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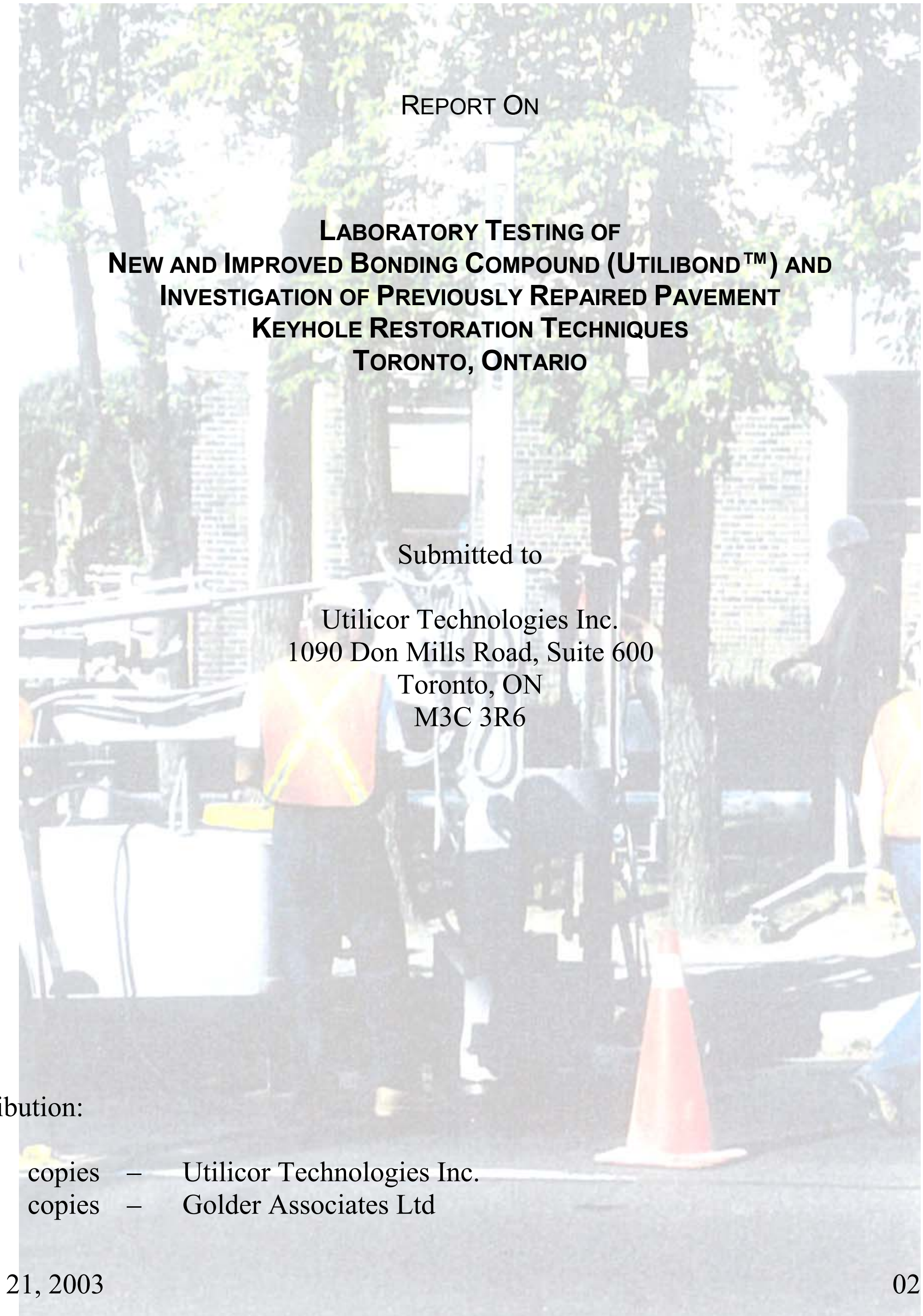

REPORT ON

LABORATORY TESTING OF NEW AND IMPROVED BONDING COMPOUND (UTILIBOND™) AND INVESTIGATION OF PREVIOUSLY REPAIRED PAVEMENT KEYHOLE RESTORATION TECHNIQUES TORONTO, ONTARIO

Submitted to

Utilicor Technologies Inc.
1090 Don Mills Road, Suite 600
Toronto, ON
M3C 3R6

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April 21, 2003 021-8487

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April 21, 2003 021–8487

Utilicor Technologies Inc.
1090 Don Mills Road, Suite 600
Toronto, ON
M3C 3R6

Attention: Mr. E. Marshall Pollock
President

RE: LABORATORY TESTING OF NEW BONDING COMPOUND AND INVESTIGATION OF PREVIOUSLY REPAIRED PAVEMENT KEYHOLE RESTORATION TECHNIQUES TORONTO, ONTARIO

Dear Sirs:

Golder Associates Ltd. was retained by Utilicor Technologies Inc. to carry out a series of verification tests on the pavement restoration and repair aspect of the portion of Keyhole Repair technology for the remote repair and maintenance of in-ground utilities. The purpose of the study was to confirm the applicability of the new Utilibond™ bonding agent.

We trust that this document is sufficient for your current requirements. If you have any questions, please call us.

Yours truly,
GOLDER ASSOCIATES LTD.

Joel M. Kimmett, P.Eng.
Materials Engineer

A.W. (Sandy) Brown, P.Eng.
Associate

JMK/AWB:

021-8487 rep 2003-03 Utilicor Keyhole - bonding agent report v5.doc

ABSTRACT

This study is an update of the work carried out over the previous ten years on the materials and installation methods used to repair or install subsurface utility plant using Keyhole Technology. Keyhole Technology was originally developed by The Consumers Gas Company Ltd. (now Enbridge Gas Distribution) over the last ten years. The method developed is less intrusive employing, among other things, a rotary cutter and improved pavement reinstatement techniques including a proprietary pavement cutting drill (patent pending) to remove the pavement surface. Using the cutter, the pavement coupon is removed and preserved. The hole is vacuum excavated to expose the plant and the repair of the plant or installation of new equipment is achieved using long handled (remote access) tools. After the repair, the hole is backfilled and the pavement coupon is reinstated with a proprietary bonding compound (Utilibond™) bonding the coupon back into place as a permanent restoration. The process saves crew time, as it can usually be completed in less than one day. It also saves cost by not only reducing time but also by reducing the volume of material to be removed for disposal and eliminating the need for repaving.

Utilicor Technologies Inc. is now the exclusive licensee and distributor of this new technology called Utilicoring™ and also manufactures and distributes the Utilibond™ compound.

TABLE OF CONTENTS

Section **page**

LIST OF FIGURES

LIST OF PHOTOGRAPHS

APPENDICES

1. INTRODUCTION

1.1 HISTORICAL

Underground service repair is one of the most disruptive operations in city streets. Not only is there major traffic disruption during excavation and repair, but the repair itself may give rise to poor pavement performance and be a source of ongoing maintenance for the municipality. The Consumers Gas Company Ltd. (now Enbridge Gas Distribution) has over the last ten years worked to develop less intrusive keyhole repair technologies employing, among other things, a rotary cutter and improved pavement reinstatement techniques including a proprietary bonding compound called Utilibond™. Utilicor Technologies Inc. is now the exclusive licensee and distributor of this technology.

In June of 1992, Golder Associates Ltd. was retained by The Consumers Gas Company Ltd. (Consumers) to provide consulting and testing services in the development of a new pavement reinstatement system, following rotary cutting of the pavement for gas service repairs in the use of keyhole repair technology. That work encompassed a series of field trials and laboratory tests undertaken over the period 1992 to 1996. This follow-up study was commissioned in October 2002, to confirm previous results and to update performance data in respect of a new and improved version of the bonding compound used in the reinstatement process, called Utilibond™.

