

THE MECHANISATION ON BRIDGE DECKS

RELIABILITY AND PERFORMANCE ON BITUMINOUS WATERPROOFING MEMBRANES

By Denis Cartier
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The latest innovation for installing thermofusible membranes on bridge decks – the automated installation system.

La toute dernière innovation en matière de pose des membranes d'étanchéité thermosoudables sur les ponts : l'automatisation des techniques de pose.

Die neueste Erungenschaft (Innovation), um waermeschmelzbare Membranen an Bruecken anzubringen, das automatische Installationssystem.

Denis Cartier is the designer of the new Macaden automated installation system.

INTRODUCTION

The successful completion of a project is the combination of a good design, quality products, and proper execution using the best installation methods. Progress is made by continually improving the weakest component. For the bridge and road sector, the manual installation process could not guarantee a uniformly installed membrane in the time frame required for this type of project. The introduction of the **MACADEN AUTOMATED INSTALLATION SYSTEM** has advanced the installation procedure so that a consistent, quality execution of the work can now be expected.

The system was developed in Canada where, through necessity due to the harsh climate, products are tested to the limits that nature provides. Temperature extremes and products such as salt and calcium found on Canadian roads during the winter months have really put this system to the test.

The Macaden system significantly reduces the number of labourers and the installation time traditionally required when

waterproofing any sized bridge. One operator and his assistant can easily operate and control the machine that covers close to 500 square meters per hour. By using this system, construction deadlines are met and maintenance costs are driven down significantly.

NECESSITY FOR AUTOMATED INSTALLATION

Strict quality control standards and tighter work schedules demanded by government agencies dictated the need for automation.

MACADEN can replace approximately ten hand torches plus labor required for handling and setting of the rolls in a typical manual operation. Fatigue, a large factor in manual operations, is not a factor in an automated operation.

The length of the roll is limited by compensation guidelines in a manual operation, and is usually below 45 kilograms. Installations of this type utilize an eight-meter roll resulting in twenty-five additional end joints per two hundred meters. The result is an additional consumption of four meters of membrane per two hundred meter length, and twenty-five additional joints, which contain the possibility for water infiltration.

A hand torch simply cannot generate the heat required for consistent bonding to the deck. The problem is magnified when wind becomes a factor.

The concentration of population in urban areas strains transportation routes. Most are utilized well beyond their design capacity. Closure for extended periods of time creates public and political pressure which government agencies are sensitive to.

The MACADEN system extends the season when work can actually proceed since it is not as sensitive to cold temperatures.

CONDITIONING THE DECK

Conditioning the deck refers to raising the temperature of the deck in the immediate area of bonding independent of the liquefying of the underside of the roll. Both must occur

simultaneously to expel moisture and cold air, which can be trapped, and cause blistering, and to guarantee a quality bond between the two surfaces. Conditioning the deck is not fully appreciated and its role is underestimated.

THE INSTALLATION PROCESS

Installation is over a dry, clean, smooth, primed deck.

Two rolls are loaded into the machine and the machine is aligned.

Operating instructions are entered into the control panel and the automatic mode is selected. It moves forward and installs the membrane according to the programmed parameters.

The membrane is mechanically unrolled and welded at a constant, continuous rate. Flattening rollers guarantee consistent and complete contact with the surface of the deck.

The welding process and conditioning of the deck is accomplished using two separate banks of hot air nozzles. Hot air is preferred over open flame for safety reasons. The temperature of the hot air is predetermined and is not affected by sudden weather changes or by cool temperatures.

The completed membrane can now accept an asphalt or concrete wearing surface.

MACADEN — THE MACHINE

MACADEN is a self-propelled metal frame machine capable of installing 480 square meters of thermofusible elastomeric membrane per hour. Two rolls, each 200 x 1 meters, are installed simultaneously. Hot air nozzles weld the membrane to the deck while a separate bank of hot air nozzles condition the deck ahead of the rolls. Guidance is automated through front mounted sensors. Once aligned, installation is automatic requiring only an operator and one assistant.

