A REPORT ON THE VIRGINIA TRANSPORTATION RESEARCH COUNCIL'S TECHNICAL DELEGATION TO THE CZECH REPUBLIC

AUGUST 16–23, 2002

Respectfully submitted by:

Mr. Stephen C. Brich

Dr. H. Celik Ozyildirim

Mr. Michael M. Sprinkel

EXECUTIVE SUMMARY

The technical delegation of Stephen C. Brich, Celik Ozyildirim and Michael M. Sprinkel departed Washington, D.C., the evening of August 16, 2002 for a week of technical exchange in the Czech Republic. On Monday, the group traveled to Brno and while in transit made a number of field visits to concrete structures, both constructed and under construction. We noticed that the concrete pavements were in good condition. We noticed stairs along the abutments to facilitate maintenance and inspections.

Tuesday included an overview of the Transport Research Centre's (CDV) and the Virginia Transportation Research Council's (VTRC) activities. The CDV focused on infrastructure and traffic engineering. Technical assistance (TA)/consulting contract type projects, mostly traffic engineering and safety studies, of the CDV represents a significant portion of their funding. The CDV is participating with the European Union (EU) on a number of projects. The Air Transport section focuses on civilian air transportation including the effects of emissions from airplanes. The CDV is participating with the EU to identify airport needs. The Social and Human Aspect of Transport section deals with the social changes in transportation, which includes changes in driver behavior and advertising on public rights of way. The Bicycling Section has been working to identify and establish bicycling demands, develop dedicated facilities, and develop a bicycle path design manual. The Transport Safety section's main focus is the integration and expansion of road safety audits. Other work includes signing and marking, integration of accident data with geographic information systems (GIS), child safety restraint research, and evaluations of deer reflectors. The VTRC overview included traffic engineering, safety, advanced transportation systems research, VTRC's organizational structure, staffing and funding.

The second day was split into two portions: Technology and Systems. The Technology Program included visits to a tunnel being built under existing buildings and materials, and the structures laboratory near Brno. Research projects discussed included use of acoustic emission equipment for corrosion monitoring, use of fly ash, self-consolidating concrete, and lightweight aggregates. Discussions indicated that a close working relationship with the Czech Republic would provide Virginia with access to the European technology. The Systems Program included Traffic Engineering, Safety, Instrumented Vehicle and GIS, pavement marking, and sign sheeting practices were discussed. Three grades of sign sheeting were used: Engineering Grade material, high-intensity material, and prismatic materials. Also discussed were performance-based pavement marking specifications, wet reflective pavement markings, and the type of sign substrate being used. The safety group discussions included accidents increased after 1989, introduction of a speed limitation of 90 km/h that led to a decrease in accidents, emphasis on filling out accident forms accurately, changing the accident report form, developing a methodology of accident/safety studies, enforcement of speeds and current laws to reduce accidents, and seat belt users. Other safety discussions also included truck escape ramp designs and other crash facts and statistics in Virginia.

Discussions covered the instrumented vehicle for safety and ITS-related research outfitted with cameras, a distance-measuring instrument, infrared sensors, all of which are linked directly to a notebook computer. The vehicle is able to determine the headways of vehicles, capture a passing vehicle's speed and collect an inventory of a roadway's assets.

The VTRC Technology Program activities were presented and discussed on August 22, 2002 on high performance concrete, corrosion resistant reinforcement, and repairs. Differences between our and their procedures were discussed. The VDOT emphasis on durability to extend the service life of structures was compared to the Czech Republic's emphasis to protect decks with asphalt concrete and membranes. VTRC studies are continuing to prepare end result specifications while the Czech Republic continues to use prescription specifications. VDOT developments with HPC pavements were compared to the Czech Republic construction of pavements in two layers. VDOT uses HPC lightweight concretes, self-consolidating concrete, corrosion systems on bridges, grouts in post tensioning, shotcrete use to repair our bridge piers, pier caps, and columns and high quality overlays.

Intelligent Transportation Systems (ITS) at the CVD include projects such as the development of ITS Architecture and Electronic Toll Collection (ETC) for the Ministry of Transport.

The control center of Tunnels and Signals monitors two tunnels and 85 signals throughout Brno. Police are responsible for the day-to-day operations of the signals. Most signals are actuated and have timing plans in place based on time of day and day of week.

Brno' Public Transportation Control Center serves Brno with approximately 100 trams and more than 400 buses with increased personal vehicle ownership, transit ridership has dropped to 60 percent. A 2-year pilot project will outfit approximately 550 vehicles with GPS to monitor the health of vehicles, allow communications with the vehicle for it to speed up or slow down, and locate the vehicle in the network at any given time.

On the final day of the visit, the delegation had a common program to see the largest construction project in the Czech Republic: the bypass of Olomouc in Middle Moravia. In the evening the group had a closing discussion on potential research and technology transfer initiatives that might be undertaken. A full listing of these proposals are in Appendix A and include: (1) Evaluate Acoustic Emission to Locate Cracks in Concrete, (2) Compare Performance of High Performance Concrete Bridge Deck with Membrane and Asphalt on Concrete Deck, (3) Evaluate Self Consolidating Concrete in Bridge Superstructures, and (4) Develop Optimum Concrete Pavement Mixtures.