The technique of keyhole repair technology cost-effectively revolutionizes the manner in which utility corporations service and maintain their plant. In the past, a utility with in-ground services would be required to first carry out a pavement cut and then excavate to expose their pipes or underground plant. Traditionally, these operations required the breaking out of pavement with jackhammers, followed by backhoe excavation or manual digging until plant, pipes or fittings are exposed. The excavation would need to be large enough (i.e. one to two metres square) to allow workers to access the plant from within the excavation resulting in the generation of a large quantity of materials to be removed. In some instances, the disposal of these materials or spoil was complicated by contamination of the material that was removed. Following the repair to the service, it was necessary to backfill the hole and reinstate the pavement.

Photo 1 – Traditional utility service cut.

In addition to the materials generated, the procedure was a lengthy one. Given that in most municipalities, road access at peak traffic times (morning and afternoon rush hours) is restricted, the procedure would frequently require two to three days. This would result in the need to temporarily backfill the hole or otherwise protect the excavation with steel plates to allow traffic to be restored. In addition to the time requirements, there was also the requirement that many different crews and equipment types would be required to access and complete the repair of the buried plant over the several day period.

Another drawback was the restrictions on the type of pavement repair or reinstatement allowed by the local municipality. Prior to the initiation of the Consumers research program, the City of Toronto did not allow the utility to carry out a permanent restoration of the pavement. After completing its work, the utility would temporarily patch the excavated road surface with asphalt. The procedure for permanent pavement reinstatement on roads within Toronto involved a separate contractor hired by the City who, six months to a year after the original excavation, would execute a full depth patch of the concrete portion of the pavement and then subsequently hot-mix patch the wearing surface. By carrying out the repair procedure separately, the City could supervise the repairs to ensure that the backfill had been placed properly and that pavement reinstatements were carried out for all service cuts in a manner that resulted in the least impact on the road system. This work by the City was back-charged to the utility in question thus substantially increasing the cost of underground maintenance or repair work.

1.2 IMPACT OF UTILITY CUTS AND RESTORATION

The long-term performance of utility street cut repairs has been a concern to public works officials for years. A number of municipally sponsored engineering studies published on the subject claim that it is "impossible" to repair or mitigate damage caused by utility cuts with the result that a number of local governments sought to recover the damage or loss of pavement life by imposing street cut fees ranging from $5 per linear foot on the low side to $100 per square foot on the high side, with a $1,000 minimum fee per cut.

In response, utility conducted research and field demonstration projects sought to show that the performance of utility cuts is more directly related to excavation restoration techniques and quality control procedures. The debate continued without resolution for years until May 2000 when Canada's National Research Council (NRC) and the U.S. Army Corps of Engineers embarked on a unique joint research study focused on developing and validating effective utility cut restoration guidelines.

The project, known as the *Utility Cut Consortium Project,* is expected to report at the end of 2003, and is managed by a steering committee representing the 28 sponsors of the study which includes a number of North American cities, utility companies and associations, as well as state DOTs.

Included in this study is the evaluation of various materials and practices used in pavement cutting and restoration and the development of a series of guidelines and best practices covering pavement cutting, excavation, treatment of the bottom of the trench, plating, backfill, pavement (flexible and composite), joint treatment and quality control. Of particular interest will be the comparative results of the test locations employing keyhole excavations in Toronto, Ottawa, California and New Jersey. A number of issues including the geometry, shape and orientation of the road cut, as well as the cutting and restoration procedures, are expected to be addressed.

What is already known, independent of the study, is that, while the utility road-cut location, orientation and depth are generally predetermined by the position of the targeted facility within the road, many of the work instructions, largely for aesthetic reasons, call for a neat and harmonized look with straight cut lines oriented parallel and perpendicular to the direction of travel and a limitation on the number of edges to four. This geometry, particularly the length of the cut and its proximity to the wheel paths and the curb or edge of the road, can have significant influence on the structure of the road-cut system.

For example, in conventional straight-line road cut systems, a longitudinal joint close to the wheel path will be subjected to heavy loads. Traffic directly over the joint will induce critical stresses and cause movements that may lead to joint opening and deformations in the road or in the restored cut or otherwise increase the potential for premature failure. This problem is typically greatest where pavement cuts occurred within three feet of the curb line or the edge of the road, as this area is usually the most heavily trafficked portion of the roadway frequented by transit buses and commercial vehicles. In these circumstances, the portion of pavement between the road cut and the curb becomes isolated from the remaining pavement structure. Under the pressure of heavy traffic, major deterioration including cracking and spalling is a typical result. In order to prevent this problem, the reinstatement is expanded to include all pavement up to the curb or road edge thus adding significant cost and complexity to the repair process.

On the other hand, where the nature of the work to be performed will permit, the smaller size and equally pleasing geometric precision of the keyhole coring technique, of which the reinstatement on Kennedy Road in Toronto discussed below is a good example, seems not to exhibit the same defects, notwithstanding the fact that it is located directly within the heavily traveled bus lane wheel path and is less than three feet from the curb. The much smaller excavation footprint and the absence of any straight dimensions in the circular cut, as well as the absence of corners in the circular cut (corners tend to concentrate stress) eliminates many of the factors that currently contribute to the weakening and premature deterioration of the road system.

1.3 UTILICORING

Utilicoring™, as the process is now known, and keyhole maintenance techniques when coupled with Utilibond™ to reinstate the pavement surface, offers both dramatic savings in maintenance and repair costs and provides assurance to the municipality or other road authority that the reinstated road surface will perform in a manner consistent with its original design specifications and construction. With Utilicoring™, an 18 inch (450 mm) diameter core to a depth of up to 22 inches (560 mm) is cut though the pavement surface with a truck mounted rotary cutting unit or drill. This core or coupon is removed, wiped down with water to remove any loose coring debris and preserved for the final restoration of the pavement surface. Following removal of the pavement coupon, the underground service is exposed using a vacuum excavation technique and the repair is effected with specially designed, long-handled keyhole tools which allow the workers to access the base of the excavation remotely from ground level. Without the need to physically put a crew in the excavation to repair the service, the process is not only safer and less disruptive, but the volume of excavated material or spoil that needs to be disposed of is kept to a minimum. The keyhole process also reduces the volume of material that must be subsequently handled and replaced. In addition, the

Utilicoring™ process and subsequent vacuum excavation are much faster than conventional techniques. In most situations, the service can be exposed and the repair commenced within half an hour of the lane closure.

Following the repair or service, the excavation is backfilled with native or engineered fill and made ready for the pavement surface restoration. The backfill is typically stopped about 2 to 3 inches (50 to 75 mm) below the underside of the pavement. The remaining space, including an annular sub-excavation of about 2 inches (50 mm), is filled with pea gravel (⅜ inch or ~9 mm nominal diameter clean clear rounded aggregate). The pavement coupon is replaced in the hole in its original orientation to ensure that it will be adequately supported and then removed again. After any required adjustments, the perimeter surfaces of both the hole and the pavement coupon are cleaned with water, and Utilibond™ is poured into the hole filling the voids in the pea gravel and providing a stable base for the core. When the pavement core is replaced in the hole, the Utilibond™ flows up to fill the annular kerf between the core and the edge of the hole and also the central pilot hole in the core. Typically, the Utilibond™ sets-up within 45 minutes to an hour.

Using the Utilicor™ system, it is possible to close the road at 9:30 AM, expose the service, perform the repair or maintenance work, refill the excavation, complete the final pavement restoration and open the road for traffic by noon. This is a significant savings in time, manpower and cost.

2. LABORATORY TESTING PROGRAM

In order to confirm that the new and improved Utilibond™ formula performs in a similar manner to the material originally used in the trial programs, a limited laboratory testing program was carried out using a variety of compression and shear testing procedures.

