Concrete Pavement:

Building Better, More Sustainable Intersections

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Concrete Pavement:
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When paving a heavy-traffic intersection, the right material makes all the difference. Concrete is characterized by its proven durability, reduced maintenance, lower carbon footprint, recyclability, ease of construction, and safety benefits — and it is a local material. Concrete pavement delivers superior value and performance — and a lower environmental impact — over an intersection's service life.

This is why many rural and urban municipalities across Canada are turning to concrete pavement for their high-traffic, high-wear intersections, bus lanes, and roundabouts. It is a proven, "best-in-class", greener solution of choice that is typically more cost-effective over the lifecycle than the alternative paving material for these applications, and ideally suited for Canada's climate.

Advantages of Concrete Intersections

Long Term Durability and Reduced Maintenance

With an average service life of 30-50 years, concrete pavement lasts longer and requires less maintenance over its lifetime than asphalt:

- Its rigid surface does not rut, washboard or shove; it minimizes the potential for potholes; and it provides better load distribution, making it less susceptible to damage from heavy vehicles.
- It stands up to seasonal stresses: concrete mixes are tailored to specific applications and conditions — including cold weather and de-icing agents — to ensure strength and durability throughout the life of the pavement.
- It retains its structural integrity and performance better than asphalt, even when inundated by floods. This is because concrete doesn't rely on the strength of the granular materials as much as asphalt does, and is therefore less affected by the saturated subgrade.

Concrete's durability reduces costs, the additional CO_2 emissions and other toxins associated with resurfacing and reconstruction operations, and the use of scarce resources. It also creates less disruption for the traveling public and commercial truckers.

Lower Carbon Footprint

- Concrete has a superior environmental performance on many metrics, such as durability, reduced use of raw materials and carbon uptake, and a clear action plan to achieve net-zero by 2050.
- Its carbon footprint has been reduced by well over 20% over the last 30 years: the manufacture of modern cement is more energy-efficient; lower-carbon cements such as Portland-limestone cement (PLC) reduce emissions by up to 10% compared to traditional cement; and the use of supplementary cementitious materials that would otherwise be destined for landfills replaces 20% or more of the cement required to produce one cubic meter of concrete.
- Through a natural process called carbon uptake, concrete sequesters carbon dioxide from the atmosphere over its entire life, further reducing its carbon footprint as well as nearby pollution levels. Studies show that up to 20% of cement process emissions are re-absorbed into a concrete product.
- Being an inert material, concrete doesn't emit fumes, which means less air pollution.

Improved Energy Efficiency

- A concrete road requires less energy to build than an asphalt one, due to requiring substantially less granular material in the subbase layer.
- Its lighter-color, highly-reflective surface reduces night-lighting needs by as much as 24% while improving visibility.
- It also absorbs less heat, which helps lower ambient air temperature and keep communities cooler, reducing the need for air conditioning and lowering smog.

Improved Construction Timelines

- State-of-the-art paving processes and innovative concrete mix designs such as fast track concrete allow concrete intersections to reopen within as little as six hours after work completion, reducing time-in-traffic auto emissions and adding convenience.

A Local, Recyclable and Reusable Material

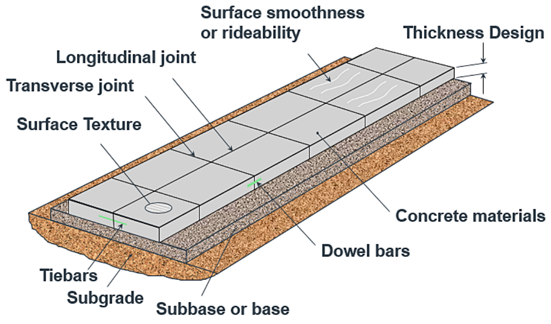
- Concrete is produced locally, using both locally-available aggregates and regionally-manufactured materials including cement. This minimizes transportation energy consumption.
- It is 100% recyclable and re-usable: at the end of its service life, it can be crushed and used as a natural aggregate for road base. This reduces the need to dispose of old material in landfills and to extract new virgin aggregate material.

