Weigh-In-Motion System for the Reduction of Commercial Vehicle Traffic Delays at the Borden-Carleton, PEI Weight Inspection Station

Author:

Darrell Evans, P. Eng. Bridges and Highway Design,

PEI Transportation and Public Works, PO Box 2000, Charlottetown

Prince Edward Island, Canada, C1A 7N8

Phone: (902) 569-0578, Fax: (902) 368-5395

Email: djevans@gov.pe.ca

Co-author:

Rod Klashinsky, Vice-President, Special Projects

International Road Dynamics Inc., 702-43rd Street East,

Saskatoon, SK, Canada, S7K 3T9,

Phone: (306) 653-6600, Fax: (306) 242-5599

Email: Rod.Klashinsky@irdinc.com

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Abstract:

Delays at commercial vehicle weighing and inspection stations reduce productivity and efficiency. Weigh-in-Motion (WIM) technology has been proven to be a successful Intelligent Transportation System (ITS) solution in regards to managing commercial vehicle traffic efficiently, decreasing congestion and delays, improving safety, reducing pavement damage, and decreasing air pollution.

This paper focuses on the management and traffic operations at the commercial vehicle weighing and inspection station on Route 1 east of the Confederation Bridge near Borden-Carlton, Prince Edward Island. A Mainline WIM (Weigh-In-Motion) Sorter was deployed in May-June, 2011 to reduce commercial vehicle back-ups at the station. For safety reasons, high-sided commercial vehicles are not allowed to travel over the Confederation Bridge during periods when high and/or gusty wind conditions are present on the bridge. When the bridge is re-opened following such a wind event, there is the potential for 300 to 400 trucks in queue to report to the weigh station. A Weigh-In-Motion System was installed on the mainline in advance of the weigh station to alleviate the problem of long commercial vehicle traffic queues following high wind events.

The WIM Sorter System automatically directs commercial vehicles which are potentially in violation of length, height, and weight compliance limits to report to the weigh station. Commercial vehicles which are not in violation can, at the station operator's discretion, either be allowed to bypass the weigh station or be directed to report to the weigh station. This paper reviews the challenges of a compressed installation schedule, coordination among the various participants, and the subsequent operation of the station with the Mainline WIM System and accrued benefits.

Introduction

Prior to the installation of a Commercial Vehicle WIM (Weigh-In-Motion) Sorter System on the Trans-Canada Highway at the Borden-Carleton Weigh Station in Prince Edward Island (PEI), there were several issues which significantly affected the trucking industry, PEI Department of Transportation and Infrastructure Renewal (DTIR), and the public.

For safety reasons, high-sided commercial vehicles are not allowed to travel over the Confederation Bridge during periods of high and/or dangerously gusty wind conditions. During these wind events, the bridge may be closed to traffic for as long as 12 hours. When the bridge is re-opened there is the potential for 300 to 400 trucks in queue to report to the weigh station. This congestion can lead to safety, workload issues, and the potential for over-weight trucks to bypass inspection.

Additionally, there were design and safety issues with respect to traffic flow in the weigh station area. Heavy trucks merging with regular non-commercial traffic posed a serious safety hazard.

A solution was required to address these issues. This paper highlights the design and traffic flow issues, how they were subsequently addressed, and the management of the project. Challenges included a compressed installation schedule and coordination of the various interested parties.

Traffic Operations and Management

The Province had safety concerns with the existing ramp design for commercial trucks exiting the weigh scale in Borden and merging with traffic exiting the Confederation Bridge.

There were also significant issues with large platoons of commercial vehicles arriving at the weigh station when restrictions to high-sided vehicle crossings were lifted following a high wind event.

Originally, two lanes of commercial truck traffic merged with regular traffic at an intersection. A small merge lane existed on the left and side of the non-commercial lane. Commercial vehicles would then tend to merge right in order to access the gas and coffee shop located inside the town of Borden (See **figure 1**).

DTIR decided on a re-design to avoid cross-over accidents. The re-design was for the egress from the scales at the weigh station to a T-intersection. However, this caused frustration for the trucking industry. Large trucks were being forced to come to a yield or stop condition, check for opposing traffic, then proceed leftward onto the Trans-Canada highway. This could prove difficult for some vehicles which may have been loaded to the maximum allowable weight. This was obviously not an ideal solution (See **figure 2**).