2.1 CUBE TESTING

The Utilibond™ compound was initially tested by evaluating the strength of the material in compression by the cube testing method. A series of cubes were cast and tested at various ages. In addition, tests were carried out at two different temperatures. The initially developed mixes suffered from a short pot life in temperatures in excess of 27° C. The temperature testing was carried out to investigate if this problem had been overcome.

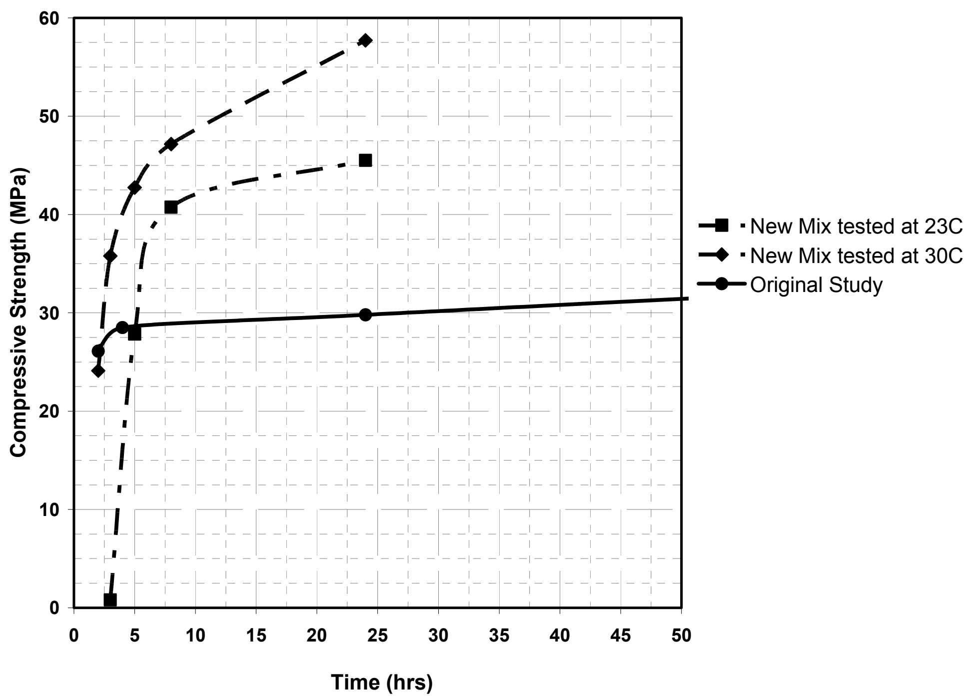


Figure 1 – Cube Strengths of the Utilibond™

Based on the test results, the newly formulated mix performed in a similar manner when tested for cube strength.

2.2 SIMULATED PAVEMENT PERFORMANCE TESTS

2.2.1 TEST SET-UP

As in previous phases of the study, the Utilibond™ compound was evaluated based on a punching shear type laboratory test that was designed to simulate to some degree the loading conditions in the field. Concrete slabs were prepared to yield a standard mix with a 28 day compressive strength of 4,500 psi (~30 MPa), using ¾ inch (19 mm) minus aggregate. A 4 inch (100 mm) core was cut from concrete slabs 10 inches (250 mm) square and 4 inches (100 mm) in thickness. The cores were bonded back in place using Utilibond™ leaving the core protruding by about ¼ inch (~6 mm) to facilitate testing.

The test arrangement for this laboratory test was designed to determine the load needed to break the shear bond at the core/core hole interface and dislodge the core and is illustrated in Figure 2. The load needed to punch the core through the slab was recorded over a range of curing ages from 1½ to 48 hours. In many instances, especially at higher failure loads, the concrete test slabs cracked as the core was punched through, indicating that the bond was stronger than the overall concrete substrate.

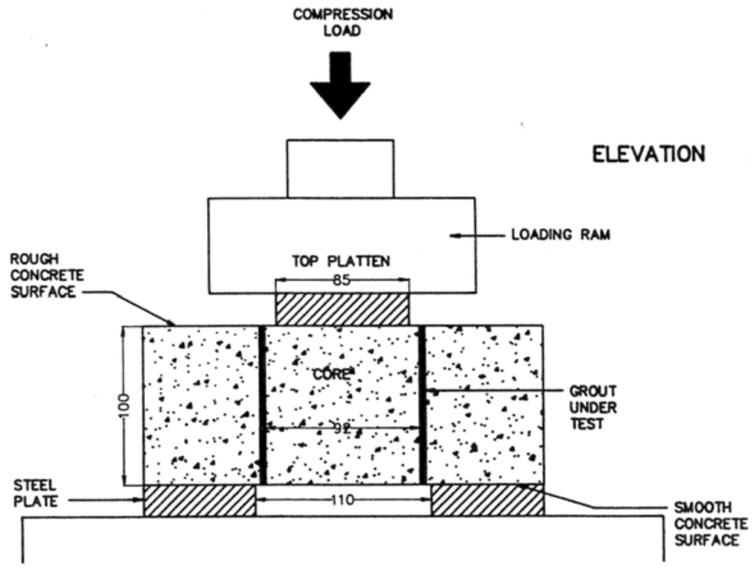


Figure 2 – Test set-up for simulated loading.

2.2.2 EQUIVALENT LOAD CALCULATIONS

The majority of the highway agencies in the United States use the AASHTO design guide which is based on the AASHTO road test and uses the 18 kip (80 kN) equivalent single axle load (ESAL) concept. The AASHTO design guide has the ability to convert heavier axle loads into ESALs using load equivalency factors which were developed at the AASHTO road test.

The loads in the laboratory were compared to the loads expected in the field by comparing the bonded area tested in the field to that tested in the laboratory. Based on this conversion, the loads were compared to the AASHTO H–25 loading. Under this loading scheme, the maximum axle load is specified as 40,000 pounds (~178 kN). Typically, this load is carried by four tires resulting in a tire loading of 10,000 pounds (~44.5 kN) per tire. Given the geometry of the pavement coupon (18 inch or ~450 mm diameter) the worst case loading is considered to occur when one tire bears directly on the coupon. Given the typical tire spacing, it is unlikely that two tires could bear at the same time without overlapping the surrounding pavement and thus reducing the stress on the joint. When allowing for the respective areas of the typical pavement coupon (8 inches in thickness and 18 inches in diameter or ~200 mm in thickness and ~450 mm in diameter) when compared to the test sample (4 inches in thickness and 3¾ inches in diameter or ~100 mm in thickness and ~95 mm in diameter), the critical load for the laboratory sample was determined to be 4.5 kN.

2.2.3 Results of the Testing

The loads recorded for the Utilibond™ are presented in Figure 3. The results for products recommended after previous phases are also presented for comparison.