The machine is a 2-meter-wide by 8¹/₂-meter-long metal structure on wheels with a front-mounted self-guidance system. It weights 7 000 kg. Inside, apart from the drive motor, are six

hot air nozzles to condition surfaces and weld the membranes. The various controls for manually turning the machine on and entering operating instructions are located on one side.

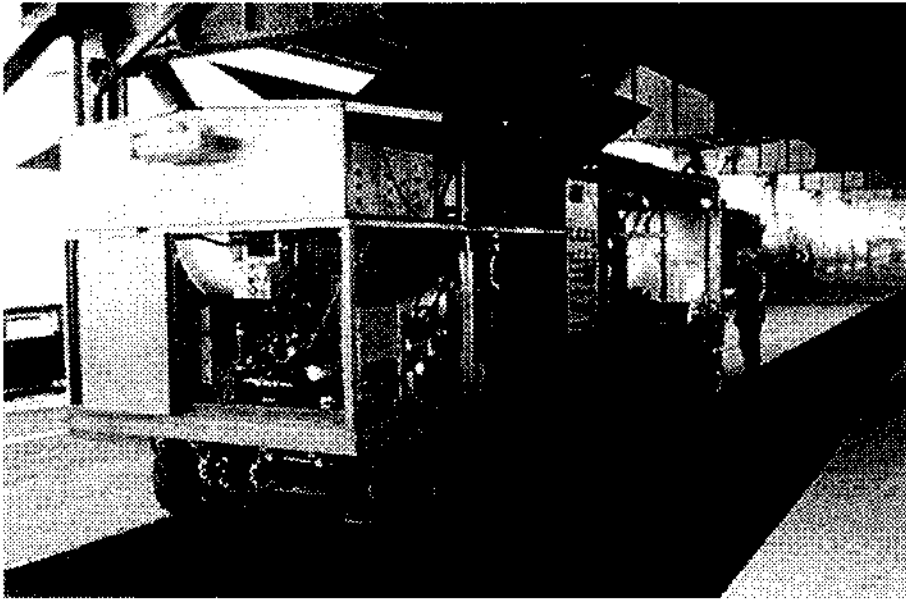


Photo 1: The Machine

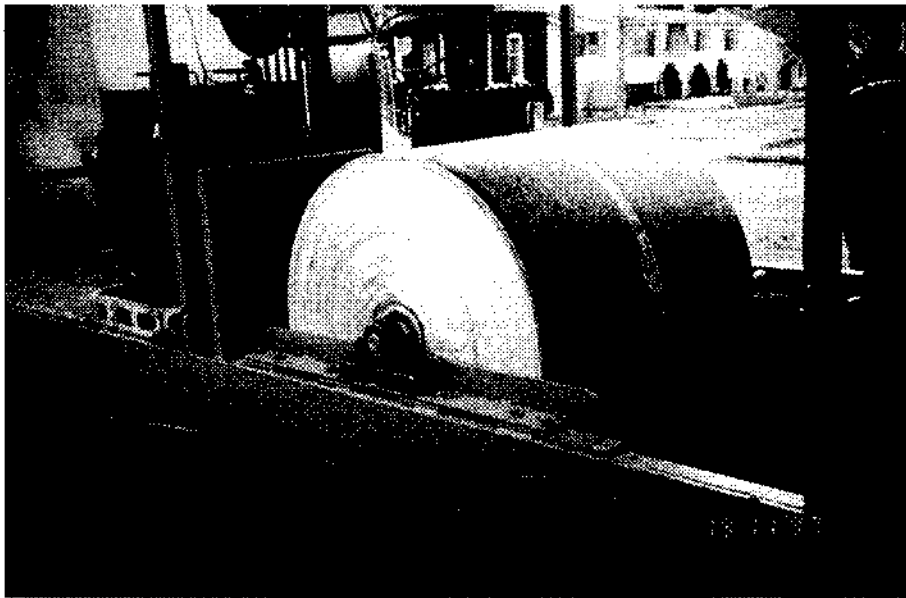


Photo 2: 200 m long rolls of membrane

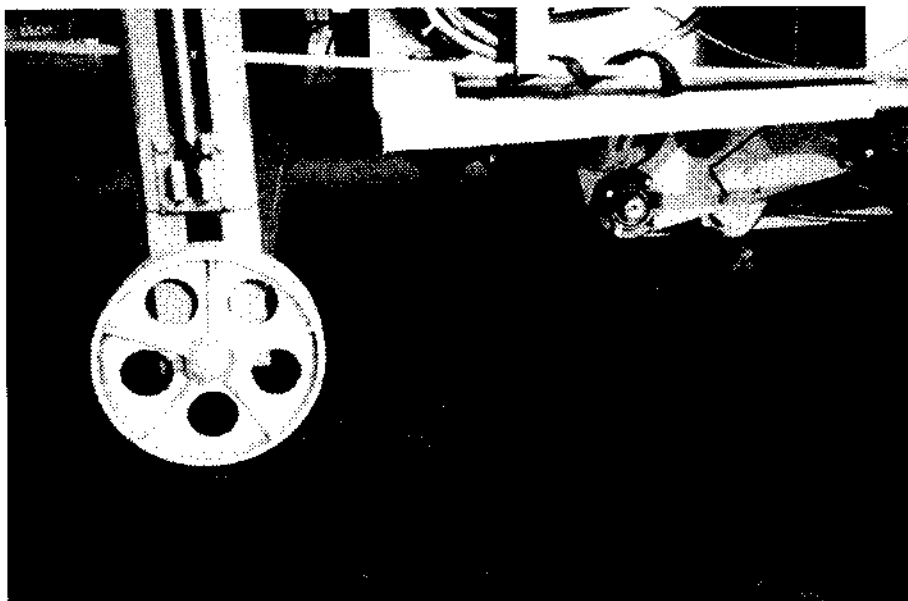


Photo 3: The constant temperature of the hot air ensures a uniform weld



Photo 4: Welding the membrane

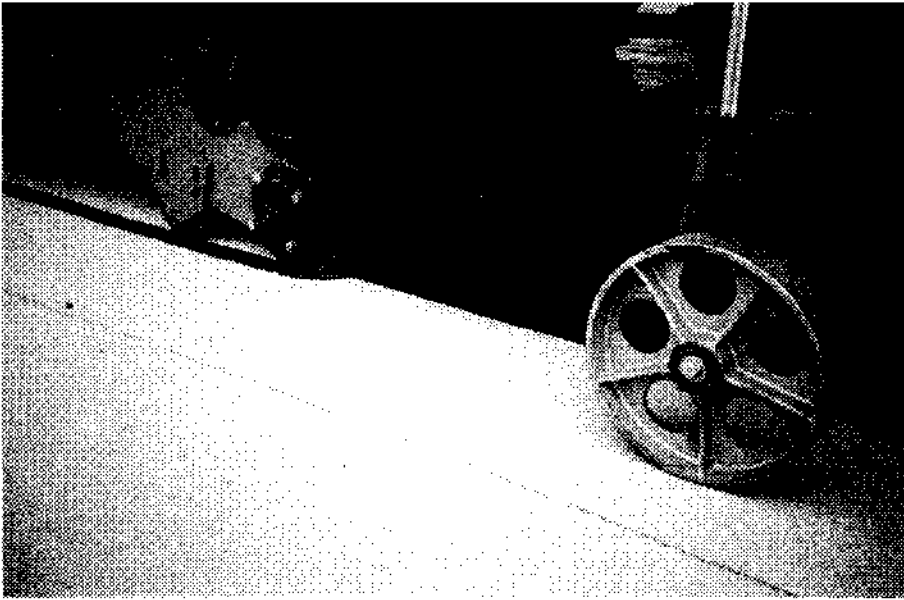


Photo 5: Uniform beads of bitumen

