USE OF INFRARED HEATERS IN ASPHALT PAVEMENT CONSTRUCTION & REPAIR

2013 SWIFT CONFERENCE
OTTAWA, CANADA
SEPT 10, 2013

Bob Kieswetter P. Eng

HEAT DESIGN EQUIPMENT INC.
The Infrared People

USE OF INFRARED HEATERS IN AIRPORT PAVEMENTS

Jean Lesage International Airport, Quebec City, in 1995

1995 to 2013

Fort Drum Air Base, NY, in 2013

Mini Recycler at Vancouver YVR

INFRARED PAVEMENT HEATER MANUFACTURERS

- K·M INTERNATIONAL
- StreetPrint® Genuine Stamped Asphalt
- Ray-Tech Infrared Corp.
- KASI INFRARED
- HEAT DESIGN EQUIPMENT INC. The Infrared People
- ARS ASPHALT REHEAT SYSTEMS Est. 1996 Infrared Repairs · Stamped Asphalt Design · Seamless Patches · Thermoplastic Installation
- S®

AGENDA TODAY

Demonstrate how Infrared can help you on your pavements!

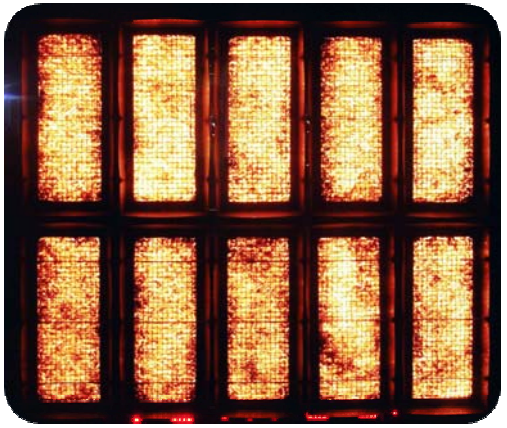
OUTLINE:

1.Description of Infrared heating
2.Infrared Longitudinal Joint heating
3.Hot in Place Patch Repair
4.Hot in Place Crack Repair
5.Unique Infrared Applications :White House
: Kuujjuak Airport
:Redensification
:Cold weather paving
7.Thermoplastic Application
8 Hot in Place Asphalt Recycling in BC

WHAT IS INFRARED ?

Infrared heating :the transfer of radiant energy from a hot surface through the air to cooler surfaces, without the use of an air mover.

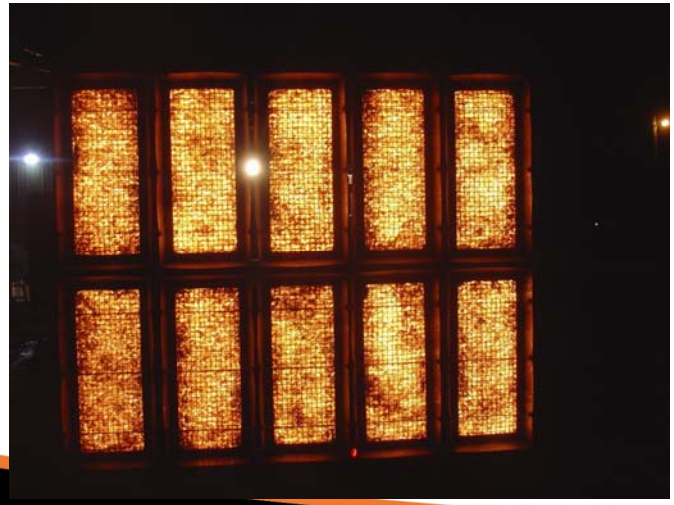
No energy loss until the infrared rays hit the asphalt then energy is transformed to penetrating heat.

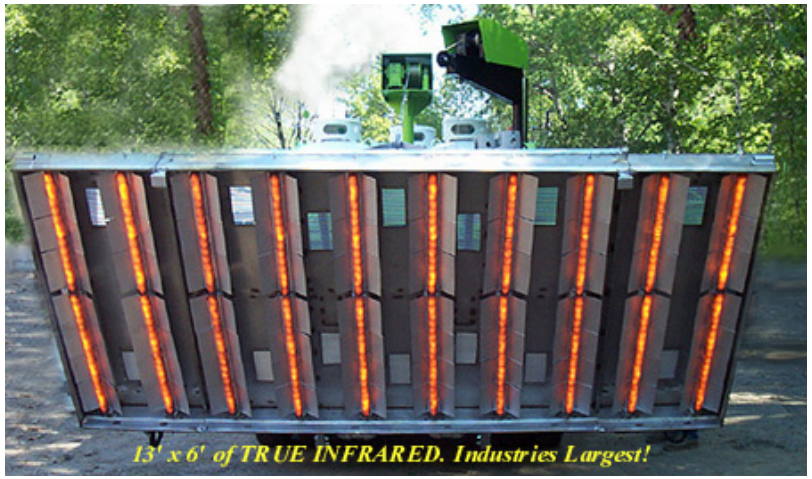


1500 F surface

INFRARED PAVEMENT HEATERS

- Ignition of propane occurs behind emitting surface.. … no direct flame
- The 1400 to 1500 F infrared surface emits high intensity infrared rays
- The radiation is absorbed by asphalt, quickly penetrates and turns to heat
- No deterioration of asphalt …… same as re-heating up a lab sample
- No open flame that will burn surface before heat penetration
- On the left below is a ceramic mat, on the right a tube heater

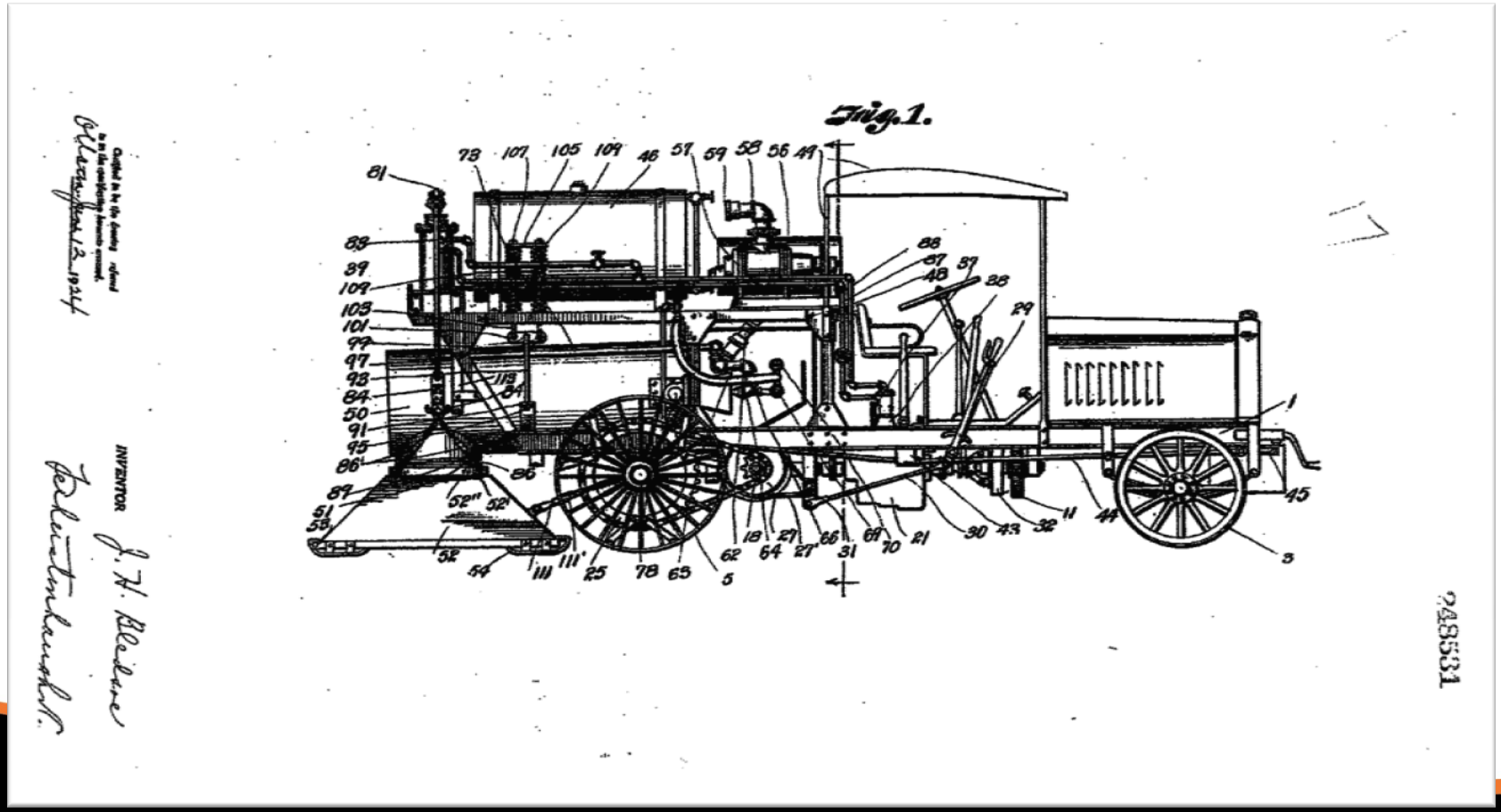




ASPHALT *REPAIR*

In Place asphalt Repair using heat is not new.

Below is a picture of a plate heater from 1928 built In Kansas City nearly a 100 years ago. Since then, the task has been heating asphalt without burning asphalt using various forms of flame



INFRARED REPAIR

Infrared has been used for the last 20-30 years in hot-in-place recycling
It has not been widely accepted due to lack of control and burning of the asphalt, but technology has improved and it is well used in areas like BC.

Infrared patching has been accepted in isolated pockets in commercial use, and some cities and states.
Only in the last half dozen years have we seen an accelerated interest in infrared patch repair, because of the rising price of bitumen, and of late, the recession

INFRARED HEATERS

One problem of acceptance :

Not much intensive research and verification of the infrared patch process.

BUT, In the last 4-5 years there were two research studies on longitudinal joint heating by the Universities of Tennessee and Arkansas for their DOT's. These proved that the heater resulted in *improving the density* and the water *impermeability* of the pavement after infrared heat and re-compaction.

Dr Baoshan Huang, Associate Professor, University of Tennessee, Knoxville, TN, USA

"The infrared heater exhibited the best effectiveness in improving joint quality among all the joint construction techniques used in this study."