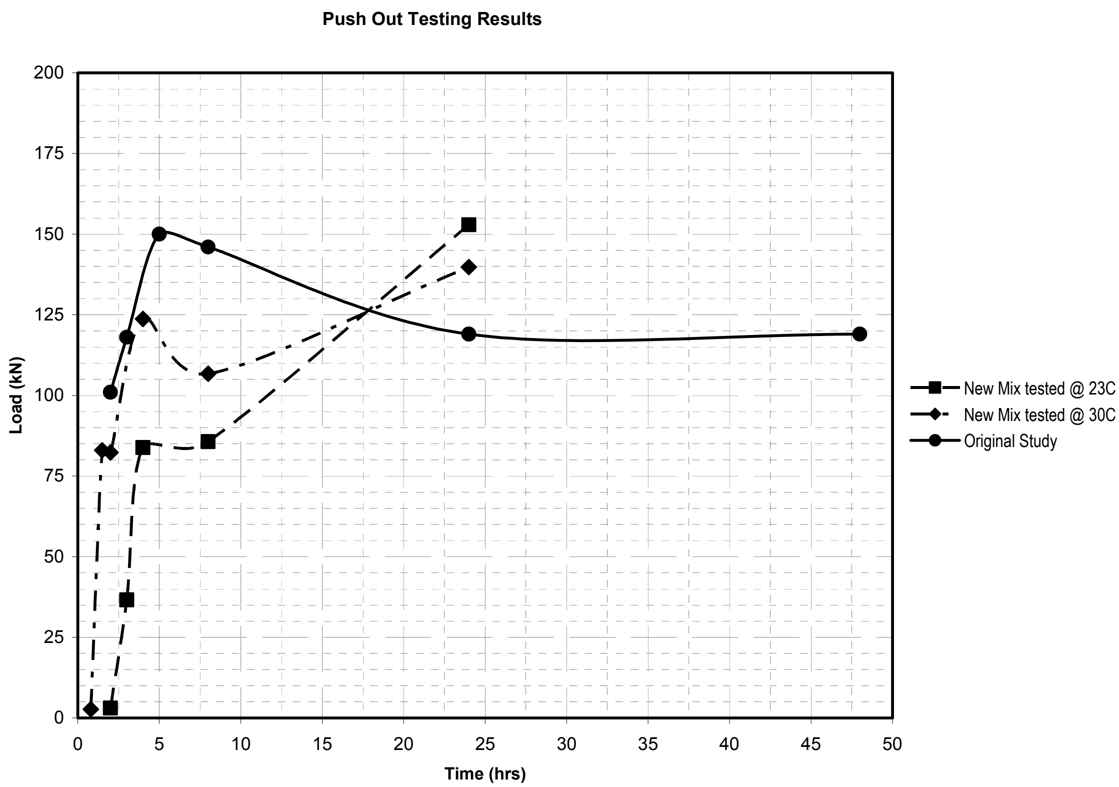


Figure 3 – Results of the Pushout Testing

The graphs show that the Utilibond™ reached the necessary load capacity (4.5 kN) to support traffic within one to two hours depending on temperature. It is interesting to note that the load decreases in the short term after achieving a high strength. This effect is attributed to the initial high heat of hydration which puts the Utilibond™ annulus in compression resulting in higher initial loads. In the original testing, which was carried out over a longer time interval, this effect was seen to dissipate and normal strength gain continued. It should also be noted that in some cases, when the load exceeded 100 kN, the substrate slab broke before the bond sheared and thus the results represent a minimum strength, not that actual strength.

For the purposes of comparison, the loads have been normalized by dividing them by the calculated critical load to determine the factor of safety. As shown on the following chart, The Utilibond™ achieves a factor of safety of five for the load within 2.5 hours at 23°C. The Utilibond™ reinstated pavement has a factor of safety in excess of 15 within 5 hours.

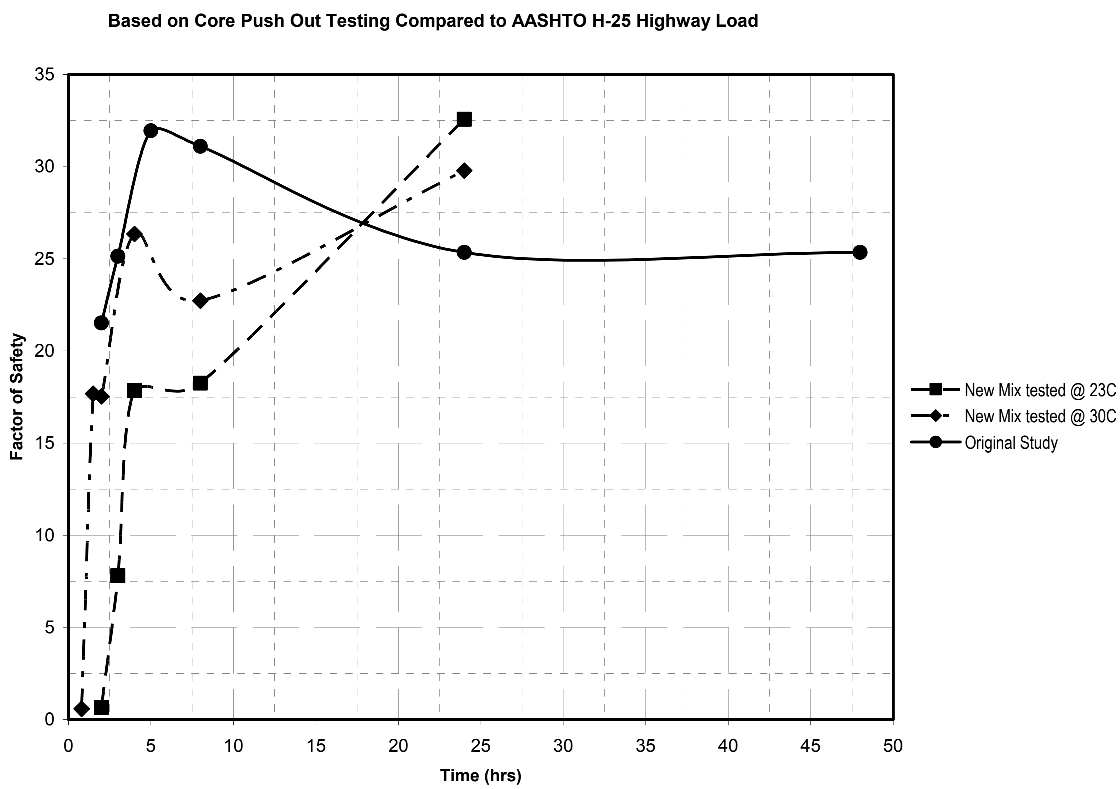


Figure 4 – Factor of Safety vs. AASHTO H-25 Loading

3. HISTORICAL FIELD RESULTS

Consumers has used the Keyhole technique for the service maintenance and repair on a trial basis from 1991 to 1994 and for the majority of the repairs since that time. Over the period, more than 3000 reinstatements using the rotary cutter and bonding process have been made in sidewalks and city streets, all without any recorded failures. Many of the reinstatements have been made in major arterial routes with high traffic volumes (Annual Average Daily Traffic referred to as AADT in excess of 20,000 vehicles). As most of the arterial roads are also bus routes for the Toronto Transit Commission, the pavement loadings are frequently very high.

One of those bus route locations was at 720 Kennedy Road where an excavation, repair and core reinstatement was effected on August 23rd, 1995.

Photo 2 – View of Utilicoring at 720 Kennedy Road in 1995.

Kennedy Road is a major arterial road in the City of Toronto with two northbound and two southbound lanes of traffic and an AADT in this location in excess of 10,000 vehicles in each direction. It is also a major bus route of the Toronto Transit Commission with an average of 380 southbound bus trips per week.

As can be seen from Figure 3, the centre of the 18” keyhole excavation and reinstatement is positioned 1 metre (39.4 inches) from the edge of the pavement, directly in the outside wheel path (OWP) of the curb or bus lane.