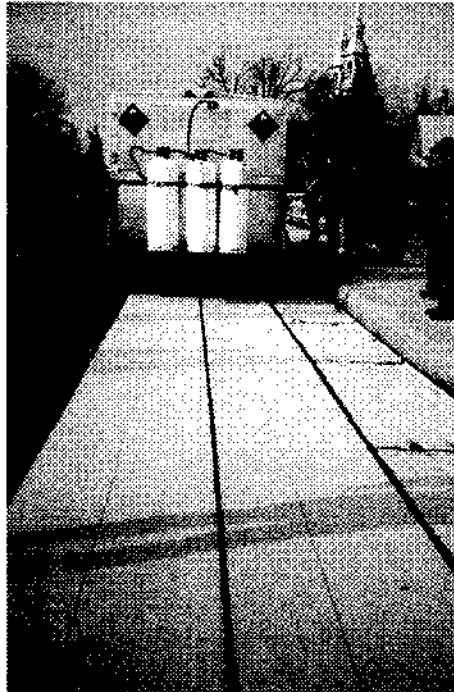


Photo 6: The machine unrolls, welds and presses down on the membrane in a single pass

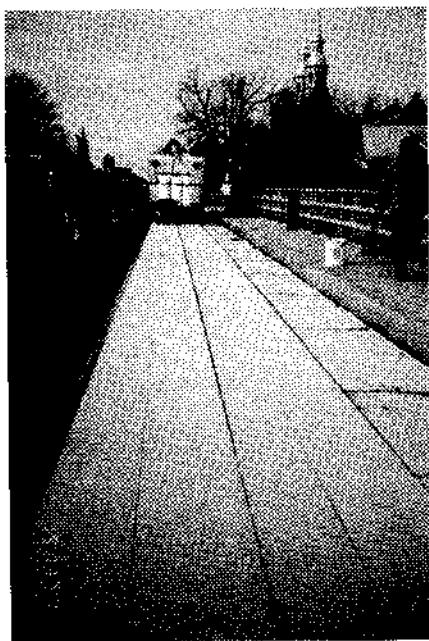


Photo 7: The machine unrolls, welds and presses down on the membrane in a single pass



Photo 8: The machine unrolls, welds and presses down on the membrane in a single pass

THE MACADEN MEMBRANE

A membrane was specifically designed for use in the MACADEN system. It is an SBS elastomeric membrane with a non-woven polyester reinforcement. The superior flexibility and strength of the membrane resists normal stresses imposed by the structure including slow moving traffic and paving equipment. This membrane is also available in small roll sizes for detail work and small areas.