August 16 and 17, 2002

The technical delegation departed Washington, D.C., the evening of August 16, 2002, and arrived in the Czech Republic the morning of August 17, 2002. The group was transferred to the hotel in Prague's City Center. Because of the significant flooding that was ongoing at the time of arrival, the group's travel was limited to areas where the water had receded. Most of Prague's subway and tram systems were out of service. After checking into the hotel, the group was able to walk through the downtown area and view some of the flood damage.

August 18, 2002

Sunday was considered to be a free day for the group before the official program began. The delegation was met by Mr. Horin of the Czech Republic's Transport Research Centre and was guided throughout the city. Figure 1 shows the swollen Vltava River and the historic Charles Bridge.

Figure 1. Swollen Vltava River and the Charles Bridge

August 19, 2002

Because of the flooding in Prague, the scheduled meeting with officials from the Ministry of Transport was cancelled. A modified itinerary for the delegation was developed and is shown in Table 1. The group traveled to Brno and while in transit made

Table 1. Modified Schedule

19 Aug	Field trip / Bridges of Czech Motorways (Prague-Brno)
20 Aug	• Initial meeting with Director of CDV • Transport Research Centre: overview of activities • VTRC presentation of ITS, safety, other systems; project solved in VDOT • Roundtable discussion with /Brno townhall representatives and researchers from CDV • Information Technology, Technology Transfer at CDV
21 Aug	*Separate program for "Systems" and " technology" groups* • Systems Team: Visit of CDV branch, testing equipment, traffic sign laboratory, meeting with consultants • Technology Team: Visit of CDV laboratory, field trip
22 Aug	*Separate program for "Systems" and " technology" groups* • Systems Team: Field trip, Traffic Management Centre, meetings with Brno town hall representatives/experts • Technology Team: Discussions with Czech material experts (15-20 persons), presentation of VDOT activities
23 Aug	*Common program for entire team* • Field trip to one of the biggest construction sites in the Czech Republic: bypass of Olomouc, Middle Moravia • Closing meeting with Director of CDV, draft of conclusions

a number of field visits to concrete structures, both constructed and under construction. Figures 2 through 4 depict a few of the structures visited. The lower bridge in Figure 4 was constructed prior to World War II and survived intact. With the realignment of the motorway, a new bridge was constructed on top using the same substructure.

Figure 2. New Bridge Under Construction on Motorway to Brno

Figure 3. Concrete Structure on Motorway to Brno

Figure 4. Two-Tiered Concrete Structure

Also during our trip to Brno, we noticed that the concrete pavements were in good condition. The 30-year-old jointed pavements without dowels were performing satisfactorily except near Brno. Those near Brno were exhibiting faulting. An explanation was not provided for the difference in service; however, we surmise that it may be related to the subbase. Grinding had been used to improve the ride quality of the faulted slabs. Recent pavements are built with 15-foot joint spacing and with dowels.

We noticed stairs along the abutments to facilitate maintenance and inspections as shown in Figure 5.

We were informed that concrete pavements cost more than the asphalt pavements (about 4 times more based on initial cost); however, concrete pavements are economical because of their longer service life. In new construction, whenever there is a cut, concrete pavement is used, and whenever there is a fill, asphalt pavement is selected.

The trip to Brno also identified that the bridge decks are protected by an asphalt overlay system on top of a membrane placed on the concrete. Such a system is different than ours, where we benefit fully from a durable concrete. Efforts in the United States are directed at producing high performance concretes with non-corrosive reinforcement that will last a long time with minimal maintenance. It is worth comparing our technology (quality exposed concrete and noncorrosive reinforcement) with theirs (asphalt overlay and membrane).

Figure 5. Stairs Along the Abutments

August 20, 2002

The official program started on Tuesday with an overview of the Transport Research Centre's (CDV) activities. In the afternoon, a presentation on VTRC was made.

Transport Research Centre Overview

The CDV was officially established in 1992 and headquartered in Brno with a primary focus on infrastructure. The focus was later expanded to include issues related to traffic engineering. In 1996, the Czech Republic started the process of privatization of particular government functions. The CDV was successful in convincing the government of the need for an independent governmental transportation research facility.

Today, the CDV has a staffing of approximately 120 people with 11 areas of specialties. Some staff are located off premises, with 28 people located in Prague. The CDV's customers range from the Czech Republic, to private companies, to local or municipal governments.

During the discussion on funding, it appeared to the delegation that the technical assistance (TA)/consulting contract type projects of the CDV represents a significant portion of their funding. These TA projects are mostly traffic engineering and safety studies and are primarily conducted for the municipalities.

The CDV indicated that they are participating with the European Union (EU) on a number of projects, three of which are "gadget," which is to monitor changes in driver behavior; "safestor," which is to develop safety standards to road design and redesign; and "arrows," which is to investigate advanced research on road work zone safety standards in Europe.

After the overview, each section of the CDV provided its own overview. A select few of those sections' discussions follow.

Air Transport

This section's focus is on civilian air transportation. A major topic is environmental concerns. The effects of emissions from airplanes are integral components of determining whether an airport design is to be built. A staff member indicated that had the strict environmental laws been in place years ago, many of the motorways the Czech Republic has today would not have been constructed.