Improved Safety

- Concrete's strength means virtually no potholes, ruts or low-temperature cracking, which means safer driving conditions.
- Its tined surface creates a superior tire pavement interface in wet weather conditions, allowing for better braking and handling performance, and reduces the potential for hydroplaning caused by pooling surface water.
- Its heat retention property means less potential for flash freezing and "black ice" in winter.
- Its brighter quality makes roads and parking lots safer at night.

Reduced Long-Term Costs and Environmental Impacts

- Durable and environmentally-friendly over the course of its long lifespan, concrete pavement reduces the need for expensive maintenance and repairs for high-traffic, high-wear roundabouts and intersections. In turn, this also reduces the additional CO_2 emissions and other toxins associated with asphalt resurfacing and reconstruction operations.
- It requires a thinner granular base than asphalt pavement, reducing the need for new virgin material and the associated costs and environmental impacts.
- Life-cycle cost analyses (LCCA) — which take into account the estimated costs of a project over its entire service life, including initial costs, maintenance, rehabilitation, reconstruction and salvage value of pavements — consistently rank concrete as "best-in-class" when compared to asphalt.



Concrete Pavement Features

Concrete Intersection Examples

67th Street and Johnstone Drive Roundabout Red Deer, Alberta

This is the first fully concrete-paved roundabout in Western Canada.

The Challenge

The 67th Street and Johnstone Drive/Orr Drive intersection in Red Deer experiences challenging traffic demands due to its location and heavy truck traffic. With the intersection being the gateway to the City of Red Deer, Edgar Industrial Park and Flying J Truck Stop, the heavy traffic at high volumes was exposing the road to serious damage.

The Solution

The City of Red Deer wanted to find a durable pavement solution with minimized maintenance and extended service life. Their Request for Proposal (RFP) allowed bids for concrete pavement to compete with asphalt on an equal footing and on a Life Cycle Cost Analysis (LCCA) basis. To handle the big traffic volumes, a roundabout was the best solution. To combat the heavy truck traffic, concrete pavement was the solution. Jointed Plain Concrete Pavement (JPCC) was selected for this project, offering an expected service life of 40+ years.

Project Details:

Expected Service Life: 40+ years

Traffic volumes: Average Annual Daily Truck Traffic (AADTT) through the job site was estimated at 2,000 trucks; peak hour at 10%.

Pavement thickness: The pavement was designed to a 240mm thickness reinforced with Euclid Tuf-strand SF Macro Synthetic Fibers at 1.8 kg/m^3.

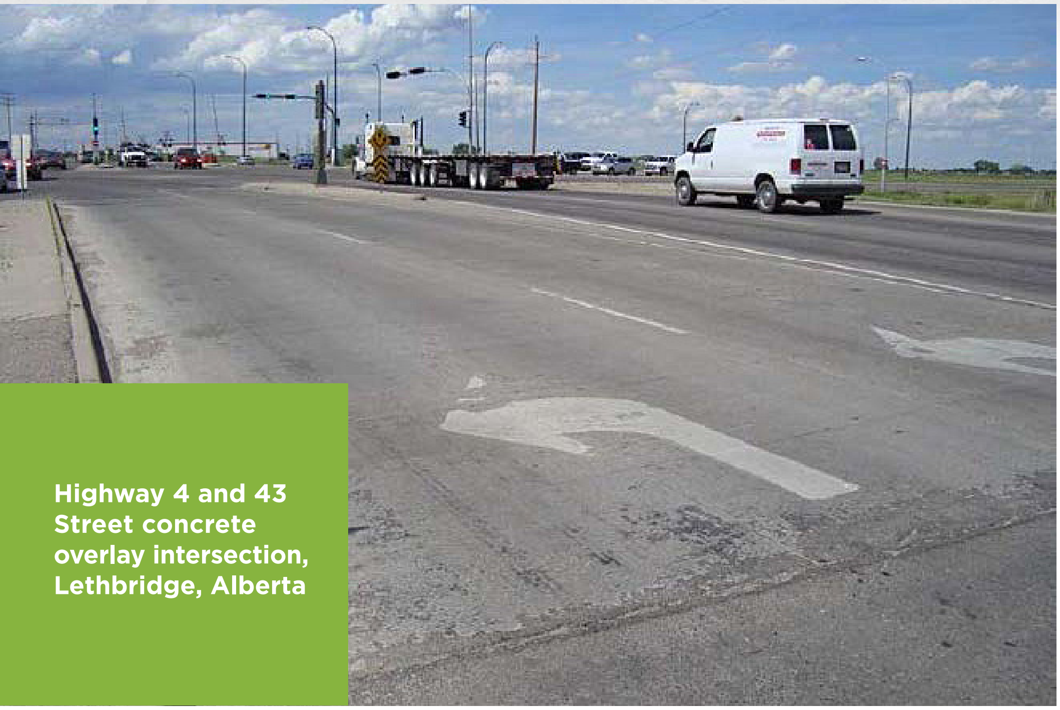
Joints: Dowel baskets with 32 mm smooth epoxy-coated dowels spaced at 305 mm on centre were placed under all joints.

