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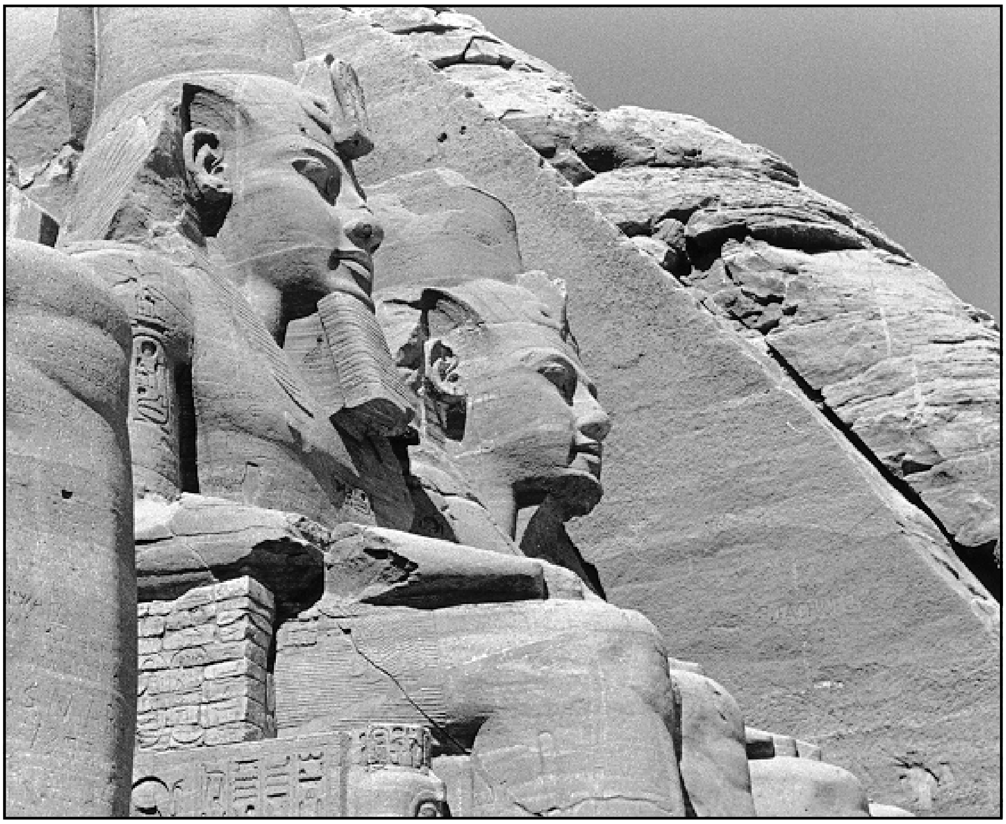


The ancient law

$$E_k = \frac{1}{2}mv^2$$

HOW CAN THE LAW

$E_k = ½mv^2$

EFFECT YOUR RESTORATION WORK ?

E_k = ½mv^2, that is how physicists define the transfer of kinetic energy, but how can this law effect your blasting work, specifically with respect to cleaning without damaging the substrate?

Like many inventions that have evolved from a natural phenomenon, the ‘sand-blasting’ process was developed from an occurrence first noticed in the South West Prairies of America. Sandstorms had the effect of polishing or frosting windows of the buildings so that a perfect impression of the wire screen or guard would be left upon the glass.

The first patent for a ‘sand-blasting’ machine based upon this observation was obtained by Mr. B.C. Tilghman in 1870, the paper says that a jet of sand, propelled at high velocity is employed as a tool for cutting stone and other materials and at a lower velocity of jet it is employed for grinding and ornamenting the surface of glass.

This process, as well as all later designed blast cleaning processes, are based on the above mentioned law, meaning that each grain of the media generates a portion of kinetic energy at impact on the surface. In layman's terms, this energy can be calculated with the given law as the energy transferred is equal to 50% of the sum multiplying mass times $velocity^2$ = J, where the J stands for "Joule" the SI unit for energy.

How Does This Effect Your Blasting?