It was noted that the Czech Airlines have 20 Boeing 737s and two A320 Airbuses. These Airbuses operate close to 20 hours per day. With the CDV participating with the EU, they are trying to have the EU identify airport needs and look at secondary fields to use as overflow airfields.

Social and Human Aspect of Transport

This section deals with the social changes in transportation, which include changes in driver behavior. This includes the use of technology in vehicles, similar to the antilock braking system, and what might happen as the technology evolves and enters the mainstream. Other work ongoing in this section has to do with advertising on public rights of way. Figure 6 shows an example of billboards becoming common sights along the Czech Republic's motorways. During this discussion it was noted that a copy of the U.S. Highway Beautification Act, which deals with advertising on public rights of way, might be beneficial to the CDV in addressing this concern.

Figure 6. Example of Advertising on Right of Way

Bicycling

Bicycling is a vital form of transportation in the Czech Republic, and they are well advanced in providing dedicated cycling facilities. The CDV has been working to identify and establish bicycling demands, develop dedicated facilities, and develop a bicycle path design manual.

During a presentation by Ms. Pliskova, she indicated that they are able to succeed in championing bicycling because of their strong partnerships with other organizations, including the Department of Health.

Transport Safety

This section's main focus is the integration and expansion of road safety audits. Other work of the group includes the development of guidelines for roadway signing and marking, signing for work zones, integration of accident data with geographic information systems (GIS), and child safety restraint research. In addition, the CDV has work underway evaluating deer reflectors for reducing deer-vehicle accidents. Early reports indicate that these devices are quite successful.

This section also has an instrumented data collection vehicle outfitted with a global positioning system (GPS) receiver, two cameras, and infrared sensors. A demonstration of the vehicle was scheduled for later in the visit.

Virginia Transportation Research Council Overview

After lunch, Mr. Brich made a presentation to staff of the CDV on traffic engineering, safety, and advanced transportation systems research that is ongoing at the Virginia Transportation Research Council. Discussions on VTRC's organizational structure, staffing, and funding were raised during this part of the program.

August 21, 2002

The second day of the program was split into two portions: Technology (concrete and the infrastructure) and Systems (traffic engineering, safety, and ITS).

Technology Program

Dr. Ozyildirim and Mr. Sprinkel visited a tunnel being built under existing buildings as shown in Figure 7.

Figure 7. Tunnel Construction

Also on this day, Dr. Ozyildirim and Mr. Sprinkel visited the materials and structures laboratory near Brno. There were interesting research projects underway, one of which dealt with the use of acoustic emission equipment for corrosion monitoring. This was intended to determine if a strand has failed. A failing strand or the flaking of material on a corroded strand would make noise that can be detected. Also a corroded strand would have voids around it, which would provide a different emission compared with a solid section.

During this meeting it was also noted that they use fly ash in mass concrete to reduce heat. Blended cements are routinely used. Another interest was self-consolidating concrete (SCC). This concrete has been widely accepted and used in Europe. Virginia has ongoing projects developing SCC for bridge structures. New test procedures are needed for the control and acceptance of SCC. Segregation is an issue, and proper aggregate selection and grading are needed. Another concern is the resistance to freezing and thawing.

Another interest of the Czech Republic is lightweight aggregates. They indicated that long bridge structures in Norway and Sweden are constructed using lightweight aggregates.

Mr. Pospisil indicated that they have close cooperation with European organizations. A close working relationship with the Czech Republic would provide Virginia access to the European technology. Such a knowledge base would be very beneficial to our research efforts.

Systems Program

Traffic Engineering and Safety

During the morning portion of the program, a visit was made to a private materials testing company headed by Mr. Liskutin to discuss pavement marking and sign sheeting practices in the Czech Republic. This discussion was extremely useful in the transference of information and findings between the two countries. Reference was made during the conversations regarding EN–1463-1998, which is the European Retroreflective Road Test Study Method, which has wet reflective test methods for pavement markings.

Findings from these discussion indicate that the Czech Republic uses three grades of sign sheeting: (1) Engineering Grade material that specifies a 2º-observation angle and a maximum 40º-entrance angle, (2) high-intensity material that specifies a 2º-observation angle and a maximum 40º-entrance angle, and (3) prismatic materials that require performance at a 1.5º-observation angle and a maximum 40º-entrance angle. It was interesting to note that the prismatic materials are used only on motorways for overhead signs. The reason provided is so the sign can be seen at great distances.

Mr. Liskutin also stated that sheeting manufacturers are attempting to increase the use of prismatic materials and that technicians are reluctant. Technicians are seeing shortcomings in using prismatic materials, which is similar to the U.S. experience. Another comment was that manufacturers should warrant signing materials for at least 7 years. Virginia requires manufacturers to provide a 12-year warranty for glass-beaded materials and a 10-year warranty for prismatic materials.

Also discussed was performance-based pavement marking specifications. The Czech Republic has requirements that pavement markings be maintained at a level of 100 mcd/lx/m^2 or more. They feel that this minimum level of retroreflectivity is almost ensured by using larger intermix glass beads. It is very interesting to note that the performance-based specification requires that the material maintain this level of retroreflectivity even after snow plowing. Snowplow operations are under a bare pavement policy, but a rubber tip blade is used.