Product Specifications:

Properties	Standards	Antirock
Thickness (mm)	--	4,5
Dimension (m)	--	200 x 1
Roll Weight (kg)	--	1125
Top face	--	Granules
Underface	--	Thermofusible plastic film
Reinforcement	--	180 g/m ² Non-woven polyester
Storage	--	Upright on pallet
Strain energy (kJ/m)	CAN/CGSB 37.56-98 (MD/XD)	9,0 / 7,0
Cold bending (°C)	CAN/CGSB 37.56-98	≤ -30
Softening point (°C)	ASTM D36-86	≥ 110
Static puncture (N)	CAN/CGSB 37.56-98	300
Breaking strength (N/5 cm)	CAN/CGSB 37.56-98 (MD/XD)	1060/785
Ultimate elongation (%)	CAN/CGSB 37.56-98 (MD / XD)	58/64

MACADEN — A SMALL VERSION

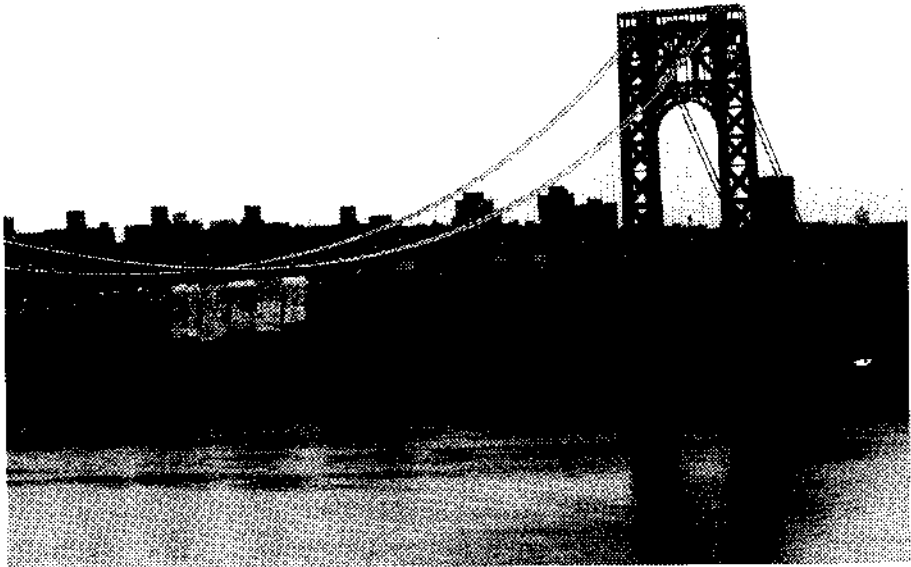
The success of the MACADEN program for large structures was adapted for use on smaller structures, bridge approaches, and