IN THESE STUDIES DENSITY AND WATER IMPERMEABILITY ARE CRITICAL

Compaction for Density is Important

To get density use the right compactor size

and number of passes for the job with the right asphalt temperature

OPTIMUM COMPACTION TEMPERATURE
230-250F (110-120C)

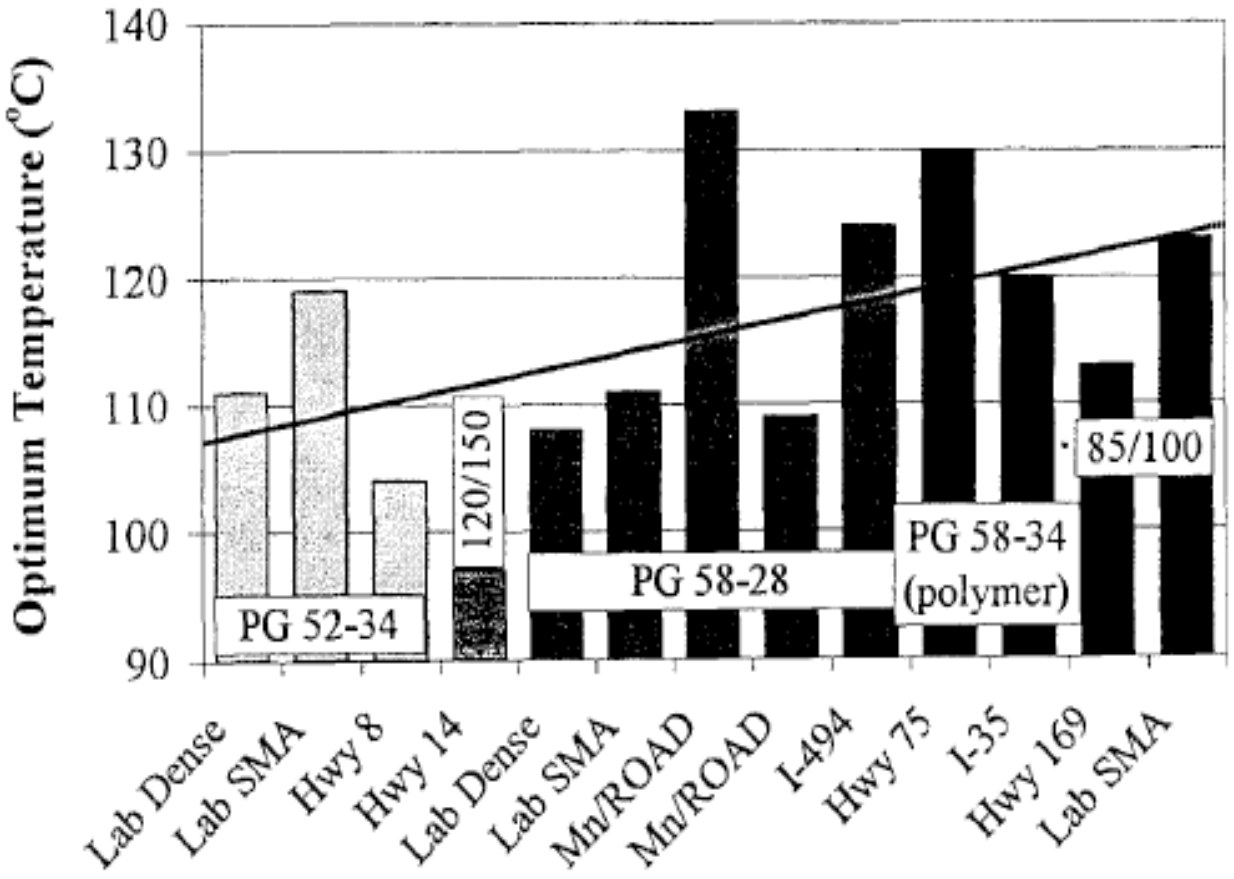
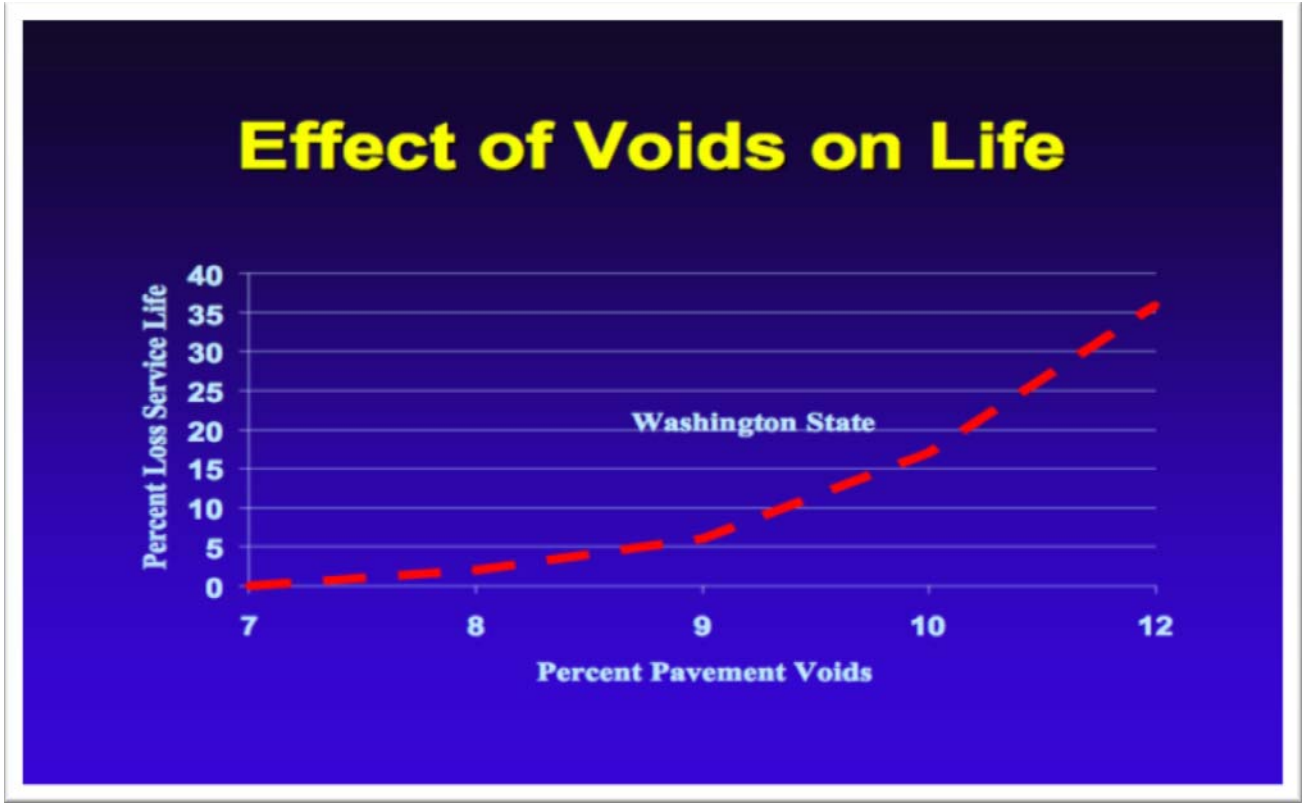


Figure 5.18 Optimum Compaction Temperatures Based on Shear Stress Curves

Compaction is Important

Poor Compaction means high voids
Higher voids means shorter service lift
Typical voids at a joint +12% equates to -35% service life



* slide from Vince Aurillio , Asphalt Institute presentation to Swift Conference 2005

Compaction is Important : Especially on Runway Pavements!

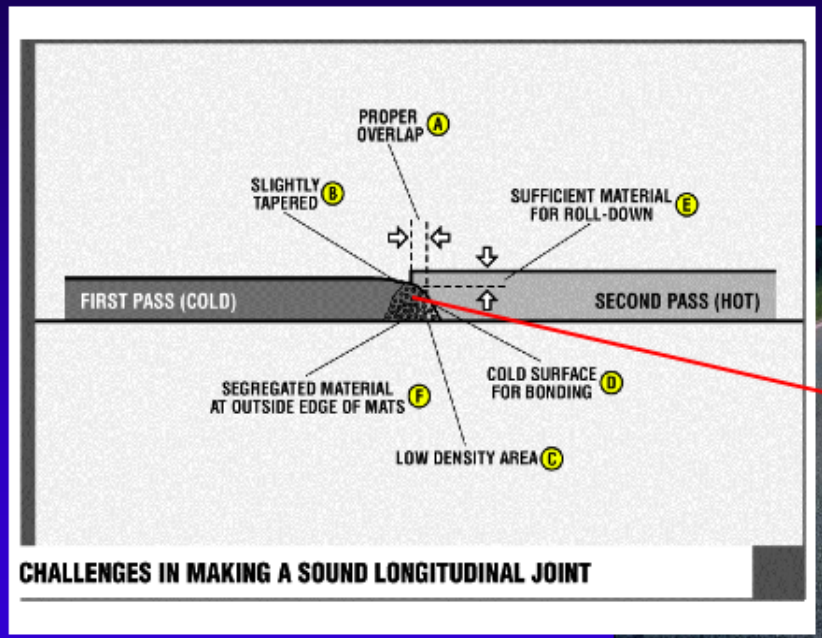
- First we will talk about density on the longitudinal joint

- Here we show Longitudinal Joint Failure as a result of poor compaction

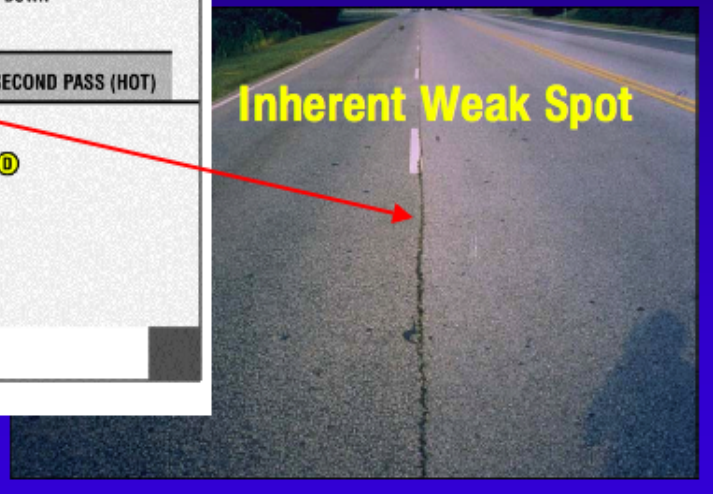
Compaction is Important : Especially on Runway Pavements!

What is the Problem?

The first pull of the paver generally leaves an area of low density along the unconfined longitudinal edges of the mat.

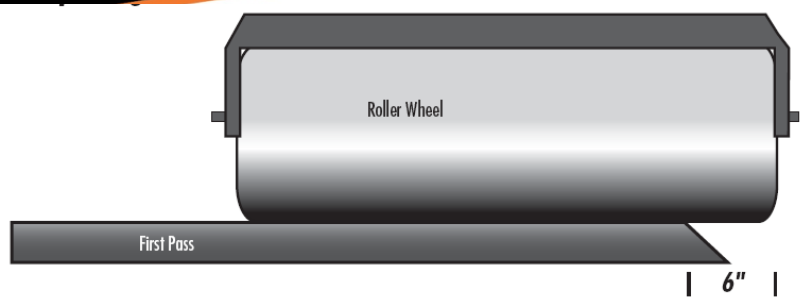


CHALLENGES IN MAKING A SOUND LONGITUDINAL JOINT



ASTEC TECHNICAL BULLENTIN 130

Compaction is Important : Especially on Runway Pavements!

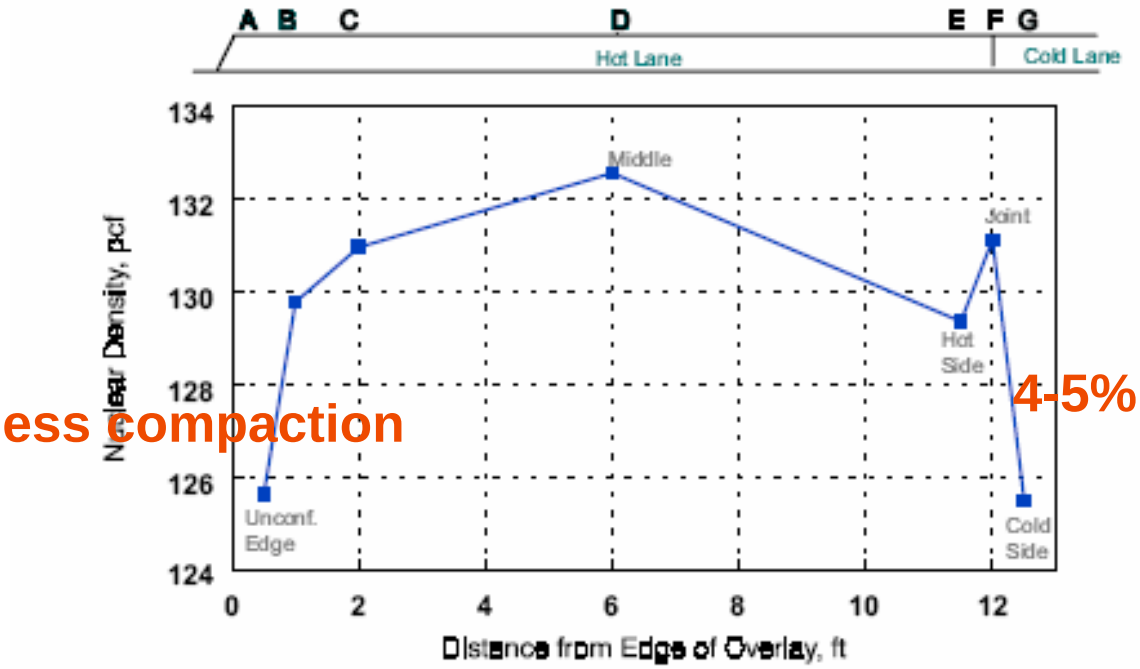


- Lack of edge support means lack of density

- Extreme example of poor edge
- FAA recommends cutting of the un-compacted edge, not always done