A short discussion on wet reflective pavement markings occurred. It appears that the Czech Republic uses structured or patterned pavement markings to provide wet reflectivity. In fact, these officials stated that structured or patterned materials are the only markings that are retroreflective when wet conditions exist. They also do not feel that the current European wet test method will work with paint or thermoplastic products. This is even true for materials with large glass beads. In fact, their comment was that "nothing works when the material is flooded." Figure 8A and B show the two types of materials used for wet reflectivity.

Figure 8A. Wet Reflective Patterned Material

Figure 8B. Wet Reflective Structured Material

One other item discussed was the type of sign substrate being used in the Czech Republic. Because of high levels of aluminum sign theft, the government changed the specifications to require a less expensive material (not aluminum). Unfortunately, the exact substrate was not known, but it was thought to be an iron-zinc compound. Figure 9 shows the testing equipment used to determine suitability of the substrate.

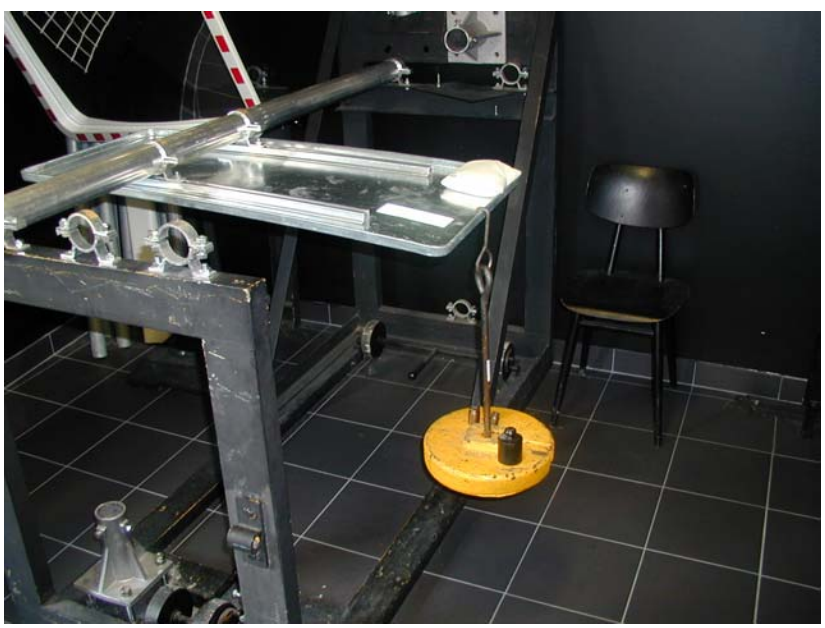

Figure 9. Sign Substrate Testing Equipment

Figure 10 shows this company's site for the exposure testing of sign sheeting materials.

Figure 10. Exposure Testing of Sign Sheeting Materials

The afternoon discussion was focused on the CDV's safety group with general discussions on the range and magnitude of their research.

Accidents (Safety Group)

Accidents increased in the Czech Republic after 1989 when it changed from a communist state. In 1998, the government introduced a speed limitation of 90 km/h that led to a decrease in accidents. Although the number of accidents decreased, the number of property damage only (PDO) accidents increased. Further discussions on this subject indicate that the CDV has attempted to introduce legislation that would increase efforts to enforce current laws.

The CDV has started to increase the emphasis being placed on filling out accident forms accurately. They have recognized that the quality of accident data is paramount in producing superior accident/safety studies. As a part of this effort, Mr. Anders showed a copy of New York's accident form. Unfortunately, Mr. Anders did not have the "code" sheet for the boxes used by police officers to provide additional information on the accident. The VTRC indicated that they would send a copy of Virginia's accident form (FR-300) as well as its code sheet. The CDV should be applauded in recognizing the need to change the accident reporting form, but it should be cautious not to make it too difficult. If it becomes too labor intensive, the police officers will not fill it out and/or the quality of the data received will suffer. This section is also interested in using GPS for locating accidents. They were already aware of the work conducted by the VTRC.

It was noted on the travel from Prague to Brno that the guardrail end treatments appeared similar to the "suicide" run-on sections that were prominent on roadways in the United States in the late 1960s through the early 1980s. Figure 11 depicts the typical run-on sections found on the Czech motorways. The CDV indicated that they had not conducted any research on guardrail related accidents or severity. It was noted that significant research has been undertaken in the United States to improve the crashworthiness of guardrail and some of this information would be forwarded to the CDV for their consideration.