The Sphinx in Egypt is nearly covered up by the sand of the desert. The neck of the Sphinx is partly cut across, and this is not done by ordinary weathering, but by the eroding action of the fine sand blown against it. In these cases, nature furnishes us with hints which may be taken advantage of in our profession of cleaning and restoring.

If due to the constant transfer of kinetic energy, the neck of the Egyptian Sphinx is partly cut across we need to know how to control this energy to our favour. In other words we need to clean buildings, facades, sculptures and ornaments etcetera without damaging them.

With present systems used, it all comes down to the knowledge of the above mentioned and how to apply the chosen process in the right way.

According to the given law our media is the mass and the pressure we are working with (when using compressed air driven systems) is the velocity. They are responsible for the generated kinetic energy transferred to the surface.

As normal sand is no longer used as abrasive due to the danger of silicoses, also the name of ‘sand blasting’ is banded. This name is replaced for many others like ‘abrasive cleaning’ or ‘blast cleaning’ and ‘compressed air blast cleaning’. Also terms as ‘grit blasting’ and ‘shot blasting’ are used.

Nearly all these process names are linked with a high grade of aggressiveness as for normal cleaning of steal and structures, the rule ‘the quicker the better’ applies. This because labour costs are the highest in the cost calculation per finished object or m^2, followed by abrasive, compressed air and maintenance. We are not discussing interest and depreciation etc.

The cleaning of buildings, facades, ornaments and sculptures is a completely different matter. That is why we for a number of years ago introduced the MicroStrip technique. Although based on the same principle, micro stripping is carried out with so called micro fine abrasives and low pressures. With low pressures we indicate the range from 0,5 Bar to 2,5 or 3 Bar as the normal working pressure. Within the MicroStrip™ technique we call everything above 3 Bar ‘high’ pressure.

How To Influence The Transfer Of Kinetic Energy?

For decades long compressed air blasting was associated, most of the time, with an oily compressor, silica sand and a working pressure of 6 Bar, preferably even higher, because as mentioned before the general rule was ‘the quicker the better’.

When contractors in the cleaning business, used to the mentioned circumstances, started to clean buildings, facades and other masonry objects, they caused a lot of damage and give the blast cleaning process a bad reputation of which we often still suffer today.

Although the damaging of mason structures, the treated objects became very clean and
a number of contractors realised that blasting was a very effective method of cleaning.
It was however necessary to clean without damaging bricks, marble and other masonry products.

Once they dropped the working pressure, and worked their way around the problem using smaller grain sized abrasive, lower harnesses and changing the strike angle, they were very well able to clean without damaging objects.

These precautions were actually influencing the transfer of kinetic energy of the law $E_k = ½mv^2$ in the following order of importance:

Pressure | **Grain Size** | **Hardness** | **Strike Angle**

• Pressure

With ‘direct pressure’ blasting systems, the working pressure creates an outlet speed of the abrasive leaving the nozzle. The final exit speed, depending on the set pressure, can be as high as 90 m./sec. As the speed in the law is of quadratic influence, it's well understood that lowering the working pressure will result in lower outlet speeds, i.e. a lower transfer of kinetic energy to the surface.

It's often said that distance is also of importance, which is completely true. The further the nozzle is away from the surface, the lower the strike velocity at the surface will be. This is caused by loss of speed of the abrasive travelling from the nozzle to the surface, that's why we are not taken distance as a parameter because distance equals velocity.

• Grain Size

For every type and shape of abrasive used, the grain size represents the mass in the law $E_k = ½mv^2$. Grain size and weight, i.e. mass, have a close relationship. Using smaller grains will therefore influence the final kinetic energy transferred to the surface. An other, even more important topic of the grain size is the so called 'cover rate' to which we come back later on.

• Hardness

The definition of hardness is the resistant offered by the material against penetration by a harder material. When hitting the surface, a hard abrasive particle will deform less then a soft particle and therefore transfer more of the kinetic energy of the impact to the surface. A hard particle is beneficial to the cleaning effect but disadvantageous for damaging the substrate.

• Strike Angle

The strike angle also plays a role of influence, an angle of 90° will have a strong hammering effect on the surface which might provoke the damaging of the substrate.