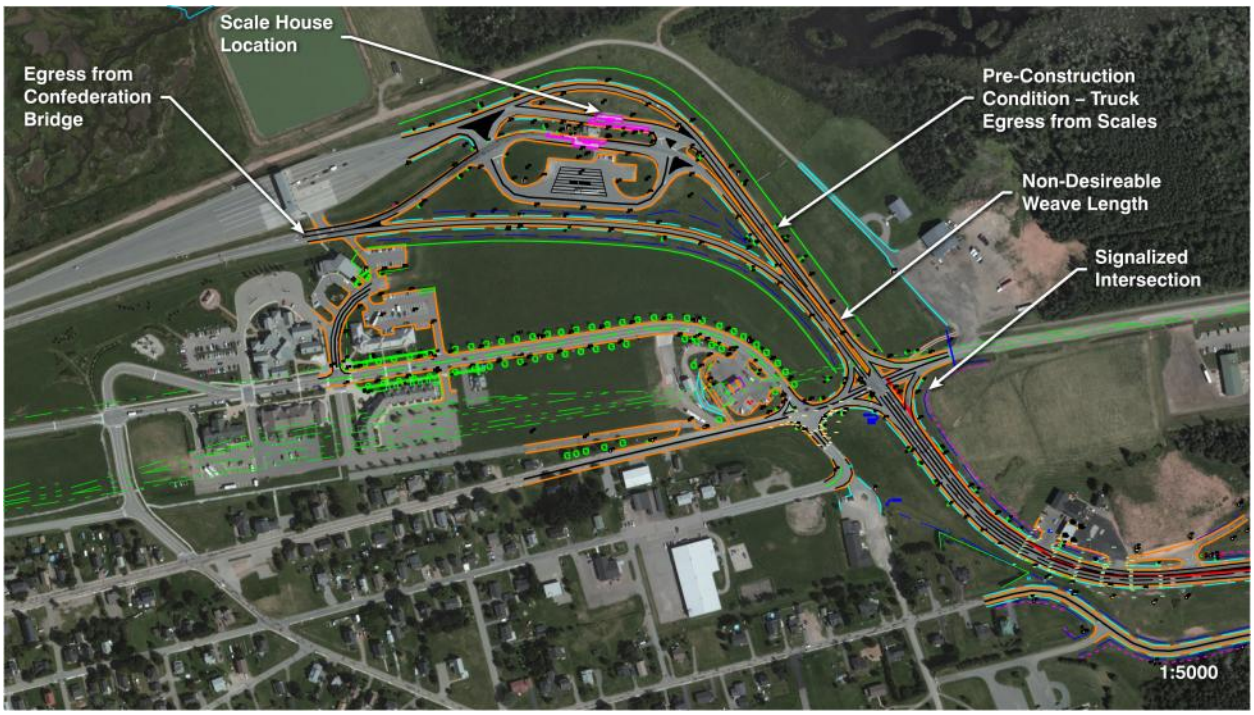

Figure 1 – Original Site Geometry

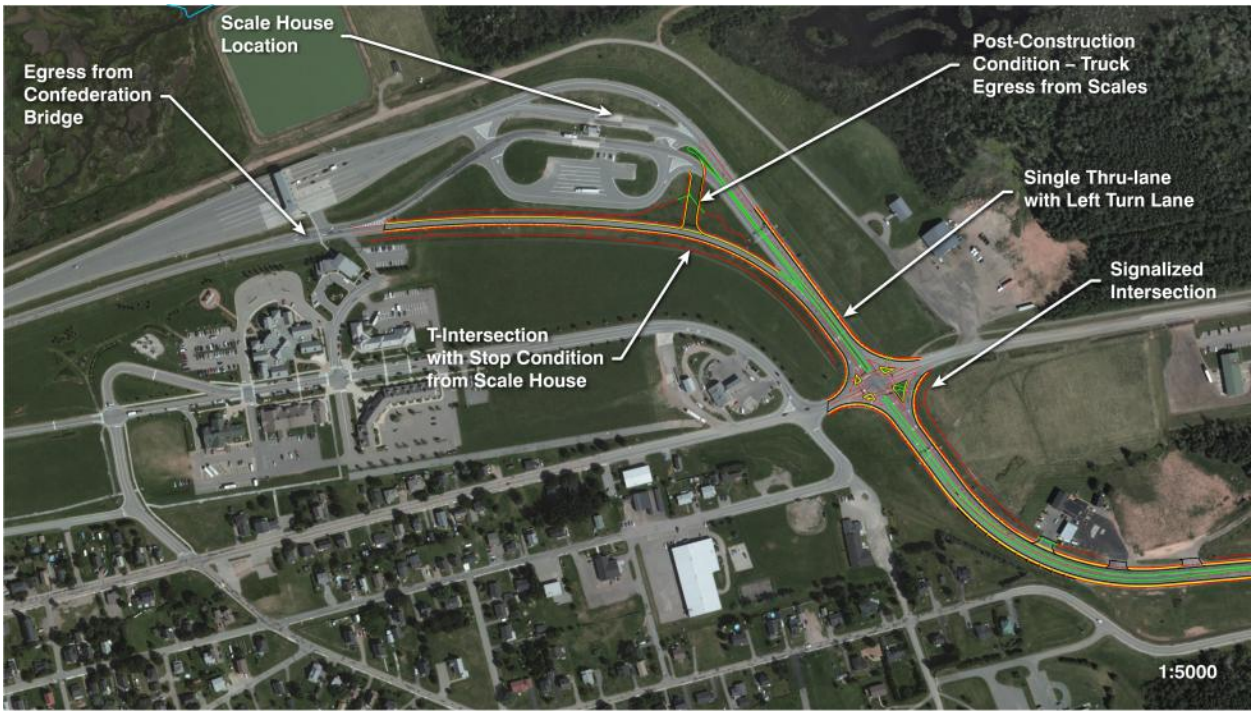

Figure 2 – Modified Site Layout

The Province decided to then further re-design the egress from the Borden weigh scales in order to better improve the safety and overall efficiency. As part of the strategy to alleviate these concerns and have a more efficient egress off of the Confederation Bridge and to address the onslaught of