NEVADA DOT Research and Technology REVIEW

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Transportation Engineering Program and Research at the University of Nevada, Reno

The Transportation Engineering Program and the Transportation Research Group at the University of Nevada, Reno (UNR) were established in 2004 by Dr. Zong Tian when he joined the Department of Civil and Environmental Engineering. The program has emerged into a regionally recognized entity for its reputation in applied transportation engineering research. The Transportation Engineering program is interdisciplinary in nature with close collaboration with other departments at UNR and institutions beyond UNR.

The program focuses on applied research and technology transfer in all aspects of transportation, although the majority of the projects are in the areas of traffic operations and traffic safety. Tools and products which resulted from the research projects have been applied to help NDOT and local agencies solve real-world transportation problems. Graduate students produce technical reports and papers based on their research. Numerous awards have been received by the graduate students at both regional and national levels.

In This Issue:

Research Capabilities and Focus Areas

Diverse research efforts within the Transportation Engineering program at UNR focus on addressing imminent transportation issues in the State of Nevada. The group envisions a close collaboration with Nevada DOT. The Transportation Research Group has emerged into one faculty, one adjunct faculty, two post-doctoral researchers, five Ph.D. students and three M.S. students. Competitive research awards have exceeded $2 million.
The primary research areas include:

- Traffic operations (signal control systems, traffic simulation),
- Traffic safety, and
- Transportation economics and policy.

Dr. Zong Tian, the program director, is very active in various national and international academic organizations. He is a member of two renowned committees of the Transportation Research Board (TRB): the Highway Capacity and Quality of Service Committee and the Traffic Signal Systems Committee. His service brings cutting-edge knowledge on advanced transportation technologies and research in the areas of signal control systems and highway capacity analysis.

Advanced Transportation Engineering Lab

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The Transportation Program at UNR is further enabled by advanced facilities and software tools used to conduct various research projects. The Advanced Transportation Engineering Lab, which was recently established has a space of about 800 square feet, which houses 12 computer stations, six advanced NEMA and 2,070 traffic signal controllers. All major traffic engineering software has been made available in the lab. These include Synchro/SimTraffic, VISSIM/VISUM, CORSIM, TransCAD/TransModeler, HCS, and Traffix. The lab will continue to develop and is envisioned to be a major research and education facility in the region focusing on traffic signal control systems. All the signal controllers are able to connect with computer stations using the hardware-in-the-loop technology which allow testing real signal control solutions in a lab environment.

Technology Transfer Successes

The program has a strong focus on applied research and technology transfer to ensure research results be implemented to improve the State and regional transportation systems. Examples of such technology transfer activities include application of diamond interchange control strategies at a number of locations in the Reno-Sparks area, application of index-based new left-turn control guidelines on converting from protected-only to protected-permissive flashing-yellow-arrow control at selected intersections in the Reno-Sparks, Carson City areas. The research efforts have resulted in over 50 publications and presentations at regional, national and international conferences.

Research Collaborations and Partnerships

Members of the Transportation Research Group have collaborated with researchers and scholars across UNR, UNLV and research institutions in other states. Such collaborations allow best use of resources, thus delivering high quality research products with minimal costs. Examples of collaborating partners within UNR include Department of Computer Science, Department of Electrical Engineering, Department of Business, Department of Geography, and Department of Political Science. Collaborating partners outside UNR include University of California at Berkeley, Siemens ITS, TransCore, and Iteris.

Awards

Graduate students in the Transportation Engineering Program have won major awards from regional and national transportation organizations. Most awards are in student paper competitions and have received spotlights at major conferences. Highlights of these student awards include:

- Dan Fambro Best Student Paper Award by ITE International,
- Best Student Essay Competition by ITS America
- Best Student Paper Award by ITE Western District
- Best Student Paper Award by ITE Intermountain Section
- Best Student Paper Award by UNR Graduate Student Association

Current NDOT employee Xuan Wang receives the Dan Fambro Best Student Paper Award from ITE International

