red brick is red brick

were frequently used in bulding construction. This red brick used as comparison to red brick of majapahit era.

Instrumentation used in this research are power supply, current regulator, plate electrode, copper cable as potential electrode, cable and multytemeter.

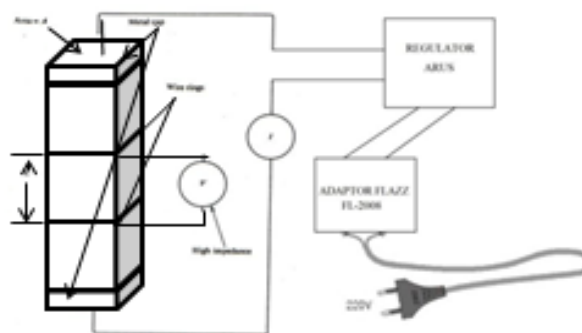


Fig 1. Red brid resistivity measurement system[7]

Output current is set nearly constant, cable are connected to plate electrode and the distance between two plate electrode is set according to sample size. The potential electrode is set with certain distance in the middle of sample and measured using voltmeter. This measurement was repeat 5 times. Measuremens performed on others red brick sample. The data resulted in current (I) and voltage (V) value are used to count resistivity value of red brick using ohm law.

$$R = \frac{V}{I} \quad (1)$$

$$\rho = R \frac{A}{L} \quad (2)$$

### RESULT AND DISCUSSION

Preliminary survey in relic buiding of majapahit era show that red brick majapahit era have size larger than recent red brick. Original size of red brick in temple relic Wuluhan has size 45x21x5  $\text{cm}^3$  and red brick in Beteng site has size 39,5x21,1x7,5  $\text{cm}^3$  therefore the recent brick have size 25x12x5  $\text{cm}^3$ . The measurement of red brick resistivity was done using 5 sample from each location. Each sample resize in same size 3,5 x 1,5 x 5,5  $\text{cm}^3$  to be easily measured. From table 1, red brick resistivity have variation that still in range 15-150  $\Omega\text{m}$  (Roy E.Hunt) and can be use as characteristic. Red brick resistivity of relic bulding majapahit era is 15,73  $\Omega\text{m}$  for Beteng site and 17,5  $\Omega\text{m}$  for relic temple Wuluhan, while recent red brick has resistivity 22,56  $\Omega\text{m}$ .

TABLE I. RED BRICK RESISTIVITY MEASUREMENT

No	Sample	V (V)	I (A)	$\rho$ ( $\Omega\text{m}$ )	$\bar{\rho}$ ( $\Omega\text{m}$ )
1	Beteng Site	17,5	0,03	16,55	15,73
2		18	0,03	17,03	
3		18,5	0,04	13,13	

4		19	0,04	13,48	
5		19,5	0,03	18,45	
6	Relic Temple Wuluhan	20	0,03	18,92	17,5
7		20	0,03	18,92	
8		19	0,03	17,98	
9		20	0,04	14,19	
10	Recent red brick	19,5	0,03	18,45	22,56
11		20,5	0,03	19,39	
12		19,5	0,02	27,67	
13		20	0,03	18,92	
14		20	0,02	28,38	

Red brick resistivity from Beteng site is close to relic temple Wuluhan but smaller. The resistivity difference between two is only 1,77  $\Omega$ m. Generally, red brick resistivity of relic building Majapahit era is much smaller than recent red brick. The resistivity difference between Beteng site and recent red brick is 5,06  $\Omega$ m, between Relic Temple Wuluhan and recent red brick is 6,83 $\Omega$ m. Therefore, can be assumed that resistivity of red brick referable to determine era of red brick in a escavation.

## CONCLUSION

Resistivity measurement results on red brick sampels of majapahit era and recent red brick are showing variations. Beteng site has resistivity 15,73  $\Omega$ m and relic temples in Wuluhan has resistivity 17,5  $\Omega$ m, while recent red has resisitivitas 22,56  $\Omega$ m. proximity on resistivity value of 2 sample red brick from majapahit era compared to recent red brick show relation between resistivity value of red brick and historical periodization

## REFERNCES

- [1] Anwar, Khoiril. 2009. Potensi Wisata Budaya Situs Sejarah Peninggalan Kerajaan Majapahit Di Trowulan Mojokerto. Surakarta: Universitas Sebelas Maret
- [2] Ias. Tanpa Tahun. Candi Deres Jember Saksi Kekuatan Ekonomi di Timur Jawa. Jember: www.titik0km.com
- [3] Juliatmoko. 2008. Situs Majapahit Ditemukan di Wuluhan. Jember: Okezone
- [4] Anonim. 2013. Napak Tilas Peninggalan Majapahit di Situs Benteng Jember. Jakarta: Kompasiana.com.
- [5] Wuryantoro, 2007. Aplikasi Metode Geolistrik Tahanan Jenis Untuk Menentukan Letak Dan Kedalaman Aquifer Air Tanah. Semarang: Universitas Semarang
- [6] Roy, E. 1984. Geotechnical Engineering Investigation Manual. Mcgraw Hill, New York
- [7] Dwiharto, Moch Fauzan. 2014. Analisa Sifat Fisik Batuan Meliputi Porositas, Resistivitas, Konduktivitas Listrik Dan Konduktivitas Thermal. Surabaya: Institut Sepuluh November.