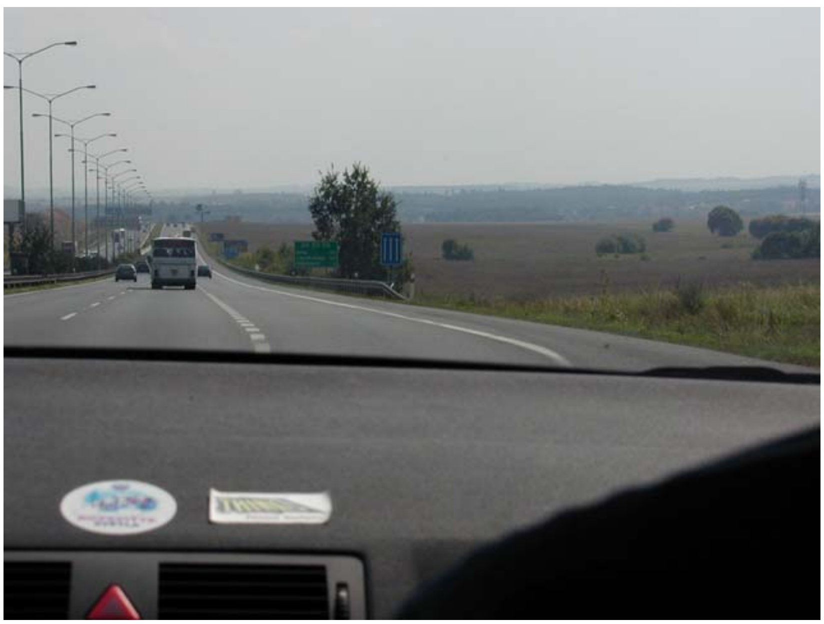

Figure 11. Typical Guardrail Run-On End Sections

Other safety discussions included truck escape ramp designs and other crash facts and statistics in Virginia. Based on these discussions, it was agreed that the VTRC would send copies of Virginia's FR-300 accident form and key, Virginia's most recent edition of *Crash Facts,* NCHRP-350 (Recommended Procedures for the Safety Performance Evaluation of Highway Features), and NCHRP Synthesis 178 on Truck Escape Ramps to Mr. Andes for his research. (A link to the Virginia Department of Transportation's *Road and Bridge Standards* for guardrails has already been forwarded to Mr. Andes via email.)

Discussions with another safety section staff member, Mr. Sklenar, were more focused on developing a methodology of accident/safety studies to ensure uniformity. During this discussion it was mentioned that developing a "toolbox" of countermeasures for use by local and municipal engineers would be a valuable asset.

The CDV's safety research activities are beginning to show that with the enforcement of speeds and current laws, accidents can be reduced. Hungary, for example, has similar accident rates, but when Hungary began strictly enforcing their highway laws, the accident rates decreased significantly.

Other safety discussions indicated there are a significant number of seat belt users, both front and back and both men and women, in rural area motorways. But the numbers are not the same in urban areas. In these areas, the use of seat belts could significantly decrease the number of injury accidents that continue to occur. The CDV believes that between enforcement and education to a target audience these usage rates can increase.

Instrumented Vehicle and Geographic Information Systems

The CDV has invested in an instrumented vehicle for safety and ITS-related research. Figures 12 through 14 show the vehicle and some of its amenities. The vehicle is outfitted with a 12-channel GPS receiver, two digital video cameras (one front, one rear), a distance-measuring instrument (DMI), and infrared sensors, all of which are linked directly to a notebook computer.

Figure 12. Instrumented Data Collection Vehicle

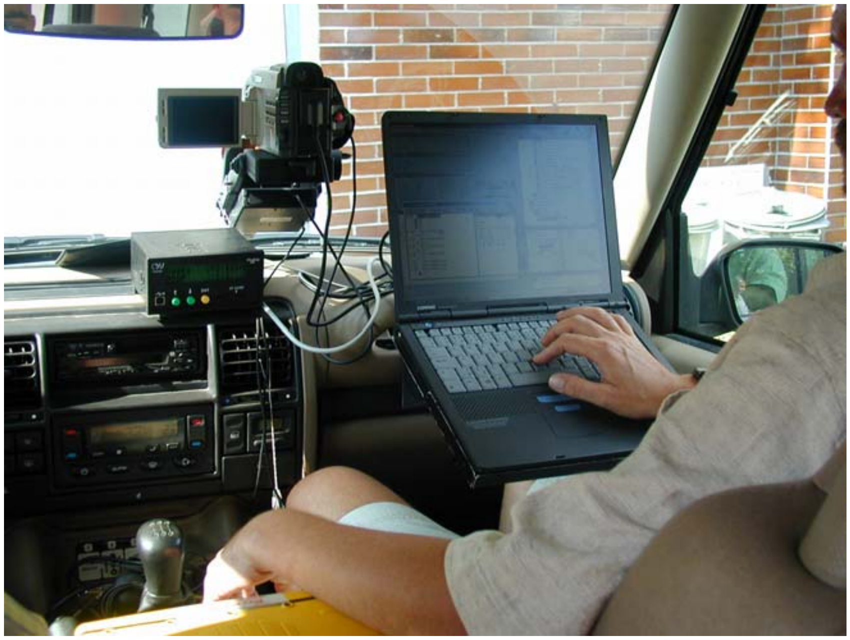

Figure 13. Digital Camera, DMI, and Notebook Computer

Figure 14. Infrared Sensors

With the digital cameras and the software developed, the vehicle is able to determine the headways of vehicles around it while in the traffic stream. The infrared sensors on both sides of the vehicle can capture a passing vehicle's speed and record this in real time on the computer.

