	TRENCHLESS TECHNOLOGY RESOURCE CENTRE	
	TRENCHLESS TECHNOLOGY GUIDELINES	SECOND EDITION
	LOCALISED REPAIR TECHNIQUES AND SYSTEMS	LAST UPDATED OCTOBER 2006

OVERVIEW

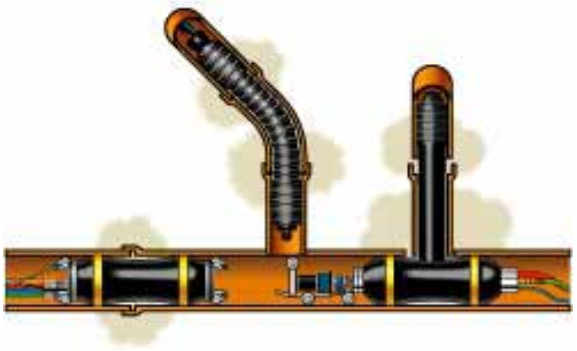
Whilst many trenchless techniques are aimed at larger scale manhole-to-manhole operations, in the renovation sector it is not always the case that such 'whole system' techniques are required. Where localised ground movement, root intrusion or joint failure has occurred, amongst other possible defects, there is a need for systems that can address a localised problem. Many of the major manufacturers have risen to this challenge, and developed a spectrum of techniques for this type of situation that addresses this situation in a more economic and practical way than total manhole-to-manhole renovation or replacement. As will be seen in the following, many of the systems developed for this industry sector are simply versions of the main line manhole-to-manhole techniques discussed elsewhere in these Guidelines.

These smaller scale techniques often lead to less cost and disruption, even as compared to the larger scale manhole-to-manhole trenchless techniques used for pipeline renovation, and they can be very specifically defect targeted.

GROUT INJECTION

One of the most common techniques used for localised repairs is that of grout injection. The technique can be used in both main line situations and in lateral connections.

Once a pipeline has been surveyed to establish exactly where the defect or substandard joint is located, an inflatable rubber packer is inserted into the pipe using winching systems that are set up at access points (normally manholes) at either end of the damaged pipeline section. Using CCTV cameras to observe the operation, the specially designed packer is winched into place with its centre over the defect. Once in position the packer is inflated with compressed air. The packer design is such that the ends inflate in a way that forms a seal at either side of the defect isolating it from the remainder of the pipe.



Grout injection packers for main pipe, lateral only and main pipe and lateral repairs. *Picture courtesy of American Logiball, USA.*

The packer has feed pipes running through it, which carry the injection grout material, usually either an epoxy resin or mortar. In the case of the epoxy resin it may be that the feed is via twin pipes that combine at a static mixer just before the injection point to ensure that,

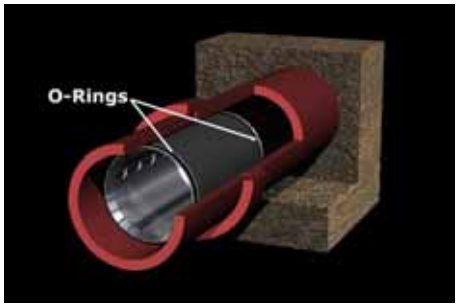
once mixed, no hardening occurs in the feed pipes so they may be used time and again with only the static mixer needing replacement.
With the inflated packer in place, the injection grout is pumped under pressure into the space between the two sealed ends. The grout spreads around the packer to fill not only the space between the packer and the pipe wall but also defects in the pipe wall. The space around the packer is such that relatively small amounts of grout are required to achieve the repair and fill the pipe wall defects.
When the packer surround is full, the grout is held under pressure to allow it to harden in place so that no 'back leakage' occurs out of filled defects. Once the grout has hardened the pressure is released and the packer deflated and removed from the pipe, leaving a local repair with filled defects and a thin grout skin on the inside of the pipe. This minimises any capacity loss at the repair point due to the grouting process.
Depending on the severity of the defect and its size, packer units are available from as little as 1.2 m long up to 5 m long and from 150 mm diameter up to 2.5 m diameter from various manufactures around the world.
Some manufacturers also make packers that can be used to inject grout from inside a mainline pipe into a lateral, sealing not only defects in the main pipe at the lateral joint but also defects in the lateral over the length of the packer in the lateral pipe. Operator training is an essential part of using such a system as this.

