

Case Study on the Use and Performance of Concrete Roundabouts in the County of Essex

Principal Author:

Tim Smith MSc. Eng., P. Eng.
Senior Technical Director Infrastructure and Specifications
Cement Association of Canada
1105-350 Spark Street, Ottawa, Ontario, K1R 7S8
Tel. (613-882-6415)
E-mail: tsmith@cement.ca

Co-Authors:

Daniel Baggio
Project Manager
County of Essex
360 Fairview Ave. W. Suite 315, Essex, ON, N*M 1Y6
519-776-6441 ext. 1507
E-mail: dbaggio@countyofessex.ca

Alen Keri, P. Eng.
Director of Technical Services
Concrete Ontario
1 Prologis Boulevard, Suite 102B, Mississauga ON, L5W 0G2
Tel. (905-564-4772)
E-mail: akeri@concreteontario.org

Lucas Bromerchenkel, M.A.Sc..
Technical Services Representative
Concrete Ontario
1 Prologis Boulevard, Suite 102B, Mississauga ON, L5W 0G2
Tel. (905-564-4772)
E-mail: lbromerchenkel@concreteontario.org

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Abstract

This paper presents a case study on the implementation and performance of concrete roundabouts in Essex County, southern Ontario. The introduction discusses why municipalities are increasingly choosing roundabouts, outlining their key features, benefits, and potential challenges. It also references the TAC Canadian Roundabout Design Guide, emphasizing its importance in the design process.

The background section covers the fundamental components of concrete pavements, the jointing methods used in concrete roundabouts, and the design considerations for determining roundabout thickness. Design specifics will be given for two roundabouts: one built in 2014 at County Road 22 and County Road 2 in the Municipality of Lakeshore, and the other, more recently constructed in 2024, at County Road 42 and County Road 43 in the Town of Tecumseh.

The construction of the 2024 roundabout at County Road 42 and County Road 43 is reviewed, including subgrade, subbase, and base preparation, as well as the installation of dowels, tie bars, and the concrete placement process. Jointing and pavement marking methods are also discussed.

The paper will then evaluate the performance of the 2014 concrete roundabout, focusing on the durability of the specially etched pavement markings. It will also compare the performance of asphalt roundabouts in Essex County, highlighting the benefits of transitioning to concrete roundabouts.

In conclusion, the paper highlights the sustainability benefits of concrete roundabouts, such as improved light reflectance, reduced hydroplaning risks, material recyclability, and the use of Portland Limestone cement and industrial by-products in the concrete mix. It will also present a comparison of the carbon footprint between the 2014 concrete roundabout using general-use (GU) cement and the 2024 roundabout using general-use limestone cement (GUL).

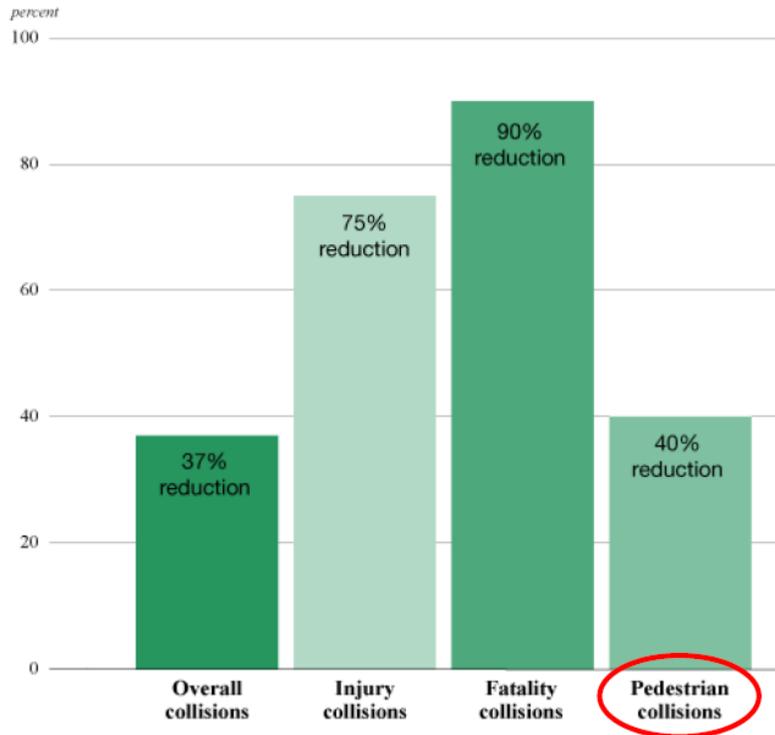
1.0 Introduction

Roundabouts are increasingly being adopted across North America and globally, primarily due to their safety benefits at roadway intersections. According to the Region of Waterloo website, “A study of 30 roundabouts in Ontario found that pedestrian collision rates are approximately 40 to 60 percent less than pedestrian collisions rates at comparable traffic signals with similar traffic and pedestrian volumes.” [1] As illustrated in Figure 1, roundabouts reduce overall collisions by 37%, and injury and fatal collisions by 75% and 90%, respectively. Additional advantages of roundabouts include better access management, no signal maintenance requirements, functionality during power outages, enhanced streetscaping opportunities, and reduced delays, fuel consumption, and emissions.

