HIR Discoveries 2021

Variable Temperature Forced Convection Heating System VTFCHS

Road Surface Recycling

100% Hot-In-Place Recycled Asphalt Paving

Progress Ave Scarborough, ON
HIR paved 2002
Photo (right) taken in 2020
Still, Out-Performing

Discoveries…

Since our inception over 36 years ago, we have learned valuable lessons:

- By innovation and adapting to the ever-changing demands of the industry, RSR proudly produces the longest lasting 100% Finished Surface HIR roads in the World.

Discoveries, with Years of Extensive Investigation

When heating an existing asphalt surface:

1. Temperature control is paramount to all facets of a successful HIR project.

2. Asphalt mixes are petroleum-based products and have a volatile flash point.

The Research

- Virgin liquid asphalt cement (AC) has a flash point of approximately 316°C (600°F)
- New plant mix asphalt surfaces and freshly exposed asphalt surfaces, similarly, have the same flash point of approximately 316°C (600°F).
- The top 3mm (1/8”) of hardened, aged, oxidized and weathered asphalt surfaces, have a higher flash point temperature, approximately 540°C (1000°F).
- This existing asphalt surface can tolerate higher temperatures for a limited amount of time, allowing for heat energy to be absorbed.

Research & Discoveries

- The maximum heating temperature an aged asphalt surface can be subjected to, without charring or an increase in its oxidization, is approximately 540°C (1,000°F).

- Exposure at this temperature can only be maintained until the aged asphalt surface reaches approximately 343°C (650°F), at which time the surface will ignite and burn to the detriment of the existing asphalt cement.

- Therefore, it is important that the temperature of the heat applied is monitored; ensuring the flash point of the asphalt surface material is never reached.

Effectively heating aged road surfaces is not premised on exposing it to damaging high temperatures, rather a function of the length of time one can expose the asphalt surface to a moderate temperature that will not promote burning of the petroleum content within the asphalt mix.

Kenora By-pass 2003 before RSR HIR

- Since our last successful HIR project with the MTO in 2003, we have taken an active roll producing a Variable Temperature Forced Convection Heating System (VTFCHS) to address this concern.
- This system forces temperature controlled heated and regulated air to the existing aged asphalt surface
- Allowing the surface to “soak” the heat energy to the depth required without damaging the existing AC.

Longevity Review of the Kenora By-pass Project

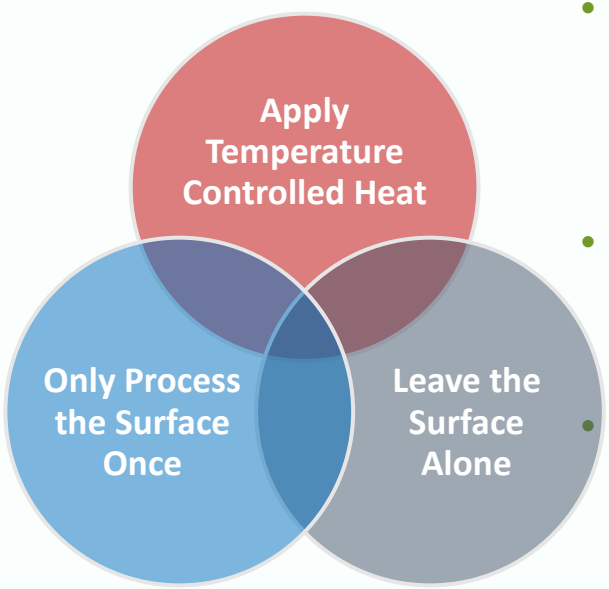
Kenora By-pass 2003
before RSR HIR

Kenora By-pass 2013
After RSR HIR – 10 years

Kenora By-pass 2015
After RSR HIR – 12 years

Not all Heat is Created or Applied Equally

How and when to heat asphalt without damaging the HIR Materials



- **Apply Temperature Controlled Heat** - Minimizes damaging the AC in the existing Asphalt material, maintaining and applying temperatures below all flash points in the spectrum.
- **Leave the Surface Alone -** Disturbing/removing it, exposes preserved asphalt cement to damaging high temperatures, charring and burning the asphalt mix prior to processing.
- **Only Process the Surface Once –** Milling the surface one time after all heating is complete, minimizes concerns of charring/burning the underlying asphalt layer and produces a homogenous uniformed temperature recycled asphalt mix.