LOCALISED CIPP

CIPP lining systems have also been developed for use over localised defects such as cracks and faulty pipe joints. Generally using ambient cure resins, the systems utilise short lengths of resin impregnated felt or fibreglass liners, which that are placed around inflatable packers which are winched into position using CCTV monitoring over the defect site. The packer is inflated and held in position for the time it takes for the resin to cure. Deflating the packer and removing it leaves the 'patch' in position over the defect. Various packers are available with some being 'flow through' units which means that the repair can be undertaken with some flow still remaining live in the pipe.
Where circumstances allow, such as the defect being close to an access manhole, the patch can be positioned using an inversion technique in the same way as would be used for manhole-to-manhole. In this instance however the inversion is achieved with a calibration sock/hose that is not resin impregnated and is used only to hold the patch in position during curing. It is designed such that once the patch is set it can be deflated and removed from the pipe. This technique is also very applicable to the lining of laterals from the main pipe, where access to the lateral from the 'customer end' may be limited or not desired.
The design of the liner patch is normally such that there is minimum capacity loss at the site of the repair. Operators familiar with full length CIPP should be able to install such patches with relative ease.

JOINT SEALING

Whilst both Grout Injection and Localised CIPP are both highly applicable to the specific repair of damaged pipe joints, there are other technologies that can also be used to solve this type of problem.
A commonly used technology is the internal repair collar. In most cases the internal repair collar is an expanding/locking metal

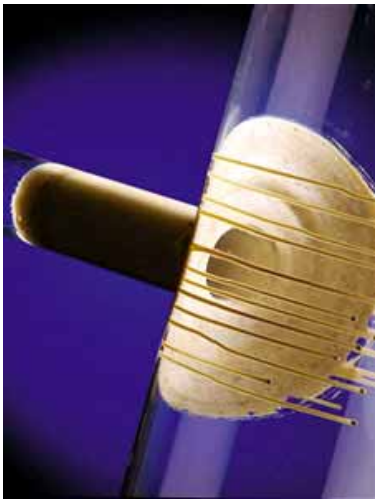


Joint sealing with an expanding shell clip. *Picture courtesy of Link-Pipe Ltd, Canada.*

cylinder that is surrounded by a rubberised seal. The sealing unit is either winched into position using CCTV monitoring on the outer skin of an inflatable packer or carried on a specially designed remote controlled robot (see later). Once in place the packer is inflated, or the robot activated, pushing/expanding the metal clip against the inner wall of the pipe across the faulty joint. The metal clip is designed with a locking system, so that once expanded to the degree required to compress the seal against the pipe wall, it will not collapse back into the pipe so making the joint repair.
The sealing units are designed to minimise the capacity loss that will occur by using an internal seal of this kind.
These systems are available for pipes of relatively small diameter up to those of man-entry sizes, where the seals are positioned and installed manually.

LATERAL/MAIN CONNECTION SEALING

Where main pipelines have been lined, in most cases the lateral/main connection has to be reopened using a robotic cutter to re-establish the lateral flow into the main. One long-term problem that has been of concern to engineers is the question of whether this allows infiltration or exfiltration to occur between the liner and the host pipe wall. Some researches say there is potential for a problem and other say not because of the bonding between liner and host pipe. Whatever the truth of the matter, various renovation manufacturers have been trying to address the potential problem with systems to negate it.
Some systems utilise injection grout techniques to ensure that the 'join' between lateral pipe and main is fully sealed.
Another technique that has been successfully developed is the 'Top Hat'. This utilises a specially shaped liner, which looks just like a 'top hat' or inverted 'T'. The stem of the 'T' forms the section of liner that is placed into the lateral pipe whilst the 'T' crossbar sits against the inner wall of the main. Resin impregnation of the liner material allows it to be positioned, using a specially designed remote control robotic installer, and held in position for curing of the resin. Once cured, the robot and retention system are removed leaving the 'T'-shaped liner forming a seal across the lateral/main joint. The 'T' stem can be made to pass as deep into the lateral as may be required, which can also make this a specialist lateral repair system in its own right if the lateral is a short one.



A stylised image of how a 'Top Hat' lateral/main seal works. *Picture courtesy of epros GmbH, Germany*

An advantage of this system is that it can be used on either lined or unlined mains if a faulty lateral joint is the only problem to be solved. Training by the manufacturer is often required as the operating system and process can be complicated at first, but once fully understood it becomes relative simple.

ROBOTIC SYSTEMS

As you will have seen in the accompanying sections and text above, robotic systems play a significant part on the pipeline renovation. Not only are they used for surveying and preparation of a pipe before renovation operations, but also for placement and control and monitoring within many of the technologies highlighted here.
One area of robot use that has yet to be touched on is the use of robots themselves as the repair system.