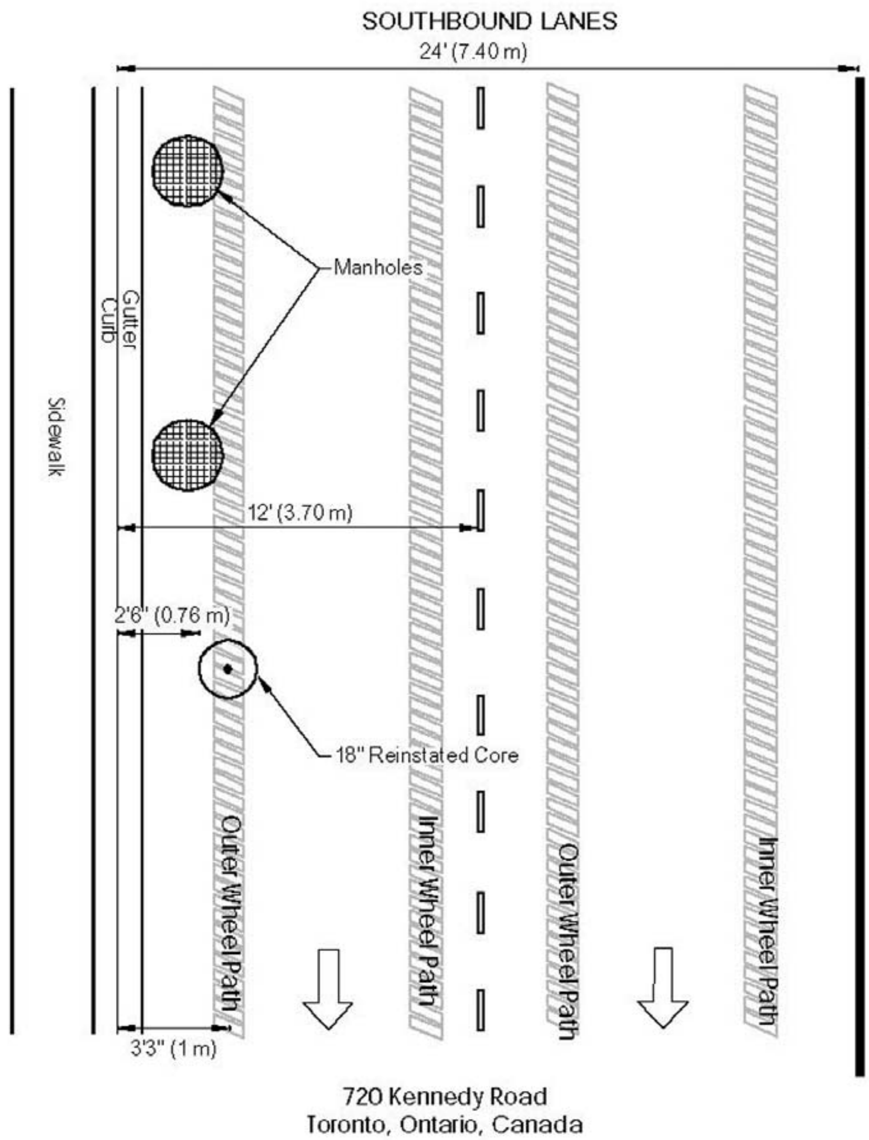


Figure 5 – Schematic of the keyhole repair on Kennedy Road.

Two weeks after the reinstatement, the site was revisited and Photos 3 and 4 were taken showing the completed repair after two weeks of traffic (approximately 70,000 vehicles including 760 bus passes later).

In September 1995, about one month after the reinstatement, the site was again revisited and two vertical satellite core samples through the repaired joint from opposite sides of the core were taken (Photo 5) and examined. The coreholes were repaired with the bonding compound. The photograph of the cores shows the Utilibond™ material as a light grey line. The photographs also show the excellent bonding of the asphalt-concrete core (central concrete in the photos) and the undisturbed pavement (outer concrete). The photograph also shows the complete infilling of the voids in the pea gravel bedding.

Photo 3 – View of reinstatement in two weeks after installation in 1995.

Photo 4 – Close view of reinstatement two weeks after installation in 1995.

Photo 5 – View of satellite cores taken one month after installation in 1995.

Four years later, on October 28, 1999, Photos 6 and 7 were taken by Enbridge Consumers Gas and confirm no displacement of the main core or the two satellite test cores or visible degradation of the road surface.

Photo 6 – Kennedy Road reinstatement in October 1999.

Photo 7 – Kennedy Road reinstatement in October 1999.

As part of this update, the site was again revisited in December 23, 2002 and additional site photographs Photos 8 and 9 were taken, showing the completed repair (including the two satellite test cores) some 7 years and 4 months after the initial excavation, repair and core reinstatement.

Photo 8 – Kennedy Rd. reinstatement in December 2002.

Photo 9 – Close view of Kennedy Rd. reinstatement in December 2002.

In the almost 7½ years since the initial reinstatement, more than 145,000 transit buses and more than 13 million commercial and other vehicles have passed directly over the keyhole with no apparent weakening or other degradation of the reinstated core or the adjacent road system or paved surface.

In April 2002 the City of Toronto approved the Enbridge Consumers Gas keyhole reinstatement process as a permanent repair for composite pavements (concrete base and asphalt) and extended the City's participation in the National Research Council of Canada and US Army Corps of Engineers joint utility cut study that is expected to report in 2003.

4. HISTORY OF THE USE IN THE CITY OF TORONTO

4.1 CITY OF TORONTO

The City of Toronto (formerly Metropolitan Toronto) lies on the north shore of Lake Ontario, the easternmost of the Great Lakes, in a zone that experiences seasonal freeze-thaw cycles with attendant frost heaving and other ground effects. Home to more than 2.5 million people, the city is the key to the Greater Toronto Area (GTA). Over 4.5 million Canadians live in the GTA, the cultural, entertainment, and financial capital of the nation. The city is also the seat of the Ontario government.

The City of Toronto, which covers 632 square kilometres (244 square miles), has more than 5,300 kilometres (~3,300 miles) of neighbourhood streets, community and inter-community roads, and expressway facilities that form the infrastructure network vital for improving the City and the quality of life that it provides.

The City of Toronto experiences a wide variety of temperatures and weather over the course on a year ranging between –20ºC (-4ºF) in the winter to 30ºC (86ºF) in the summer. The following tables indicate the average monthly temperature and precipitation levels for Toronto.

Temperature (°C)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Maximum	-2	-1	4	12	18	24	27	26	21	14	7	0
Minimum	-10	-10	-4	1	6	11	14	13	9	4	0	-6
Mean	-6	-5	0	6	12	17	21	20	15	9	3	-3

Precipitation

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rain (mm)	19	21	35	56	66	69	77	84	74	62	64	38
Snow (cm)	32	26	20	7	0	0	0	0	0	1	6	31
Total (mm)	46	46	57	64	66	69	77	84	74	63	70	66
Snow Cover (cm)	8	6	0	0	0	0	0	0	0	0	1	6

4.2 ROAD CONSTRUCTION

The sub grade soils in the City vary considerably given the geological history of the area. Sub grade types can range from sands and gravel to soft clays. The typical sub grade is a clayey silt till deposited during the last glacial period.

Road construction also varies depending on both the road type and its location within the city. In the past, the City was composed of five boroughs (North York, East York, York, Toronto and Scarborough) that had differing outlooks in pavement design for their local roads. In addition, there was a co-ordinating body known as Metropolitan Toronto that administered the major arterial links that crossed the city. Much of the urban network is composed of flexible pavement (asphalt over granulars) while the remainder and many of the principal arterial roads are composite pavements (asphalt surface over an 8 inch or 200 mm concrete base, refer to Appendix A).

4.3 USE OF KEYHOLE TECHNOLOGY

For an alternate pavement reinstatement method to be approved by the City, it would have to be demonstrated that the proposed method would effectively transfer loads from the patched area to the undisturbed pavement. In addition, it would have to be demonstrated that the proposed system had effectively filled any voids beneath the slab that may have been produced during the repair of the service. Finally, it would have to be shown that procedure used materials of known and reproducible quality and that the procedure itself was simple and could be reliably used.

As mentioned above, Consumers has used the Keyhole technique for the service maintenance and repair on a trial basis from 1991 to 1994 and for the majority of the repairs since that time. Since then more than 3000 reinstatements have been made in sidewalks and city streets, without any recorded failures. Many of the reinstatements, such as the Kennedy Road site referred to above, have been made in arterial routes with high traffic volumes and high pavement loadings without any apparent damage or reduction in performance of the road system.