Strength: The concrete for the pavement was designed to achieve a minimum flexural strength of 4.2 MPa at 28 days.

Curb and gutter: These structures were increased in thickness to match the concrete pavement structure to eliminate a need for pavement edge thickening.

Completion date: 2017

Performance review after 5 years: No load transfer failure or vertical displacement of the panels.
No major cracks or movement of the panels.
Some abrasion on wheel path but does not affect safety or surface quality.
Overall condition of joints and joint sealer is good.
No rutting.



Highway 4 and 43 Street concrete overlay intersection, Lethbridge, Alberta

The Challenge

At the intersection of Highway 4 and 43 Street, within the City of Lethbridge, heavy trucks transporting goods from the United States had caused severe rutting in the existing asphalt. Alberta Transportation has undertaken frequent repairs to this section of road which historically had lasted between one and two years.

The Solution

Alberta Transportation was looking for a durable, long-term solution to the rutting issues experienced at this intersection. After consultation with Concrete Alberta and the Cement Association of Canada, a bonded concrete overlay was chosen. The construction of the pavement was completed over a two-day span during which traffic was easily rerouted around the construction. The service life of the concrete overlay was approximately 11 years, exceeding initial expectations. It also proved highly cost-effective, as it was estimated to have saved more than $100,000 over its service life when compared to an asphalt mill and inlay approach.[1]

Project Details:

Application: Two turning lanes, 40 m in length and 3.7 m wide were paved with concrete.

Service Life: 11 years

Cost savings: The service life cost savings of the bonded concrete overlay solution compared to an asphalt mill and inlay approach was estimated to have been over $100,000.

Concrete Depth: The deteriorated asphalt was removed to an average depth of 100 mm on the inside lane and 125 mm on the outside (heavy truck traffic) lane. An average of 125 mm of asphalt thickness was left under the concrete inlays. The concrete inlay was bonded to the asphalt to help distribute the load from the truck traffic.

Concrete placement: Concrete was hand-placed one lane at a time.

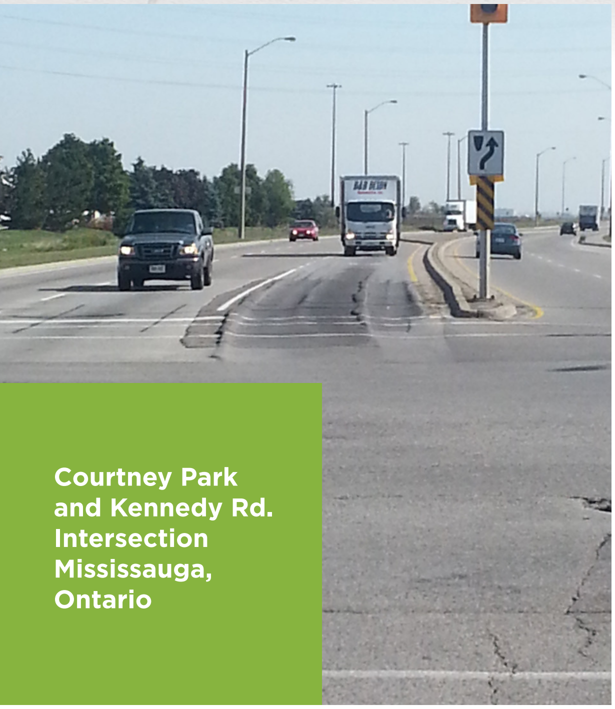
Joints: Joints were cut at 1.5 m spacing.

Synthetic structural fibers: Synthetic structural fibers were used rather than dowels or tie bar.