commercial vehicles following a high wind event, the Department decided on the installation of a Mainline WIM Sorter System (See **figure 3**).

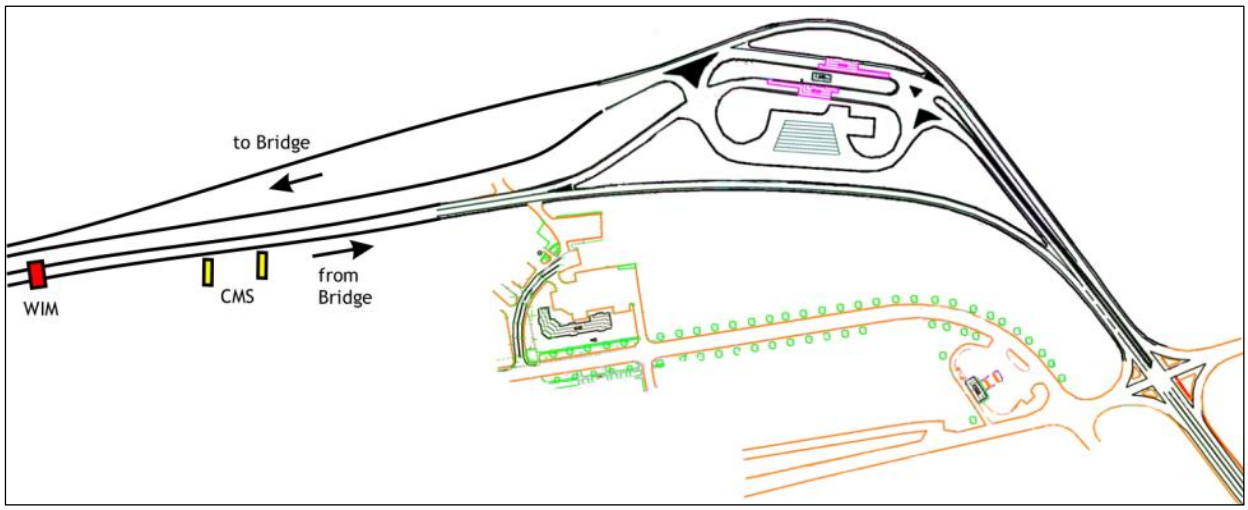

Figure 3 – WIM System Location

The Department contacted International Road Dynamics, Inc. (IRD) with a goal to install and commission a new WIM Sorter System by the end of June, 2011. Negotiations began in March of 2011 and a contract was signed in May of 2011.