Future Development

Establishment of the Center for Advanced Transportation Education and Research (CATER) at UNR has been proposed and is under consideration by the provost. The center will significantly enhance transportation education and research at UNR. The center will be composed of faculty and staff from several departments at UNR. The theme of the center is “development of efficient, sustainable, and environmentally friendly transportation systems”. The vision is “a focal research and education center in the desert southwest region (primarily covering Nevada, California, Utah, Arizona, and New Mexico) that emphasizes interdisciplinary collaboration in applied transportation research.” The mission includes: (1) develop operationally efficient, economically sustainable, and environmentally friendly transportation systems for the state of Nevada, the desert southwest region, and the United States; (2) educate the next generation of transportation professionals with advanced technical skills and strong professional motivations.

The center will include three research groups: Transportation Systems and Operations; Transportation Planning and Policy; and Advanced Technologies and Applications.

An Evaluation of the Detour System for I-15 North Design-Build Project

Principal Investigators: Pushkin Kachroo, Ph.D., P. E. & Neveen Shlayan

Objectives

This Nevada DOT sponsored study at the University of Nevada, Las Vegas examined many aspects of the I-15 North Design-Build project including traffic management during construction, public outreach, construction zone rules and specifications, and safety. Evaluation through qualitative analysis was performed. Literature survey research that covered a wide range of key construction zone studies was conducted to provide, general and area-specific, best practices and lessons learned.

Data collection and general analysis were initially conducted. Regular meetings were held with several agencies such as the Freeway and Arterial System of Transportation (FAST), North Corridor Construction (NCC) contractor, a joint-venture between Las Vegas Paving Corporation and engineering firm CH2M Hill, Jacobs, and NDOT. This study began after the construction project was completed. This introduced some shortcomings, particularly regarding data. Manual data collection was not possible since the project had ended. Furthermore, relevant FAST detectors were not in operation during the I-15 North construction period. Therefore, traffic data as well as other types of data were not available for quantitative analysis. Data is currently being gathered on I-15 South in order to perform quantitative studies for the I-15 S Design Build project. This will lead to more conclusive results and tools development for future construction projects.

Detailed meetings were conducted with multiple agencies in order to extract as many details as possible. It was found that many key strategies that were used on the I-15 North contributed to the success of the project. These strategies can be structured, further studied, and implemented in future construction projects.

Findings and Recommendations

Communications among Agencies: Traffic management teams were formed which included various agencies such as FAST Traffic Management Center (TMC), Nevada Highway Patrol (NHP), NCC, and media, etc. Weekly meetings were held in order to discuss issues of the week in order to come up with immediate solutions. This tremendously improved communications and resulted in significant benefits in resolving ongoing issues in a timely manner.

Public Outreach: Drivers were targeted through media: faxes website, billboards, TV, and mail. Businesses and residents in the region were sent notices, emails, faxs, and letters suggesting alternate routes. Sticky notes were also posted on the local newspapers. This method has proven to be a very effective public outreach method and one of the cheapest methods.

Rules Flexibility: Initially, it was agreed upon to keep three lanes open in both directions throughout the duration of the construction project. The project originally had three phases where each phase was composed of reconstruction subprojects across all segments. Furthermore, the contractor had to abide by rules relating to other construction work that was taking place in conjunction. The construction period under this strategy was estimated to last a minimum of three years.

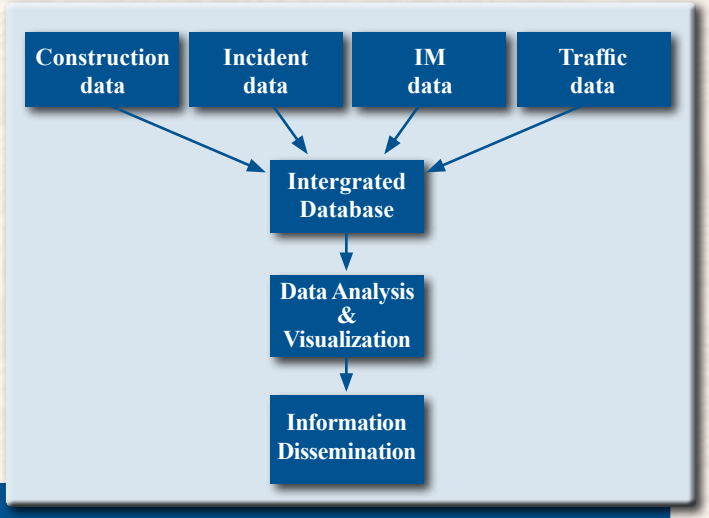

Figure 1: Intergrated Analysis and Visually Interactive Database (IAVID) for Transportation Systems

