**Versatility of diamond wire saws in the construction industry**

The growth in the use of diamond tooling in the construction industry has many contributing factors, most of which are driven either by improvements in operating and training methods by the contractors or by ongoing developments in tooling and machinery by the toolmakers and diamond suppliers. Of this latter category, the diamond wire saw has proved to be one of the most significant developments and it is now used extensively by contractors the whole world over as a standard method for controlled demolition. This report by Martin Jennings describes two recent jobs carried out by a Japanese contractor which demonstrate how diamond wire sawing can be equally effective when applied to both large-scale and relatively smaller jobs.

Japan is a country which consists of four small narrow islands and the topography of each island is very similar. Every island features a high range of mountains, acting almost as if they were the backbone of the island. Areas of flat land (where most of the population are located) are very limited and the presence of high mountain ranges is never far away. In addition, the slopes on most of the mountains are relatively steep and the action of the winter rain and snowfalls often causes severe erosion of the mountain slopes. This can lead to catastrophic avalanches of mud and rocks onto the populated areas below. As a countermeasure to natural disasters such as this, many erosion control dams were built and these are a common feature throughout Japan.

A major problem with all these erosion dams is that, over the years, sand and rubble tend to accumulate behind the walls of the dams till eventually they become completely buried and lose their effectiveness. To remedy this, accumulated rock and sand has to be removed at regular intervals, an operation which is both time consuming and labour intensive. In order to reduce the frequency of this removal of debris that builds up behind the dam walls, it was decided to try an experiment at one dam, whereby vertical slits would be cut into the dam which would allow much of the smaller rocks and finer sands to pass through and therefore reduce the amount of build-up behind the wall. The dam chosen was located at Shibata City in the Niigata prefecture, a place famous for the production of Japanese sake, distilled under the brand name of ‘Shibata’ using the fine local rice and mineral water. The time scale chosen to carry out the works was between July and August 2003, when the rainy season was at its lowest.

**Wire sawing and concrete bursting**

Daiichi Diamond Koji Co Ltd, a member of the Japanese Concrete Sawing and Drilling Association, was appointed to execute the work and due to the large scale of cutting involved, it soon decided to choose a combination of diamond wire sawing coupled with diamond core drilling and hydraulic concrete bursting as the preferred method.

*Editor’s note: The complexity of the work involved on the Shibata dam and the innovative way in which Daiichi dealt with it was recognised by the company being awarded 3rd prize in the recent Diamond Award, organised by the International Association of Concrete Drillers and Sawers (see IDR 2/2004, page 10).*
The dam was tapered in cross section so the ‘slit’ area of concrete to be cut out of the dam wall measured 25 m in height and was 18 m wide at the bottom and 8 m wide at the top. Four cuts with the wire saw had to be made to form the two slits required, which were 1.5 m wide.

Accuracy of drilled pilot holes

The first difficulty was the accuracy involved in drilling the four pilot holes required to thread the wire through to commence the cut. Each pair of pilot holes for each separate slit had to be aligned in parallel, otherwise the cut slit would be formed in a wedge shape which could affect the structural integrity of the dam in future years.

The pilot holes were drilled using 52 mm diameter core bits which comprised three sections: bit, tube and coupling. Extra tubes were added as the cut progressed to reach the total 18 m width of dam and allow the bit to just penetrate on the opposite side of the wall.

The diamond core bits were supplied by Shibuya Company Ltd. These were specially made for the job with extra wide segments to give extra clearance between the sidewall of the tube and the drilled core.

By careful drilling with Auto-feed Shibuya and B&D drills, Daiichi achieved the necessary accuracy to ensure the pilot holes were in parallel. Each of the 18 long pilot holes took approximately 12 hours to drill.

Diamond wire

A Crime wire sawing machine equipped with diamond wire from Asahi was used to cut out each of the four vertical sections. Each cut area was 346 m² giving a total of 1384 m². The 80 m long wire was mounted with 11 mm diameter diamond beads spaced at 40 beads/m.

As the cut progressed, the slack on the wire was taken up by rearranging the pulley system. A cutting rate of 2 m²/hr was achieved with a good wire life of around 2.5 m²/m on the concrete which contained only minimal reinforcement in the cutting plane.

Daiichi was very pleased with this combination of powerful Crime wire sawing machine with Asahi diamond wire which carried out the job with no problems at all.

To core the holes needed to enable the hydraulic cylinders to be inserted for the concrete bursting, 200 mm diameter core drills were used, also supplied by Shibuya Company Ltd to a similar specification as the 52 mm diameter drills used for the pilot holes.

The 9 diamond segments on each of the 52 mm diameter core drills were 6 mm high, 14 mm long and 4.5 mm wide, brazed onto a 2.5 mm thick barrel. The 16 segments on each 200 mm diameter core bit were 7 mm, 24 mm and 5.5 mm respectively, in this case brazed onto a 3.0 mm thick barrel.

Hydraulic bursting

Scaffolding was erected to allow horizontal drilling on the dam walls. Vertical drilling was also employed to enable the Hydrostress concrete burster to break up the cut section into 3 to 5 tons weight of concrete block.

While making the horizontal drilling, Daiichi checked the location of reinforcement bars very carefully. This enabled the company to decide exactly where the vertical holes should be made to ensure the concrete cracked as planned. In total, 998.2 tons of concrete blocks were carried away.

Although the job was large in scale, it was relatively easy to a company with the experience of Daiichi. However, like all jobs, there were unforeseen difficulties – in this case the time allowed to complete it. Although 60 days were available, in reality only 40 were possible because of sudden summer rainstorms which often cause freak avalanches and mudfalls. For safety reasons, therefore, the job had to be stopped quite regularly. Despite this, Daiichi was pleased to finish the job on time.

Limited working conditions

At the other end of the scale from large demolition projects such as the one at Shibata dam, diamond wire sawing proved equally effective on an entirely different job carried out by Daiichi in the heart of Tokyo.

This involved the demolition of a three storey building – the Tokyo Diamond Building located in Tokyo’s Chuo district – which butted directly onto its adjacent 7 storey neighbour. Both buildings had the same owner and it was intended to build a new 15 storey building on the site of the old one.

Because of the proximity of the adjacent building, severe restrictions were imposed on the work in terms of noise and vibration such that diamond sawing and drilling was almost mandatory. The only time conventional percussion-type power drills were allowed on site was from between 6.00 and 7.00 am, when small diameter holes for anchor bolts could be drilled.
Main beams wire sawn

The job entailed a combination of diamond floor saws and wire saws. The main concrete deck was 150 mm in depth and wall saws were used to cut through this. In places though, a 200 mm thickness and above was encountered and wire saws were used for this cutting work.

Also, all main beams were cut with a wire saw, the largest being those at the face of the adjacent building which were 350 x 700 mm in cross section and contained an I-section steel girder.

Using a Consec wire sawing machine driven by a Hydrostress power pack and equipped with diamond wire from either Asahi or Disco, cutting rates of around 1 m²/hr were achieved in the heavily reinforced concrete that was encountered. Blocks had to be no more than 2 m wide (and were never more than 4 m long) to enable them to be loaded onto trucks to be carted away on the relatively narrow streets.

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Top left  Connecting beam to adjacent building was cut off cleanly by the wire saw
Top right  Wire sawing in action to cut a slab in restricted working conditions
Above left  Core drilling in advance of wire saw set-up
Above right  Concrete sections had to be no more than 2 m wide to allow for craneage and trucking limitations