LOW DENSITY AT UNCONFINED EDGE

- **Density at Unconfined Edge: Typical Mat Density**



4-5% less compaction

4-5% less compactio

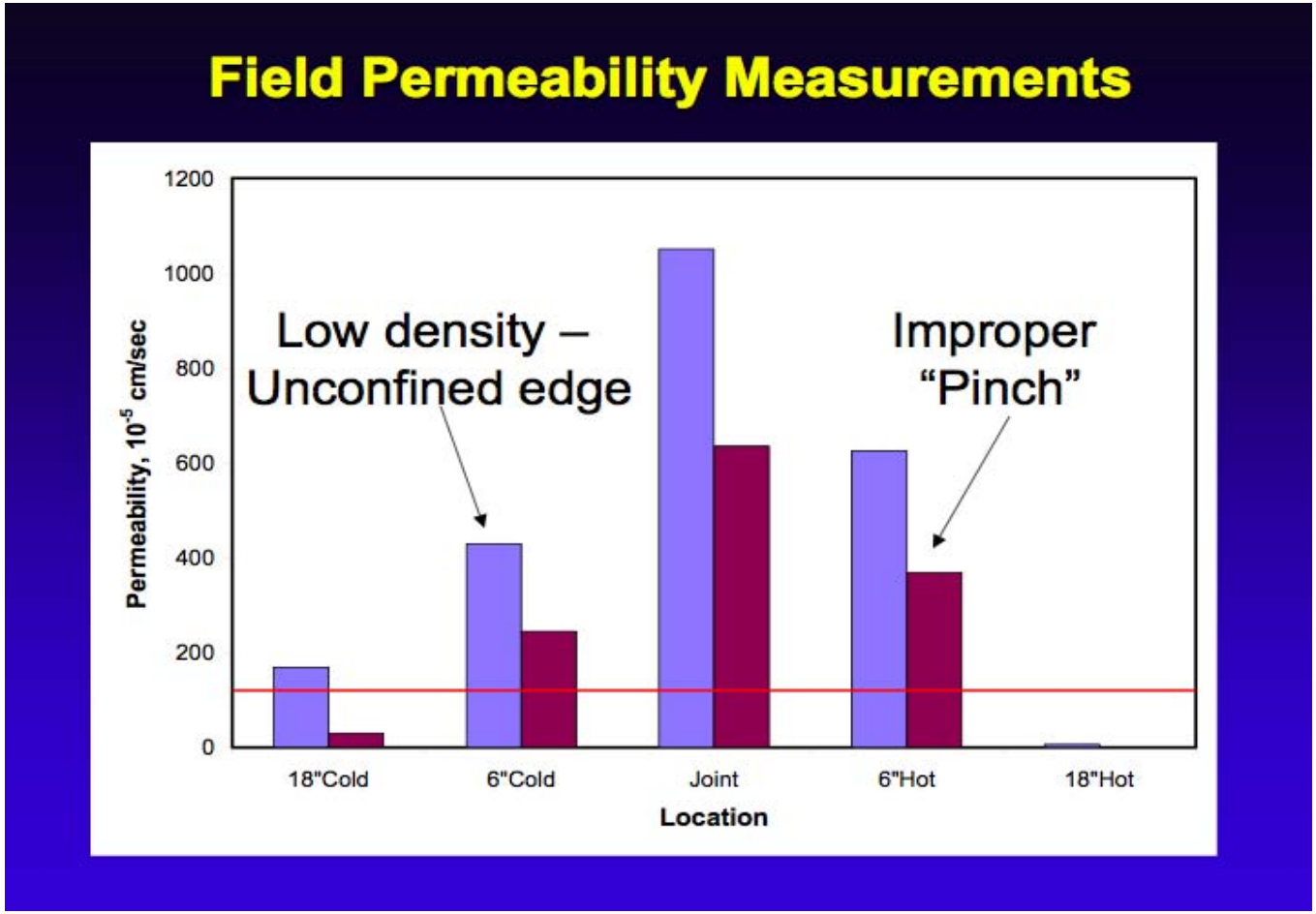
Ref: Texas Transportation Institute

A lot of time density at the joint is not even checked on highways.

Is it checked at airports?

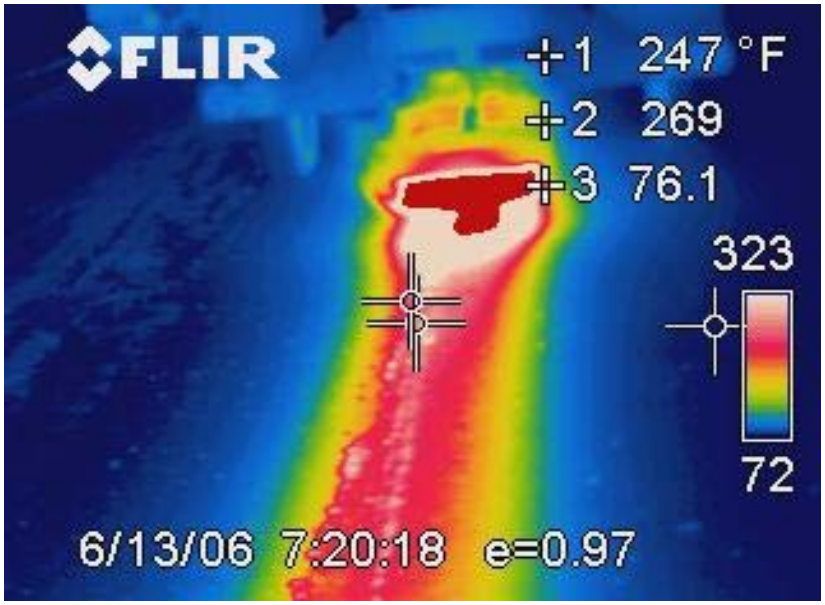
LOW DENSITY / HIGH PERMEABILTY

- High permeability at a typical joint



A SOLUTION

- Heat the JOINT to 200 to 250F (95 to 120C)
- Recompact with the New Hot Lane



UT - RESULTS ON 2008 STUDY

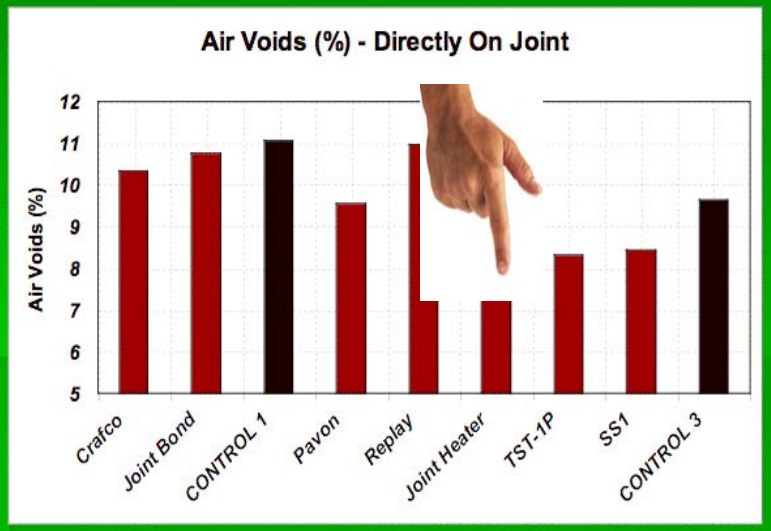
TDOT LONGITUDINAL JOINT RESEARCH UPDATE

MISSISSIPPI QUALITY ASPHALT CONFERENCE (QAC) – February 2010

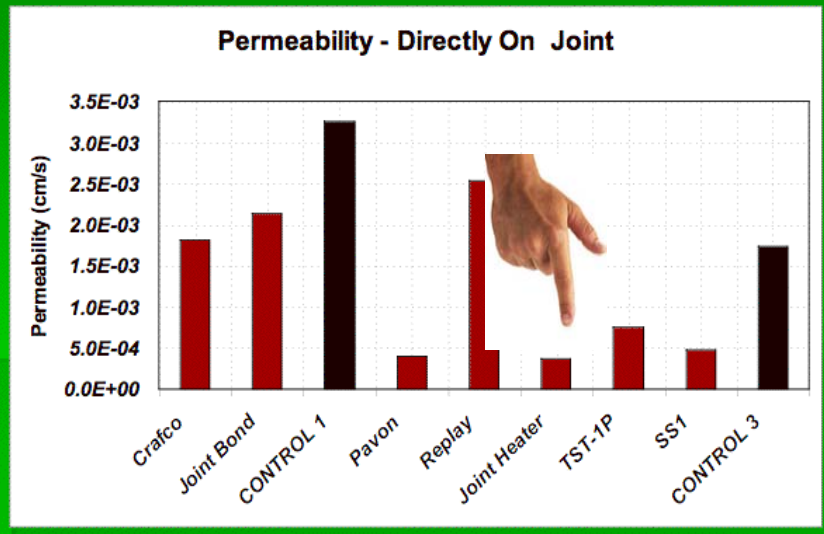
Mark Woods, P.E. –
TDOT Materials & Tests

UT - RESULTS ON 2008 STUDY

Air Void Results

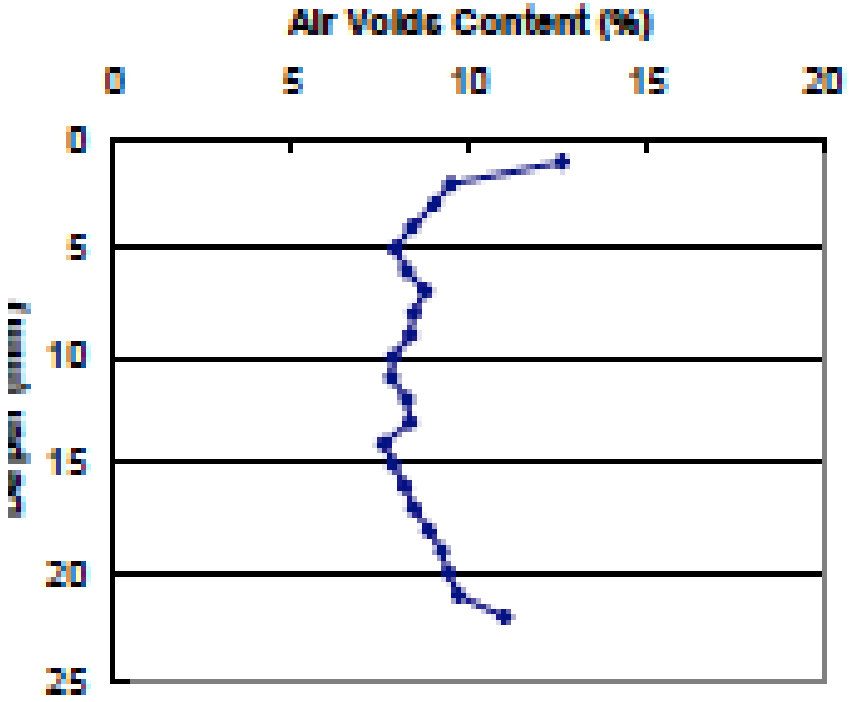


Permeability Testing

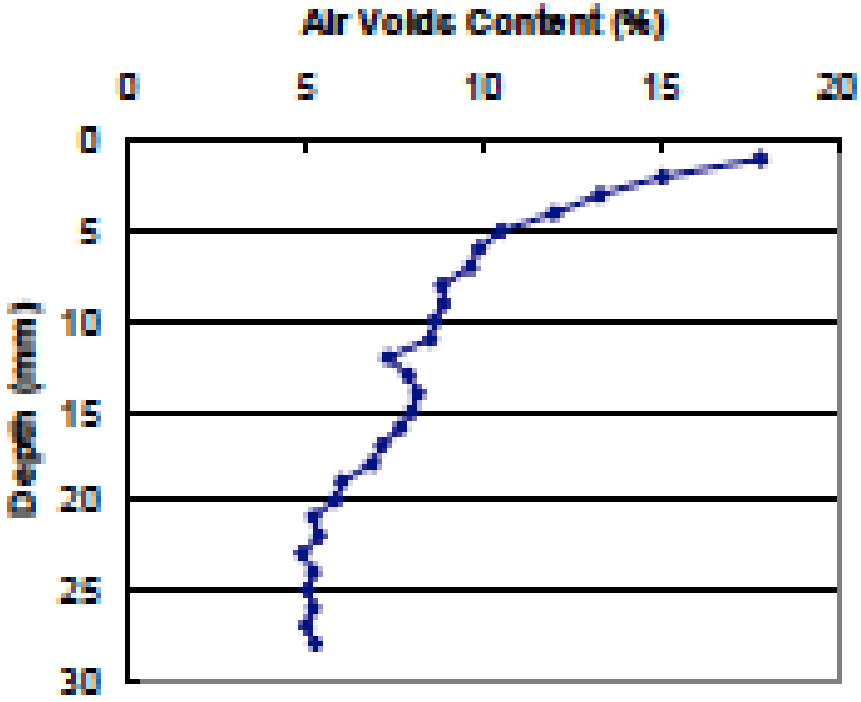


Test Results: Joint heater had lowest air voids(highest density) & lowest permeability