However, roundabouts do have some drawbacks, such as higher initial construction costs, the need for more space, lower accessibility compared to signalized intersections, challenges with turn prohibitions or transit priority, and the need for public education. [1]

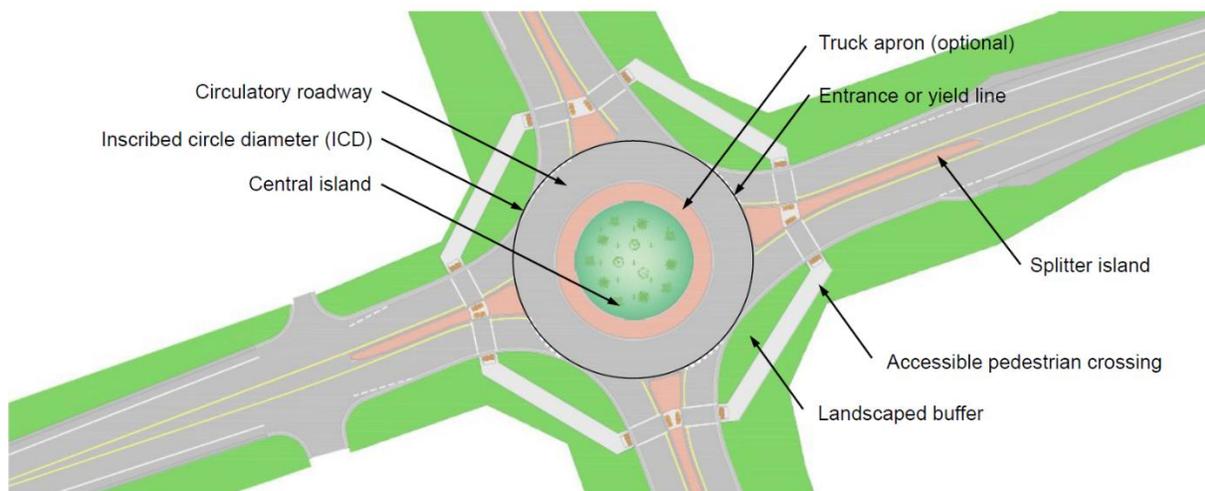
Roundabouts can be categorized into three basic types: single-lane, multi-lane, and mini-roundabouts. Figure 2 below illustrates the key features of a roundabout. For further details on roundabout design, refer to the TAC Roundabout Design Guide, which offers comprehensive guidance on the planning, design, construction, operation, maintenance, and safety of roundabouts in Canada. [2]

Reduction in Collisions



Source: Federal Highway Administration (FHWA) and Insurance Institute for Highway Safety (IIHS)

Figure 1: Reductions in Collisions due to Using Roundabouts



CIM+ Engineering for people

Good Roads Conference
April 2025

Source: 2025 Good Roads Conference presentation by Phil Weber

Figure 2: Basic Features of a Roundabout

Roundabouts can be built using either asphalt or concrete. This paper explores the decision by the County of Essex in southern Ontario to begin constructing roundabouts with concrete pavement.

2.0 Background

The County of Essex has established a process for determining when concrete roundabouts should be considered. According to this process, locations such as arterial roads, heavy vehicle traffic routes, areas with high truck or industrial use, high-speed zones, and industrial and commercial corridors are identified as potential sites for concrete roundabouts. These areas are seen as prone to high centrifugal forces and wheel track rutting, making concrete roundabouts an ideal solution to mitigate these issues.

The County of Essex has identified several benefits of using concrete roundabouts including the following:

- Extended service life of 30+ years
- Minimal maintenance – It is expected that only panel repairs will be needed over time, and these can be completed while keeping traffic flowing
- Higher traffic loads with no rutting
- Increased resistance to freeze/thaw cycles due to optimized concrete mix design
- Better Cost/Benefit vs. Asphalt -

The County of Essex also highlighted some potential disadvantages of using concrete roundabouts. Below are the issues identified by the County, along with explanations of how these concerns can be addressed:

- Decreased coefficient of friction over time – This potential issue can be mitigated by specifying a fine aggregate requirement of 60% acid insoluble residue, which is now mandated by MTO for their concrete pavements. This measure will help preserve the long-term skid resistance of concrete pavements, ultimately improving the safety of the traveling public.
- Increased material testing budget – This additional testing is conducted to ensure the concrete meets specification requirements. Once the County is confident in the quality of the supplied concrete, this requirement may be reduced to standard testing levels.
- Installation of the concrete pavement and load transfer devices – Proper installation of dowels and tie bars is crucial for the optimal performance of concrete pavement. The County has observed that they have high-quality contractors in the area, so the proper installation of dowels and tie bars should not pose a problem.
- Correct delivery of concrete specified – Using a Concrete Ontario certified ready-mix concrete supplier will ensure the delivery of high-quality concrete that meets the required strength, slump, and air content, while also complying with all CSA A23.1 Class C-2 exposure requirements.

The County of Essex's first concrete roundabout was built in 2014 to address rutting and shoving issues caused by heavy truck traffic at their asphalt roundabouts. This concrete roundabout was constructed at the intersection of County Road 22 and County Road 2 in the Municipality of Lakeshore. The concrete pavement was 220 mm thick, with 32 mm epoxy-coated dowels and 10M epoxy-coated tie bars. A 32 MPa Class C-2 exposure concrete mix was specified, and the surface texture was achieved using longitudinal tining with a burlap drag. Over the past 11 years, this roundabout has proven to be much more durable than the previous asphalt roundabouts, with no maintenance required. Following the success of this pavement, the County of Essex has begun using concrete roundabouts to resolve the rutting and shoving issues previously seen with asphalt roundabouts. To date, the County has constructed three concrete

roundabouts, with a fourth expected to be completed in 2025. Additional roundabouts are planned for the next 5 to 10 years.

This paper examines the construction of a concrete roundabout in 2024 at the intersection of County Road 42 and County Road 43 in the Town of Tecumseh, as depicted in Figure 3.



