Cutting Rates of Materials on Various Cutting Instruments

1.0: Purpose

Determining the cutting speeds and rates of various materials is important in understanding the mechanisms of cutting and the length of time expected for particular specimen types. When approaching specimen preparation, it is best to understand first how materials will behave when certain methods are applied. By understanding these methods, namely cutting methods, the user can much more efficiently use the equipment and determine the proper approach to preparation. This experiment will determine the cutting rates for various material types to provide a guideline for cutting. Several samples were cut using four cutting instruments: Model 650 Low Speed Diamond Wheel Saw; Model 660 Low Speed Diamond Wheel Saw; Model 850 Wire Saw; and the Model 860 Diamond Band Saw. Determination of cutting rate was based upon the sample area cut and the time for cutting.

2.0: Experiment and Procedures

As there are several different instruments used for this comparison, the methods, parameters, and materials used for each piece of equipment will be discussed individually in the following section.

2.1: Diamond Saw Tests

For tests run on both the Models 650 and 660 diamond wheel saws, the following parameters were used for each stage of cutting.

Blade Type:	High concentration, fine diamond; 4” diameter; 0.015” thick
Load:	150 grams
Speed:	5 setting on dial
Blade Dressing:	Prior to each sample cut
Coolant Density:	30:1 (water:coolant)

Procedure

1. Specimens were measured and the total area of each sample was calculated.
2. Specimens were mounted onto the graphite mounting block using MWH 135.
3. Blade dressing was done prior to each cut and times were recorded.
4. Cutting rate was determined from the cutting times and the area of the specimen.

2.2: Wire Saw Test

The Model 850 Wire Saw parameters were as follows:

Blade Type:	Stainless steel wire; 0.010” diameter
Load:	5 turns on arm
Speed:	4 setting on dial (ramped up over 30 sec. period)
Slurry Type:	14 micron BC slurry

Procedure

1. Specimens were measured and the total area cut was calculated.
2. Specimens were mounted onto graphite mounting block using MWH 135.
3. Cutting was timed and recorded, and total cutting rate calculated.

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2.3: Diamond Band Saw Tests

The Model 860 Diamond Band Saw is a very simple instrument to operate. For these test samples, the same materials were used for calculation of cutting rate as was used with the other instruments. Samples are simply fed into the saw blade using the guide table, and the time for cutting was recorded. From this information the cutting rate could be plotted as with the other samples.

TABLE 1: Cutting Times and Cutting Rates for Each Test Run

Model 650 Diamond Wheel Saw		Model 850 Wire Saw	
Sample	Cutting Rate (relative units)	Sample	Cutting Rate (relative units)
Pure Copper	10	Pure Copper	21
Brass	16	Brass	60
Aluminum	13	Aluminum	51
Silicon	67	Silicon	126
Quartz	67	Quartz	159
Model 660 Diamond Wheel Saw		Model 860 Diamond Band Saw	
Sample	Cutting Rate (relative units)	Sample	Cutting Rate (relative units)
Pure Copper	23.5	Pure Copper	194
Brass	33	Brass	244
Aluminum	24.5	Aluminum	263
Silicon	144	Silicon	876
Quartz	167	Quartz	816

Based upon the cutting times of each saw type, the Model 860 Band Saw had the highest cutting rate among the saws tested. This is primarily due to the speed of the motor which is the main limiting factor in determining cutting rates in general. The Model 850 and the Model 660 were both comparable in cutting rate, exhibiting similar behavior. Both of these particular models exhibited similar cutting speeds and rates for all materials. The Model 660 saw was the slowest of the four tested.

