CSP vs RCP Culverts

Is Short-Term Planning Putting Road Users at Risk?

Tyson Dyck, P. Eng.

Culverts under roadways are an essential component of any drainage system to manage storm water and prevent flooding of roads. They tend to be more economical than constructing a bridge when the higher hydraulic capacity isn't needed. Culverts are also used as crossings for pedestrians, livestock, or other wildlife. While there are many different factors to consider when choosing a material for culverts under roadways, designers working for municipalities and highway authorities need to prioritize public safety above all else; other factors to consider include hydraulic performance and life-cycle cost. This article will address these factors by comparing rigid culverts (reinforced concrete pipe, RCP) and flexible culverts (Corrugated Steel Pipe, CSP).

In addition to conveying storm water, culverts are also designed as wildlife crossing.

Concrete pipe is generally accepted to have a service life of 100 years, with countless examples of proof still in service. A concrete culvert "failure" commonly occurs much more gradually and won't be catastrophic; it will typically first show cracking which exceeds industry standards (>0.1" in width), which usually implies the steel reinforcing is exposed. The culvert is still able to support the road structure until the pipe can be remediated in a safe manner. This is in contrast to CSP culvert failures, which have multiple modes of failure. The most worrisome being when the soil structure supporting the CSP is removed or washed away, resulting in the thin steel pipe having to carry the load. CSP relies on the backfill around it to resist loading and doesn't have the inherit strength that concrete pipe has, resulting in a sudden, catastrophic failure. Furthermore, corrosion resistant coatings and liners are prone to abrasion, degrading the already short service life of the CSP culvert. It is because of these threats to public safety that highway authorities like the Delaware DoT have banned the use of CSP under their roads.

This 400' long CSP failure is still fresh in minds of many residents of Mississippi. It happened instantly once the soil structure around the pipe was disturbed. Thankfully no one was hurt.

It is also important to ensure culverts are disaster proof. Climate Change is generating far more unpredictable weather patterns which means designers need to add higher factors of safety to account for larger, more intense storms. This also means specifying a pipe material that won't burn, is abrasion resistant to debris in runoff, won't corrode, and won't float away. All culverts, even concrete pipe, can float! Should lightweight culverts be used in these applications?

This lightweight CSP was washed away from a rainstorm, blocking essential access for road users

Hydraulically, concrete pipe will offer better performance, regardless of if your culvert design is governed by Inlet Control or Outlet Control.

Inlet Control

Inlet controlled flow occurs when the culvert barrel is capable of conveying more flow than the inlet will accept. In this case, the inlet geometry can improve the flow; all other hydraulic characteristics downstream of the inlet do not affect the culvert capacity. RCP and precast box culverts are supplied with either flared ends or headwalls. In addition to looking more aesthetically pleasing, these end sections will offer a reduction in head losses as well.

Left: In addition to offering improved hydraulic performance, precast concrete headwalls are also aesthetically pleasing.
Right: A typical CSP inlet with no end treatment.

Outlet Control

Outlet controlled flow occurs when the culvert inlet is able to accept more flow than the barrel will allow. Here, all hydraulic characteristics, including entrance/exit head losses and barrel roughness, are accounted for. In addition to the benefits mentioned for inlet control, concrete pipe is also much smoother than CSP, hence a smaller diameter concrete pipe can convey the same flow as a larger CSP culvert. The following table shows the size reduction that can be achieved if the culvert is governed by outlet controlled flow:

RCP ID mm) n=0.012	CSP ID (mm) n=0.024
305	400
381	500
457	600
533	700
610	800
686	900
762	1000
914	1200
1067	1400
1219	1600

When annual budgets are being drafted and infrastructure mangers are trying to construct and maintain the most with the least cost that year, it makes sense that they would want to invest in the cheapest culvert material with the lowest initial cost. However, it is bordering on insanity when CSP culverts fail and are replaced with more CSP. When you consider the entire culvert design life, the improved hydraulic performance, and the overall protection to the public, concrete is the best choice culvert material.

The world needs concrete solutions!

For all your precast needs, contact:

Tyson Dyck, P. Eng.
Technical Marketing
Office: 403-279-5531
Tyson.Dyck@lehighhanson.com
www.inlandpipe.com

INLAND Pipe
HEIDELBERGCEMENT Group

British Columbia
OCEAN PIPE
9265 Oak St.
Vancouver, BC V6P 4B8
Toll free tel: 1888 788 221
Office tel: 604 269 6700
Fax: 604 261 6751

Southern Alberta
INLAND PIPE
7336 112th Ave. NW
Calgary, AB T3R 1R8
Toll free tel: 1 800 268 0785
Office tel: 403 279 5531
Fax: 403 279 7648

Northern Alberta
INLAND PIPE
12250 170 Street
Edmonton, AB T5V 1L7
Tel: 780 448 1351
Fax: 780 448 1354

Saskatchewan
INLAND PIPE
300 10th Ave.
Regina, SK, S4N 6G7
Toll Free tel: 1877 974 7473
Office tel: 204 334 4300
Fax: 204 334 7957

Manitoba
INLAND PIPE
2494 Ferrier St.
Winnipeg, MB, R2V 4P6
Toll Free tel: 1 877 974 7473
Office tel: 204 334 4300
Fax: 204 334 7957