Source: County of Essex Project Photo Library

Figure 3: Aerial view of Concrete Roundabout in the Town of Tecumseh

Listed below are some project details obtained from the County of Essex on the 2024 roundabout construction:

- Pavement Structure for concrete apron and concrete lanes
 - 220 mm thick concrete pavement with 32 mm epoxy coated dowels 450 mm long and 15M epoxy coated tie bars 750 mm long
 - 100 mm of open graded drainage layer (OGDL)
 - 225 mm Granular A Base
 - 480 Granular B Type II Subbase
 - Stamped concrete apron

- Longitudinally tined surface texture with burlap drag to improve the pavement microtexture
- Joint width of unsealed joints was 3 mm wide and 75 mm deep
- All expansion joints were sealed with Dow-Corning 890 or approved equal
- Closed-cell polyethylene foam backer rod used at sealed joints
- White pigmented curing compound meeting OPSS.MUNI 1315 requirements
- Subgrade Soil Type: clay

The minimum strength and durability requirements necessary to provide long lasting and durable concrete pavements are specified in CSA A23.1:24. Table 1 in CSA A23.1:24 [3] which states concrete pavements are a Class C-2 exposure. Table 2 of the document states the following minimum requirements for Class C-2 concrete to provide quality and durable concrete pavements:

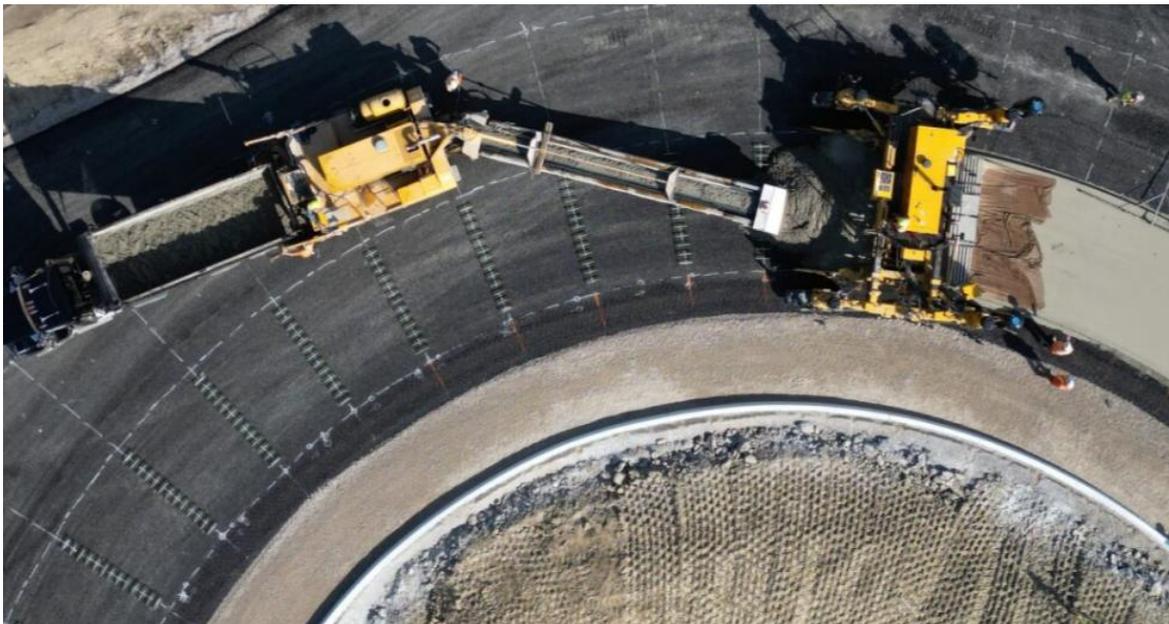
- 0.45 maximum water to cementitious materials ratio
- 32 MPa minimum specified compressive strength at 28 days
- Air content category 1 for exposure to cycles of freeze / thaw

3.0 Construction of the Concrete Roundabout

The County Road 42 and 43 concrete roundabout was constructed in 2024 between June and November by Green Infrastructure Partners (GIP).

Earth excavation and grading were conducted in accordance with OPSS.MUNI 206, Construction Specification for Grading. The existing subgrade was excavated to the required depth to accommodate 480 mm of Granular B Type II aggregate and 200 mm of Granular A base aggregate. The placement of Granular A and B was done following OPSS.MUNI 314, Construction Specification for Treated Granular Subbase, Base, Surface, Shoulder, and Stockpiling. A 100 mm layer of asphalt OGDL was then applied over the Granular A base material, in line with OPSS.MUNI 320, Construction Specification for OGDL.

As shown in Figure 4 the concrete roundabout lanes were then placed using a slipform paver with the ready mixed concrete being delivered by dump trucks to a transfer vehicle that distributed the concrete in front of the paving machine. The concrete surface was hand finished with bull floats and a highway scraping straightedge to provide a smooth flat concrete surface. Figure 5 shows the curb and gutter slipform paver used to place the concrete curb and gutter. Sidewalks and any triangle shaped panels were hand placed using concrete supplied by ready mixed concrete trucks.



Source: Concrete Ontario Drone Picture of Construction Site

Figure 4: Aerial Shot of Concrete Pavement Placement Showing Transfer Vehicle Delivering Concrete



Source: County of Essex Project Photo Library

Figure 5: Slipform Curb and Gutter Machine Placing the Concrete Curb

Given the expected traffic loading, 32 mm dowels were placed at the locations of the transverse joints to improve load transfer across them. As shown in Figure 6, dowel baskets were used to hold the dowels in the correct position across the transverse joints. The baskets position the center of the dowels at half the concrete depth and spaced 300 mm apart. These baskets were pinned to the surface of the asphalt-based OGDL to prevent displacement during the paving process.

Tie bars were installed along the longitudinal joints using a gang drill, as shown in Figure 7. After the holes were drilled, 15M epoxy-coated tie bars 750 mm long were grouted into place. These tie bars help to bond the concrete lanes together, ensuring the longitudinal joint remains tight between the two lanes.

Once the concrete pavement was placed and finished, two different curing methods were used. Figure 8 below shows the manually applied curing method on the left and the machine curing method on the right. A white pigmented curing compound, compliant with OPSS.MUNI 1315 requirements, was used for the project.