Studies & Data

- Florida Department of Transportation (FDOT), in conjunction with the State Materials Office (SMO) Test track in Gainesville, December 2010 had undertaken a study.
- Researched and documented by Hesham Ali, Ph.D., P.E., Sustainable Road Engineering Inc. and Khaled Sobhan, Ph.D FAU. Titled, “On The Road to Sustainability: Properties of Hot in-place Recycled Superpave Mix, July 22, 2011”
- Samples were cut out of the test track area and tested to determine the existing Penetration value before RSR applied heat to the asphalt surface mix.
- Insitu samples proved to have an average penetration value of 27 dmm.

Studies & Data

- After heating the asphalt with our Variable Temperature Forced Convection Heating System (VTFCHS) and processing it, without applying a rejuvenation agent, found the results demonstrated and confirmed our preheaters had no deleterious effects on the existing recovered penetration value.
- As reported, after processing the AC, maintained an average penetration value of 28 dmm. (depicting no change, therefore no damage of the AC)
- Further testing proved by adding our rejuvenator @7.5% per AC weight, resulted in an increased average penetration value of 72 dmm.
- Data and research have always played an integral role in our development and more importantly in producing higher stability, longer lasting and performing roads.
- A vast number of RSR Hot In-place Recycled roads stand today as a testament to the success of our heating system and our ability to correctly process the existing asphalt surface, meeting all manner of End Result Specifications; AC content, recovered penetration, PG AC requirements, air void content & mix stability criteria.

Properties of Hot in-place Recycled Superpave Mix
July 22, 2011

SP-12.5 Mix Recycled by RSR at Florida Gainsville SMO on December 21, 2010

Material	Existing Material Cut (Slab)				Hot Milled No Rejuvenation				Hot Milled 7.5% Rejuvenator				Hot Milled 4.5% Rejuvenator			
	Sample 1	Sample 2	Sample 3	Average	Sample 1	Sample 2	Sample 3	Average	Sample 1	Sample 2	Sample 3	Average	Sample 1	Sample 2	Sample 3	Average
3/4"	100.00	100.00	100.00		100.00	100.00	100.00		100.00	100.00	100.00		100.00	100.00	100.00	
1/2"	97.58	98.09	99.00		98.14	98.65	98.77		98.42	99.47	99.05		99.79	99.47	99.59	
3/8"	91.22	91.29	93.43		90.07	88.23	92.02		92.20	91.18	93.34		93.28	94.24	94.40	
#4	68.84	65.56	69.50		59.76	59.84	63.75		67.17	67.42	68.84		70.62	69.48	70.56	
#8	46.48	45.36	46.94		40.22	39.56	42.26		46.17	46.41	47.37		49.05	47.97	48.18	
#16	32.85	32.06	32.76		29.37	28.84	30.34		33.33	33.33	34.19		35.43	34.93	34.48	
#30	24.98	24.34	24.81		23.14	22.79	23.81		25.72	25.71	26.41		27.30	27.03	26.45	
#50	14.34	14.03	14.27		13.82	13.66	14.37		15.27	15.28	15.74		16.67	16.63	16.10	
#100	5.89	5.89	5.92		5.85	5.80	6.30		6.74	6.80	7.02		8.03	8.14	7.69	
#200	3.33	3.33	3.39		3.32	3.27	3.58		3.98	3.99	4.17		4.87	4.98	4.64	
%AC	5.72	5.70	5.85		5.43	5.53	5.43		5.90	5.81	5.93		5.93	5.81	5.74	
Gmm	2.47	2.46	2.47		2.51	2.52	2.50		2.46	2.46	2.46		2.46	2.46	2.46	
Gmb	2.38	2.38	2.38		**2.37**	2.38	2.37		2.41	2.41	2.41		2.43	2.42	2.43	
% AIR	3.65	3.33	3.53		5.65	5.75	5.32		1.91	1.95	2.19		1.34	1.54	1.50	
Penetration	26	27	27		30	26	29		72	72	71		56	56	61	