Compressive strength: 20 MPa was achieved at three days and 30 MPa at 28 days.

Completion date: 2004

[1] TAC 2015 Fall Conference — 11 years of performance of Alberta Transportation's First Bonded Concrete Overlay



Courtney Park and Kennedy Rd. Intersection Mississauga, Ontario

The Challenge

In August 2012, the City of Mississauga was looking to repair a heavily rutted left turning lane at this intersection. The lane had been fixed in 2007 and 2010, and the asphalt pavement already had up to 100 mm (4-inches) of rutting by 2012. The city was looking for a solution that would offer longevity for the turning lane, which has high levels of truck traffic that strain it further. [2] The relatively high traffic volume made it imperative to complete the repair in as short a time as possible.

A life-cycle cost assessment (LCCA) for asphalt and concrete pavement options that also considered the time required for the initial construction and all future maintenance activities was conducted.

The Solution

Due to the severity of the rutting and the two previous failed asphalt repairs, the City of Mississauga opted to repair the intersection with concrete. The entire 225 mm of asphalt was removed and replaced with 35 MPa fibre-reinforced concrete, with macro-synthetic fibres added in the concrete mix design. The concrete pavement also had 32 mm dowels spaced at 300 mm intervals placed at the transverse joint locations. The maturity testing concluded that 15 MPa was achieved at the eight-hour mark and 20 MPa at the 14.5-hour mark.

Project Details:

Project area: 220 m^2 (4 m x 55 m)

Expected service life: 25 years

Pavement thickness: 225 mm

Strength: 35 MPa concrete, with macro-synthetic fibres added in the concrete mix design.

Joints: 3 m spacing.

Dowels: 32 mm dowels at 300 mm c/c were used.

Completion date: August 2012

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[2] OnSite Magazine, A concrete future for road repair, March 1, 2013

About Jointed Plain Concrete Pavement (JPCP)

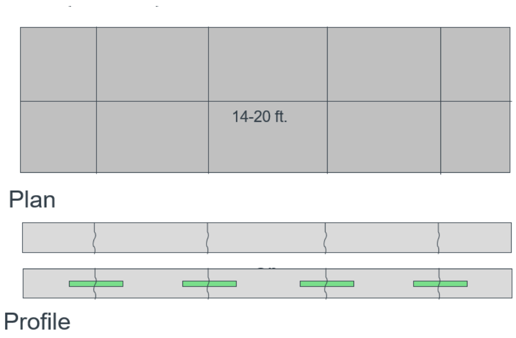
Jointed Plain Concrete Pavement (JPCP) is the most common conventional concrete pavement. With JPCP, concrete slabs are typically constructed directly over a prepared aggregate base structure. Transverse joints separate the concrete into panel sections and are located where the concrete would be expected to crack naturally (typical panels are 4 – 6 meters long, based on the thickness of the concrete pavement; the pavement width is typically 3.7 m and is usually extended on the outer lane to eliminate edge loads — or a tied concrete shoulder is used.) Transverse joints are installed perpendicular to traffic and allow load transfer between the panels according to two different methods:

Undoweled: Typically, for pavements 175 mm thick or less, joints do not require dowel bars, and load transfer is achieved through aggregate interlock.

Doweled: For pavements 200 mm thick or greater, smooth steel dowel bars are placed at the mid-point of the pavement thickness parallel to the direction of traffic. Dowel bars enhance the load transfer between slabs to prevent potential faulting issues.

Tie bars (deformed rebar) hold the pavement lanes together and are placed perpendicular to traffic direction along the longitudinal joint.

Jointed Plain Concrete Pavement



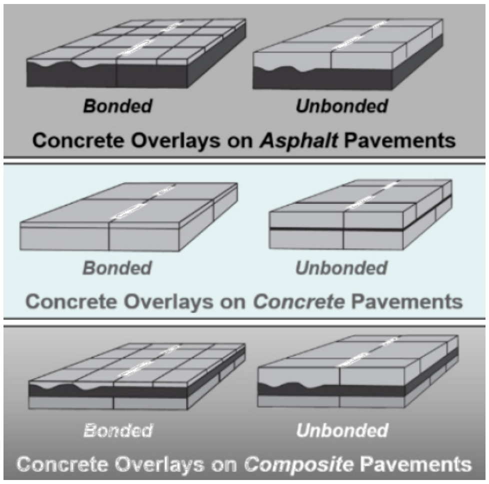
About Concrete Overlays

The overlaying of concrete on asphalt, composite or old concrete pavements provides an environmentally friendly, long-lasting and cost-effective rehabilitation pavement solution. There are two types of concrete overlays:

Bonded: A relatively thin concrete (50 to 125 mm) is placed and bonded directly on existing pavement surfaces that are in good to fair structural condition, adding structural capacity and eliminating distress such as rutting and shoving of the asphalt.