parkades with the development of a smaller version of MACADEN. The second machine utilizes all of the same principles, as the original machine but is only one half the size. The roll size remains two hundred meters long but only one roll can be installed at a time.

CONCLUSION

The advantages of the MACADEN AUTOMATED INSTALLATION SYSTEM are significant—application uniformity, quality control, deadline compliance, and waste reduction. The machine is unique in both features and technology. Installation speed and quality is consistent in hot or cold temperatures, and is not affected by abrupt changes in temperature. The installation contribution towards a successful project completion is no longer the weakest contribution.

A PROJECT REFERENCE - THE GEORGE WASHINGTON BRIDGE IN NEW YORK CITY



Project Description

Waterproof a total of 20,000-square-meters east to west of the lower deck section of the George Washington Bridge linking New Jersey to Manhattan.

Special Features

The work had to be performed as quickly as possible. It also had to be done at night to allow the bridge to be reopened to traffic every morning at 10 AM.

The bridge deck is a steel structure with small, transversal beams welded every six inches. The gaps between the cross-members were filled with poured concrete. The very uneven surfaces, depressions in the beams, the presence of holes, and the high moisture content of the concrete made manual welding impossible.

Installation of 2¹/₂" high by 3" wide expansion joints every 20 meters. Shot blasting was also necessary to remove rotten concrete and rust on the steel beams. We had to use a water-based primer rather than a solvent-based primer because of the high moisture content of the concrete. Obviously, every step of the project required very tight coordination among the various work crews.

The construction schedule allowed for 30 weekends. The actual time it took to complete was 11.

The Solution

The MACADEN was chosen to waterproof the deck of the George Washington Bridge. The result was even, uniform welding of the membrane with continuous overlaps and no blisters or wrinkles. The quickness of the process made it possible to install membranes in all sorts of weather, and the reduction in the number of joints drastically reduced the possibility of leaks.

A PROJECT REFERENCE - VILLE-MARIE EXPRESSWAY IN MONTREAL, CANADA

Project Description

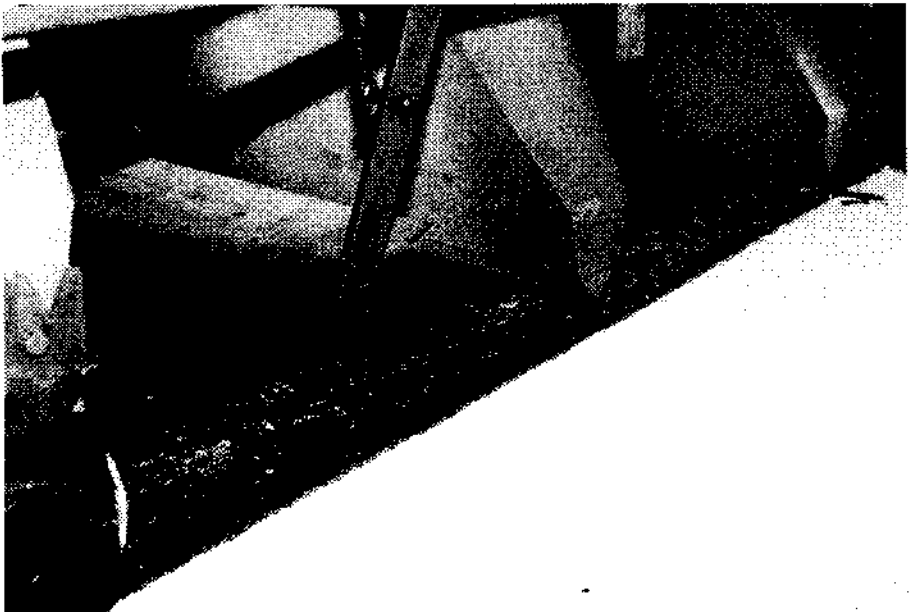
Waterproof a total of 45,000 square meters of the elevated section of the Ville-Marie Expressway in Montreal, Canada.