X-Ray for density in core top to bottom



(c) Control, joint



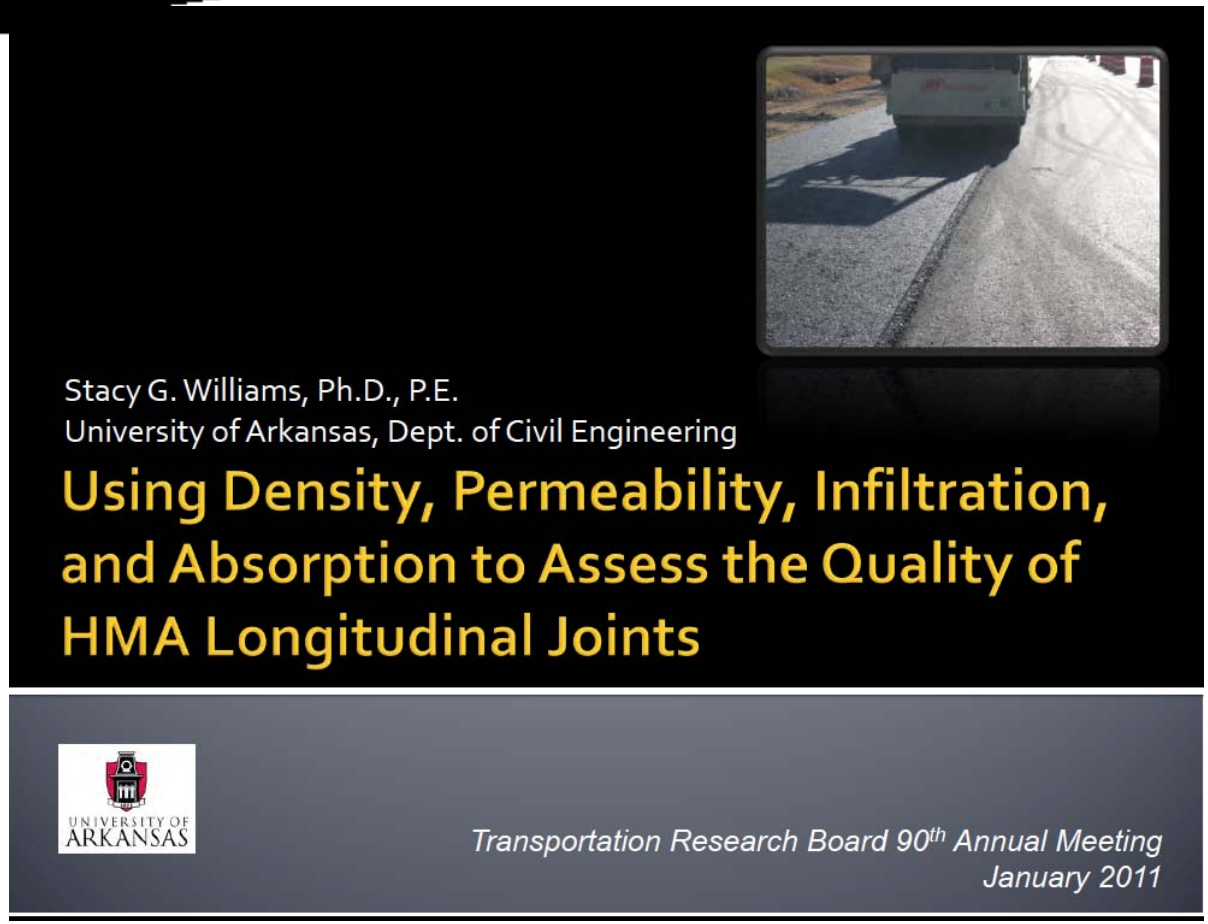
(d) Infrared heater, joint

“ The infrared heater exhibited the best performance among all the joint construction
techniques used in the study. The infrared heater was effective in reducing air void content
and water permeability, and increasing IDT strength.

l The air voids distribution obtained from the X-ray CT images shows that the effectiveness of
infrared heater in improving joint quality was through increasing the compaction degree of
longitudinal joint deep to the overlay bottom and thus making the joint denser.
Journal of Materials in Civil Engineering. Submitted November 23, 2009; accepted April 16, 2010;

- Dr Baoshan Huang

U Arkansas - RESULTS ON 2009 STUDY



Joint heater came out on the top of the list for performance

Shearwater Heliport: McClure on Joints

Shearwater Heliport: Summary

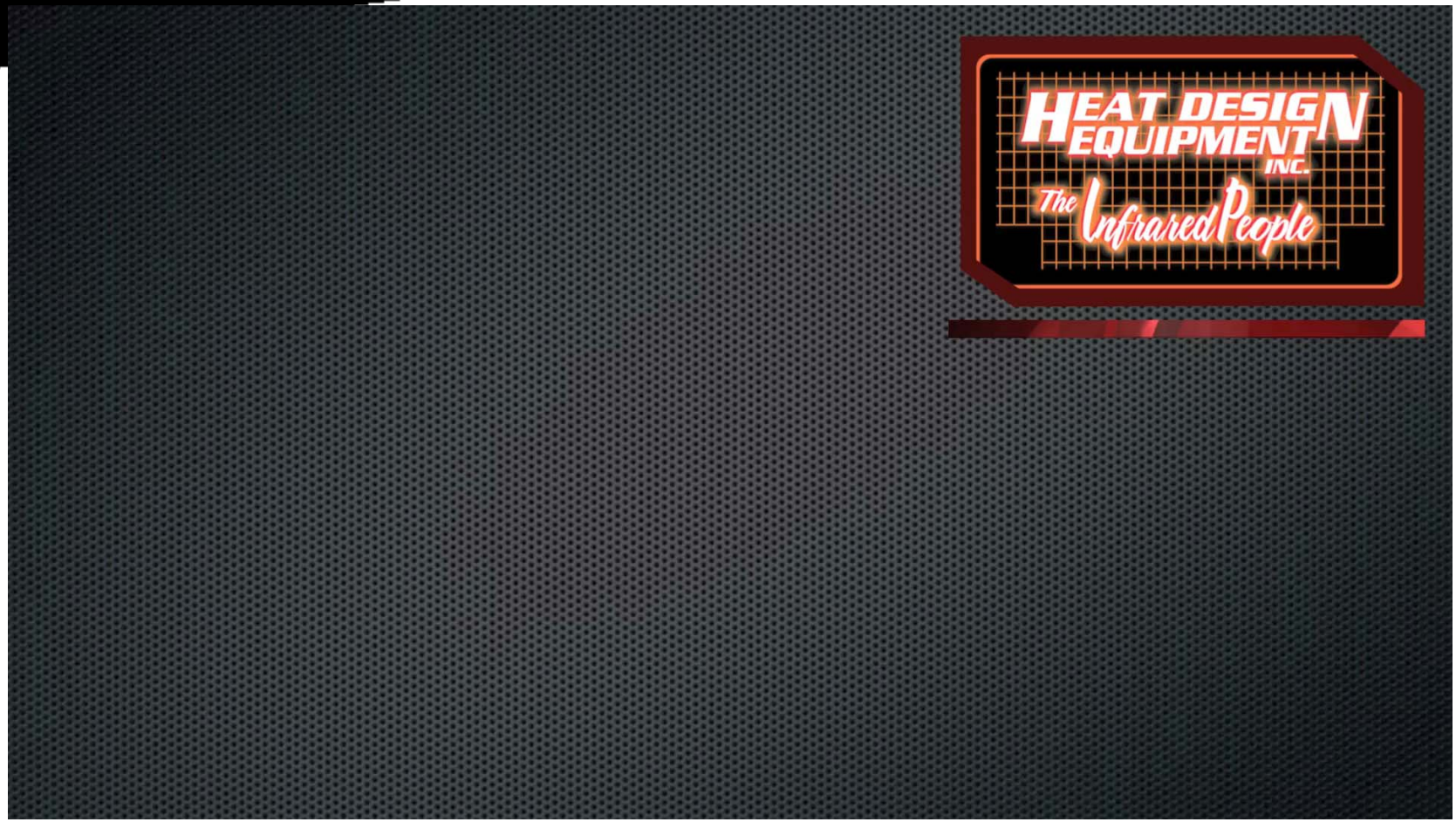
Achieved a Mat Density Base HMA -94.4 Surface 95.1

- Heated Joints -94.1 no failures
- Where only Cut joints used 92.6 and several failures, these were fixed
- Minimal non-conformances were experienced
- The quality of the placed HMAC on this project was considered to be very good, especially considering that paving was done in late October and November.
- The longitudinal joints are all well bonded and tight and the surface tolerances were all within the specified parameters

BY: Hatch Mott MacDonald,
2008 Swift Airport Conference, Calgary AB

JOINT HEATING : Various equipment suppliers, same goal

JOINT HEATING



2013 Runway Reconstruction : Fort Drum, NY: No density Failures

Contractors Perspective is Important

Billy Chandler of Summers Taylor Construction TN
Email to Gary Head of TDOT, May 4, 2010

"the joint heater has worked great has not slowed our production any at all. I think you guys have picked the correct fix for joint problems this will pay big dividends in years to come for your pavement life cycle. THANKS!!! BC"

HOT-IN-PLACE
INFRARED PATCHING

1. **No real research studies like joint heating**

2. **It is a top course, wear surface patch, much like mill and fill where you can expect reflection cracks**

3. **Advantages include cost, speed, less equipment, 100% recycling, and leaves a seamless watertight edge.**

Pavement Restorations Inc. Milan TN

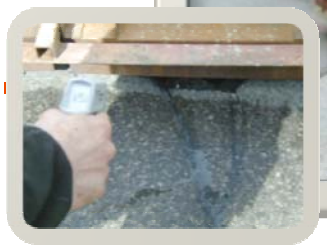
HOT-IN-PLACE *INFRARED PATCHING*

The Process

1. **Identify repair area**

2. **Heating deck is lit and positioned overtop of damaged area.**

3. **Allow heat to penetrate for *5-10 minutes*. Check temperature of surface. Range *220-275 F.***