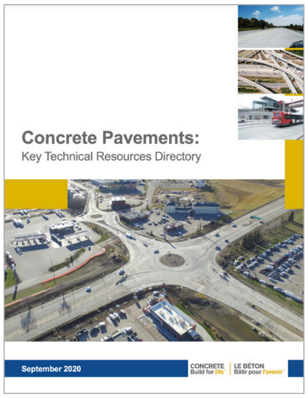
Unbonded: Usually thicker than bonded overlays, unbonded overlays restore structural capacity to existing pavements that are moderately to significantly deteriorated. Prior to overlay, a separation medium or stress relief layer is placed on the old pavement to isolate the existing deterioration and prevent reflective cracking. A layer of concrete (normally 100 to 275 mm depending on the traffic loading) is then placed over the thin separation layer.

Concrete Overlays



Find out more about concrete pavement:

Concrete Pavements: Key Technical Resources Directory, Cement Association of Canada



Concrete Pavements:
Key Technical Resources Directory

September 2020

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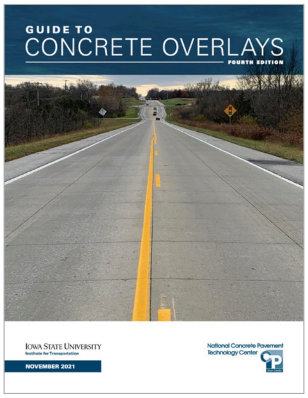
Guide to Concrete Overlays
Iowa State University and National Concrete Pavement Center



GUIDE TO
CONCRETE OVERLAYS
FOURTH EDITION

Iowa State University
Institute for Transportation

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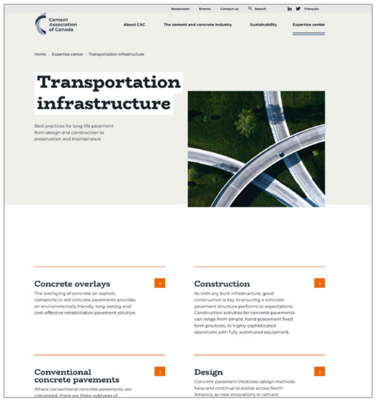
National Concrete Pavement Technology Center

Cement Association of Canada Expertise Center — Transportation Infrastructure



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Transportation infrastructure

Best practices for long-life pavement from design and construction to preservation and maintenance.

Concrete overlays

The overlaying of concrete on asphalt, composite or old concrete pavements provides an environmentally friendly, long-lasting and cost-effective rehabilitation pavement solution.

Construction

As with any built infrastructure, good construction is key to ensuring a concrete pavement structure performs to expectations. Construction activities for concrete pavements can range from simple, hand-placement fixed form practices, to highly sophisticated operations with fully automated equipment.

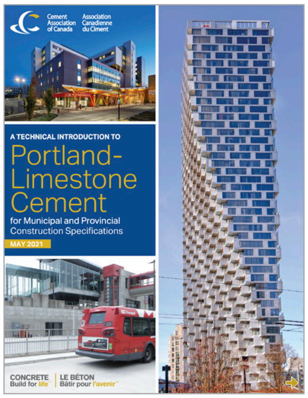
Conventional concrete pavements

Where conventional concrete pavements are concerned, there are three subtypes of

Design

Concrete pavement thickness design methods have and continue to evolve across North America, as new innovations in cement

Technical Introduction to Portland-Limestone Cement
Cement Association of Canada



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A TECHNICAL INTRODUCTION TO
Portland-Limestone Cement
for Municipal and Provincial Construction Specifications
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Find out more about Concrete Canada or the Cement Association of Canada:

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