The vehicle can also be used to collect an inventory of a roadway's assets (i.e., signs, signals, and markings). The digital camera in the front of the vehicle records the asset, and the computer operator codes the image in the database. Since the vehicle is outfitted with a GPS, the system automatically provides latitude and longitude coordinates based on the location of the asset. The system is able to perform this since the camera's field of view is calibrated prior to each run. The capabilities of the field inventory system would be an asset to a department of transportation attempting a sign inventory program.

The CDV received the GIS software and accident database shortly before the visit, and therefore it was not completely operational. However, this system, the accident database, and the instrumented vehicle will be a valuable tool to the CDV and the Czech Republic.

August 22, 2002

Technology Program

Mr. Sprinkel and Dr. Ozyildirim presented the VTRC activities to a group of Czech experts from the Ministry of Transportation, Industry, and the University. Virginia's research program including high performance concrete, corrosion resistant reinforcement, and repairs were explained. Pavements and bridge structures were covered and differences between our and their procedures were discussed. Several of which are enumerated below.

The most visible difference was the emphasis on durability to extend the service life of structures. Pozzolans (fly ash, silica fume) and slag are used to reduce the permeability of concrete. Proper design (adequate cover depth, proper drainage, minimum skews, more rigid superstructure), proper ingredients, and proper construction practices (adequate consolidation and curing) result in structures with extended service life. Bridge decks in Virginia are built with high-performance concrete (HPC) having low permeability and proper design and construction are emphasized. The decks are not covered with asphalt. In the Czech Republic concretes contain pozzolanic materials; however, the emphasis is to protect the concrete in decks and to protect the reinforcement by covering them with asphalt concrete and membranes.

Another difference noted was that in Virginia, HPC with high strength concretes up to 10,000 psi (69 MPa) are used in bridge beams leading to fewer beams in structures. Cost savings are achieved. In addition, these are concretes with very low water-cementitious ratios (as low as 0.28) and have very low permeabilities that are expected to lead to extended service life. Many bridge structures are built with high strength beams and low permeability concretes. A low permeability specification is available. Studies are continuing to prepare end result specifications, which will include low permeability, strength, and also construction related parameters such as cover depth, thickness, and rideability. The Czech Republic continues to use prescription specifications.

Virginia is also interested in HPC pavements and evaluating combined aggregate grading and larger size aggregate (2 inch = 50 mm) to reduce water and paste content. This would result in lower shrinkage in pavements. The Czech Republic constructs pavements in two layers with the upper layer having special requirements such as aggregate grading and resistance against polishing that can be classified as HPC, but is currently called "pavement concrete".

HPC lightweight concretes (HPCLW) with strengths of 8,000 psi (55 MPa) in beams and low permeability in bridge decks have been investigated and placed in a bridge structure that carries heavy loads. After a year, the performance is very good. With HPCLW long spans are expected, and these concretes have characteristics that are desirable in many applications such as internal curing (due to the water in the pores of the aggregate) and high creep and low modulus (desirable in crack control). The Czech Republic does not use HPLWC.

Another HPC characteristic evaluated is the self-consolidating concrete (SCC). SCC with high flow characteristics is very helpful in congested areas and thin members. SCC provides faster construction, smoother surface, requires less labor, and improves safety due to lack of vibrators. An arch bridge with 25 arches has been successfully constructed. There are some concerns with the air-void system, segregation, and shrinkage and are being investigated. The Czech Republic has had limited use of SCC.

Corrosion problems are costly to fix and are not uncommon to Virginia or the Czech Republic. In Virginia, HPC is widely used to minimize the intrusion of chlorides to the level of the reinforcing steel. Another protective system is to use reinforcement that is less likely to corrode. The reinforcement available are epoxy-coated steel (ECS), galvanized steel, epoxy-coated galvanized steel, specialty steel (MMFX), stainless steel clad, stainless steel, fiber reinforced plastics (FRP). Laboratory studies have been conducted on most of these systems and field applications are planned. The Czech Republic continues to use uncoated, plain steel reinforcement because of the high cost of ECS (three times more than black steel).

Repairs are costly and require special attention. One area that has been neglected is the grouts in post tensioning. Strands in tension are more prone to corrosion than the regular reinforcement. Their protection in ducts is very important. Problems with bleeding, shrinking and cracked grouts that lead to a loss in corrosion protection have prompted us to investigate and improve the grouts used in ducts. Another repair is shotcrete and we use it widely to repair our bridge piers, pier caps, and columns including vertical and overhead sections. For bridge decks that have spalls, extensive cracking, and delaminations due to corrosion, overlays are widely used. High quality overlays are placed over cleaned base concretes and are performing successfully. The Czech Republic has not used the newly developed high performance grout in post-tensioned tendons. Czech Republic uses high performance mortar and shotcrete, but there is no ongoing research in these areas. Concrete overlays are not used in the Czech Republic.

Intelligent Transportation Systems (ITS) at the CDV

The CDV established the ITS Department in 2000. Since its inception, this section has been involved in numerous projects in the Czech Republic and EU. These projects include the development of ITS Architecture and Electronic Toll Collection (ETC) for the Ministry of Transport. The ITS Architecture project is a 5-year project that focuses on intermodalism, rather than on the highway modes.

