AQUAJET®
TECHNOLOGY

3 ways to rid yourself of pipe holes

AQUAJET INFINITY
OSCILLATION

3 ways to rid yourself of pipe holes

In recent years, hydrodemolition has been growing in popularity for projects from bridge repair and parking structures to industrial cleaning and a myriad of other concrete removal and rehabilitation projects. The popularity is attributed in part to reduced labor, enhanced efficiency and better precision. But another benefit of hydrodemolition is the ideal bonding surface it creates, leading to longer-lasting repairs. Concrete removal via high-pressure water creates a rough, irregular surface without damaging the surrounding concrete or rebar.

However, as ideal as hydrodemoltion is, potential still exists for some bothersome imperfections known as pipe holes. Any contractor working with hydrodemolition is familiar with these small but deep pits in the surface that can lead to problems if not handled properly.

Pipe holes can compromise the bond of the new concrete. But proper training, understanding the right machine settings and finding the best oscillation pattern give control over pipe holes back to the operator. Here are some expert tips for addressing the pipe hole nuisance.

Hydrodemolition sequence

Pipe holes occurs when the speed of the lance oscillation motion fluctuates within the hydrodemolition sequence. To understand the hydrodemolition sequence and what can cause these pipe holes we set an example:

The nozzle carrier (power head) is moved linear over a feed beam at a certain traverse speed. It could for example be 10 m/min. Call it the X-direction. To cover a bigger surface the hydrodemolition robot also indexes with its tracks, the Y-direction. In this example we index the tracks 50 mm. By combining the two directions we get our production rate. To be able to cover the indexing “gap” of 50 mm we must add an oscillation motion. This moves the lance in a pendulum motion in the Y-direction. If the oscillation stroke is 100 mm we will then overlap the indexing distance by two times.

Now we must break down these motions into milliseconds. The oscillation motion is created by an excentric crank, similar to a combustion engine. This means that the lance will accelerate and decelerate in each oscillation stroke. At the top and bottom dead center, it will stop completely and start accelerating the other way. The oscillation speed can be up to 360rpm, meaning that it can be down to 80 milliseconds between each dead center. In between the two dead centers, the oscillation motion reaches its max velocity. If combining a fast oscillation speed with a long oscillation stroke, the nozzle speed over the surface will be more than 100 m/min at this point.

To understand the complete motion pattern of the nozzle, we have to combine the oscillation motion with the traverse speed. In our example we have a traverse speed of 10 m/min combined with a max oscillation velocity of 100 m/min. This means that the surface speed is 10 m/min each time the oscillation is at dead center and more than 100 m/min when has max velocity. Remember that this happens each 80 millisecond it this example. When projecting the combined motion on the surface, the water jet will create a sine wave pattern. Surface speed will be lowest in the top and bottom of the sine wave and highest in the middle.

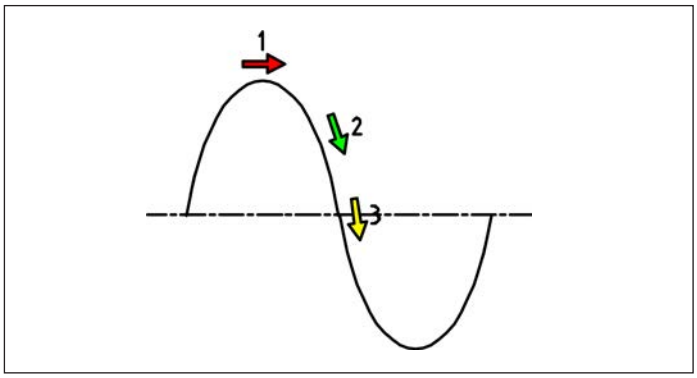


Illustration shows the lowest speed at 1 (dead center), highest speed at 3 and optimal speed at 2 (average speed).

Pipe holes

The example above is quite extreme, but it illustrates well how the surface speed fluctuates within the hydrodemolition sequence. These high frequency speed changes are also what sometimes can cause pipe holes. As the lance is at its dead center, the water jet slows down, meaning that it is removing more material in that particular spot. As the lance goes through a series of these speed fluctuations it can sometimes create a pipe hole at each dead center. The end product reveals a honeycombed appearance and holes that may be difficult to completely fill with new material, leaving air pockets between the bonding surface and the overlay. Problems with pipe holes are getting more noticeable at higher water pressure and lower flow. The reason is that higher pressure (2000-3000 bar) has a more “cutting” effect to the concrete than the traditional selective removal (1000-1600 bar). The selective removal pressurizes and widen the concrete pores and removes bigger chunks, while the high pressure method is more precise and removes only the material the water jet is hitting.