NDOT, however, realized the need for a more aggressive plan due to the fact that I-15 supports large traffic volumes and such a long period would not have been feasible. Therefore, a new aggressive plan was devised and implemented which had only two phases. However, it required the closure of a minimum of two lanes at a time. The new plan was expected to reduce the period of the project by five months. The situation became a question of whether accommodating less traffic for a shorter period of time would be more beneficial than accommodating slightly more traffic due to lengthening the project's duration.

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Detour Placement Stages

The main concern of the traffic management teams was where to divert the traffic. The following are some stages that were taken into consideration when placing detours and managing traffic signal timings for detours and other surface streets.

Detour Planning Stage

Traffic Evaluation: After the project's design, schedules as well as ramp and lane closure specifications were put in place; it was necessary to determine how much traffic volume the corridor could handle during construction and how much traffic needed to be diverted. NDOT, Regional Transportation Commission (RTC), and FAST were the main organizations to determine traffic flow demand and requirements for the construction project.

Type of traffic: Two types of traffic were considered: commuters as well as trucking and transport industry.

Traffic demand: It was found that prior to the start of the construction project, 170,000 commuters used the I-15 and 317,000 commuters used some of the alternate routes. Through traffic studies, these agencies together with NCC traffic engineers, established that a 30 percent reduction in traffic volume was needed for a successful completion of the project within the desired timeframe.

Area Evaluation

School zones: When placing detours and alternate routes, school zones were a major factor in choosing one detour vs. another. Ultimately, the goal was to get as close as possible to user equilibrium.

Truck stations: Another significant factor that traffic management teams had to take into consideration was truck volume. Truck volume was estimated to be 20 percent of total traffic. The high truck volume was due to the fact that there were multiple truck stations, stops, and inspection services in the region under construction.

No-truck zones: What makes truck traffic so special is that it cannot be detoured to any surface street. For example, trucks may not be allowed on certain arterials. Furthermore, it is not recommended to divert truck traffic to arterials that are school-zone intensive since it would degrade safety and increase delays.

Concurrent projects: The Design-Build team was also aware of other construction projects that were taking place in the region concurrently. This awareness was vital in order to avoid diverting traffic to roads that were under construction.

Detour Plans Placement

Coordination with construction schedule: Regular communications took place between personnel that were placing the detours and those that were monitoring the construction events and schedule. Information regarding times of construction, locations, lane and ramp closures, etc. was communicated in order to implement the appropriate detour plans at the right time.

Main plans placement: Main detours were the primary routes that were determined to be most suitable.

Secondary plans placement: Secondary plans were also prepared to handle unexpected traffic conditions.

Detour Implementation: The following were the identified detour implementation stages: (a) Location identification, (b) Signage, (c) Signal timing plans, and (d) Evaluation and testing plans.

FAST's Role in Detour Planning and Implementation

Throughout the project, FAST's responsibilities were: implementing signal timing on any signals affected by the construction on I-15, detour routes and traffic, assisting in setting up the detour (using the NCC monthly planned construction bimonthly meetings to facilitate this), and providing maintenance and suggestions.

A long-term detour was needed. The detour involving Charleston Blvd. was eliminated since it was over-congested. The North Las Vegas Blvd. route was also too congested and consequently was eliminated. Below is the reasoning behind placing the main detours.

Detour 1: This detour was placed in order to divert traffic going from 95 North to I-15 North due to the closure of the connecting ramp. Another consideration was that the North Lake Mead Blvd. ramp was also going to be shut down. The estimated time for these closures was three months.