Source: County of Essex Project Photo Library

Figure 6: Slipform Paver Operation with Dowel Baskets In-place and Side Loading of Concrete



Source: County of Essex Project Photo Library

Figure 7: Gang Drill Drilling Holes for Longitudinal Tie Bars



Source: Concrete Ontario Drone Picture of Construction Site and County of Essex Project Photo Library
 Figure 8: Picture of Manually Applied Curing Compound and Automated Curing Machine

Jointing concrete roundabouts is more complex than jointing concrete roadways due to the circular layout of the roundabout. The American Concrete Pavement Association (ACPA) provides a six-step guide for properly jointing concrete roundabouts, which includes the following:

Step 1: Draw all pavement edges and back-of-curb lines in plan view

Step 2: Draw all lane lines on the legs and in the circular portion, accounting for roundabout type

Step 3: Add transverse joints in the circle, being mindful of the maximum joint spacing

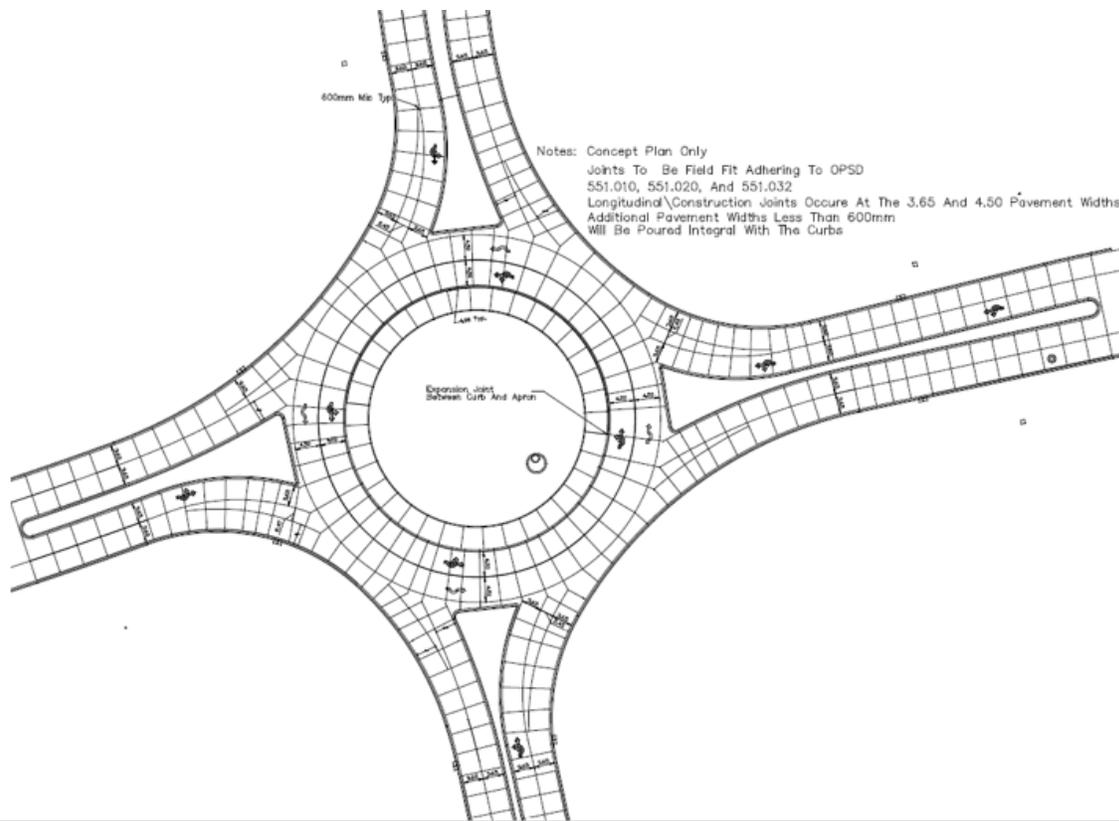
Step 4: Add transverse joints where width changes occur, keeping these joints perpendicular to the edges of the pavements

Step 5: Add transverse joints between those added in Step 4, while attempting to make these joints evenly spaced and being mindful of the maximum joint spacing

Step 6: Lastly, make adjustments for in-pavement objects, fixtures, and eliminate odd, shaped slabs, using the same principles used in a typical intersection [4]

Figure 9 below is a copy of the concept plan for the jointing of the County of Essex concrete roundabout. Some key observations from the drawing are as follows:

- An isolation joint is specified at the interface of the concrete pavement and the concrete apron which is good practice.
- Matching the radial joints of the circle with the longitudinal joints of the roundabout legs is an acceptable practice. Some organizations such as EUPAVE, however, recommend an isolation joint around the perimeter of the outside circular lane as it prevents the expansion of the concrete in the lanes from putting pressure on the concrete in the circular part of the roundabout. [5]
- The two longitudinal joints from the start of the islands into the concrete roundabout lanes on each entrance and exit area present two potential problems:
 - a. The aspect ratio on some of the panels is greater than 1:1.5 which can lead to mid panel cracking.
 - b. There are also some areas in the jointing diagram with acute angles. ACPA notes in their literature to avoid slabs less than 0.3 m, slabs greater than 5.0 m wide, angles less than 60 degrees, creating interior corners and odd shapes. [4]



Source: County of Essex Documents
 Figure 9: Concrete Roundabout Conceptual Joint Layout Plan

4.0 Performance of Concrete Roundabout and Etched Pavement Markings

As mentioned earlier in the paper, the first concrete roundabout was constructed in 2014 in the Municipality of Lakeshore. The County of Essex has observed that no maintenance has been required on this pavement over its 11 years of operation. In contrast, previous asphalt roundabouts required frequent milling and repaving, and experienced significant degradation, cracking, and wheel track rutting. As a result, the concrete roundabout has significantly outperformed the asphalt roundabouts.