A site visit on March 2, 2011 was conducted by IRD and its electrical sub-contractor, Black and McDonald. A meeting with all of the stakeholders followed in Charlottetown. The meeting was coordinated by Delphi-MRC, who was acting on behalf of PEI DTIR. The compressed schedule, site challenges, and mitigation strategies were discussed at the meeting. The WIM site location, system operation, features, and capabilities were also topics at the meeting.

The site inspection was a challenge, since there was still snow on the ground in the weigh station area and not all of the pertinent aspects and characteristics of the site were evident. It was difficult to inspect existing conduit runs and cabling, since they were still buried under the snow (see **figure 4**).

Figure 4 – Site Inspection (Snow Cover)

Another challenge was the necessity to place the WIM Scales in a location such that acceleration or deceleration would not occur at or near the Scales. Additionally, there could not be any significant changes in the geometry of the roadway (side slope or grade change).

The location which was finally selected was on the east side of the Confederation Bridge Toll Plaza. The property was owned by Transport Canada and operated under a lease by Strait Crossing Bridge Limited (SCBL). This required that the Province enter into secondary negotiations with SCBL and advise Transport Canada of requirements and desire to proceed with the WIM installation.

In terms of their own operational requirements, SCBL had a strict time line of when construction on their leased property and disruption of traffic would be allowed. SCBL needed the work completed in time for the tourist season. June 24th was the imposed deadline. Transport Canada also required that DTIR satisfy certain environmental requirements through the Canadian Environment Assessment Act (CEAA).

A further requirement for deploying WIM is a smooth road surface before and after the scales, in order to minimize dynamic loading on the scales (vehicle bounce). The existing asphalt was rutted and exhibited signs of deterioration and longitudinal cracking, however, no differential settlement was observed (see **figure 5**).

Figure 5 – Pavement before Resurfacing

It was agreed that milling the road surface flat and an overlay pavement would be sufficient to improve the smoothness of the roadway. This process consumed some of the already compressed schedule. A tender was awarded for the asphalt portion of the work and the work was completed in mid-May (see **figure 6**).

Figure 6 – Resurfaced Road

A temporary detour road was constructed for commercial vehicles to bypass the in-road construction area (see **figure 7**). The temporary detour consisted of granular A material and was maintained by SCBL. DTIR supplied the jersey barriers, while IRD and its sub-contractor were responsible for traffic control. SCBL assisted to slow down traffic so that the work zone area was safe for both motorists and workers.

Figure 7 – Bypass Road During Construction

Daily safety toolbox meetings were held and hazard assessments were performed on a regular basis. Additionally, weekly on-site project meetings were held between DTIR and IRD.

Construction was phased with the electrical/signal conduits and pull-boxes installed and checked first. A 3.65m wide x 11.5m long section of road was replaced with Portland Cement Concrete to provide a smooth transition for traffic traveling over the WIM Scale (see **figure 8**). The concrete was poured and the Single-Load Cell WIM Scale was then installed into the road way. The traffic cabinet and electronics controller, poles, electronic message signs, cameras and vehicle over-height detectors were then installed, and electrical and fiber-optic cabling terminated. The scale-house electronics and computer monitors were installed in the scale-house and the network was connected and system integration tests were performed. Calibration and accuracy tests were conducted on the WIM Scales and it was verified that the scales met the accuracy specifications.

Figure 8 – Concrete placement prior to and after the WIM Scale

For security reasons, the Province's internal IT Shared Services Division was required to set up the on-site computer network. The IT Division also was needed to set up a VPN (Virtual Private Network) to provide IRD with remote access into the system to conduct any software upgrades or troubleshoot from IRD offices.

The schedule of completing work on the roadway by June 24th was achieved, thereby, satisfying SCBL's requirement. The entire system was completely installed and commissioned in early July 2011, and this met DTIR's requirements.

