

AFTER THE QUAKE - REBUILDING A CITY'S WATER AND WASTEWATER PIPELINE NETWORK

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ABSTRACT

In February 2011, a 6.2 magnitude earthquake struck Christchurch, New Zealand causing devastation to buildings, roading and infrastructure. Over 6,500 people were injured and 185 people lost their lives.

Following the quake, Christchurch City Council (CCC) was faced with rebuilding the city's 3 water pipeline network. The existing polyethylene (PE) watermain network performed well during the quake and CCC chose PE as the material of choice for all rebuilt water and wastewater pressure pipelines.

Although PE has been used in pipe networks since the 1960's, a lack of knowledge and experience surrounds electrofusion, one of the main methods used to connect PE pipes. Installation inexperience amongst construction workers on Christchurch's rebuild, caused failures rates of 30% of newly installed PE pipeline joints.

CCC implemented an oversight system to monitor welder performance. Within 12 months of the system's establishment, electrofusion and butt weld test failures fell to less than 1%.



Christchurch, New Zealand 22 February 2011

1.0 INTRODUCTION

Polyethylene has a range of attributes including ductility, flexibility and non-corrosiveness and is increasingly selected as the material of choice for pipeline applications ranging from municipal water and waste water networks to irrigation, mining, gas and plumbing.

Polyethylene pipes performed exceptionally well in the Christchurch earthquake with only a handful of documented mains failures in the water and sewer networks.

Due to the low rates of failure, CCC specified PE as the material of choice for pressure pipelines in the rebuild:

"All water supply reticulation pipework shall be PE until further notice, including laterals such as fire services and this applies to all areas across the city " CCC July 2012

PE is mainly joined by butt welding or electrofusion. An underestimation of the knowledge and skill required for the successful installation of electrofusion joints persists in the installation industry and as the use of PE increases, shortfalls in installation skills have lead to concerns around pipeline integrity.

Some asset owner concerns regarding the quality of installation have lead them to try and 'design out' welded joints from projects. However, properly installed welded connections are proven to provide a long lasting, leak tight, monolithic system. Instead of moving to different joining methods, CCC decided a better approach was to increase installation oversight.

This paper discusses how Christchurch City Council showed that a well managed process which combines installation training with oversight can mitigate installation risks and deliver a long lasting pipeline system.



Christchurch Wastewater Treatment Plant. Courtesy Fusion Solutions

2.0 INSTALLATION CHALLENGES

To check the long term integrity of electrofusion joints, councils often require contractors to perform test welds before they are given the green light to weld on projects. The test welds are sent to a laboratory for destructive testing. The fractured surfaces of the welds must meet the level of ductile cohesion specified in AS/NZS 4129.

Some installers in Christchurch were found to be carrying out test welds which would fall short of the AS/NZS 4129 threshold during the destructive lab test. The test results were sent directly from the laboratory to the installer who would continue to carry out test welds until they received a 'pass' from the lab. The 'pass' result was then sent to the council who were unaware of the previous results. The council then gave the installer the green light to commence welding on the project.

Within a short period of time, the council found a significant number of newly installed joints were leaking. This prompted the council to carry out 'post construction' tests - newly installed joints were randomly selected by council staff, cut from pipelines and destructively tested. The results showed over 30% of the newly installed joints failed the requirements of AS/NZS 4129.

3.0 COUNCIL OVERSIGHT

In response, CCC tightened installer oversight and the destructive testing regime.

- Installers had to provide certification showing they had completed PMBWELD302E, an Australian certificate provided on completion of a formal electrofusion training course run by Registered Training Organisations (RTO's).
- Installers were required to follow the steps listed in Plastic Industry Pipe Association (PIPA) Guideline POP001 *Electrofusion Jointing of Plastic Pipes and Fittings for Pressure Applications*.
- Individual *installers*, not companies, were listed in an approved welder register administered by the CCC.
- New installers had to provide the CCC with 8 successful test weld results, paid for by the installer as part of their request for admission to the register.
- To prevent installers only choosing pass weld results for submission to CCC, laboratory test results were sent directly to CCC, not to the installer.
- All test welds were carried out at the installer's expense and factored into the project price.
- CCC created and administered a master record which listed all welders and test weld outcomes.
- It became apparent that greater skill was needed when working on larger diameter pipe. New installers were limited to DN250 for a period of 6 months while being monitored by CCC. Once CCC was satisfied the installer was competent, the installer could then undertake welds on larger diameter pipe. The installer had to supply 8 test weld results on the larger diameter pipe to be accepted onto that level of the register.

- To ensure welders were invested, all installation equipment had to be owned by the installer and suitable for the pipe size being worked on. Hire equipment was prohibited. Tooling was randomly checked by council staff.
- 1:20 'construction' welds were randomly selected by CCC for destructive testing. If a weld failed, CCC would test welds either side of the failed joint. If these failed all joints in the line were exhumed and replaced at the installers expense.
- Fittings and pipe were required to be supplied by approved manufacturers and conform to AS/NZS 4130 (pipe) and AS/NZS 4129 (fittings).
- CCC adhered closely to the regime, providing limited flexibility to installers who fell outside the requirements.

4.0 RESULTS

Immediately after the quake, CCC estimated over 200 individuals were carrying out electrofusion and butt welding work in Christchurch.

The council's system forced installers to choose between developing skills and investing in equipment for certain pipe diameters or declining work. Installers also had to stand behind their workmanship – joint failures were replaced at their expense.

The number of installers involved in electrofusion and butt welding fell as installers became specialized in either small or large diameter pipe. The distribution of work over a smaller installer base ensured installers businesses were profitable.

Within 12 months, less than 1% of electrofusion test welds resulted in failure and those that did, were almost always attributed to new welders, allowing quick and concise fault finding and remediation before delays or large costs were incurred.

Today there are 20 individual electrofusion and butt welding installers in Christchurch. Less than 0.3% of test weld results fall below the AS/NZS 4129 threshold.

The entire system was implemented and managed by a single staff member. The staff member was not an engineer or plastics expert and instead had a trades background.

5.0 CONCLUSION

- Current welding installation processes frequently suffer from incorrect use or lack of necessary tooling.
- Asset owners should implement a QA process which installers must follow.
- The cost of oversight is small compared to the increased lifespan of the asset and potential cost of rework required.
- Oversight ensures key pipeline assets have long term integrity.

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