INFRARED PATCHING

4. Define edges of repair area, keeping it square. Leave 2” (50mm) hot border at edge.

5. Cracks and imperfections are raked out.

INFRARED PATCHING

6. Spray heated area with rejuvenating agent.

7. Fresh asphalt is then added and luted to the correct grade. *Use finer mix than original.*

INFRARED PATCHING

8. Edges of repair area are compacted.

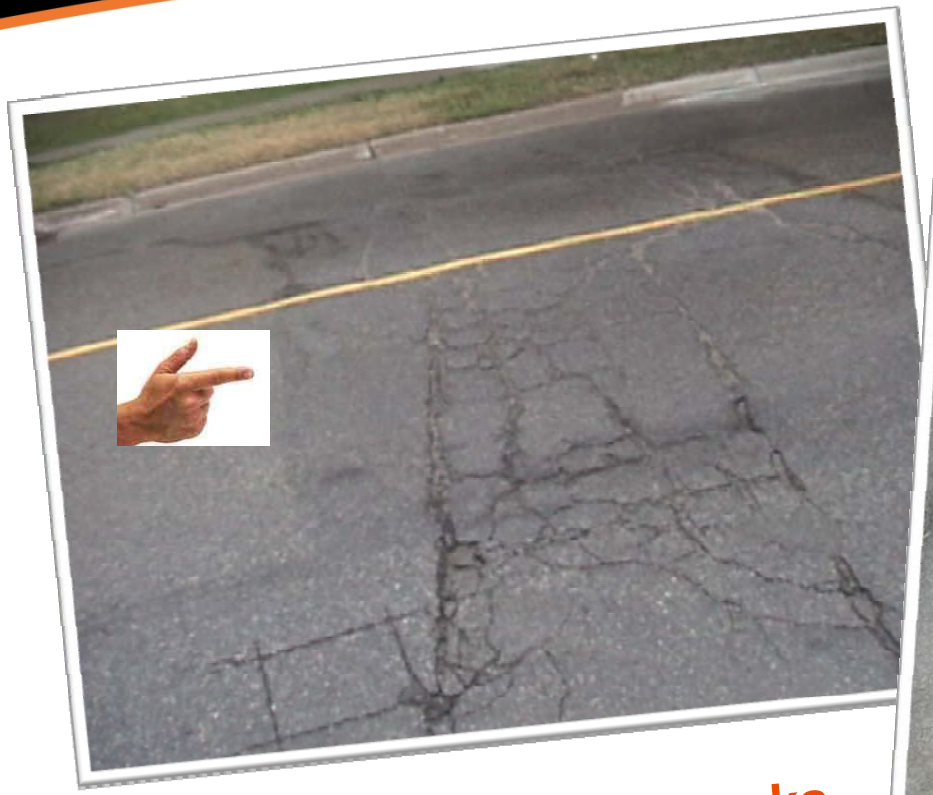
9. Patch is integral part of existing pavement.
Good load transfer, no water penetration

INFRARED PATCHING

How Long can an Infrared Patch Last?
Goal is to extend life to match the adjacent pavement

1997 **- Water St. New Hamburg Ontario, Canada Settlement in trench caused severe bump so was fixed with infrared patch**

INFRARED PATCHING



2005 Heavy reflection cracks from old trench, hot seam still intact, No severe bump

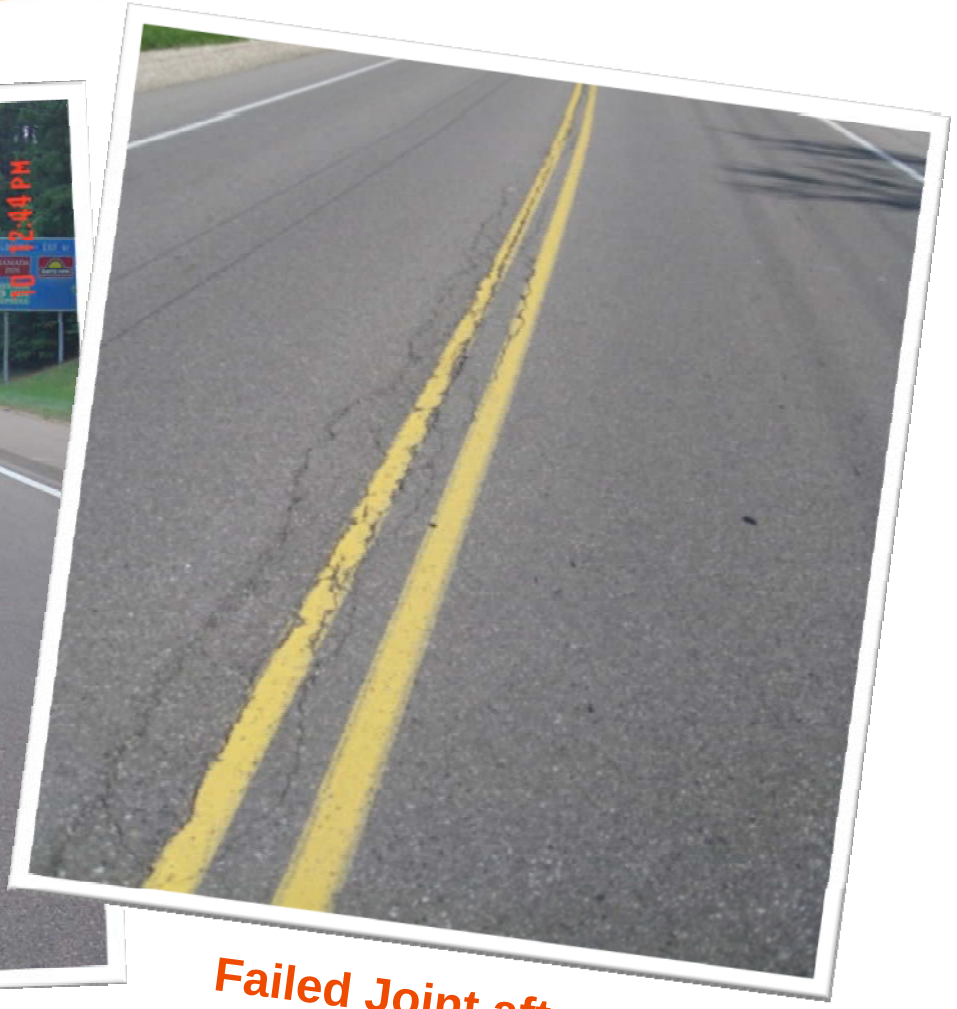
2009 some failure, minor cold mix added Hot seam still intact! Still no bump!

INFRARED PATCHING

IN 2012 Road was repaved, patch survived 15 years without growing beyond original envelope, no major potholes
The patch didn't look pretty, BUT THE ROAD BUDGET WAS!

LONGITUDINAL JOINT REPAIR

Typical failed joint, Mississippi



Failed Joint after one year
Region of Waterloo, Ontario

LONGITUDINAL JOINT REPAIR

One of the most critical and costly problems in asphalt construction today

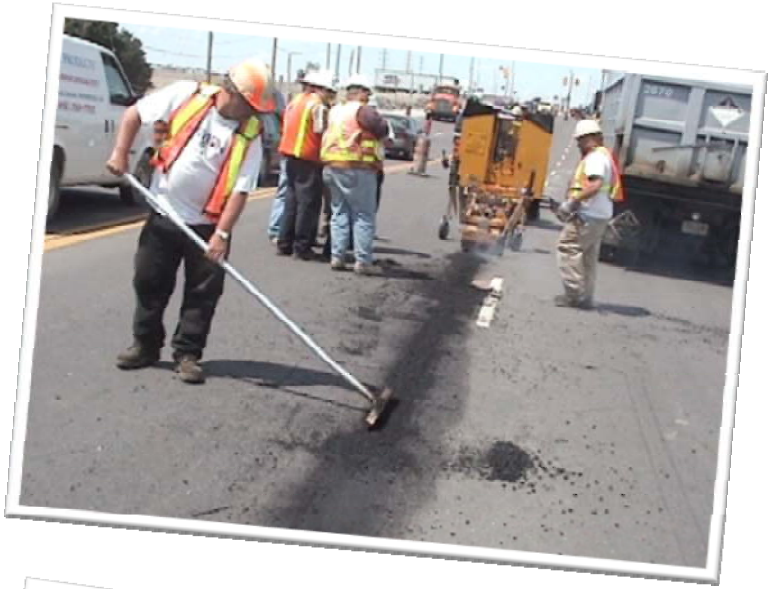
LONGITUDINAL JOINT REPAIR

The traditional repair, the mill and fill method. It leaves a crack on either side, and explains this repair lasting only 4 years!

INFRARED LONGITUDINAL JOINT REPAIR

Major Mackenzie & Hwy 400, Toronto, 2004

- **2100’ of unacceptable joint**
- **reheated with infrared**
- **material removed and replaced**
- **extended one year warranty provided by contractor**
- **after warranty period 20 feet required to be redone**
- **previous joint repair could not be easily identified**
- ***TODAY YOU CAN’T FIND THE JOINT!***

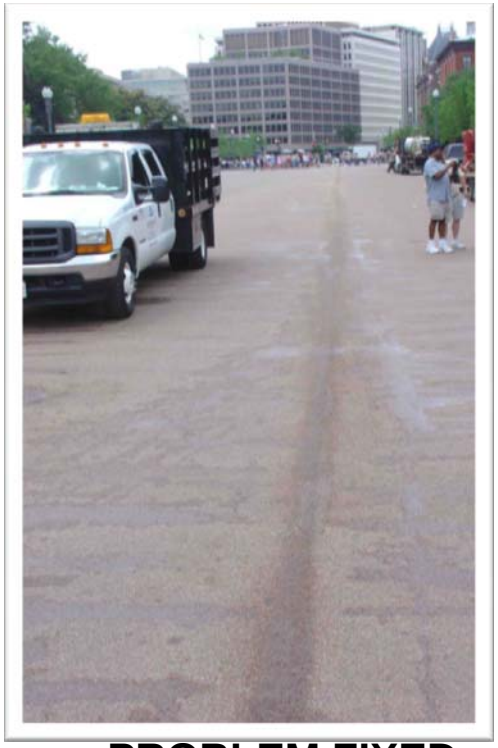


White House *2005* and *2008*

In 2004 FHWA let a tender for a synthetic asphalt in front of the White House
Clear synthetic resin and two colored aggregates
Resembles an old rustic pavement
Contractor was supposed to pave in echelon with 5 pavers across the project
Ended up two with ravelling joints that were not accepted
They were close to milling up 2 million dollars of pavement (800/ton)

Longitudinal Joint Problem Solved

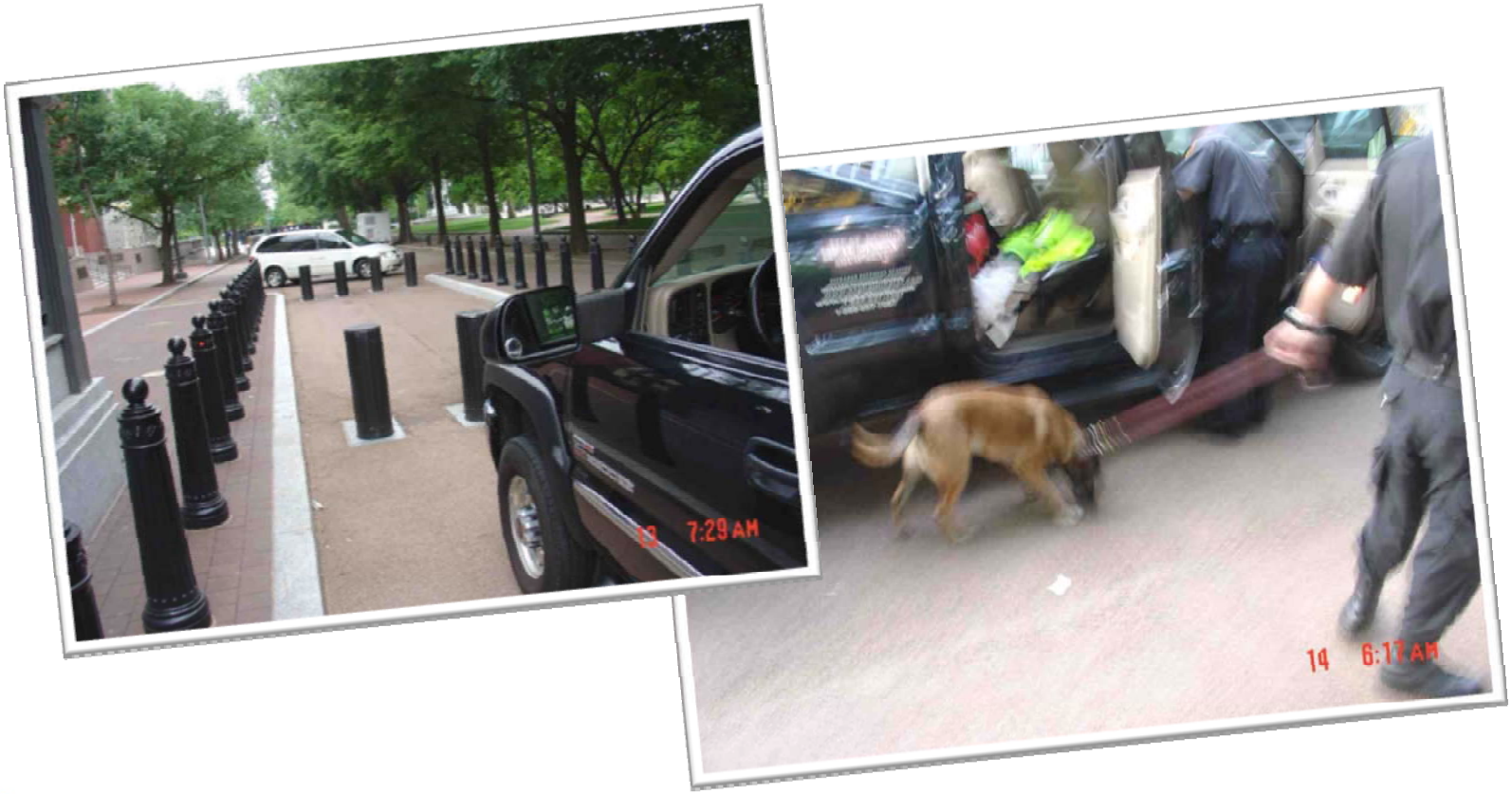
PROBLEM



PROBLEM FIXED

Contractor, asked HDE to work with them on re-heating and repairing joint
Test Section in Richmond Battlefield Park, close to Richmond VA
On approval worked for two days on Pennsylvania Ave