Small imperfections that create big problems

The air pockets, if not properly addressed, can translate into several potential problems, such as shorter repair intervals and higher overall costs. While pipe holes don’t equate to problems in every case, they do require additional attention to make sure the proper bond is achieved. Perhaps the most critical area to pay attention to is making sure the surface is completely cleaned before the new concrete is applied. This helps ensure no contaminants get trapped in the pipe holes to prevent the overlay from adhering properly. It’s critical that, as soon as the cleaning is completed, the new concrete is placed, because any exposed time will allow more dust or debris to settle. Trapped contaminants can have adverse effects, such as causing the rebar to rust or, in extreme climates, freezing/thawing cycles that result in cracking.

Example of surface with pipeholes that appears in lines.

Increase desired results with training and experience

The first step to eliminating pipe holes is proper training on how to use hydrodemolition equipment. Every concrete repair project has different variables, so each job requires a different approach. Aquajet offers training to ensure operators are equipped with the knowledge to achieve optimal results.

To help understand the equipment, Aquajet offers product training that teaches safety, operation and service of the equipment upon delivery. Additional training is available through the Aquajet Academy. The training program consists of a comprehensive range of courses that include advanced Aquajet and hydrodemolition training, safety and technique, service training, and more. Watch this video to see what you can learn through our personalized training program.

Pipe holes can be a tricky task but knowing your machine and being comfortable with adjusting settings is key to achieving optimal results. Take advantage of Aquajet's training to ensure your team is operating as safely and efficiently as possible.

Adjust settings for each project

Once the operator is fully trained on the equipment, they can take steps to reduce pipe holes by adjusting the parameters of the machine. We recommend starting with the machine's factory settings. The operator should make test cuts, inspect them and adjust the parameters until they achieve the desired result. Modifications to the lance angle, speeds, pressure levels and indexing are all great places to start.

Water pressure
Of course, the higher the force, the more cubic meters per hour you can remove. However, if the pressure is too high, the operator will have less control and can sometimes produce more pipe holes. With a lower pressure, the pipe hole effect can be reduced.

Oscillation speed
The surface speed is a combination of the traverse speed (roller and lance) and the oscillation velocity. A higher oscillation speed means that the surface speed fluctuation is getting larger because the oscillation velocity is getting higher while the traverse speed remains the same. A slower oscillation speed will reduce pipe hole effect.

Oscillation stroke
The oscillation velocity is getting higher with a longer oscillation stroke. This also means that the fluctuation in surface speed is getting larger. A shorter oscillation stroke will also reduce pipe hole effect.

Indexing distance
Adjust the indexing distance so it doesn't line up with the oscillation strokes. This amplifies the pipe hole problem because the lance pauses at the same point which can double the depth of your pass by cutting deeper into that spot on the surface.

Lance Attack Angle
A greater lance angle will remove a greater amount of material from under the rebar and give a more even surface with fewer pipe holes. A smaller angle gives a more uneven or pitted surface but with a faster removal. It will also remove less material under the rebars.

When determining the best settings for a concrete restoration project, many variables come into play including pump pressure, surface thickness and deterioration. The best setting for each project is a compromise between different parameters. Learning all the parameters of the machine and how they work together will greatly reduce the potential for pipe holes.

Infinity oscillation

Earlier this year, Aquajet revolutionized the hydrodemolition industry once again with the launch of the newly patented Infinity oscillation technology on the Aqua Cutter 750V hydrodemolition robot.

The innovative Infinity oscillation technology moves the water jet in an infinity pattern providing constant lance motion that eliminates speed fluctuations that occur with the standard wave pattern. The consistent motion virtually eliminates pipe holes, resulting in a superior bonding surface and increased productivity.

Technically it means that a second motion is added to the oscillation stroke that moves the lance sideways (in X-direction) at each dead center. This basically means that the dead center phenomenon is eliminated. When projected to the surface, the lance creates a figure-eight (8) pattern, a constant infinity motion that never stops. When combining this new motion with the traverse speed, the surface speed can be totally constant.