During the construction of the original concrete roundabout in the Municipality of Lakeshore, the County of Essex implemented an innovative approach for concrete pavement markings. This process involved recessing the pavement markings into the concrete surface to reduce exposure to wear from snow removal equipment blades. Figure 10 illustrates the process of etching the concrete surface using a pavement marking template and etching compound. Durable paint strips, cut to fit the template, were then applied. The paint strips were hot air lanced, bonding the paint to the etched surface. The combination of recessed markings and the bond between the paint and concrete has resulted in a significantly longer service life for the pavement markings. To date, the markings have required no maintenance.



Pavement Marking Template



Etching compound after the template is removed



Start of placing durable paint pieces



Zoom in of the arrow tips



Heating process to bond Paint to etched surface

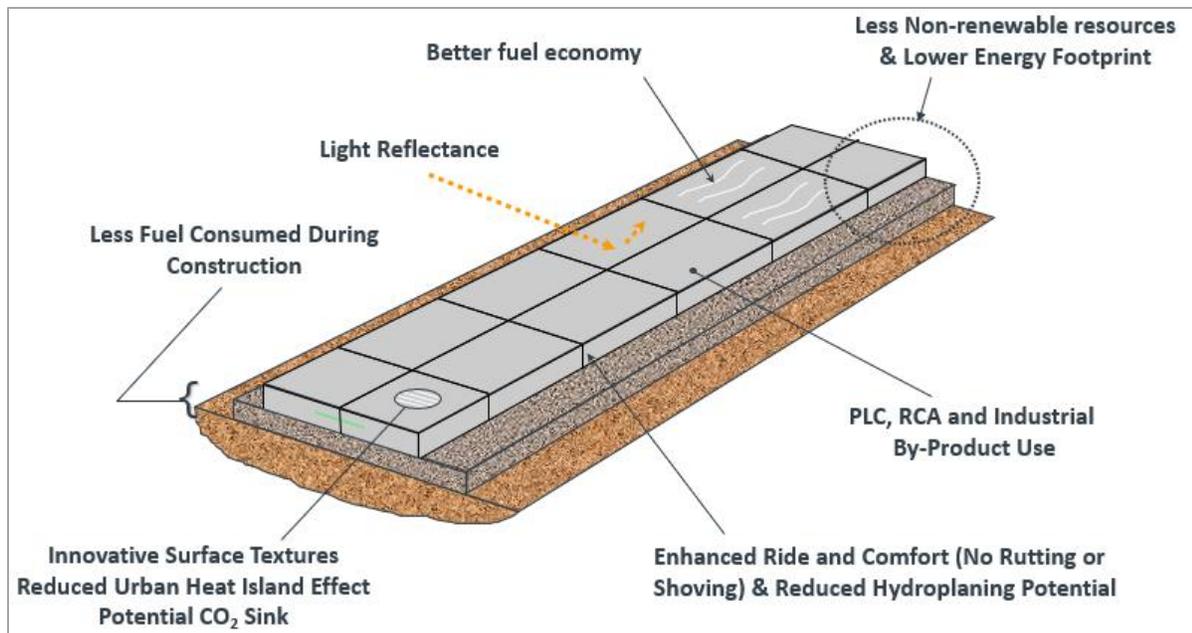


Finished lane marking

Figure 10: Placement of Etched Pavement Markings

5.0 Benefits of Concrete Roundabouts

Figure 11 highlights the various benefits of using concrete pavement on roads. This paper discusses several of these advantages, including a lower carbon footprint from the use of Portland limestone cement (PLC) and SCMs, improved light reflectance, reduced hydroplaning risk, recyclability, and the potential for CO2 sequestration.



Source: Cement Association of Canada and American Concrete Pavement Association diagrams
 Figure 11: Benefits of Using Concrete Pavement.

5.1 Use of Portland Limestone Cement and Higher SCM Amounts

The majority of concrete's carbon footprint, approximately 80 to 85%, results from the production of clinker in cement kilns. To create clinker, temperatures of around 1,500 degrees Celsius are required, which are achieved by burning fossil fuels. This process generates combustion emissions, which account for about one-third of the clinker's carbon footprint. The remaining two-thirds of CO₂ emissions, known as process emissions, occur when CO₂ is released from the limestone during heating. Reducing the amount of clinker used in cement helps lower the carbon footprint of concrete.

An effective way to reduce the carbon footprint of concrete products is by using Portland limestone cement (PLC). Also known as general use limestone (GUL) cement, it contains up to 15% interground limestone, compared to general use (GU) cement, which contains up to 5%. As a result, the carbon footprint of GUL cement is reduced by approximately 10%. For more information on PLC cements, refer to the Cement Association of Canada's PLC Technical Summary document [6].

Another method to reduce concrete's carbon footprint is by producing blended cements with supplementary cementitious materials (SCMs) that replace a portion of the clinker, or by incorporating SCMs into the ready-mixed concrete mix to decrease the amount of cement used. Maximizing the use of SCMs in a concrete mix or blended cement reduces its carbon footprint, and while OPSS.MUNI 1350 encourages the use of SCMs, written approval from the Owner is required when HVSCM 1 levels are met.

To demonstrate the effect of using GUL and SCMs in a concrete mix on its carbon footprint, this paper presents the CO₂ savings realized when using concrete produced with GUL cement compared to GU cement.

For this comparison, we refer to the Athena Sustainable Materials Institute’s Concrete Ontario Member Industry-Wide Environmental Product Declaration (EPD) for Ready-Mixed Concrete, verified by ASTM International [7]. This document includes EPDs for over 125 mix designs for various concrete strengths, both with and without air entrainment. Another useful tool is the Concrete Ontario Industry Average Self Declaration calculator also developed by Athena.

Table 1 below shows the results from the Concrete Ontario Industry Average Self Declaration calculator, comparing the baseline 32 MPa Class C-2 GU mix with 10 % slag compared to the actual mix design (25% slag) if Type GU was used. It is safe to say that this impact could have been expected from the 2014 at County Road 22 and County Road 2 in the Municipality of Lakeshore roundabout project. A 15% reduction is observed in this case.