First, we had to get through security



INFRARED LONGITUDINAL
JOINT REPAIR

MR75 Mini Recycler

100,000 Btu infrared heater over a 2”screen deck

Heated fresh material to be added to failed joint

JMH 400T, 400,000 Btu

Heated joint for pre-set time

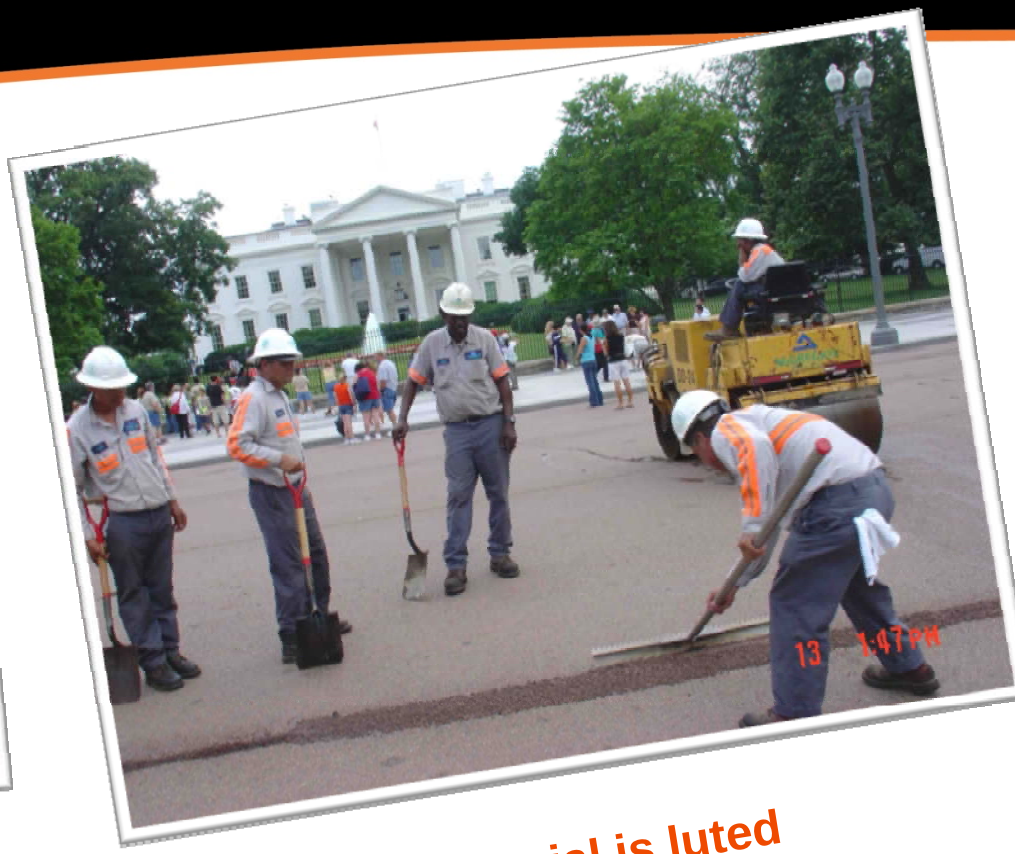
Monitored temperature closely

Synthetic resin binder stickier, lower burn point than conventional

Turned black easily if overheated

INFRARED LONGITUDINAL
JOINT REPAIR

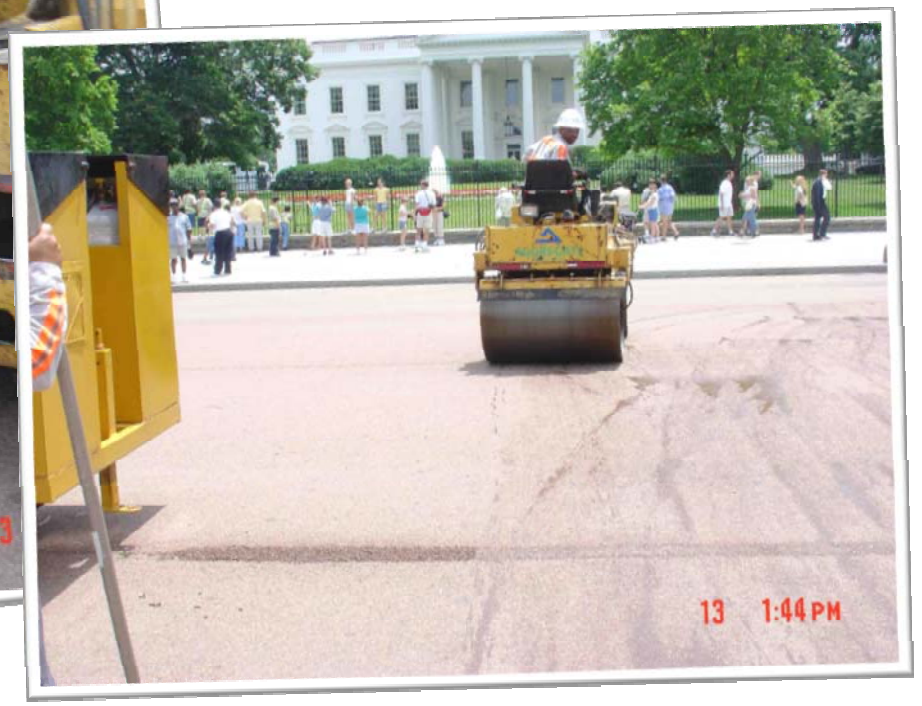
Heated fresh material is added to the heated deteriorated joint



Fresh material is luted

INFRARED LONGITUDINAL
JOINT REPAIR

Vibratory compaction across the joint
DD24 Dual Drum by Dura Pac



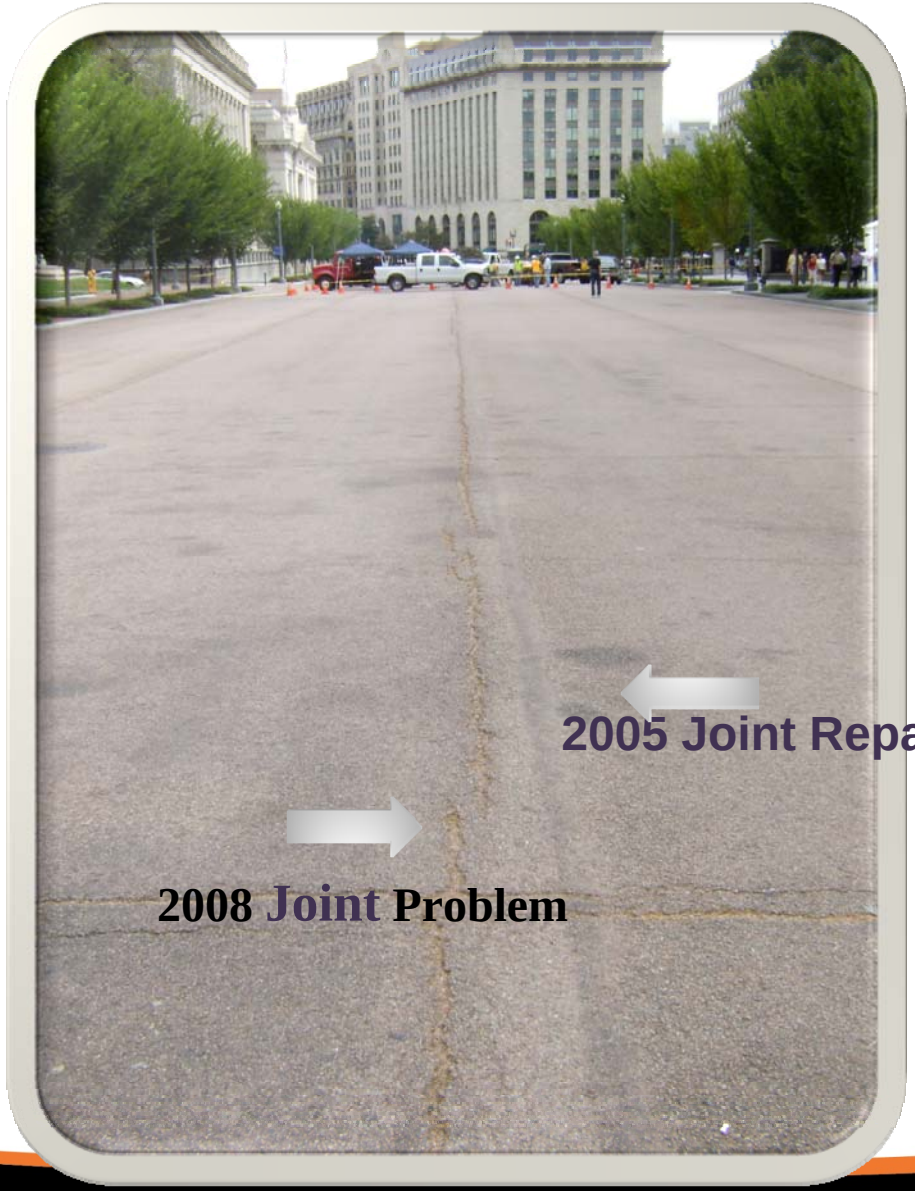
Compaction occurred close behind heater

INFRARED LONGITUDINAL JOINT REPAIR

Final compaction along joint for smoothness
Federal Highways accepted the job and contractor got his money

INFRARED LONGITUDINAL JOINT REPAIR

In 2008 HDE was called back to help fix new cracks over concrete joints for the inauguration parade .
2005 repair was still good