An angle of 45° and lower, the cutting effect of the abrasive particle is used with which the contaminants are scratched of the surface. The influence of the strike angle is proportionate to the sinus of the angle, the bigger the sinus value the bigger the hammering effect will be.

These are the 4 parameters that enable us to influence the transfer of kinetic energy and they are always in direct relation to each other.

All systems functioning on 'direct pressure' are subject to the law $E_k = ½mv^2$, with or without water, with or without so called high production nozzles, with or without exact abrasive metering systems and all other type of features. At the end of the day, they are all using the above mentioned parameters to influence the result on masonry substrates.

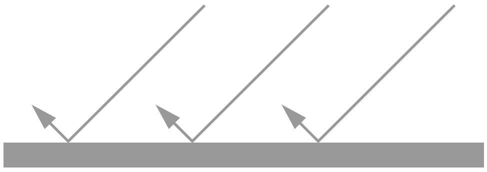
What Is The Right Grain Size Of Abrasive?

There is only one answer possible to this question. The right grain size of all type of abrasives that can be used for any purpose is 'the smallest grain size possible'.
Note: not the smallest grain size available, but repeated with importance 'the smallest grain size possible'.

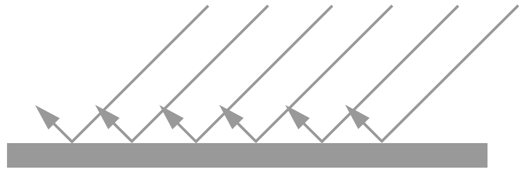
What do we mean with this answer?

We mean the smallest possible grain size, that still generates enough kinetic energy to remove the contaminant and impurities from the surface without damaging the substrate.