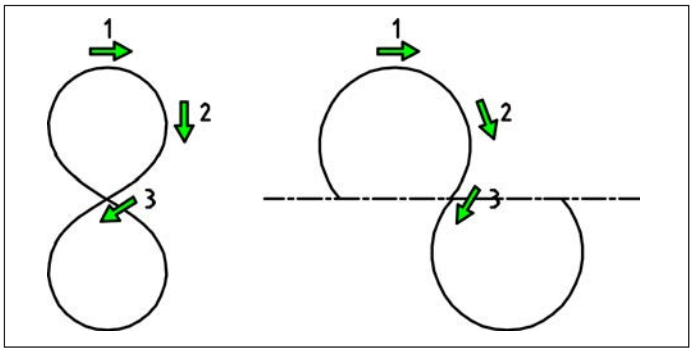


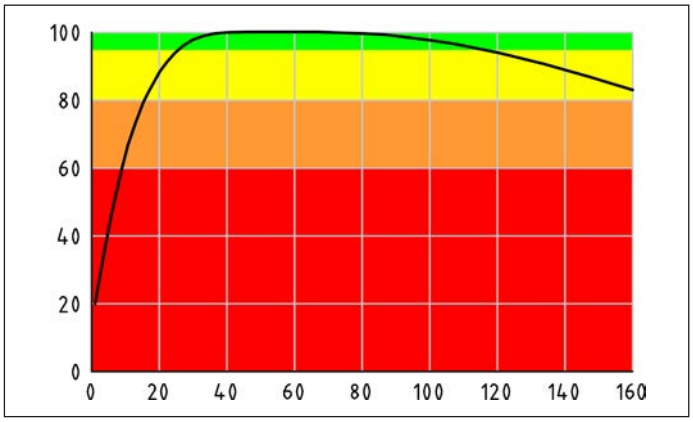
Illustration shows the sideways movement at dead center (1), which creates the recognizable Infinity pattern.

Settings optimized for performance

The infinity oscillation means a hole new game plan, where virtually no sacrifices to the performance has to be made.

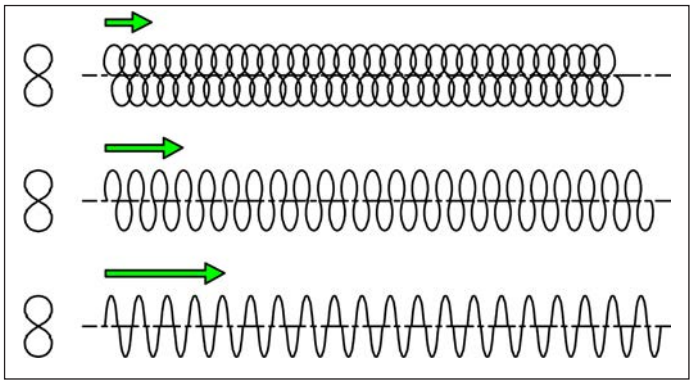
Water pressure
Higher force of water removes more cubic meters per hour. Because of the constant surface speed, the pipe hole effect is reduced regardless of pressure/flow combinations.

Oscillation speed
Oscillation speed can be set create the optimal oscillation pattern. Because of the new sideways motion, the oscillation can create



X-axis: Surface speed (m/min) / Y-axis: Performance factor (%). With Infinity oscillation, the surface speed can be constant within the green zone.

X-direction overlaps within each oscillation stroke. More overlaps means higher performance. Even with high oscillation speed, the surface speed will not fluctuate and thereby not creating pipe holes.



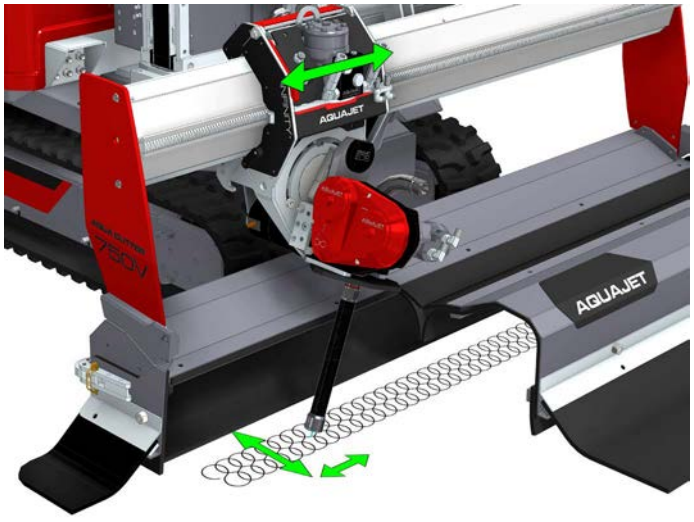
The overlap changes with speed ratio between oscillation and roller. The surface speed still remains constant in any combination.

Oscillation stroke
The oscillation stroke can be set as high as necessary to match the indexing length. Because of the possibility to set a long oscillation stroke without surface speed fluctuation, we can also create more indexing overlaps which also helps increasing the performance.

Indexing distance
As the oscillation pattern does not have any variations in speed there are no critical spots. The indexing distance can be set to achieve the highest performance regardless of oscillation stroke.

Lance Attack Angle
Because of the constant motion of the infinity, the lance angle does not have to be compromised to reduce pipe holes. The lance angle is instead used to optimize the performance and the result.

The control system on the Aqua Cutter 750V automatically calculates ideal combination of oscillation stroke and oscillations speed based on the traverse speed, to achieve a constant surface speed. This takes the guesswork out of finding optimal machine settings and not only maximizes production but prevents miscalculations from manual adjustments.



Standard oscillation

Examples of surfaces with pipeholes that appears in lines during hydrodemolition with standard oscillation method.