Over the past decade of so, a number of different robot manufacturers have developed a selection of sophisticated, remote-controlled robots that, in themselves, constitute a pipe repair system. Operating as a single unit or in pairs, with the pipe section under repair isolated from the main flows, CCTV robots are first used to survey the pipe in question to determine the extent of damage and where it is positioned in the system.

A typical Grinding Robot with onboard CCTV monitoring system. *Picture courtesy of PMO, Switzerland.*

The second function is to prepare the pipe itself for repair. This usually entails using a hydraulically or compressed-air driven rotating motor mounted on a specially designed robot with onboard CCTV facility, to power a rotating grinding head which can be used to remove scale, root intrusions or displaced lateral pipe intrusions into the main pipe by remote operation from a surface control point. Where individual cracks and defects can be highlighted, the grinding head can also be used to clean these out and prepare them for specific repair.

The next phase, which is where the second robot comes into play on two-robot set ups, comprises using the robot to place repair compounds such as resins or mortars directly into the defects being repaired. This requires the robot to have either an on-board reservoir of grouting material that can be controlled remotely by the operator on surface, or a surface based supply that can be pumped directly to the robot in the pipe as required.

With the repair grout in place, some robots also have a facility built in which allows them to smooth out the grout in the defect to make a smooth inner wall so as to reduce flow impedance as far as possible. Flows are prevented from running in the pipe for the time it takes for the grout to cure so as to prevent wash out of the grout.

The CCTV facility then inspects the final repair to ensure that no further work is required at that specific point.

These systems normally require a significant degree of manufacturer training before operators can be deemed sufficiently experienced to operate them in the field alone.

LOCALISED FLOOD GROUTING

The basic technique for flood grouting is described extensively elsewhere in these Guidelines and the use of the technique on a localised problem is essentially the same. The technique for localised operation varies only slightly in that the section to be treated has to be isolated whist maintaining an access for the pumping in and out of the required fluids that affect the repair. Inflatable seals, pipe stoppers and other such equipment can be utilised for this purpose. Of course, limiting the volume of pipeline in this way can mean that much less of the fluids needs to be handled for any one situation. The technique however is not known to be used extensively for very small, localised repairs due to the level of mobilisation required in terms of pumps, fluid transport trucks etc which tend to be the same as those used for major renovation operations anyway.

PRESSURE PIPE SEALING

Whilst most of the above systems deal with gravity sewer pipes, a recent development in the field of leak sealing without the need for excavation has recently undergone a series of successful field testing in pressure pipelines in the UK Water Industry.

The new system has already been successfully applied in the oil production industry, sealing leaks on water injection pipelines on production wells.

Whilst details of the UK water industry tests are still currently unavailable, the manufacturer has said the tests are running successfully.
The technology itself is designed around the 'leak sealing' platelets used by the human body's blood circulation system. By adding platelets, specially designed using Biomimetics technology, to a fluid stream in a pipeline, the platelets flow along with the fluid (be it oil, water, gas etc) to a point where there is a leak.
The Platelets, caught in the flow that passes through the leaking fault in the pipe wall, collect at the point of the leak so preventing further flow through the faulty pipe wall. This coagulation of platelets at the leak point then remains in place until the pipe is either lined or replaced.
The Platelets sealing system is not designed as a permanent repair but as a significant 'stop-gap' repair, enabling a more permanent solution to the leak problem to be developed and applied. Whilst not a permanent solution, previous examples of repairs using the system have been designed for an active life of between 6 to 12 months, and in practice the actual repairs have lasted up to 18 months after the initial application.
As part of the platelet design, they can be manufactured with either a radio or radioactive tracing system that enables precise detection of the leak point once the seal has been achieved, so ensuring minimum excavation requirements to access the leak as and when the permanent repair is applied.
In terms of use in domestic water supplies, the supplier manufactures the platelets in a way that is completely non-toxic, so ensuring that its use in potable water supplies is possible without risk to end users.

Operation of the platelet technology for sealing a pressure pipeline leak. *Picture courtesy of Brinker Technology.*

Loss of Containment event

Platelets® introduced and carried down the pipeline due to the fluid flow

Platelets®sealing leak

Seal achieved – excess Platelets® retrieved from the pipeline.

Detection process can be carried out.

SUMMARY

1. Localised repair techniques can be used to address specific defects where the cost of manhole to manhole renovation may not be viable.
2. In gravity systems, such techniques are used to repair latera; connections and short sections of damaged pipe.
3. In pressure pipes, the systems are most commonly used at leaking joints.
4. To be effective, all the systems must be fully understood and properly deployed by the project manager.

Bibliography: The Bibliography may be accessed via the TRC Home page. If none is currently available on-line, please contact ISTT – info@istt.com for further information.

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