Cover rate

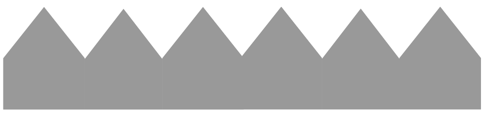


Low cover rate



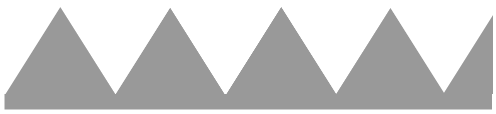
High cover rate

How To Achieve Coarse And Fine Surface Roughness

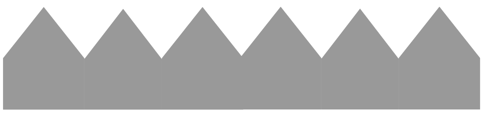


Low velocity

Same grain size, hardness and strike angle

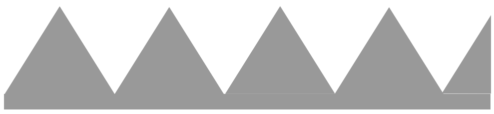


High velocity

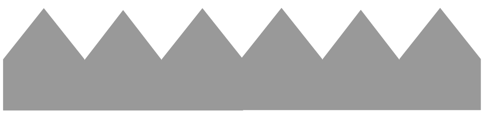


Small grain size

Same velocity, hardness and strike angle

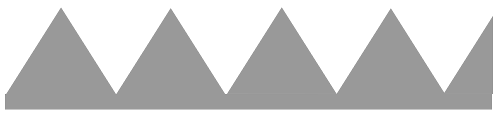


Big grain size

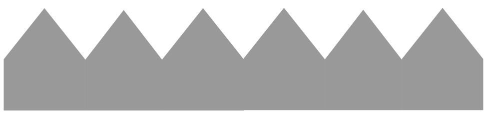


Low hardness

Same velocity, grain size and strike angle

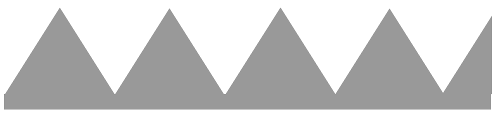


High hardness



Small strike angle

Same velocity, grain size and hardness



Large strike angle

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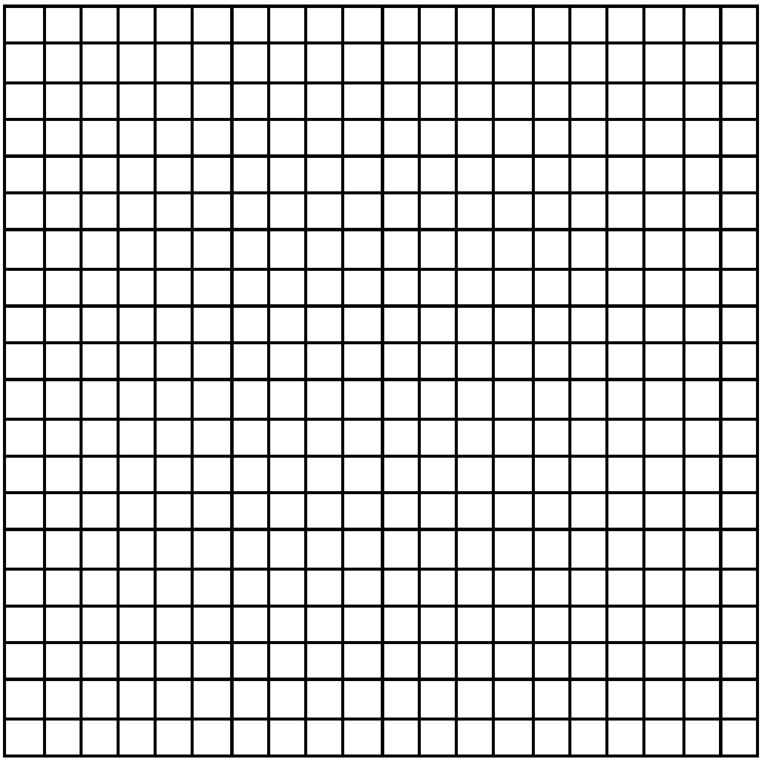
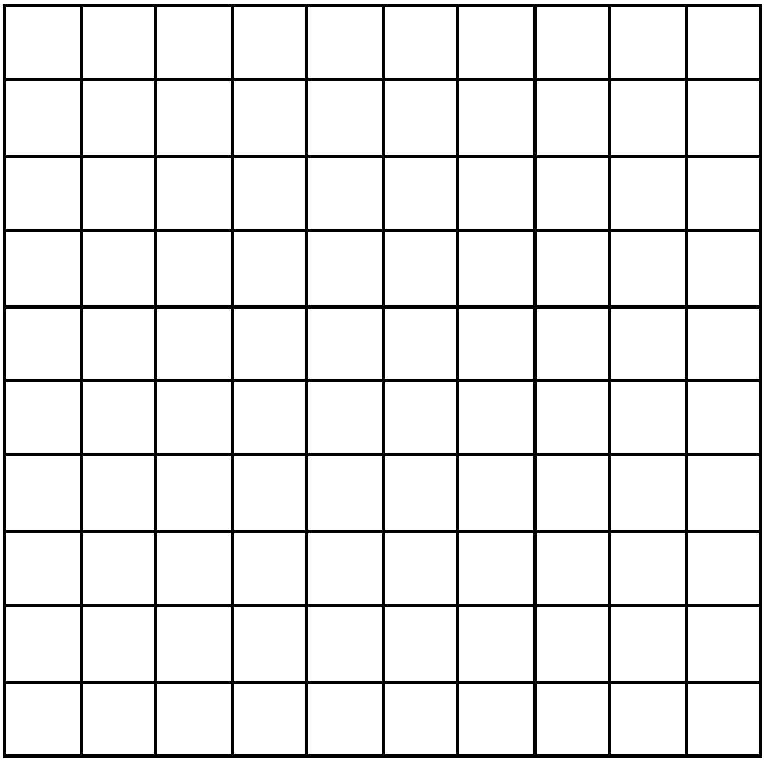


1 cm² (Scale 10:1)

