Comparison of performance of diamond wires in marble cutting

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Abstract— The diamond wire cutting method is an indispensable production method for marble industry in mines and factories. The performance of the method is vital for continuous profitable working. In this study, we examined different brand of diamond bead wires with same machines and more or less same type marble blocks in the same quarry. The chosen quarry in this study is located in Karamanlı (Burdur, SW Turkey), and the corrosion tests for diamond beads were undertaken in relatively well-known marble 'Burdur-Karamanlı Beige'. This study reveals that the brand of diamond wire is an important factor for the cutting performance of the devices. The critical point for the performance is corrosion percent of the wires during cutting off the marble. We used tree brand of diamond bead wire for the tests. All the beads' diameter of the wires are 11 mm for the beginning of the tests. After 1 to 1.5 mm corrosion depending on the brand, the cutting performance of the machine used dramatically disrupts.

Index Terms— dimond wire cutting, marble industry, Karamanlı, Turkey

1 INTRODUCTION

The marble industry is one of the oldest industry in the world. Ancient Mesopotamia, Egypt, China, Central-South America and Indian civilizations were used marbles as dimension stones in their homes, streets, religious places and sculptures. Mining of marbles is as old as these civilizations. In modern times, quarrying marble is still inevitable mining activities since its economic and aesthetic values. For the case of operating machines, Today's wire cutters can be used on all types of marble, granite and many other stones with high performance and life of the diamond-bead wire at maximum cutting speed. In addition, the control is full-automatic and not necessary constant presence of operator. The cost of these quarrying is strictly depending on many factor, such as used technologies (Onargan and Köse, 1997), wires (Aktürk, 1991; Urhan ve Şişman, 1993; Özçelik, 1999), machinery-labors (Capuzzi, 1980), quality of the rocks quarrying. Jain et al (2013) developed useful equations related to wearing of

diamond beads and cutting rates by using regression models. The performance of the used equipment is strictly depend on predictable and unpredictable factors. The type of rocks is one of the most known unpredictable-uncontrolled factors for dimension stone quarries (Mikaeil et al. 2016). Cardu et al. (2014), specified that the performance of the cutting machines also depends not only the type of the rock, but also the design and quality of the wires used.

In this study, we examined the performance of diamond bead wires used to cut-off marbles. Our main goal was to compare the different brand of the wires for shaping of blocks and cutting off the produced blocks from the quarry to factory.

2 METHODOLOGY

Depending on the increasing demand for processed marble products, new marble quarries are opened in many countries of the world. As a result, produced marble and marble derivative products also show a large increase. Not only the type-brand of diamond wire cutting machine (Figure 1), but the type and brand of the beads are also so important. Therefore, cutting and shaping blocks produced in marble quarries, diamond wire selection and socket design are very important. The type of diamond bead that must be used to cut marbles with a certain degree of hardness can only be determined after a few tests. These studies are both expensive and very time consuming, with different work being done to cut marbles with different characteristics. In the scope of this study, it was tried to determine the optimum life of diamond beads and their cutting performances in order to choose the appropriate

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diamond beads for the marble to be cut. In addition, efficiency calculations have been made depending on the diamond wire life and cutting performance, and attempts have been made to determine the transition point from the main mass segment to the cut-off segments of the diamond core. The method used in this study is as follows;

- Performing diamond wire cutting with specified beads,

- Obtaining the data,

- Measuring the surface area of the cut surface (m^2),

- Measuring the abrasion of the diamond beads in mm,

- Analyzing the obtained data,

- Cutting performance analysis,

- Graphical change analysis,

- Determination of the life of the beads,

All our tests and calculations are made in the Karamanlı Marble Quarry (Figure 2) operated by Çelikkol Marble Company.

Figure 1. Diamond wire cutting machine performing in marble quarry.

3 RESULTS

The brand (producer), total cutting area, wire life and bead diameter are shown in Table 1.

Figure 2. General view of beige marble quarry in Karamanlı, Burdur, SW Turkey.

Table 1. Used diamond wires in this study.

producer	total cutting area (m^2)	wire life (m^2/m)	bead diameter (mm)
Okaytaş 420 metre	34126,44	81,25	<9,7
Dünya mermer 100 metre	6690,22	66,90	<10,02
Sonmak 600 metre	44849,07	74,74	<9,7

As can be seen in table 1, the diamond bead wire of “Okaytaş" company has completed the economic life after reaching 9.7 mm bead diameter by completing 81,25 m^2/m cutting. After this point, the wire were used as scrap metal. 100 meter diamond bead wire of "Dünya Marble", 66.90 m^2/m wire life were measured before going to scrap metal container. The wire of “Sonmak" company could have 74.74 m^2/m cutting performance. Note that, all the bead diameters are 11 mm for all brands for the beginning of the tests. The length of the wires are different since all the firms produce their own rolls.