Technological Solution – Mainline Weigh-In-Motion

Purpose

The purpose of the Mainline Weigh-In-Motion System is to sort vehicles that may be in violation of regulations from the stream of inbound commercial vehicles coming off of the Confederation Bridge on a single lane highway on Route 1. Before the implementation of the Mainline WIM

System, all commercial vehicles were required to report to the weigh station. The Mainline WIM Sorter System automatically directs only those commercial vehicles that are potentially in violation of dimension and weight compliance limits to report to the weigh station. Commercial vehicles which are not in violation can bypass the weigh station or can be directed to report by the weigh station operators. As a result, approximately 80% of the commercial vehicles can now bypass the weigh station. The officers can focus more attention on the 20% of the commercial vehicles which are directed into the weigh station.

An additional consideration is protection and preservation of pavement infrastructure. When over-weight trucks bypass the weigh station, there is the potential for considerable damage to the pavement infrastructure. There is an exponential relationship between overloaded trucks and pavement damage. Studies have shown that a 10% increase in overloaded trucks results in pavement structural damage ranging from the 2.5^{th} to 8^{th} power of vehicle weight [1].

Mainline WIM System Solution

After speaking with the Departments of Transportation in Nova Scotia and New Brunswick and visiting a weigh station operation, DTIR selected the IRD Single Load Cell WIM Scale as the Mainline WIM solution (see **figure 9**). The scale meets or exceeds the accuracy specifications for a Type III WIM system as presented in the American Society for Testing and Materials (ASTM) E1318-09 specifications. This accuracy is contingent upon the road surface meeting the pavement conditions specified under ASTM E1318-09.

Figure 9 – Single Load Cell (SLC) WIM

The primary component of the roadside electronics is the iSINC (Intelligent Sensor Interface and Network Controller) which is a low power, microprocessor controlled electronics package in a weatherproof enclosure for harsh environments (see **figure 10**). The iSINC connects with the in-road and off-road sensors, signs, cameras, and other peripheral devices, and communicates information to the weigh station computer.

Figure 10 – iSINC® WIM Electronics

In the scale house, commercial vehicle records appear on the weigh station monitor and commercial vehicle side view and license plate images are also viewed by the operator (see **figure 11**).

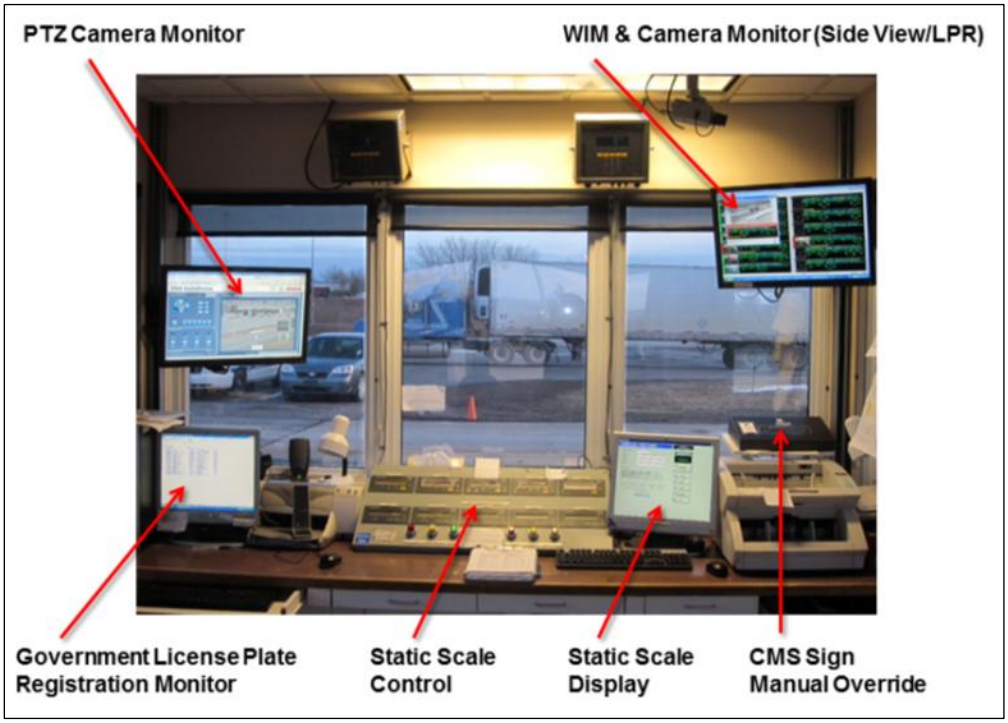

Figure 11 – Weigh Station Operations Center

Operation

The system weighs and classifies commercial vehicles as they travel from the Confederation Bridge towards the weigh station. All data collected is automatically evaluated and compared with legal load, dimension, and speed limits. If the vehicle is found to be compliant, the driver

will be allowed to bypass the weigh station without stopping (unless the station operator chooses to manually signal the carrier in for further inspection). If the vehicle is non-compliant, the driver will automatically be instructed by two bilingual Changeable Message Signs (CMS) prior to the weigh station entry ramp to report to the weigh station for further processing (see **figure 12**).