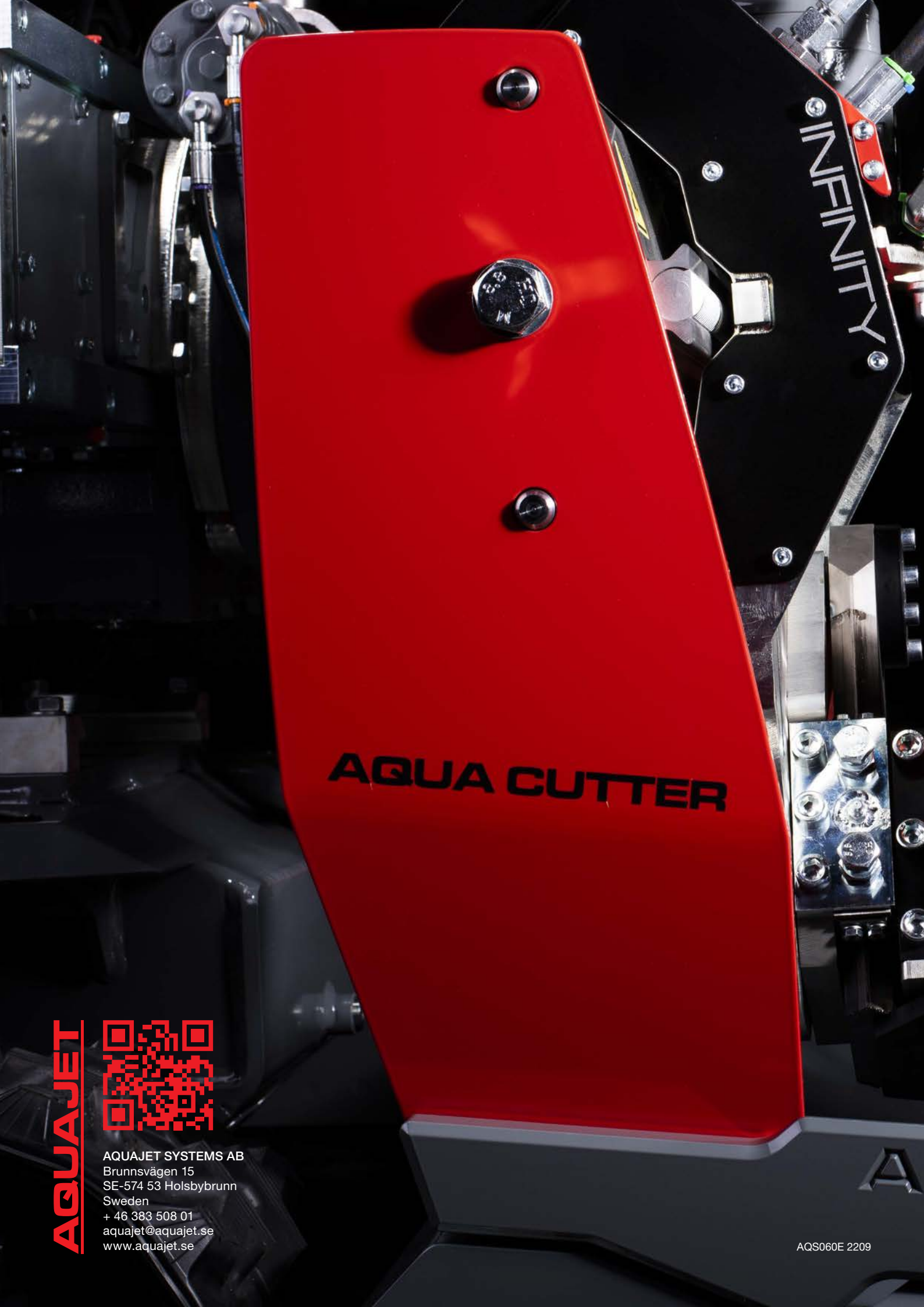
Infinity oscillation

Examples of surfaces where the effect of the Infinity oscillation is clear, with a much smoother surface and significantly steeper and more even sides of the cut compared to the standard oscillation.

Cutting-Edge Technology

Aquajet focuses on developing industry-leading innovations to help increase efficiency in hydrodemolition while also reducing pipe holes and increasing the quality of the finished project. All of our Aqua Cutter robots feature our Equal Distance System (EDS), which maintains a consistent preset distance between the nozzle and concrete surface at all times regardless of the lance angle. The EDS system leverages distance and pressure consistency to achieve higher removal rates than competitive designs.

Hydrodemolition is recognized more and more as a highly efficient method to extend the life of concrete repairs. You don't have to settle with the pipe holes that can come in some conditions. Reducing pipe holes can be combatted to maximize the integrity and longevity of the structure. Contact Aquajet to learn more about our solutions and cutting-edge technology for your hydro-demolition jobs.



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