The electronic toll collection study is a 3-year study focusing on tolls for freight transportation on motorways. The first phase focused on reviewing work conducted by Austria, Germany, and Switzerland, which are each implementing different types of systems.

The CDV is also participating with ERTICO, which is the Association of Auto Industry. This group helps organize the ITS World Congress and participates with ITS America. The CDV's role here is to be a link between the Ministry of Transport and ERTICO.

Discussion of other activities within this section indicate they have been focused on becoming involved with other ITS activities in Europe and becoming a clearinghouse for ITS studies. Much of their time appears to be spent on developing and publishing the *ITS Revue,* which is a synthesis of activities occurring in the ITS community.

The ITS Section is participating in a large number of activities, but there does not seem to be a unified direction for the Czech Republic. When asked what the specific role of this group was, they stated that it is to set the direction for ITS in the Czech Republic. However, there does not appear to be a vision of ITS for the Czech Republic or a strategic plan on how to achieve a vision. A recommendation for this group might be to continue to synthesize information but to place more emphasis on the development of a strategic plan. This would aid in prioritizing potential research and deploying particular technologies that have high payoffs. Otherwise, ITS activities will continue to be "piecemealed" with no clear direction.

Visit of Control Center of Tunnels and Signals

The control center monitors two tunnels and 85 signals throughout Brno (Figure 15). The tunnel system monitors traffic via cameras inside and outside the tunnel. The cameras inside are fixed (zoom only), and the outside cameras have pan/tilt/zoom capabilities. Traffic speed and volume are monitored via inducted loops placed before the entrance. A computer system also monitors the environmental systems of the tunnel (air conditioning, ventilation, and lighting).

Figure 15. Tunnel and Signal System Control Center

Figure 16 shows the monitoring wall for the 85 signals. The signals are only monitored since the communication corporation is responsible for only the maintenance of these systems and not for their operation. It was interesting to learn that the police are responsible for the day-to-day operations of the signals. Most signals are actuated and have timing plans in place based on time of day and day of week. Timing plans are developed at the communication corporation and then sent to the Police Department to implement. (From an observation viewpoint, this process appears to require twice the number of people to perform the same function.)

Figure 16. Signal System Health Monitoring Wall

Brno Public Transportation Control Center

A tour of Brno's Public Transportation Control Center took place in the afternoon. This center serves Brno, which has 400,000 inhabitants and a ridership population of almost 1 million riders per day. This is handled with approximately 100 trams and more than 400 buses in the system at any given time. The headway for the buses during the peak period averages 30 seconds.

It was interesting to note that 20 years ago, public transportation had a captive ridership of almost 80 percent, and during the peak period almost 90 percent. However, with the change to a democratic form of government and the ability for increased personal vehicle ownership, transit ridership has dropped to 60 percent. This trend of decreasing ridership will likely continue.

Brno's public transportation agency will start a 2-year pilot project in October 2002 that will outfit approximately 550 vehicles with GPS to monitor the health of vehicles, allow communications with the vehicle for it to speed up or slow down, and locate the vehicle in the network at any given time. Motorola will be the contractor and will be supplying the equipment. The system is being designed to be expandable to include other elements, which could include providing information to passengers waiting in shelters or stops about the estimated time of arrival of the next tram or bus.

August 23, 2002

On the final day of the visit, the delegation had a common program to see the largest construction project in the Czech Republic: the bypass of Olomouc in Middle Moravia. This project involves both bridges and pavements. Figures 17 through 20 are a small selection of the photographs taken on this field visit.

During the tour, we were fortunate to watch a typical paving operation. Figure 17 shows the use of a two-stage construction technique. That is, in the same paver, two sections provide the two layers: a higher quality concrete over a base concrete. Thus, the wearing surface is made with a very high-quality concrete and is expected to provide long service. The paver inserted plastic coated dowels automatically. A curing compound is sprayed after the concrete is textured.

Figure 17. Pouring of Concrete Slab

The group was also taken to a bridge construction site. The bridge depicted in Figures 18 and 19 show a Norwegian technology that enabled the construction of a span in 12 days. Using normal procedures the time to construct the span would have been 1 month. Thus, speed of construction is an issue and can be achieved using new technologies. As with other bridges throughout the Czech Republic, the bridge decks on this project will have an asphalt overlay.

In the evening, the group had a closing discussion on potential research and technology transfer initiatives that might be undertaken. A full listing of these proposals are in Appendix A. A photo of VTRC's concrete experts is shown in Figure 20.

Figure 18. Bridge Over Railroad

Figure 19. Construction Activities of Structure

Figure 20. VTRC's Concrete Experts: Michael Sprinkel (left) and Celik Ozyildirim (right).

August 24, 2002

The group traveled in the morning from Brno to Prague to return to the United States. Figure 21 provides an aerial view of Prague and the Vltava River.