INFRARED LONGITUDINAL JOINT REPAIR

Engineers specified saw-cut 36 inches wide centered on crack

36” cut area then heated, then scarified to 1 inch

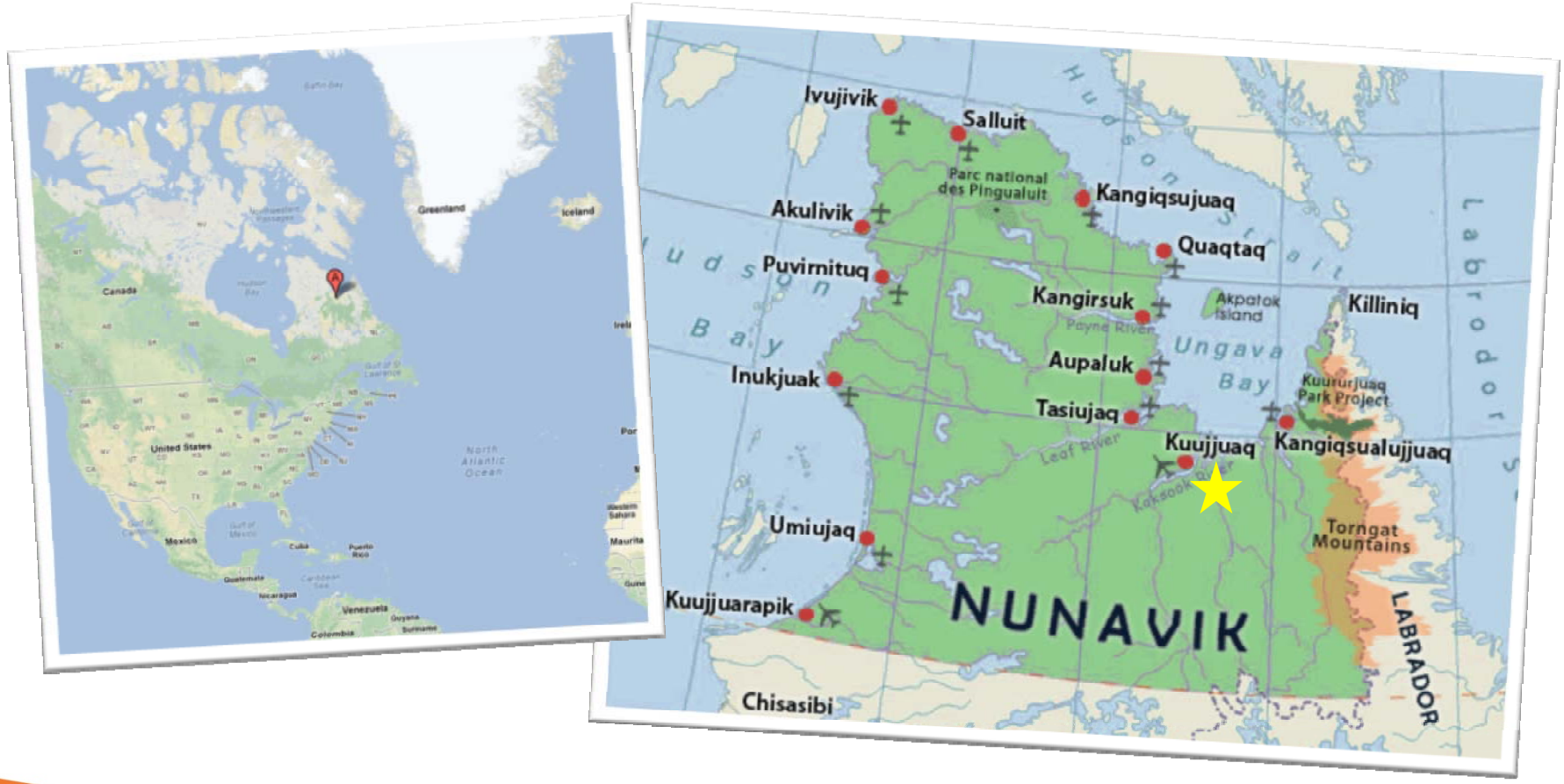
INFRARED LONGITUDINAL JOINT REPAIR

Fresh mix from original mix design is loaded into infrared recycler where it is re-heated

INFRARED LONGITUDINAL JOINT REPAIR

Then placement, luting, compaction
THEN ON TO THE PARADE!

Kuujjuaq , PQ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Killiniq
Payne River
Aupaluk
Inukjuak
Ungava Bay
Tasiujaq
Kuururjuaq Park Project
Kangiqsualujjuaq
Kuujjuaq
Leaf River
Koksoak River
Umiujaq
Torngat Mountains
Kuujjuarapik
NUNAVIK
LABRADOR
Chisasibi
Hudson Strait
Hudson Bay
Labrador
Greenland
Iceland
Canada
United States
Mexico
North Atlantic Ocean
Venezuela
Colombia

INFRARED CRACK REPAIR ON AIRPORT PAVEMENT

Kuujjuaq Airport

Runway crack was 1.5 inch (40mm) wide

Depression to 4 feet (1.2m) wide

Problems with planes going airborne at crack

INFRARED CRACK REPAIR ON AIRPORT PAVEMENT

Crack Repair at bottom end of runway
4’x3’ Infrared heater, 200,000 Btu

INFRARED CRACK REPAIR

First Challenge: Remove heavy lift of crackfiller
Heated with infrared heater for 2-3 minutes to gooiness
Scraped with Ice Scraper

Depression

INFRARED CRACK REPAIR

Removing crack filler from scraper impossible, used a torch and melted into a 45 gallon drum
Next heated crack area to 2-2/1/2 inches and scarified

INFRARED CRACK REPAIR

Hot Mix Asphalt is available every 3-4 years when a plant is shipped in. Instead we used bagged 3/ 8”(10mm) cold mix, sprinkled on, scarified material, luted level

INFRARED CRACK REPAIR

Cold Mix was then compacted lightly to tighten surface for heating
CAUTION: loose material does not transfer heat, so easily overheats

INFRARED CRACK REPAIR

Level Check across crack

INFRARED CRACK REPAIR

Finished Surface: withstood 747 landing *30 minutes later*

Fixing Longitudinal Joints on Runway Pavements!

- Speed and Co-ordination is essential, even if this is not the situation

LONGITUDINAL JOINT REPAIR: FASTER

Longitudinal Joint Heater/Scarification & Repair
Bleams Rd Region of Waterloo

- **Speeds of 1.5-2 meters per minute**

Presentated as successful by Dr Ludomir Uzarowski of Golder Associates at TAC 2011 in Edmonton

Longitudinal Joint Repair at 5 ft/minute

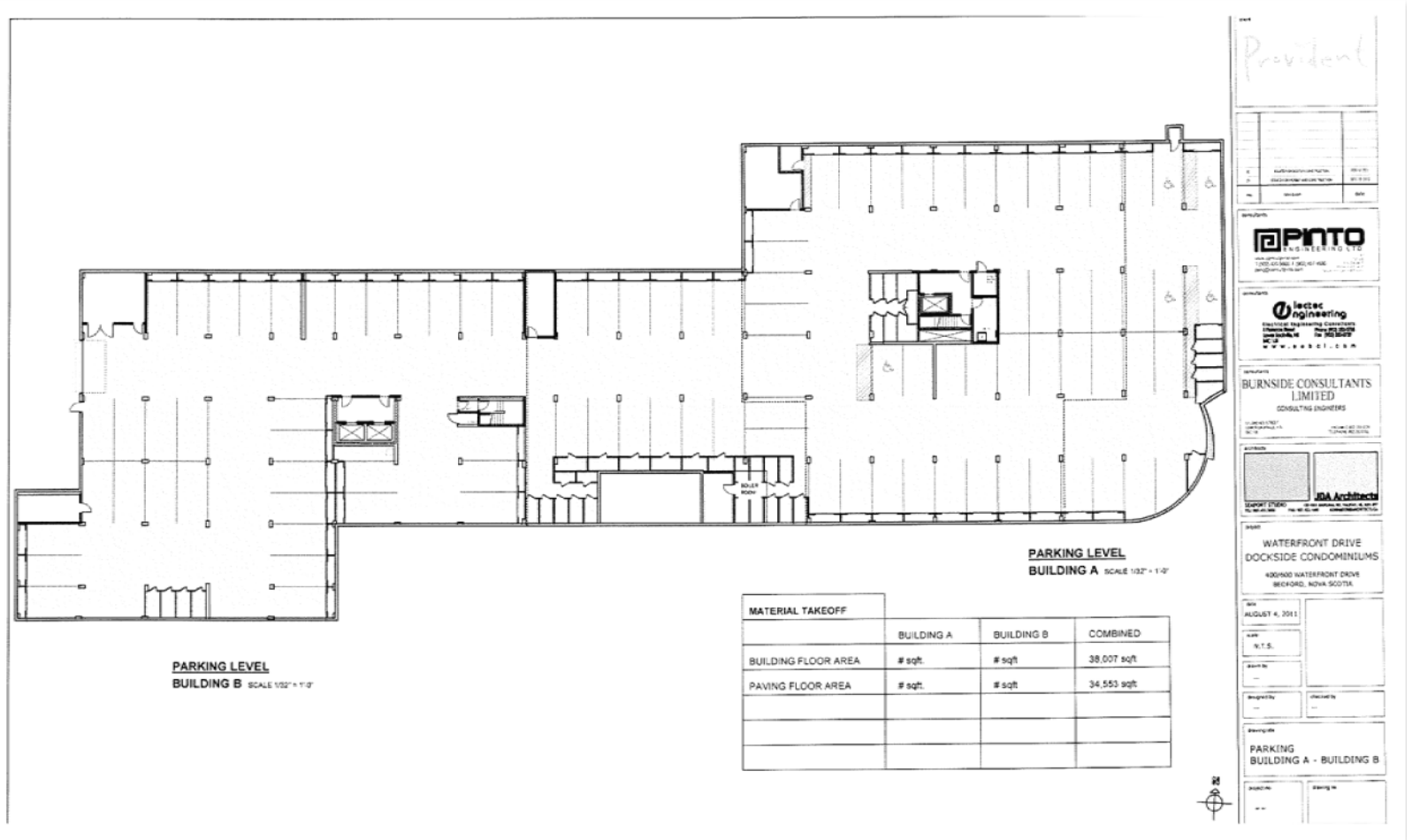
REPAIR OF SURFACE DEFICIENCIES & RE-COMPACTION

Provident Parkade, Halifax, NS,

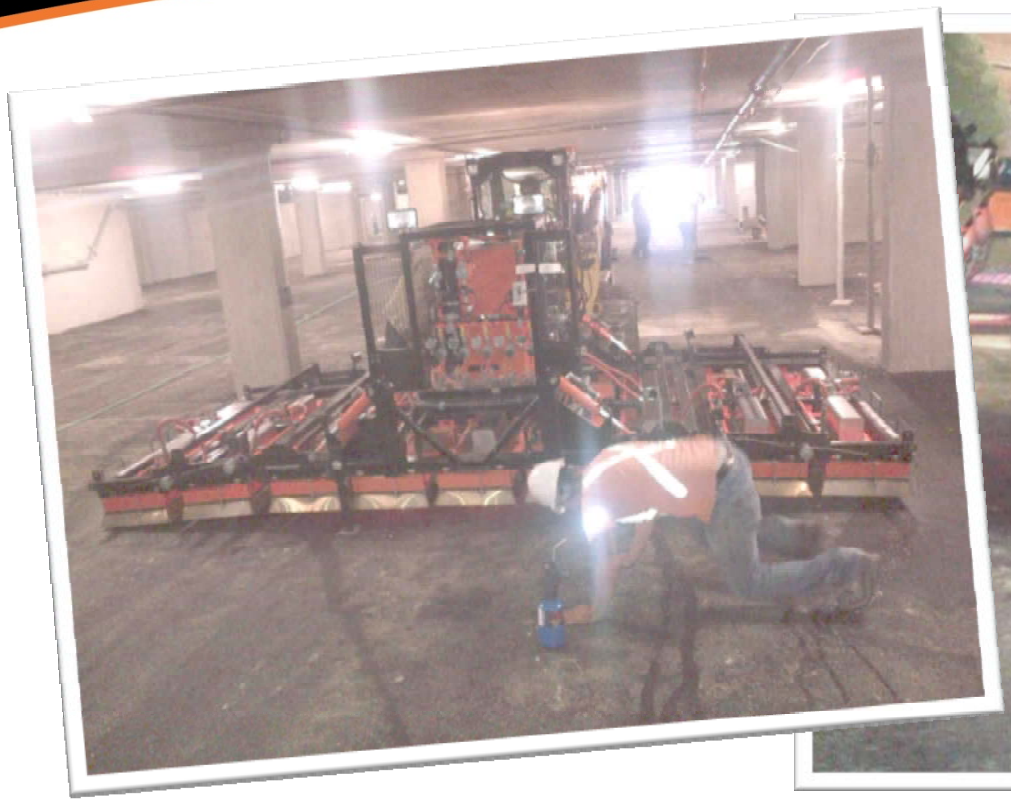
Access to basement minimal
Asphalt carried in by bucket
Slow process cooled asphalt
Poor compaction of asphalt