Detour 2: Drivers could take Washington Ave., D Street, Lamb Blvd. then I-15 from Las Vegas Blvd. northwest on Washington Ave.

Detour 3: Approximately 25 percent of trucks took this detour. This detour had many advantages such as existing

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lower volume (based on observation), high capacity, two to three lanes each direction, and protected left turn movement. Finally, North Lamb Blvd. was an official state route already which was very appropriate for truck traffic.

Detour 4: In case drivers missed the detour routes near the spaghetti bowl and arrived to the closed ramp they would have to take the next exit and turn around.

Transportation Research Center (TRC) at UNLV, In-house Hardware and Software Products

Major construction projects are currently taking place in Las Vegas such as I-15 South and more are planned in the future. A significant portion of the freeway that is under construction is covered by detectors. However, additional tools are needed in order to perform thorough qualitative analysis accommodating the large amounts of construction data. Furthermore, data collection tools are needed for arterial streets and freeway stretches that are not covered by detectors.

Construction Database: Integrated Analysis and Visually Interactive Database (IAVID), for transportation systems is under development. Construction data is being collected that includes microscopic and macroscopic levels of information. This data is being integrated in IAVID allowing data overlay for methodical analysis.
[Figure 1: Integrated Analysis and Visually Interactive Database (IAVID) for Transportation Systems]

Data Gathering iPhone Application: Traffic data collection is needed at certain arterial or freeway roads Figure 2:with no detector coverage. An iPhone application has been developed, as depicted in Figure 2, for this purpose and is already in use. The application collects video, longitude, latitude, and speed data. This can be used as a tool to conduct travel runs. However, with further development, this tool can be used as a real time traffic sensor.

Application Icon Application

Figure 2: Data Gathering iPhone application

Travel Run Data Collection System: A laptop based data collection system, as depicted in Figure 3, has been developed to conduct travel runs as well. This system consists of a GPS, two cameras, and an inertial navigation system. Video, longitude, latitude, rotation and acceleration information can be gathered.

Figure 3: Travel RunsData Collection System

Analysis

The following types of analysis are planned:

Quantitative traffic data analysis in combination with crash data: An integrated database that combines traffic, incidents, and construction data is under development. This data will be analyzed based on traffic and safety evaluation.

Qualitative public commentary data analysis: Specialized analysis software will be used in order to quantify qualitative information such as public reviews.

DynusT Simulations: Based on the traffic data being collected, especially from FAST, online calibration data software has been developed in order to calibrate the I-15 model in DynusT. This model will be used to conduct simulations on various construction scenarios.

PRODUCT EVALUATION
VENDOR PRESENTATIONS

PRODUCT EVALUATION COMMITTEE (PEC) DECEMBER 7, 2010 MEETING SUMMARY

The Qualified Products List category 624.03.03 Reflective Sheeting (for Flagger Paddles) was eliminated because it has become redundant due to ASTM and Federal Highway Administration changes to reflective sheeting standards. This category will now be covered under category 716.03.01 Reflective Sheeting.

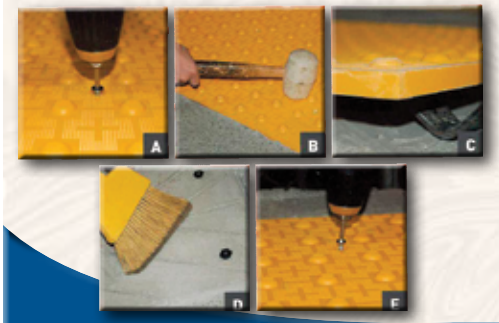
The original approval of McTech Ultra-Cure Curing Blanket was rescinded primarily due to apparent limitations of the product to meet NDOT's deck curing specifications that require pre-wetted covers placed soon after the final pass of the deck finishing machine. Subsequently additional feedback from NDOT personnel and the manufacturer has shown that the product can in fact be used in conformance with specifications. Revisions to specifications section 501 will allow use of the alternate curing blankets. Regardless of the curing system used, the specifications will require use of a soaker system to ensure the deck is continuously wetted during the 10-day cure and placed soon after the final pass of the deck finishing machine.