One of the critical measures of the effectiveness of any road reinstatement process is the degree of coupling between the undisturbed road structure and the newly restored cut. Effective coupling is achieved where the road will share the effect of traffic loading, as postulated in conventional road design theories. The lab trials and previous demonstrations on the rotary cutting method have shown that the pavement coupon has been bonded into the slab in such a manner that the loads of traffic are effectively transmitted to the remaining intact slab. In addition, the investigation of former trials over a number of years indicates that the repair technique continues to perform well. Based on this successful performance, the City of Toronto has approved the Utilicor™ pavement restoration technique as a permanent reinstatement.

5. NEW FEATURES OF THE UTILICOR™ SYSTEM

In the initial trials, several different bonding compounds were evaluated. Most were dismissed due to potential problems with chemicals or with the inability to be used in local weather conditions. Based on several laboratory studies, a pre-bagged bonding compound was chosen to bond the coupon back to the in situ pavement. The pre-bagged compound was chosen to ensure consistency in the product and uniform performance. While the original pre-bagged compound was effective, accurate mixing and storage was a problem. In addition, the material tended to have a short pot life in warm summer weather. Utilibond™ has been reformulated and is now distributed in sealed plastic bags to prevent moisture contamination. The bags are, in turn, packaged in 20 litre polyethylene pails with a clearly marked fill line to ensure accurate and trouble free mixing and dispensing.

6. CONCLUSIONS

Based on trials carried out at our testing laboratory in Whitby and our in-field performance observations, we are satisfied that the equipment, procedures and materials developed and used by Enbridge Gas Distribution over the last 10 years will ensure satisfactory long term performance of the pavement reinstatement.

GOLDER ASSOCIATES LTD.

Joel M. Kimmett, P.Eng.
Materials Engineer

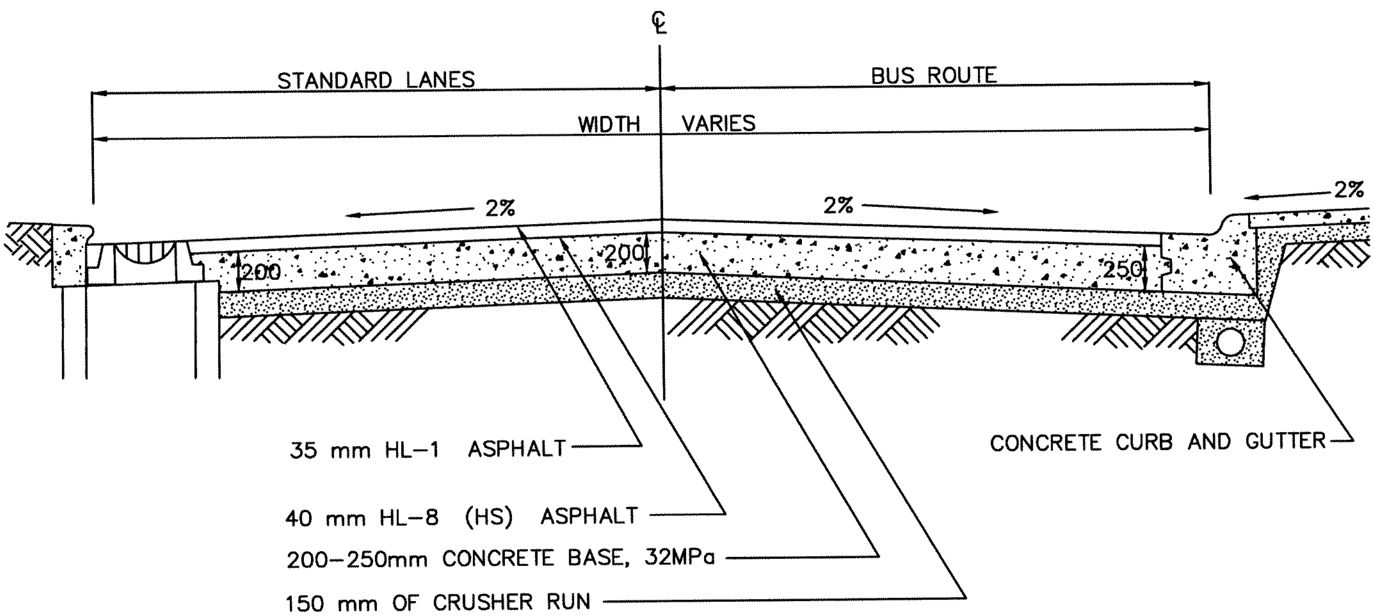
A.W. (Sandy) Brown, P.Eng.
Associate

JMK/AWB:

021-8487 rep 2003-03 Utilicor Keyhole - bonding agent report v5.doc

APPENDIX A

TYPICAL COMPOSITE PAVEMENT CONSTRUCTION, CITY OF TORONTO



NOTES

1. VARIATIONS FROM STANDARDS SHOWN HERE ARE MADE TO SUIT SPECIAL CONDITIONS.
2. RAISED TRAFFIC MEDIANS REQUIRED AT MAJOR INTERSECTIONS SEE OPSD 504.01

METRIC
ALL DIMENSIONS SHOWN HERE ARE IN MILLIMETRES UNLESS OTHERWISE NOTED

	APPROVED BY TOM DENES, P. ENG. EXECUTIVE DIRECTOR TECHNICAL SERVICES	SCALE N.T.S.
TORONTO Works and Emergency Services	COMPOSITE PAVEMENT CONSTRUCTION FOR MAJOR ROAD	DATE: JUNE, 2001 REVISED: STANDARD No. T-216.02-2

APPENDIX B

PHOTOGRAPHS OF THE LABORATORY TESTING PROGRAM

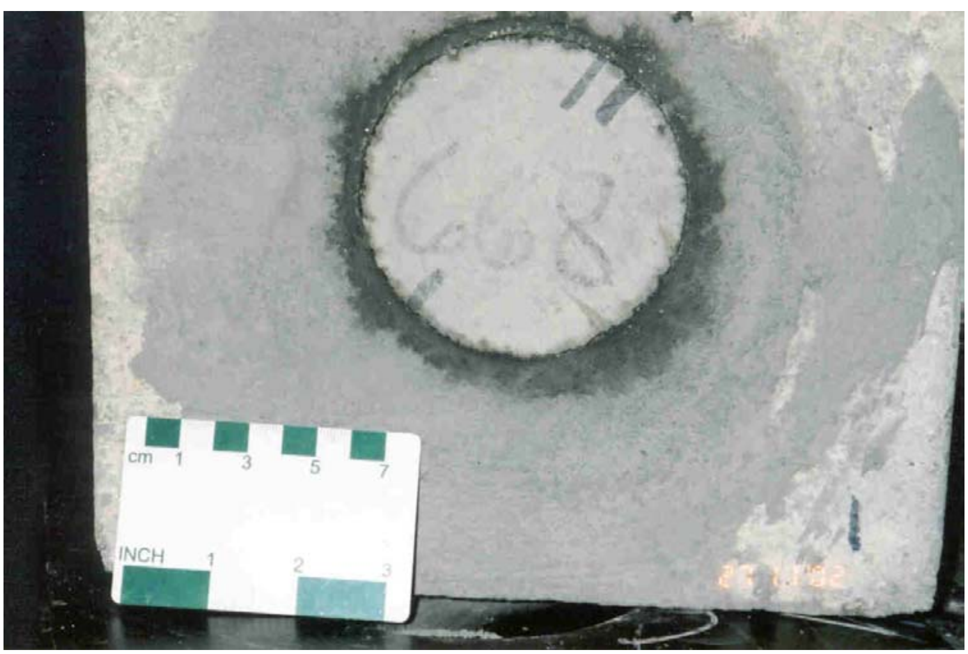
Photograph 1 – Test slabs with samples removed.