Samples taken from the Slab with Backhoe

Samples were taken after heating and milling
No rejuvenator added.
Penetration values did not change after heating
Gradation remained constant no change

Rejuvenator added

Positive results, NO damage to AC after heating & milling.

https://cfpub.epa.gov/ncer_abstracts/index.cfm/fuseaction/display.abstractDetail/abstract/9497

Success of RSR HIR

- The MTO Hwy 17A By-pass completed in 2003 by RSR, surpassed all expectations and longevity, as it performed for approximately 17 years.

- It was an honour being the subject of an MTO paper “Performance of Hot In-place Recycling the Kenora By-Pass” by: Susanne Chan, M.A.. Sc., P.Eng, Heather Bell, P. Eng., Pamela Marks, P.Eng. Stephen Lee, P.Eng., MTO. Where in they had provided the appropriate data confirming the overall longevity and performance attained.

- Based on this past performance it has further led to the reintroduction of HIR projects within Ontario.

- As witnessed by the seminar presentation provided to the AARA 2018 Semi Annual Meeting, Norfolk, VA. “Reintroducing Hot In-Place Recycling in Ontario,” Presenter & Author, Becca Lane P.Eng. Manager MERO MTO. Which was well received by all in attendance.

MISATTRIBUTED OBSERVATIONS OF THE MTO PAPER

In review it had come to our attention, various photos unfortunately, had misattributed observations noted.

Let's clear up any mis-information in the Industry.

This particular picture depicted the asphalt surface being somewhat charred. Unfortunately, the charring of the surface was mistakenly attributed to our heating system.

We know this photo displays a portion of the back end of the *high temperature (1204°C-2200°F) radiant heater system (left side of picture*) that did the charring. The Radiant heater system exiting the picture frame preceded the recycling machine entering the picture frame.

Our equipment had not yet applied heat to this surface. Our system did/does not char the surface/s. However, it had unfortunately been deemed the cause. At that time, we obtained these radiant heaters to supplement the in-place heating of the Hwy 17A Kenora Bypass project.

Misattributed Observations of the MTO Paper (con't)

We noted, while considered efficient, radiant heaters produce an enormous amount of incredibly high temperatures. Without the benefit of a temperature control, they will inherently char and burn the asphalt surface/s as depicted in this picture. If radiant heaters burn and char the existing oxidized surface; what damage is being done to the now exposed good surface material to high temperature radiant heat, multiple times?

Our heater systems have long laid to rest the fire breathing dragon myth once used anecdotally and in folklore.

We have researched, modified and advanced our systems to produce one of the most effective and efficient methods of heating asphalt.

The introduction and use of VTFCHS ensures only temperature controlled heated air greets the asphalt surface, not an unwarranted direct open flame.

We are continually striving to advance and improve our heater systems and our recycling units.

Note: We are currently adapting and incorporating a new heat transference barrier to our heating systems. This allows for temperature controlled radiant heat to be incorporated, to effectively promote efficient heat distribution, further ensuring the surface will not be charred or damaged.

We are dedicated to achieving and maintaining the highest level of our road infrastructure system in a natural, safe and GREEN environment...100% Recycling

We look forward to working with all Ontario Regions in order to share the inherent benefits of HIR and again to produce unparalleled hot in-place 100% recycled roads in Ontario. By working in unison, we can better serve taxpayers, motorists and further build on sustainable infrastructures for the future.