Table 1: Global Warming Potential Calculation for GU and 25% Slag Mix Design (Actual Mix Design)

Ready Mix Concrete Produced By: Concrete Ontario

FACILITY: Average Concrete Ontario Ready Mix Plant
 STRENGTH: 32 MPa @ 28 days
 MIX NAME: 32MPa Class C-2 Slipformed
 BENCHMARK: Baseline 32MPa concrete with air & 0.45 w/cm (C-2) GU 10

IMPACT PER M ³		Declared Mix	Baseline	+/- Baseline
Global Warming Potential	kg CO ₂ eq	275.20	326.46	-15.70%
Ozone Depletion	kg CFC-11eq	8.12E-06	8.24E-06	-1.45%
Acidification	kg SO ₂ eq	1.39	1.50	-7.14%
Eutrophication	kg N eq	0.25	0.25	-1.07%
Smog Formation	kg O ₃ eq	23.96	24.91	-3.80%
Non-renewable energy	MJ, NCV	1836.97	1921.65	-4.41%

Source: Concrete Ontario Industry Average Self Declaration calculator

Table 2 shows the global warming potential (GWP) for the concrete mix design used in the County Road 42 and County Road 43 roundabout project, which includes GUL cement with 25% slag. The calculator indicates a 21% reduction in GWP, or CO2 emissions, compared to the baseline mix design.

Table 2: Global Warming Potential Calculation for GUL and 25 % Slag Mix Design (Actual Mix Design)

Ready Mix Concrete Produced By: Concrete Ontario

FACILITY: Average Concrete Ontario Ready Mix Plant

STRENGTH: 32 MPa @ 28 days

MIX NAME: 32MPa Class C-2 Slipformed

BENCHMARK: Baseline 32MPa concrete with air & 0.45 w/cm (C-2) GU 10

IMPACT PER M ³		Declared Mix	Baseline	+/- Baseline
Global Warming Potential	kg CO ₂ eq	258.52	326.46	-20.81%
Ozone Depletion	kg CFC-11eq	7.86E-06	8.24E-06	-4.56%
Acidification	kg SO ₂ eq	1.34	1.50	-10.97%
Eutrophication	kg N eq	0.24	0.25	-5.46%
Smog Formation	kg O ₃ eq	23.20	24.91	-6.88%
Non-renewable energy	MJ, NCV	1760.31	1921.65	-8.40%

Source: Concrete Ontario Industry Average Self Declaration calculator

As noted earlier, OPSS.MUNI 1350 encourages the use of SCMs, with written approval from the Owner required only when HVSCM 1 levels are reached. This means that up to, but not including, 50% slag—Ontario's primary SCM—would be permissible for a municipal concrete paving project. While challenges may arise in terms of mix design performance and construction practices as these SCM levels are approached, Table 3 outlines the potential for concrete roundabouts to reduce the carbon footprint of concrete, should future construction practices evolve. It should be noted that this approach is only acceptable in OPSS.MUNI and not OPSS.PROV where concrete pavements are limited to 30% slag.

Table 3: Global Warming Potential Calculation for GUL and 49.9 % Slag Mix Design (Actual Mix Design)

Ready Mix Concrete Produced By: Concrete Ontario

FACILITY: Average Concrete Ontario Ready Mix Plant

STRENGTH: 32 MPa @ 28 days

MIX NAME: 32MPa Class C-2 Slipformed

BENCHMARK: Baseline 32MPa concrete with air & 0.45 w/cm (C-2) GU 10

IMPACT PER M ³		Declared Mix	Baseline	+/- Baseline
Global Warming Potential	kg CO ₂ eq	202.95	326.46	-37.83%
Ozone Depletion	kg CFC-11eq	8.24E-06	8.24E-06	+0.02%
Acidification	kg SO ₂ eq	1.26	1.50	-16.06%
Eutrophication	kg N eq	0.21	0.25	-14.62%
Smog Formation	kg O ₃ eq	22.98	24.91	-7.77%
Non-renewable energy	MJ, NCV	1672.65	1921.65	-12.96%

Source: Concrete Ontario Industry Average Self Declaration calculator

Using the Concrete Ontario Member Industry-Wide Environmental Product Declaration (EPD) for Ready-Mixed Concrete document the total CO₂ savings for the project can be calculated based on the industry average EPDs. Table 4 below shows the CO₂ savings achieved on the CR42 roundabout project for both the actual mix design at 25% slag and potential savings when using the maximum allowed 49.9% slag with any required constructability adjustments. The actual mix used for the CR42 roundabout concrete pavement provided reduction in CO₂ of over 475 thousand tonnes, when compared to the baseline mix for a 32 MPa concrete. If the contractor used the maximum allowable slag percentage at 49.9% the CO₂ reduction for the project would have been in the range of 864 thousand tonnes.

Table 4: CO₂ Reductions Calculations for Concrete Roundabout

Using Concrete Ontario's Industry Average EPD's

**Mix: 32 MPa Class C-2 with air
GUL and 25% Slag**

A1	Volume	7000	m ³
A2	EPD Baseline from report	326.46	kg CO ₂ /m ³
A3	Concrete Placed (GUL 25% SL)	258.52	kg CO ₂ /m ³
A4	CO ₂ e Baseline (A1 * A2)	2285220	tonnes CO ₂
A5	CO ₂ e Project (A1 * A3)	1809640	tonnes CO ₂
A6	GHG Reduction (A4 - A5)	475580	tonnes CO ₂
A7	CO₂ Reduction (A6 / A4)	21%	

**Mix: 32 MPa Class C-2 with air
GUL 49.9% Slag**

A1	Volume	7000	m ³
A2	EPD Baseline from report	326.46	kg CO ₂ /m ³
A3	Concrete Placed (GUL 25% SL)	202.95	kg CO ₂ /m ³
A4	CO ₂ e Baseline (A1 * A2)	2285220	tonnes CO ₂
A5	CO ₂ e Project (A1 * A3)	1420650	tonnes CO ₂
A6	GHG Reduction (A4 - A5)	864570	tonnes CO ₂
A7	CO₂ Reduction (A6 / A4)	38%	

5.2 Decreased Potential for Hydroplaning

Hydroplaning occurs when a layer of water separates a vehicle's tires from the pavement surface, leading to a loss of steering and braking control. Several factors contribute to hydroplaning, including tire wear, driver speed and experience, and pavement surface characteristics. Since government agencies have limited control over tire conditions and driver experience, this discussion focuses on pavement surface characteristics, the area where agencies can exert influence.