Of most interest is which materials produced the fastest cutting rates and which produced the slowest. From the data in the chart as well as the graph it can be seen that the ductile materials such as copper and brass exhibited poor cutting rates which are a reflection of long cutting times. The brittle, hard materials such as quartz and silicon exhibited much higher cutting rates, which are a result of fast cutting times. This can be explained by the mechanisms at work during the cutting process. Ductile materials are cut by a shearing type of force, where the abrasive particle pushes material away until it is removed. This tends to clog the abrasive, with all of the sheared material collecting in the spaces between particles. Eventually, the abrasive particles act as a continuous surface with no asperities or bumps producing the cutting action. This is known as blade loading. In the case of brittle, hard materials, removal is done through brittle fracture and chip formation. The abrasive particle,upon impact with the specimen, causes it to chip and fracture. The fractured pieces are then carried off in the coolant. A small amount of blade loading will occur in the brittle case, but will not be nearly as significant as the ductile case.

3.0: Conclusions

It has been demonstrated that ductile materials cut at slower rates as compared to brittle materials. Although the equipment used has an effect on cutting time and rate, certain issues of specimen damage should be investigated in future experiments. By understanding the mechanisms involved in cutting materials of different composition, one can better approach the cutting and sectioning steps of specimen preparation to optimize preparation time and quality.

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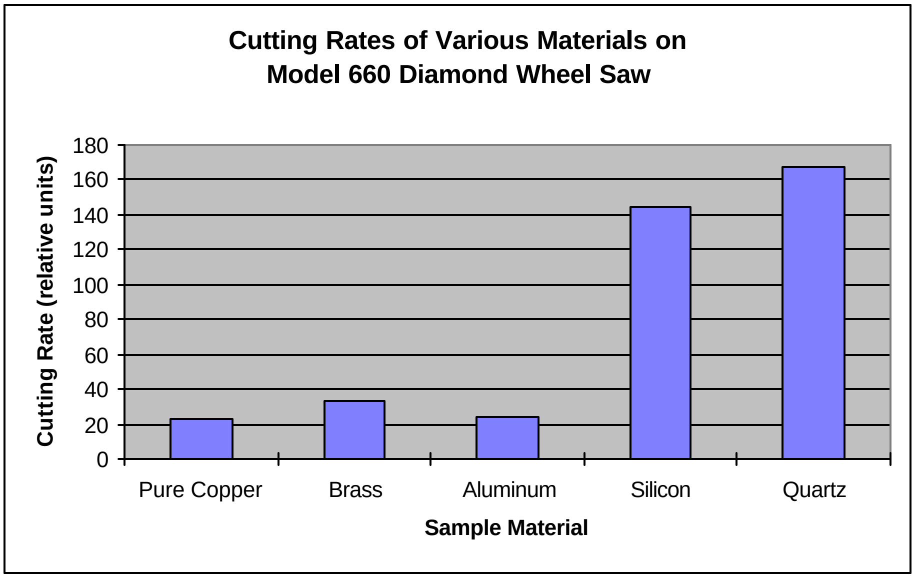