Figure 12 – Changeable Message Sign

Data collected from each commercial vehicle that passes over the WIM scale includes gross vehicle weight, axle weight, axle spacing, axle group weight, vehicle classification, speed, date and time of vehicle passage, a vehicle record tracking number, overall length, number of axles, axle configuration, and any error or warning events (such as over height, off scale, etc.). This information is used to determine in real time vehicle compliance or non-compliance.

Station operators are also able to manually signal commercial vehicles to report via the CMS (Changeable Message Sign). When an operator sees the vehicle record for a truck that is to be pulled in displayed on the workstation monitor, he or she can click on that vehicle record and select a REPORT button on the screen before the vehicle reaches the first Changeable Message Sign trigger loop. The CMS will then display the report message to the driver.

Benefits

The Department of Transportation and Infrastructure Renewal and the commercial trucking industry have realized substantial benefits from this system. As explained previously, traffic flow is now better controlled and safer for both commercial and private vehicles.

Perhaps one of the biggest benefits occurs just after a wind event which closes the bridge to high-sided vehicles. Before the WIM Sorter was installed at Borden, a large platoon of commercial vehicles would cross the bridge after restrictions were lifted by SCBL. In order to minimize congestion entering and exiting the scales, the bulk of these trucks were permitted to by-pass the scales. This caused concerns that some over-weight vehicles were not being checked and potentially damaging highway infrastructure.

After installation of the WIM Sorter, when a platoon of trucks approaches the weigh station following the lifting of wind restrictions, only those trucks which are potentially in violation of regulations are signalled to report to the scale house for inspection. This not only allows scale-house personnel to check all vehicles quickly and lets compliant vehicles proceed without any hindrance, but it also ensures that all commercial vehicles entering the Province are doing so with weights within regulations, thereby reducing damage to PEI's infrastructure.

The staff at the scale house can be better utilized on road patrols within the Province to conduct spot checks on commercial vehicles operating inside provincial boundaries. This can reduce wear and tear on PEI's highway and bridge infrastructure by allowing inspectors to be more vigilant with respect to policing and enforcing the Roads Act and pursuant Regulations.

Another benefit accrues from the system's License Plate Camera. It now provides concrete proof of any commercial vehicles which 'run-the-scale' and they can be located and charged accordingly.

One major benefit of negotiating with SCBL and Transport Canada was that there was existing infrastructure that could be used. This included additional LAN (Local Area Network) bandwidth and empty conduits and pull-pits through which to run the fibre-optic and power cables. There was also electrical power available in existing computer racks that were located at various locations along the route. This lowered the overall capital costs, since work required to supply and install conduits and hardware racks was reduced or in some instances eliminated.

There is a significant environmental benefit by allowing commercial vehicles which are within weight and dimension regulations to bypass the weigh station. Vehicles which start, stop, and idle emit more emissions then vehicles which travel at a relatively constant rate of speed. Additionally, there is a reduction in wear and tear on vehicle brakes and drivelines and improvement in overall efficiency for the trucking industry.

Conclusion

A compressed timetable and considerable traffic operational challenges presented the PEI Department of Transportation and Infrastructure and its partners with significant challenges. However, through regular communication, tight coordination and rigorous management among the partners, the project was completed on time.

The Mainline WIM System has eased commercial vehicle traffic flow and operational issues, particularly after a high speed wind event, by allowing officers to focus on only those trucks which are overweight and/or outside of regulatory dimensions. A more orderly process is now followed as commercial vehicles exit the bridge following a wind event, and officers can better deal with the traffic flow resulting in improved safety.

REFERENCES

[1] AASHTO 2002 Guide for the Design of New and Rehabilitated Pavement Structures