The relation between the cut-off areas and the bead diameters for each brand is also shown in figure 3 for 100 meters long diamond wires.

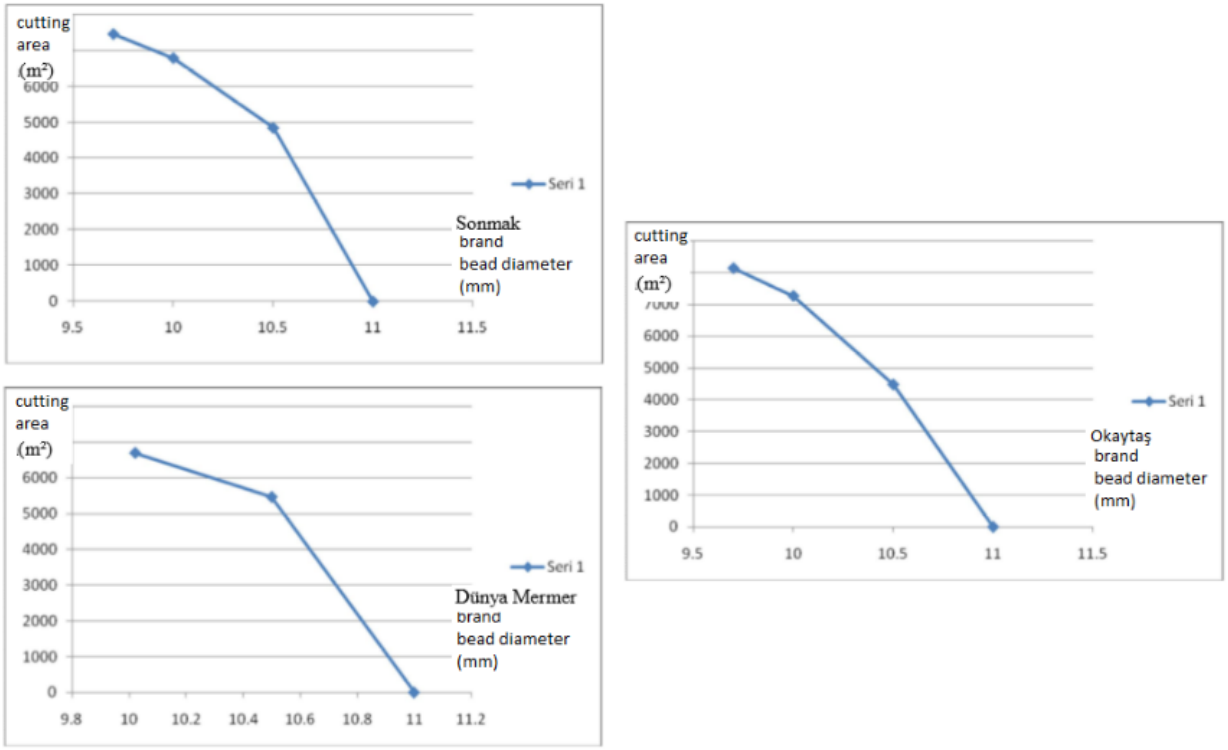

Figure 3. The relation between the cut-off areas and the bead diameters for 100 meters long diamond wires for different brands.

4 CONCLUSIONS

In this study, cutting performance of sintered diamond beads used in the diamond wire cutting method applied in the marble quarry operation of Burdur-Karamanlı beige marble has been examined. The results of these studies made in Çelikkol Mermer Ocağı in Burdur region were examined to determine the different performance of different brand of the diamond wires. As a result of the investigations made, the performance of diamond beads drastically decrease after a certain corrosion points for each brand. The cutting performance of the diamond wires were drastically falls after the diameter of beads reached in 9.7 mm for Okaytaş brand, 10.02 mm for Dünya Mermer brand and 9.7 mm for Sonmak brand. The wire of Okaytaş Company displayed best performance at our tests. Our study displayed that the brand of diamond wires is important criteria for the cutting costs for the marble mines and factories.

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