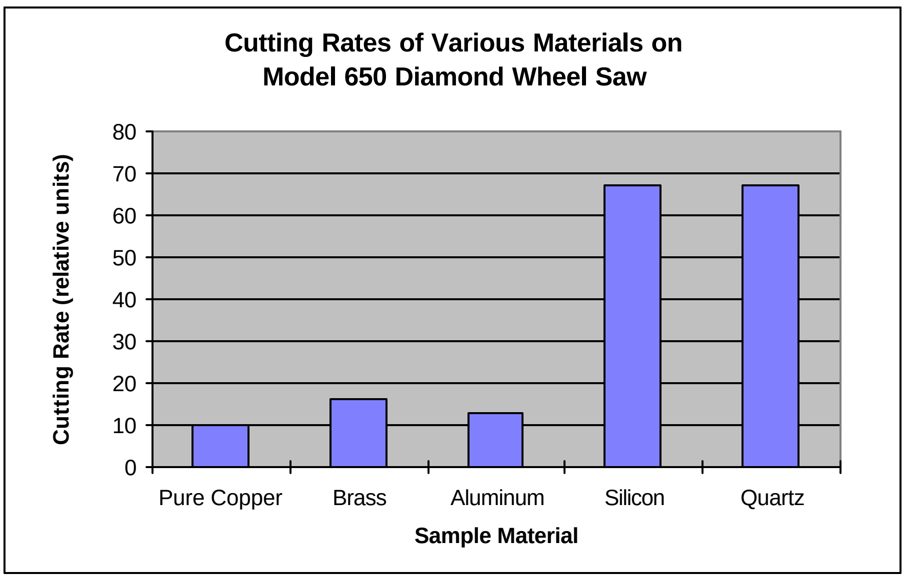

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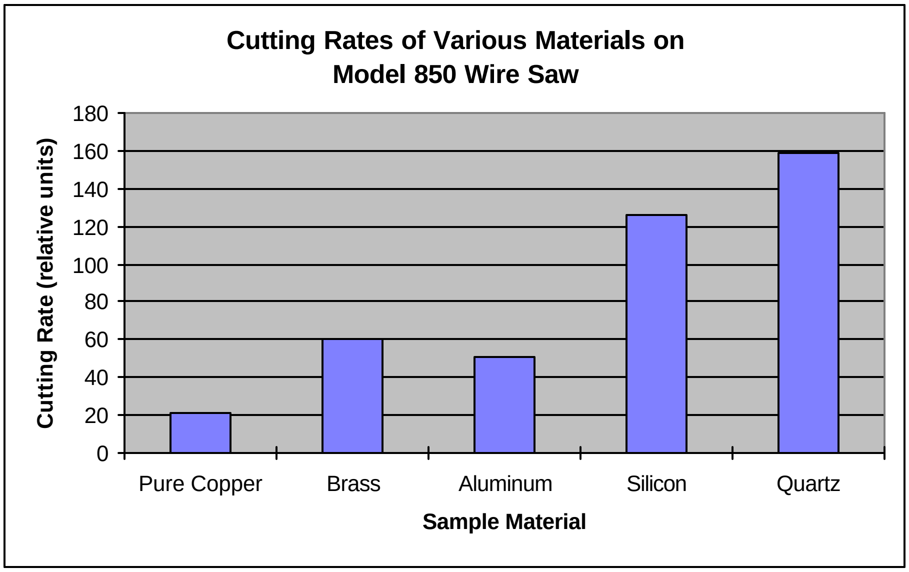

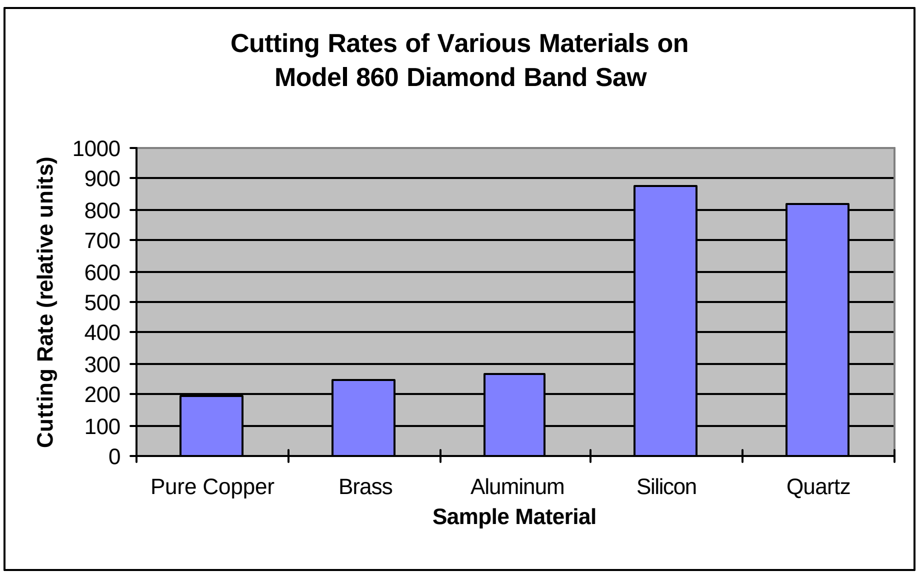

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