REPAIR OF SURFACE DEFICIENCIES & RE-COMPACTION

34,500 sf parkade



REPAIR OF SURFACE DEFICIENCIES & RE-COMPACTION



Re-heating surface to re-compation temperatures

Check asphalt temperature with infrared gun

REPAIR OF SURFACE DEFICIENCIES & RE-COMPACTION

Compaction close behind heating

REPAIR OF SURFACE DEFICIENCIES & RE-COMPACTION

- INFRARED PRODUCES CARBON MONOXIDE
- Important to monitor CO while running heater inside
- Make sure to supply extra ventilation
- No problem till gas pressure washer used
- Required shut down to clear air

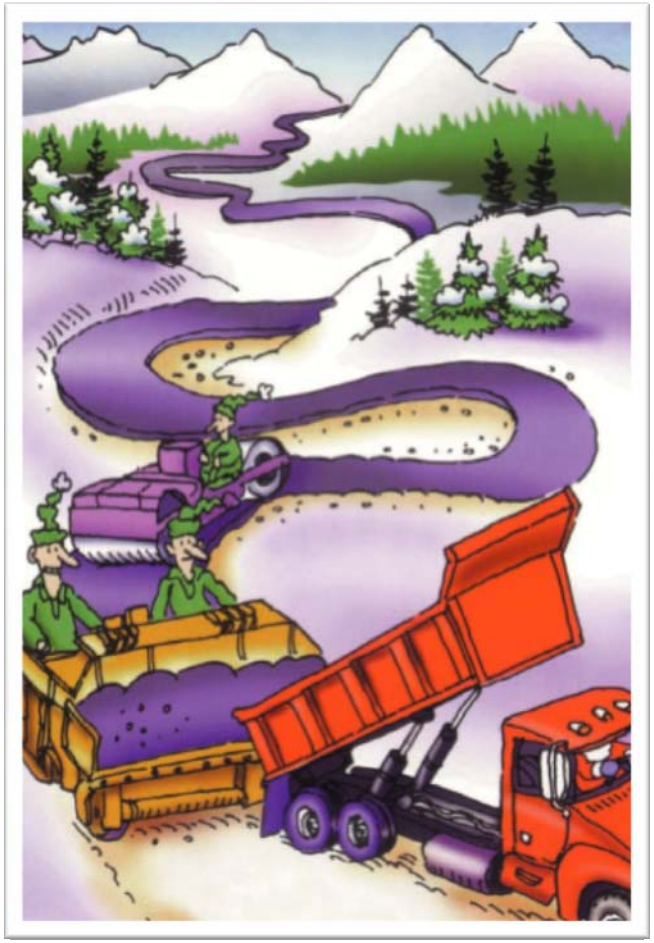
letter from Engineering Consultant

Aug 29, 2012 letter from
Engineering Consultant LVN/Maritime Testing

"Locations were marked out for testing with the nuclear densometer to enable testing before and after heating and recompaction. A heating and compacting pattern was developed that resulted in desired improvements. For the tested locations, the average improvement in compacted density was approximately 6-7% of maximum theoretical density (MTD), with some locations improving up to approximately 9%. Based upon initial core results, this improvement would result in approximate compacted densities of **91-92%** average."

"On-site visual examination after completion of the work showed an overall tighter and less segregated surface. Also , the ridges that were present from initial rolling were no longer evident and the joints between paving lanes were appreciably smoother. It was also observed that areas surrounding the floor drains had been cut regarding. "

COLD WEATHER PAVING
WHEN IS IT TOO COLD ? WHAT CAN YOU DO?



Bomag: Compaction Temperatures

Compaction Temperatures

Start
160 (320F)-140(284F)

Favourable
140 (284F)-100 (212F)

End
100(212F)-80(176F)

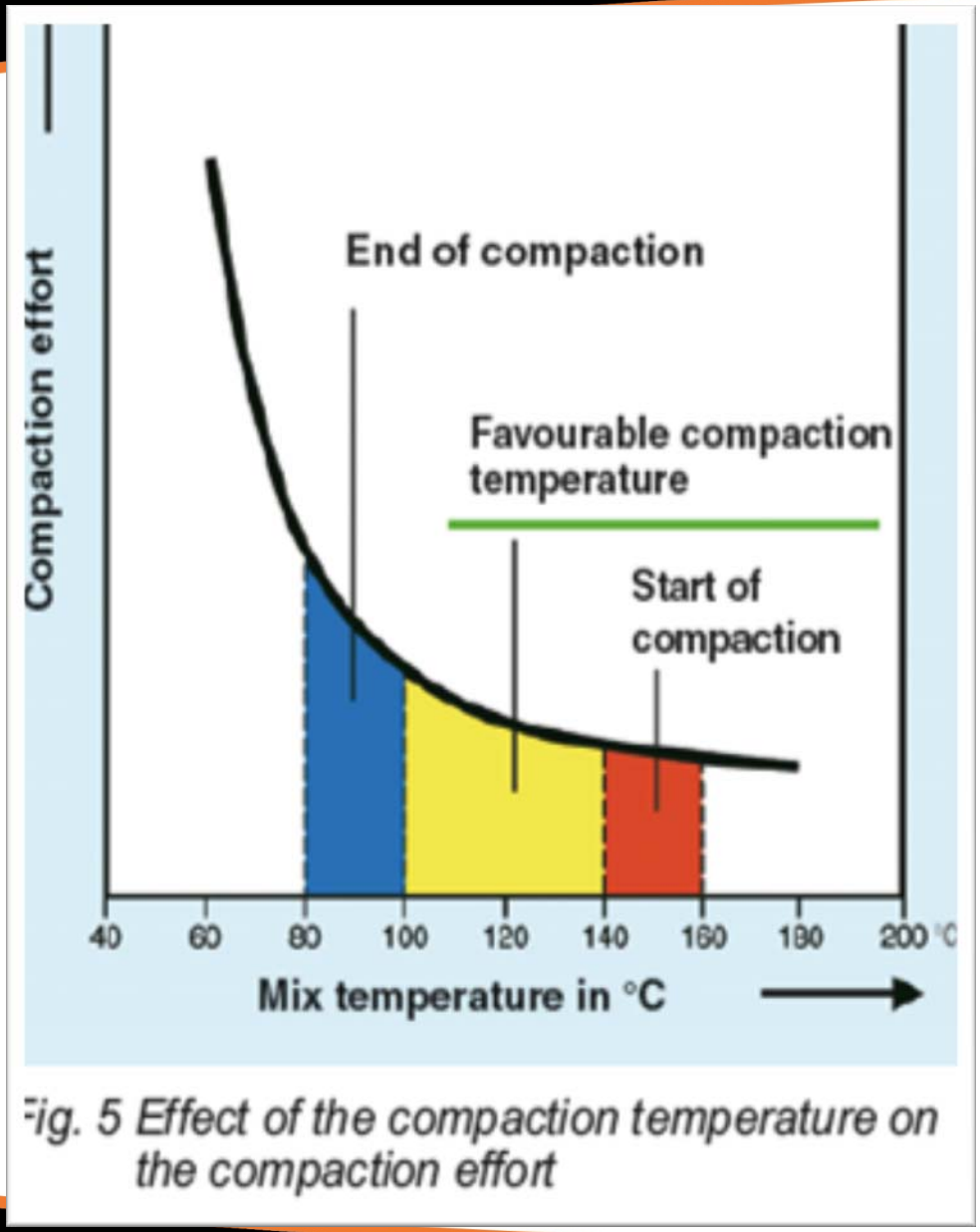


Fig. 5 Effect of the compaction temperature on the compaction effort

Nov 2004, Highway 417, OTTAWA, Canada

1 mile of eastbound and westbound lanes

LaFarge Const. Ottawa, ON, Canada.

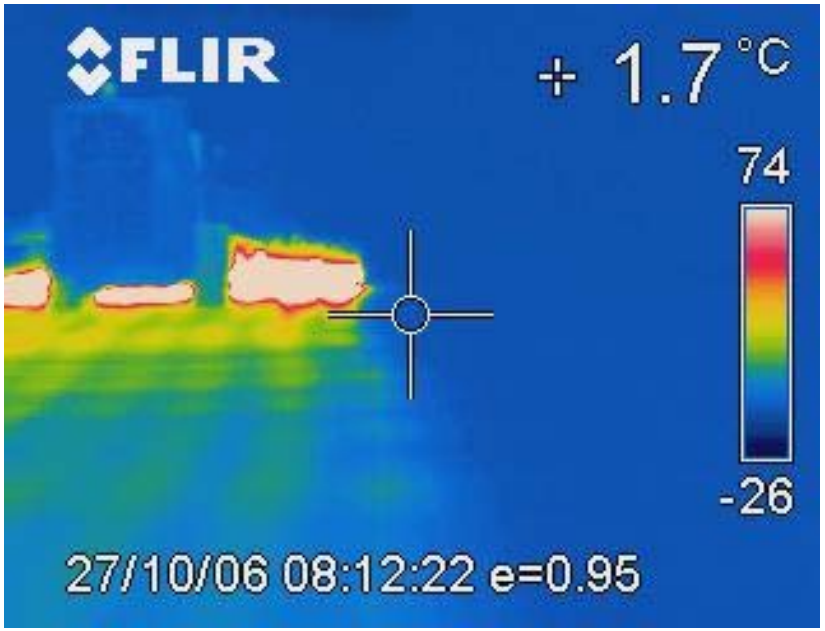
Paving temperature 23F, asphalt base heated to + 60F at 35 ft/min.

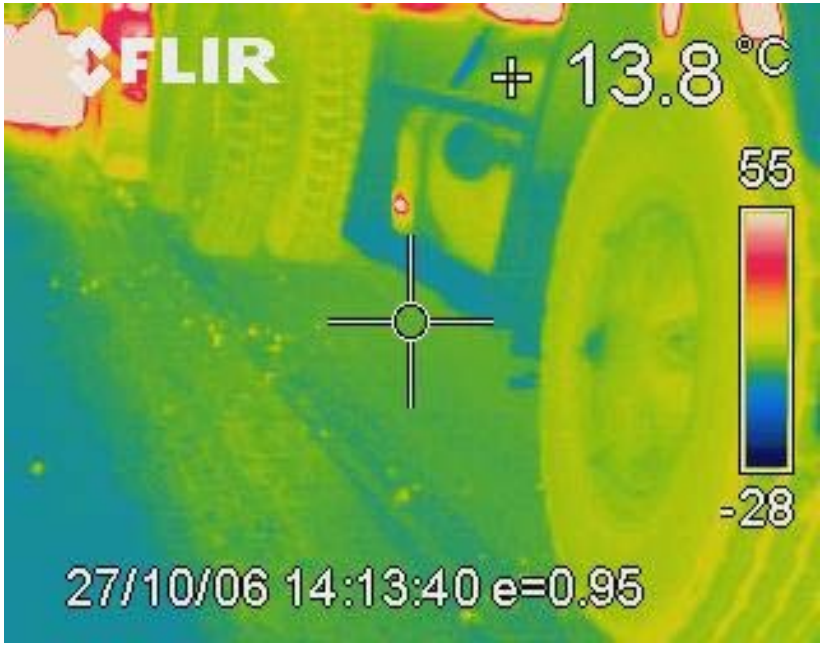
Temporary emergency mill and fill project turned into permanent lane replacement.

PRE-HEAT BASE ASPHALT TO MEET TEMPERATURE REQUIREMENTS

November 27, 2006, La Tuque, Quebec, Canada

LaTuque, Quebec, Canada paving speed 35 ft per min





- Upper left pavement temp 1.7C (35F)
- Middle right 23.9 C (75F) behind heater
- Lower left 13.8C (56.8F) in front of paver

PREHEAT BASE ASPHALT

Jan 2007, Cornell Const. Clinton, Oklahoma

1. 35 million Btu, 15x6’ deck attached to paver

OTHER INFRARED APPLICATIONS

Mini- Recycler
(Pizza Oven)

Asphalt chunks on screen deck
1 75,000 Btu infrared heater
Hot mix in 5-10 minutes

THERMO – PLASTICS

THERMO – PLASTICS

On airports: a popular, long term solution to pavement markings

Hot In Place Asphalt Repair HIPAR

On airports: HIPAR
Ken Fyvie on Thursday
Source of heat is Infrared

QUESTIONS & thank you