Canadian Concrete Pipe & Precast Association

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Manitoba Addressing Deteriorated Steel Culvert Problem

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Stories of motorists having near misses from sudden culvert failures and sinkholes within our highway infrastructure system have increasingly gained the attention of Canadians. As provinces already struggle to keep up with existing infrastructure that is reaching a 100 year service life, the premature failure of culverts that are in some cases less than 25 years old, will continue to hinder the ability for all levels of government to balance their budgets. Alternative pipe materials chosen strictly on low initial cost instead of long-term risk assessments is not only resulting in enormous emergency culvert replacement costs, but the unplanned closure of a highway also poses economic losses for all users who depend on a reliable highway system, not to mention the serious risk to public safety when these culverts fail with little warning.

The highways department in Manitoba, Manitoba Infrastructure and Transportation (MIT), recognizes that concrete pipe is a structurally engineered product with a proven service life of 70 to 100 years. The MIT Culvert Design Specification outlines what type of pipe materials can be used as a culvert under its provincial highways. This process is based on the highway classification such as Provincial Trunk Highway, Provincial Road, etc.; type of pavement structure such as concrete, asphalt or gravel; and the Average Daily Traffic (ADT) volumes.

Based on the MIT culvert selection criteria excerpted in the following tables, concrete pipe is the only pipe material allowed under any provincial highway with high traffic volumes.

Jacking concrete pipe under Manitoba Highway

Provincial Trunk Highway (PTH)

Roadway Type	Average Daily Traffic (ADT)	Culvert Type
Multi-Lane Divided (concrete or asphalt pavement)	All	**Concrete Pipe**
Concrete Pavement	All	**Concrete Pipe**
Asphalt Pavement	Greater than 1000	**Concrete Pipe**
Asphalt Pavement	Less than 1000	Corrugated Steel Pipe

Provincial Road (PR)

Roadway Type	Average Daily Traffic (ADT)	Culvert Type
Concrete Pavement	All	**Concrete Pipe**
Asphalt Pavement	Greater than 1000	**Concrete Pipe**
Asphalt Pavement	Less than 1000	Corrugated Steel Pipe
Asphalt Pavement Gravel Road	All	Corrugated Steel Pipe

Trenchless Concrete Culvert Installations
Trenchless technologies such as pipe jacking are an attractive method of installing culverts because a new pipe can be installed quickly, cost effectively, and with minimal disturbance to highway traffic and the surrounding ecosystem. The basic method of pipe jacking is similar for all pipeline applications, however the method of excavating, or boring, through the earth horizontally immediately in front of the pipe jacking operation can vary depending on the pipe size, length of pipe run, and existing ground conditions. Also, the accuracy of alignment and grade required for a gravity flow system is typically maintained by a laser guided system.

Horizontal excavation methods can range from manual excavation by workers inside large diameter installations to micro-tunnelling boring machines that can be steered remotely from the safety of a control room at the surface. The method generally follows a repetitive sequence of excavation at the face, pushing the concrete pipe into the excavated cavity with hydraulic jacks, and removing the spoil by muck cart on rails, augers, or liquefying the soil to pump it out. Unlike deep sewer installations, culverts are typically jacked through an embankment so a framework of steel or concrete must be constructed to provide a means to resist the horizontal thrust of the jacks.

Decommissioned CSP culvert being filled with concrete

Rigid pipe, such as concrete pipe, is more robust and well suited not only to the high axial forces of jacking but can also accommodate the unpredictable variables that may be encountered along the entire length of an installation. Concrete pipe manufactured specifically for the axial and transverse forces from the jacking method is available in a range of sizes and can be used in a wide range of ground conditions. The Indirect Design method for determining the strength class of concrete pipe installed by jacking can be done with the computer design program PIPEPAC, while the design software PIPECAR can determine the reinforcing steel requirements under the ASCE Direct Design method (ASCE 27-00).

Formation of the Centre for Advancement of Trenchless Technologies (CATT) at the University of Waterloo and the Regional Chapters that represent 10 Canadian Provinces in the North American Society for Trenchless Technology (NASTT) is also recognition that pipe jacking will become a large part of pipeline installation in the future.

Rusted CSP culvert in service under busy Ontario highway

Culvert Replacements in Manitoba
During the period between August 2011 to June 2013 MIT issued a total of 16 tenders for the replacement of existing corrugated steel culverts under Provincial highways with concrete pipe installed by jacking, instead of the traditional open cut method. The 16 tenders by MIT included the installation of 118 new concrete culverts by the jacking method adjacent to an existing CSP which would then be abandoned and completely filled with concrete. Pipe sizes of the new concrete culverts in these MIT tenders ranged between 750mm to 2100mm for a total length of 4.4 km.

One sudden failure of a culvert occurred in Manitoba on May 8, 2013 when an 1100mm CSP culvert collapsed 20km west of Falcon Lake on Provincial Trunk Highway (PTH) 1. The CSP corroded at the invert and lost its surrounding embedment soil resulting in a sinkhole in the paved shoulder. The sinkhole presented a severe safety hazard to users of the highway and required immediate attention. Based on the classification of this roadway, MIT followed the Culvert Design Specification, and replaced the failed pipe with a 1200mm precast concrete pipe.

In addition to using concrete pipe, which was supplied by Lafarge Canada Inc., MIT engaged a local contractor to install the new culvert by using the jacking method next to the failed CSP culvert. To provide stability to the highway pavement above, the decommissioned CSP culvert was plugged using concrete. The local contractor used an Akkerman Tunnel Boring Machine (TBM) to jack the concrete pipe.

Contact the Ontario Concrete Pipe Association at resources@ocpa.com, or your local concrete pipe manufacturer for more information on concrete jacking pipe, or the jacking method of installation.