Special Features

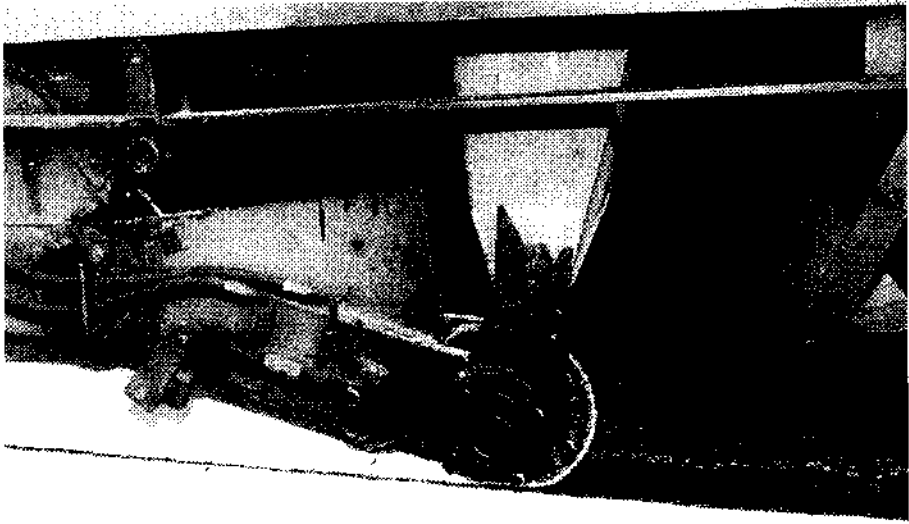
This elevated highway is one of the most important arteries linking downtown Montreal to the southern and western suburbs. Work had to be completed quickly and at nighttime in order to prevent any circulation problems during morning and evening rush hours.

The Solution

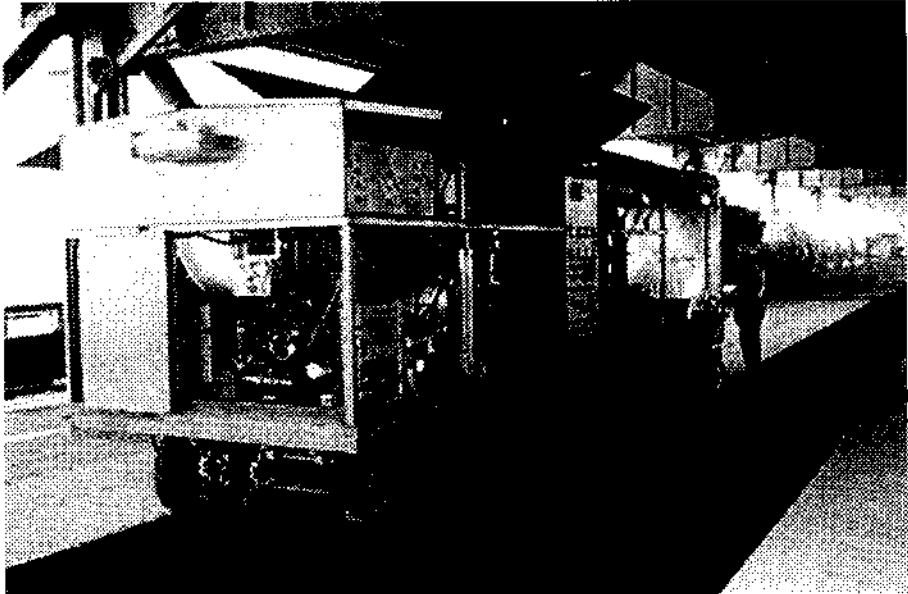
The MACADEN was chosen to waterproof the Elevated portion of the Ville-Marie Expressway. The result was even, uniform welding of the membrane with continuous overlaps and no blisters or wrinkles. The quickness of the process made it possible to install membranes in all sorts of weather, and the reduction in the number of joints drastically reduced the possibility of leaks.