All types of pavements whether gravel, asphalt or concrete have the potential for hydroplaning when it is raining, or water is present on the surface. However, concrete pavement, being a moldable material when first placed, can be textured to provide adequate friction characteristics and improved wet weather

performance. As shown in Figure 12 from the American Concrete Pavement Association [8] Concrete Pavement Surface Texture document, texture created on the concrete surface is classified into two categories:

- 1) Microtexture – the fine-scale roughness contributed by the fine aggregate (sand) in the concrete matrix and provides the dry weather friction. This texture is created in the concrete surface by dragging burlap or astro-turf over the surface of the plastic concrete prior to applying the curing compound.
- 2) Macrotexture – the measurable striations or grooves formed in the plastic concrete by hand operated tining brooms or automated machines which provides the wet weather friction. Macrotexture may also be formed by cutting or sawing grooves into the hardened concrete surface.

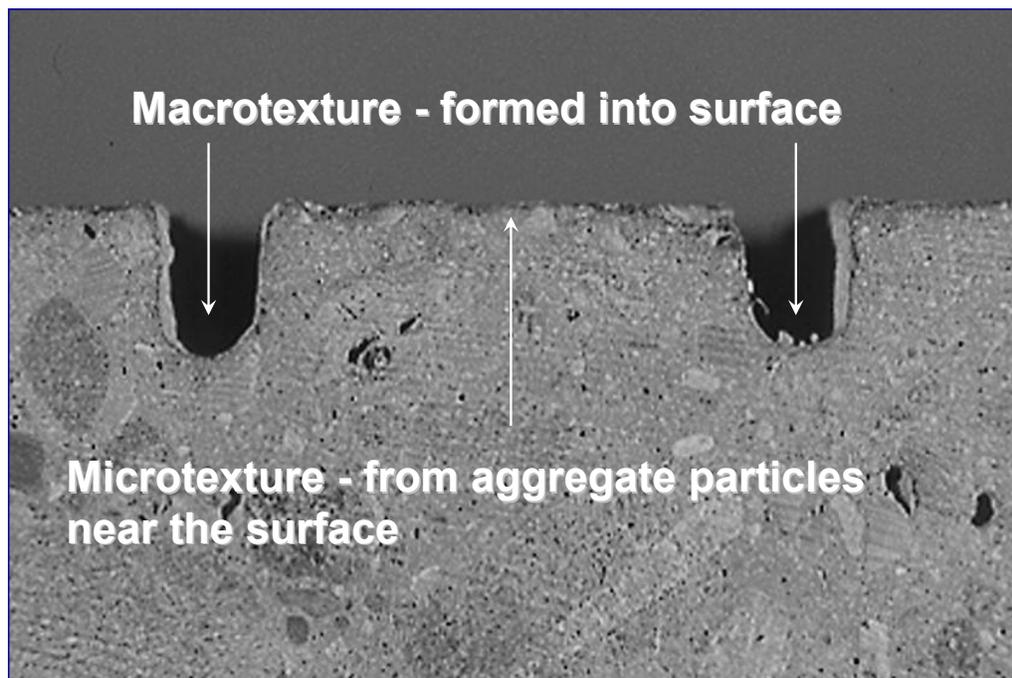
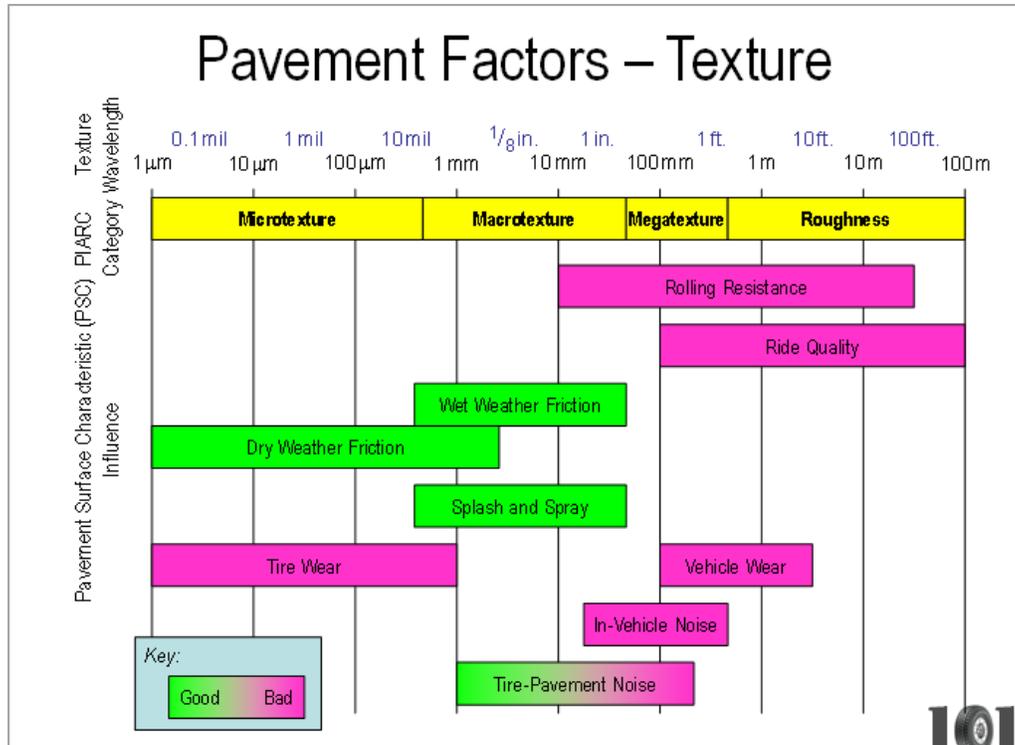