Accessible Detectable Warning System (DWS)

A replaceable system of tactile panels is manufactured by Access Products Incorporated and is used in 50 states, approved for use in 40 State DOTs, is sole sourced in Montana and Kansas, and is the only approved replaceable product in Michigan.

The advantages of this system are its exceptional value, replaceability, installs in minutes, superior performance (no fading and no cracking), durability, and audible detection.

Concrete pavers cost approximately $17.00-24.00/per square foot as opposed to $11.00-12.95/ per square foot for Access panels.



Even though the panels are installed in wet cement, the panels can be removed or replaced in approximately 5 minutes. Their design minimizes contractor error.

The 2'x4' panels come in a range of colors and weigh about 3 pounds per square foot. The panels can be cut to match the roadway or sidewalk design with the ability to add or remove anchors as needed. Nylon replaceable anchors are used to prevent stripping and rust.

There are over one million square feet in the field. The panels have been manufactured for over three years with no failures. More information at: *http://www.accessproducts.com/*

Autosock

The Autosock was developed in 1996 by a Norwegian company. It is a traction device used on both automobiles and trucks, in lieu of tire chains, to achieve grip on snow and ice. The product is quick and easy to fit and remove (approximately 5 minutes); does not impede vehicle electronics, traction control systems, or anti skid devices (e.g., ABS); provides greater safety to the driver fitting and removing the snow traction device; is lightweight (between 2-5 pounds); quiet; recyclable; does not cause damage to rims, suspension, or body; usable with alloy rims; and is reusable and machine washable.

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Two concerns were noted: 1) How to determine that the product has failed, as the product is very quiet and will not produce the clang of a broken chain. The answer is that the Autosock turns black when the product fails or begins losing traction on the roadway. And 2) How well the Autosock works in deep snow. This is an acknowledged limitation without a suitable answer.

The cost of a pair of 1100R24.5 high quality truck chains is approximately $300.00 versus the cost of a similar pair of Autosocks at $226.00.

Various test results and endorsement information are available at *http://www.autosock.us.*

Glass Fiber Reinforces Plastics Composite Rebars

Glass Fiber Reinforced Plastics (GFRP) Composite Rebars have been available for 27 years in Europe and the Middle East; however, it has only been available in Canada and the United States for two years. The manufacturing plants are located in New Zealand and Dubai.

The composite advantages are the product is non-thermal, impervious to water and corrosive environments; cutable; and is a cost-effective solution to epoxy coated steel, stainless steel, stainless steel cladding, MMFX, and other GFRP bars. The composites have a low carbon footprint with recycled material that can be ground up and reused (Leadership in Energy and Environmental Design (LEED) certified); and non-magnetic transparency to radio waves and electrical currents. The rebars can be used in new projects or retrofitted projects. The resin is combined with an Electron Cyclotron Resonance (ECR) glass during pultrusion. Per Pultron's web site, the product is:

- **STRONG** - Having a high tensile and flexural strength, with a specific strength exceeding that of steel.
- **LIGHT WEIGHT** - With a specific gravity of approximately 1.8, a density 1/4 that of steel and 2/3 that of aluminium.
- **DIMENSIONALLY ACCURATE** - Manufactured to fine tolerances.
- **COLOURFUL** - Blended in colours which permeate each section, eliminating the need for painting. However, painting is also an option.
- **NON-CONDUCTIVE** - Providing excellent electrical and thermal insulation.
- **CORROSION / CHEMICAL RESISTANTANCE** - Offering resistance to corrosive media such as salts, acids and alkalis over a wide temperature and concentration range.

In addition, the product offers a modulus of elasticity to allow for movement. Cold and heat does not affect the product. The need for cathodic protection is eliminated.

A test was conducted in Boise, Idaho (Franklin to Gary Street) to check the alignment of the rebar after the concrete was poured. While the concrete was still wet, it was uncovered. Underneath the bars were 100% aligned. The concrete was then replaced and allowed to cure. FHWA feedback stated "very open to composites for roads because it works better than steel."