Photograph 2 – Utilibond bonding compound being prepared for testing.

Photograph 3 – Core sample being placed into test panel.

Photograph 4 – Core sample being placed into test panel.

Photograph 5 – Testing configuration in compressive strength machine.



Photograph 6 – Close up of test specimen after completion.

APPENDIX C

GOLDER ASSOCIATES LTD. 2002 FACT SHEET

Golder Associates — Fact Sheet 2002

Golder Associates

An international group of companies that provides science and engineering consulting services in support of environmental, industrial, natural resources, health and civil engineering projects.

Facts at a Glance

- Founded in Toronto in 1960
- 88 offices worldwide
- 100% employee-owned
- 2,841 employees
- More than 6,000 clients
- More than 12,000 projects yearly
- 144 countries served
- Consistently rated each year as one of the top design and engineering firms by Engineering News Record Magazine
- 2002 winner of 4 best firms to work for contests in Canada and U.S.

Market Sectors

Agriculture
Forestry
Finance, Insurance, Real Estate and Legal
Land Development
Manufacturing
Mining
Oil & Gas
Power
Transportation
Waste Management
Water Resources

Capabilities

Consulting (Planning and Design)
- Geotechnical engineering
- Mining engineering
- Hydrogeology

Hydrology
- Geosciences
- Biological sciences
- Risk and decision analysis
- Materials engineering
- Laboratory testing

Quality Assurance
- Air quality
- Cultural sciences
- Information management
- Process engineering

Technical Products (Integrated Services)
- Waste management
  - Mine waste
  - Solid waste
  - Hazardous waste
  - Nuclear waste
- Contaminated land evaluation/remediation
- Environmental impact assessment
- Environmental liability assessment
- Environmental Management Systems
- Water resources management
- Rapid transit
- Pipeline construction

Contracting/Construction Management
- Contaminated site remediation
- Mine closure
- Facility demolition
- Paste fill plants
- Treatment plants
- Water supply

Facility Operations
- Paste plants
- Landfills
- Tailings areas
- Treatment plants
- Water supply

Project Development
- Paste plants
- Treatment plants
- Water supply

Golder Associates

Golder Associates Operating Companies

Africa

Over 100 staff members in 3 offices.

Golder Associates Africa Pty Ltd.
Fred Sutherland, Managing Director

Kloof, Durban, South Africa
Halfway Gardens, Midrand, South Africa
Brooklyn, Pretoria, South Africa

Australia and Asia

More than 300 staff members in 13 offices.

Robert A. Fraser, Regional Leader for Asia Pacific, Managing Director for Australia

Golder Associates Pty. Ltd.
Adelaide, South Australia
Brisbane, Queensland
Cairns, Queensland
Maroochydore, Queensland
Melbourne, Victoria
Perth, Western Australia
Sydney, New South Wales

Golder Associates Pty Ltd Trading as BioQual
Melbourne, Victoria

Golder Associates (NZ) Limited
Christchurch, New Zealand

Golder Associates (HK) Limited
Hong Kong
Shanghai, People's Republic of China

Golder Associates PT-Indonesia
Jakarta

BTG-Golder Company Limited
Bangkok, Thailand

Golder Associates (Philippines) Inc.
Pasig City

Golder Associates Operating Companies

Canada

Over 1,200 staff members in 25 offices.

Golder Associates Ltd.
Brian H. Conlin, President

- Abbotsford, B.C.
- Calgary, Alberta
- Castlegar, B.C.
- Coquitlam, B.C.
- Don Mills, Ontario
- Edmonton, Alberta
- Fort McMurray, Alberta
- Guelph, Ontario
- Kamloops, B.C.
- Kelowna, B.C.
- London, Ontario
- Mississauga, Ontario
- Montréal, Québec
- Ottawa, Ontario
- Prince George, B.C.
- Saskatoon, Saskatchewan
- Sudbury, Ontario
- Toronto, Ontario
- Val d'Or, Québec
- Vancouver, B.C.
- Victoria, B.C.
- Whitby, Ontario
- Windsor, Ontario
- Winnipeg, Manitoba
- Yellowknife, Northwest Territories

Subsidiaries of Golder Associates Ltd.

Golder Associates Innovative Applications (GAIA) Inc.

- Calgary, Alberta
- Mississauga, Ontario
- Montréal, Quebec
- Burnaby, B.C.
- Sudbury, Ontario

Golder Paste Technology Limited

- Sudbury, Ontario

Golder Associates Ltd. Affiliate Companies

IMG~Golder

- Inuvik, Northwest Territories

Golder Associates Operating Companies

Europe

Over 300 staff members in 18 offices.

Pietro Jarre, Regional Leader GAE

Golder Associates Europe Limited
Maidenhead, England (European Information Centre)

Golder Associates AB
Gothenburg, Sweden
Stockholm, Sweden
Uppsala, Sweden

Golder Associates Oy
Helsinki, Finland
Turku, Finland

Golder Associates Geoanalysis S.R.L.
Milan, Italy
Padua, Italy
Rome, Italy
Turin, Italy

Golder Associates Global Iberica S.L.
Madrid, Spain

Golder Associates GmbH
Celle, Germany

Golder Associates (Hungary) Kft.
Budapest, Hungary

Golder Associates S.ARL
Lyon, France
Paris, France

Golder Associates (UK) Limited
Maidenhead, England
Nottingham, England
Stanton, England

Subsidiary Companies in Europe

Geometrik I Stockholm AB
Stockholm, Sweden

Golder Land Services Limited
Nottingham, England

South America

More than 130 staff members in 5 offices.

John R. Busbridge, Regional Leader

Golder Associates Brasil LTDA
Belo Horizonte, Brasil
Rio de Janeiro, Brasil
São Paulo, Brasil

Golder Associates S.A. (Chile)
Santiago, Chile

Golder Associates Peru S.A.
Lima, Peru

Golder Associates

Golder Associates — Fact Sheet 2002

Golder Associates Operating Companies

U.S.A.

Over 700 staff members in 24 offices, plus six satellite locations.

Golder Associates Inc.
Steve Thompson, President

- Anchorage, Alaska
- Atlanta, Georgia
- Boca Raton, Florida
- Buffalo, New York
- Denver, Colorado
- Gainesville, Florida
- Houston, Texas
- Irvine, California
- Jacksonville, Florida
- Lansing, Michigan
- Las Vegas, Nevada
- Manchester, New Hampshire
- Minneapolis/St. Paul, Minnesota
- Oakland, California
- Oak Ridge, Tennessee
- Philadelphia, Pennsylvania
- Portland, Oregon
- Reno, Nevada
- Richland, Washington
- Roseville, California
- Seattle, Washington
- St. Louis, Missouri
- Tampa, Florida
- Tucson, Arizona

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Golder Associates

APPENDIX D

UTILIBOND™ DATA SHEET

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Tel: 416.391.3901
Fax: 416.444.7352
www.utilicor.ca

Utilibond™

DESCRIPTION

Utilibond™ is a ready-to-use, fast setting, high strength waterproof bonding agent. It is non-metallic, non-staining, and non-toxic. ***Utilibond™*** is specially formulated to be used for permanently reinstating pavement cores. It comes in two colors: Asphalt Gray and Natural Concrete.

WHERE TO USE

Utilibond™ is specially formulated for permanently replacing excavated cores in asphalt, asphalt and concrete, and concrete road systems and sidewalks and other paved surfaces. The rapid hydration of this product allows the roadway to be reopened within 40 minutes at 70°F/21°C.