Grain size: 0,5 mm

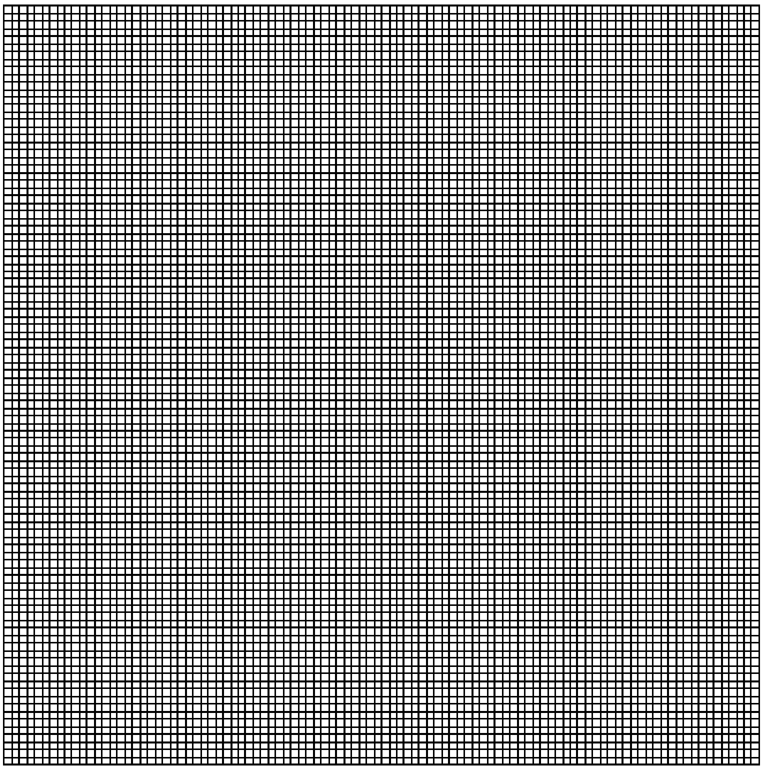
Cover rate: 20 x 20 = 400 / cm²



1 cm² (Scale 10:1)

Grain size: 1 mm

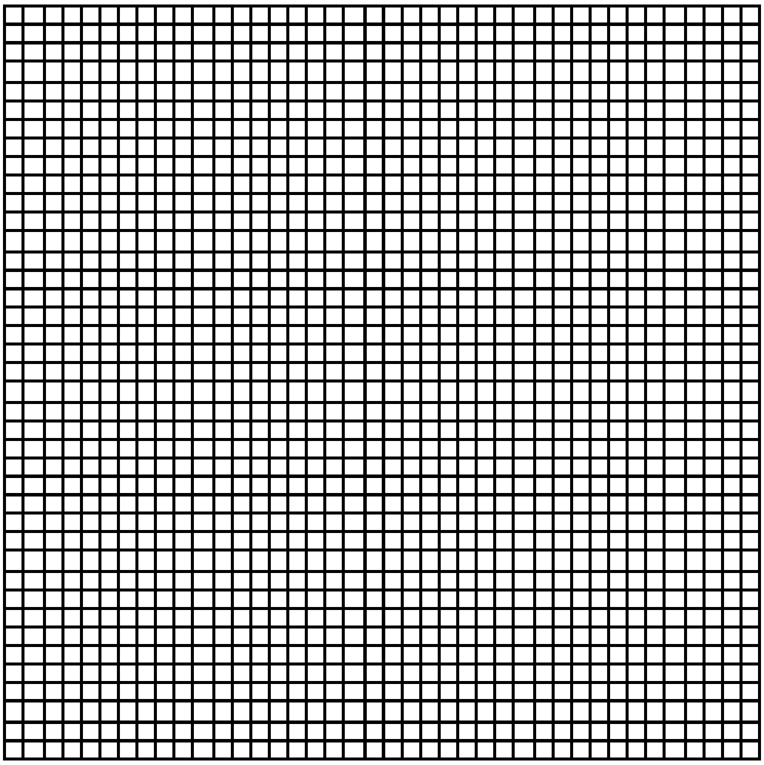
Cover rate: 10 x 10 = 100 / cm²



1 cm^2 (Scale 10:1)

Grain size: 0,1 mm

Cover rate: 100 x 100 = 10.000 / cm^2



1 cm^2 (Scale 10:1)

Grain size: 0,25 mm

Cover rate: 40 x 40 = 1.600 / cm^2