Figure 12: Close-up of Microtexture and Macrotexture on Concrete Pavement. [8]

As shown in Figure 13 from the Concrete Pavement Surface Texture document [8], macrotexture is the primary factor contributing to concrete pavement's superior performance in wet weather conditions. The grooves in the concrete pavement surface provide channels for water to escape from beneath the vehicle's tires, significantly reducing the potential for hydroplaning. Another factor contributing to concrete's excellent performance in wet conditions is its rigid structure, which prevents heavy vehicles from causing deformations such as ruts and washboarding in the pavement surface. Additionally, longitudinal grooving reduces splash and spray, making driving safer for vehicles in wet weather conditions.



Source: Iowa State University

Figure 13: Effect of Texture on Pavement Surface Characteristics. [7]

5.3 Superior Nighttime Visibility

An earlier paper on concrete pavement sustainability by Tim Smith [9] noted concrete pavement’s light reflective surface not only provides a pavement surface that minimizes heat island effect in urban areas but also enhances nighttime visibility in urban and rural environments. This is accomplished due to the light coloured (high albedo) surface of concrete pavement. Table 5 below from that same paper shows the albedo (solar reflectance) ratings for various pavement types. As shown in the table concrete pavement has superior albedo to ACP in both new and weathered conditions: concrete pavement (0.35 – 0.40 new PCCP and 0.20 – 0.30 weathered concrete) and asphalt (0.05 -1.0 new ACP and 0.10 – 0.15 weathered ACP).

5.4 Reusable and Recyclable Paving Material

Concrete pavement is a versatile product which can be reused by performing concrete pavement restoration (CPR) techniques on the damaged areas. Repair techniques such as full depth / partial depth repairs, crack cross-stitching and load transfer restoration combined with diamond grinding will restore the pavement to an almost new state.

Table 5: Albedo for Various Pavement Types

PAVEMENT TYPE	ALBEDOS (SOLAR REFLECTANCE)
ASPHALT	0.05-0.10 (NEW) 0.10-0.15 (WEATHERED)
GRAY PORTLAND CEMENT CONCRETE	0.35-0.40 (NEW) 0.20-0.30 (WEATHERED)
WHITE PORTLAND CEMENT CONCRETE	0.70-0.80 (NEW) 0.40-0.60 (WEATHERED)

Source: TAC Paper [9]

Concrete pavement is also a 100 percent recyclable material and provides government agencies an attractive option at reconstruction time. If subgrade or pavement condition doesn't allow the older PCCP to be reused in its existing state it can be rubblized and used as granular fill, base course for new pavement and / or as an aggregate for new concrete pavement. In addition, steel in the PCCP such as dowels and tie bars can be recycled [10].

Reusing the concrete pavement minimizes the amount of non-renewable resources required for a new pavement structure and eliminates potential material going to landfill sites. In addition, the short hauling distance for the aggregate reduces the cost of providing aggregates to the job.

5.5 Concrete as Carbon Sink

Carbon dioxide sequestration is another climate change mitigation advantage of concrete. It has long been known concrete absorbs CO₂ over its life, but little was known about this potential. According to the Cement Association of Canada Concrete Zero [11] document, "Research conducted at IVL, the Swedish Environmental Research Institute finds an average of 20% of the CO₂ calcination emissions (i.e., process emissions from clinker production) can be permanently sequestered when a concrete structure has been built. Another 2% of calcination emissions can be permanently sequestered when the concrete structure is demolished. Another 1% of calcination emissions are considered permanently sequestered if the demolished concrete is reused as an aggregate." [11]

HOLCIM's website has a video explaining the Recarbonation process. It notes cement will absorb approximately ¼ of the amount of CO₂ emitted during its production. Overtime, CO₂ in the atmosphere

reacts with the calcium in the cement paste. This reaction forms calcium carbonate, effectively neutralizing the CO₂. Recarbonation continues over the course of years, progressing from the outer surface to the concrete moving inwards. Various factors affect the level of Recarbonization of the concrete including humidity, concrete composition and exposure condition. [12]

Concrete pavement is often diamond-ground later in its life to help restore skid resistance. When diamond grinding is performed, a fresh surface of concrete is exposed, which will absorb more carbon dioxide.

6.0 Conclusion

The performance of the concrete roundabout constructed in 2014 in the municipality of Lakeshore has convinced the County of Essex to utilize concrete roundabouts on a more frequent basis. This paper discusses the construction of the third concrete roundabout constructed in the County of Essex in the Town of Tecumseh in 2024. As shown in the paper the construction went well due to the quality contractor doing the work and the collaboration with the County of Essex staff. The durable concrete surface will not rut due to the heavy truck traffic and can withstand the shear forces created when heavy vehicles travel around the traffic circle. The County has tendered a fourth concrete roundabout for construction in 2025 and is looking at tendering a few additional concrete roundabouts in the next 5 -10 years. In addition to being a durable long-lasting pavement, concrete roundabouts provide several other benefits including lower carbon footprint due to use of GUL cement and SCM's, decreased potential for hydroplaning due to grooved surface, superior nighttime visibility due to a more reflective surface, reusable and recyclable material and CO₂ sink which will absorb carbon over its life.

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