BENEFITS

- Fast setting
- High strength
- Forms waterproof bond
- Excellent freeze-thaw resistance
- Very low permeability
- High resistance to sulphate attack
- Non-toxic
- Chloride free

PROPERTIES

Compressive Strength @ 70°F (21°C)

(ASTM C109-77)
Mixture Consistency
0.53 US gal water/44 lb (2 L water/20 kg bag)

1 hour	1,640 psi (11.3 Mpa)
2 hours	2,459 psi (17.0 Mpa)
24 hours	6,344 psi (43.8 Mpa)
4 days	7,659 psi (52.8 Mpa)
7 days	8,600 psi (59.3 Mpa)
28 days	9,500 psi (65.5 Mpa)

Slant Shear Bond Strength @ 70°F (21°C)

(ASTM C882-91)
0.53 US gal water/44 lb (2 L water/20 kg bag)

30 minutes	231 psi (1.6 Mpa)
45 minutes	422 psi (2.9 Mpa)
1 hours	670 psi (4.6 Mpa)
2 hours	836 psi (5.8 Mpa)
4 hours	1182 psi (8.2 Mpa)

Punch Through Bond Strength @ 70°F/21°C

0.53 US gal water/44 lb (2 L water/20 kg bag)

30 minutes	137.0 psi (0.9 Mpa)
45 minutes	186.9 psi (1.3 Mpa)
1 hour	281.5 psi (1.9 Mpa)
2 hours	288.3 psi (2.0 Mpa)
4 hours	322.0 psi (2.2 Mpa)

Punch Through Bond Strength @ 70°F/21°C

Compared to AASHTO H-25 Highway Load
Factor of Safety 10,000 psi (69 Mpa) per tire
0.53 US gal water/44 lb (2 L water/20 kg bag)

30 minutes	4.8 Times
45 minutes	6.6 Times
1 hour	9.9 Times
2 hours	10.2 Times
4 hours	11.4 Times

Length Change (Shrinkage)

(ASTM C157-91) % Shrinkage

1 day	0.04%
3 day	0.05%
28 days	0.06%

Chloride Permeability @ 73°F (23°C)

(AASHTO T-277-831)
0.53 US gal water/44 lb (2 L water/20 kg bag)
……………………….208 Coulombs

Water Absorption

(M1-67-92) % Weight Gain
0.53 US gal water/44 lb (2 L water/20 kg bag)
………………..……………..3.67%

Salt Scaling

(MTC Method 1315-07)
50 cycles…………………. 0.467 kg/m²

The above information is representative of actual production runs. Independent test results may vary from the above by approximately ± 10 %.

Utilibond™

APPLICATION

PREPARATION
Remove all loose dirt and particulate from the cut surface. Wipe the cut surface of the core and substrate with a clean damp cloth. To achieve maximum bridging strength the core should be bedded on a 1 inch layer of clean 10mm (3/8") pea gravel.

MIXING
For optimum strength ***Utilibond™*** should be mixed with .53 US gallon (2 L) of clean water to 44 lbs (20 kg) bag. Open the ***Utilibond™*** pail. Remove the bag of ***Utilibond™*** from the pail. Add 0.53 US gallon (2 L) of clean water to the pail. Add the Utilibond mixture to the water in the pail while mixing. Mix for 3 minutes until you have a smooth consistent mixture with no lumps. (For best results use a universal power mixer).

CURING
Utilibond™ will begin to cure in less than 15 minutes @ 70°F/21°C. Be sure all surface areas are properly prepared before mixing.

LIMITATIONS
- Not recommended for use on substrates below 32°F (0°C) (see cold weather procedures).
- Not recommended for structural bonding applications.
- Not suitable for acid exposure.
- Maximum service temperature 350°F (176°C).
- Minimum kerf thickness 3/8" 9.5mm.

COVERAGE
Up to an 18" diameter by 22" deep core replacement per 44lb (20 kg) bag.

STANDARDS
Approved for use in reinstatement of pavement cores.

PACKAGING
Utilibond™ is packaged in 44lb (20 kg) multi- wall bags in a 5 US gallon (18.9 L) sealed polyethylene pail.

CLEAN UP
Clean all mixers and tools with water before product hardens.

STORAGE
May be stored short term anywhere as long as the product is kept dry. Dry, heated warehouse storage is recommended for extended storage.

SHELF LIFE
Two year shelf life when stored in dry, heated warehouse in original packaging. Protect from moisture.

SAFETY PRECAUTIONS
Consult Material Safety Data Sheet (M.S.D.S.) for specific instructions. MSDS # 216.

WARRANTY
The recommendations made and the information herein are based on our own laboratory and field experience, and are believed to be accurate under controlled conditions. However, no warranty or guarantee of accuracy is made because we cannot cover, nor anticipate, every variation encountered in weather and job-conditions, methods used and types of substrates to which the product is applied. The users should make their own tests to determine the suitability of this product for their purposes *Utilicor™* makes no other warranty, express or implied, and hereby expressly disclaims a warranty of merchantability or fitness for a particular purpose.

The liability of *Utilicor™* shall be limited in all events to supplying sufficient product to re-treat and/or repair the specific reinstatement for which *Utilibond™* product has been used. *Utilicor™* reserves the right to have the true cause of any difficulty or failure determined by accepted test methods. *Utilicor™* shall have no other liability, including liability for incidental, consequential or resultant damages, however caused, whether due to breach of warranty, negligence, or strict liability.

THIS WARRANTY MAY NOT BE MODIFIED OR EXTENDED BY REPRESENTATIVES OF *Utilicor™*, ITS DISTRIBUTORS OR DEALERS.

Utilibond™

INSTRUCTION FOR USE

1. Prior to coring, the surface of the core and the adjacent road surface should be scored or marked with a registration line to allow for accurate positioning and realignment of the core in the reinstatement process.

2. Before reinsertion of the core, remove all loose dirt and particulate from the cut surfaces and wipe the cut surface of the core and substrate with a clean damp cloth to remove all coring residue.

3. Ensure that backfilled material is compacted in accordance with relevant municipal and state compaction standards. To achieve maximum bridging strength Utilicor recommends the addition of approximately 1" of pea gravel or approved alternate base material to the top of the compacted backfill before adding the ***Utilibond***™.

4. Using the core puller dry fit the core inside the hole, align the core with the registration lines and check for level with the original road level. Adjust the level of base material as required to obtain the proper level. Repeat the dry fit procedure as often as required.

5. Using the core puller, remove the core from the hole.

6. Open the ***Utilibond***™ pail. Remove the bag of Utilibond from the pail. Add 0.53 US gallon (2 L) of clean water to the pail. Gradually add the Utilibond to the water in the pail while mixing until you have a smooth, consistent mixture with no lumps. (For best results use a universal power mixer).

7. Pour the entire ***Utilibond***™ mixture into the hole.

8. Place the core into the hole on top of the ***Utilibond***™ mixture.

9. Gently rock the core from side to side to ensure that the ***Utilibond***™ uniformly fills the entire kerf around the perimeter of the core, and the excess oozes to the surface expelling all air pockets.

10. Tamp the core in place until it is slightly above the level of the road surface.

11. Remove the core puller from the pilot hole and allow the ***Utilibond***™ to flow to the surface through the pilot hole.

12. Tamp the core to ensure that it is solidly bedded, and level with the road surface.

13. Remove the excess ***Utilibond***™ from the surface of the road with a flat shovel. Smooth the surface with a trowel or shovel to ensure that the reinstated core and ***Utilibond***™ are even with the road surface.

14. Allow the ***Utilibond***™ to begin setting up before finishing the surface. (Approximately 10 minutes @ 70ºF).

15. Clean up tools with water.

16. Allow the ***Utilibond***™ to completely set at the surface before washing and sweeping the road surface. (Approximately 40 minutes @ 70ºF).

17. Properly dispose of all excess Utilibond mixture and recycle or reuse ***Utilibond***™ pail.