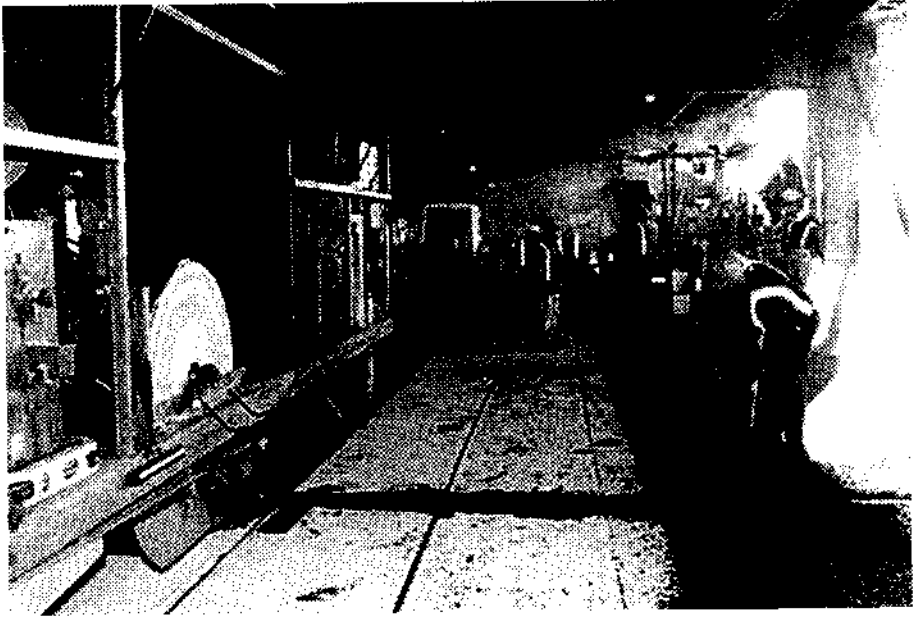
The conditioning of the deck



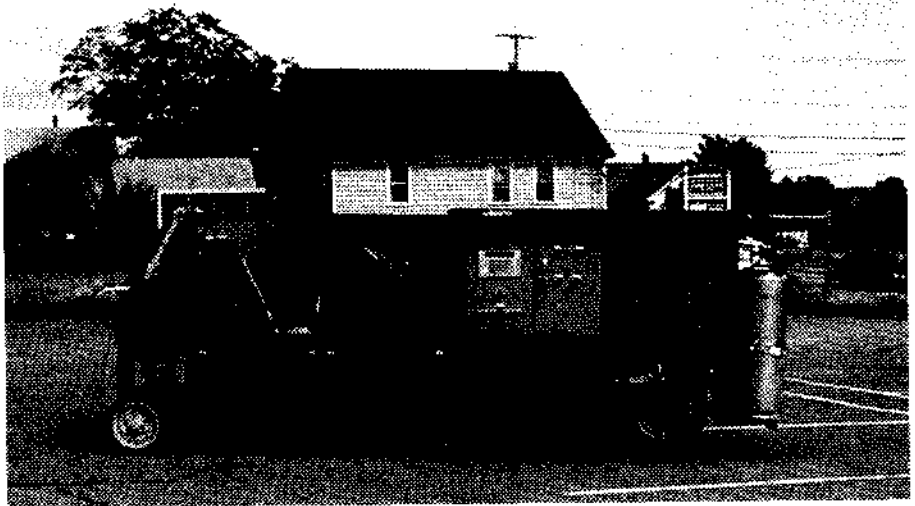
The heat-welding process



The installation of membranes with Macaden



The completed membrane can now accept an asphalt or concrete wearing surface.



The new smaller version of the Macaden