Figure 21. Aerial View of Prague and the Vltava River

Appendix A

VTRC/FHWA/CZECH REPUBLIC COOPERATIVE TECHNOLOGY TRANSFER RESEARCH PROJECTS

Technology Proposals

1. Evaluate Acoustic Emission to Locate Cracks in Concrete
2. Compare Performance of High Performance Concrete Bridge Deck with Membrane and Asphalt on Concrete Deck
3. Evaluate Self Consolidating Concrete in Bridge Superstructure
4. Develop Optimum Concrete Pavement Mixtures

Evaluate Acoustic Emission to Locate Cracks in Concrete

Objective and Scope

Evaluate the potential of acoustic emission to:

1. Define crack initiation and propagation.
2. Locate cracks.
3. Relate cracking to rate of corrosion and subsequent concrete spalling.

Background

The Czech Republic has an ongoing study that needs to be expanded. The rate of corrosion measurements do not accurately predict time to spalling of concrete

Estimated Funding

$15,000 for 3 years = $45,000.

Benefit

Rate of corrosion measurements do not accurately predict time to spalling of concrete. Better methods are needed to relate corrosion to time to spalling of concrete.

Compare Performance of High Performance Concrete Bridge Deck with Membrane and Asphalt on Concrete Deck

Objective and Scope

Construct and evaluate a high performance concrete bridge deck with:

1. low-permeability concrete

2. 66-mm cover over rebar
3. broom or burlap textured surface
4. option (high performance rebar)

Background

- Membrane and asphalt overlay is current Czech Republic practice, and high performance concrete bridge deck is current VDOT practice.
- Saw cut grooves on surface is current VDOT practice.
- Czech Republic has no alternative to membrane and asphalt overlay.
- VDOT has no alternative to saw cut grooves on exposed concrete surface.
- Saw cut grooves cause high traffic noise.

Estimated Funding

$30,000 for 3 years = $90,000.

Benefit

Alternative would lead to competition, reduced cost, and reduced noise.

Evaluate Self-Consolidating Concrete in Bridge Superstructure

Objective and Scope

Construct and evaluate self-consolidating concrete in bridge superstructure:

- Develop standards for acceptance and control of self-consolidating concrete.
- Evaluate various fines as filler material.
- Evaluate durability of mixtures.
- Use self-consolidating concrete in a bridge superstructure.
- Evaluate the superstructure.

Background

- Self -consolidating concrete being evaluated in Virginia.
- Use of self-consolidating concrete can reduce the cost of labor and equipment required to place concrete

Estimated Funding

$30,000 for 3 years = $90,000.

Benefit

The use of self-consolidating concrete can reduce the cost of labor and equipment required to place concrete.

Develop Optimum Concrete Pavement Mixtures

Objective and Scope

Develop optimum concrete pavement mixtures:

- Identify aggregate gradations that are uniform and minimize shrinkage.
- Identify mixture proportions that maximize the stiffness of concrete pavements.

Background

- VDOT is developing aggregate gradations that are uniform and minimize shrinkage aggregate gradations.
- The Czech Republic is using concrete mixtures that provide high stiffness.
- Jointed concrete pavements in the Czech Republic are performing well over 30 years

Estimated Funding

$20,000 for 3 years = $60,000.

Benefit

The use of high-strength, low-shrinkage concrete mixtures in pavements should increase the life of concrete pavements.

Systems Potential Research

1. Innovations in Pedestrian Safety

With the Czech government assigning an increased importance to motorists to stop at pedestrian crossings through the use of red pavement markings in crosswalks, this passive measure has given a false sense of security/safety to the pedestrian. As a result, there has been an increase in fatalities and serious injuries. There is an opportunity to evaluate innovative treatments (active and passive) collaboratively to determine their effectiveness.

2. Fog/Adverse Weather and Driver Behavior

Utilize off-the-shelf technology to (1) identify fog conditions and alert DOTs and incident response personnel, (2) alert motorists about the fog condition by using VMS signs and/or radio, and (3) evaluate in-pavement technologies (lights or sequencing of lights) to elicit a response from drivers. This test can evaluate the speed of sequencing the lights based on vehicle speeds. The product of this research could be to develop an algorithm that uses the environmental condition (density of the fog) and speed of the vehicle to determine the cycling rate of lights.

3. Wet Reflective Pavement Markings

The Czech Republic has a number of marking manufacturers that are not represented in the United States. There is an opportunity to test a number of materials under varying actual rain events. Evaluations can also be made after winter maintenance activities occur.

Technology Transfer to the Czech Republic

1. Guardrail End Treatments and Crashworthiness Research

There could be a simple transference of NCHRP-350 and VDOT end treatment designs.

2. U.S. Federal Highway Beautification Act

The Czech Republic is beginning to experience the same effects the United States felt as economy and travel increased. This included the advertisement of products and services on their mainline roadways. Providing a copy of the Highway Beautification Act of 1954 could provide the framework for the Legislative Section of the CDV to take a proactive measure in eliminating/reducing advertising on particular types of roadways.

3. LED Traffic Signal Retrofit

Many U.S. states, Virginia included, have a retrofit program to reduce power consumption, maintenance, and costs for signals. For example, traditional incandescent light bulbs are 135 watts and last for 2 years. LED units average between 15 and 19 watts, depending on the color, and last 8 to 10 years. Although there is a higher initial cost, this retrofit program has reduced maintenance and power consumption. In fact, VDOT has found that this program pays for itself in approximately 3 years. This program would be a win for the Czech Republic because of their strong environmental activism and their desire for sustainable developments.