Other state roadway approvals include Idaho, Virginia, New Jersey, Louisiana, and Utah with New York and Washington's approval expected in the spring. Three bridge installations are scheduled for next year (2 in Maine and 1 in Idaho). Virginia banned epoxy coated steel in all their new structures and by June, Mateen will be the defacto company of choice competing against MMFX stainless steel and stainless steel clad. For more information go to: *http://www.pultron.com*

TRIAXTM Geogrid

Tensar International has made new, innovative changes to their Geogrids. The Biaxial geogrid has been manufactured for 30 years in Buffalo, New York, but recently a design change occurred. The new product, TriAxTM geogrid, was introduced to NDOT project 3389 in Reno, Nevada. The new product can be used on project designs for stormwater, drainage, bridge decks, and earth stabilization. It offers greater stabilization through a triangular grid aperture, coupled with an increase in rib thickness and junction efficiency. The multi-directional properties leverage the triangular geometry to provide a new level of in-plane stiffness, increase aggregate confinement, dissipates radial stress imparted by in-service loads, and enhances the "snowshoe effect" over soft subgrades by locking aggregate particles during the compaction effort. Other research is available upon request at: *http://www.tensarcorp.com/TriAx/*

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NDOT's crews save $529,200.00 in 2010!

Special thanks to the following NDOT crews whose hard work and innovative product solutions lead to graffiti clean-up and removal in 2010!

CONSTRUCTION AIDS CREW 160:
CHERYL CARLO, CARLOS EASTERLING, JORG GAMBECK, DANIEL GREEN, ANDREW JACKSON, BERT LUCAS, DEMETRUS, FAITH PATEA, GUS POMPA-GAZPAR, JULIE RANSOM, GILBERT SEALS, MARKELL SULLIVAN, EZEQUIEL VARELA, CHARLIE WHITE, ED TAFOYA

LANDSCAPE CREW 145:
JOHN RIGGS, VINCE RUIZ, GEORGE ELLING, ROBERTO FRANCESCHI, JOE GARCIA, EUGINA CROFT, ELAINE JONES, RICHARD KNUDSEN, CRUZ ONTIVEROS, AARON LINEBARGER, KENNETH BRIDGEWATER

GRAFFITI CREW 145:
VINCE RUIZ, ROBERTO FRANCESCHI, RICHARD KNUDSEN, CRUZ ONTIVEROS, AARON LINEBARGER, KENNETH BRIDGEWATER

BRIDGE CREW 155:
DARRIN TURNER, MARIO THOMPSON, DAMON HENDERSON (BRENTON SMITH NOT IN PICTURE)

Library Corner

The library is here to help! It holds a large selection of magazines, journals, study materials, and publications from AASHTO, FHWA, TRB, TRR, and US DOT. If the library doesn't have what you want, the librarian can get it! We can purchase items for the library that you feel would be beneficial for everyone to have access to as well! The library is located in room 115 of the NDOT Headquarters building.

American Society of Civil Engineers Electronic Journal Access

This library of journals is accessible at each of your workstations authenticated by an IP Address (NDOT employees only). This means that by accessing this URL, *(http://www.ascelibrary.org/)*, you will have access to approximately 73,000 papers.
If you are in need of assistance, don't hesitate to email, call or visit the librarian: Sena Loyd, ***sloyd@dot.state.nv.us***, 775-888-7895, Research Library Room #115, 1263 S. Stewart Street, Carson City, NV 89712.

When requesting articles or other materials from the library please include as much of the following information you can:
• Author • Year • Article Title • Journal Title
• Volume Number • Issue Number • Page Numbers (inclusive)
• Subject • Any other information you think might help!

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The NDOT Research Section administers the NDOT's research, development and technology transfer program and serves as the "clearing-house" for product evaluations.
Research and Technology Review is published quarterly by the NDOT Research Section. Its purpose is to provide the latest information on the NDOT research activities including product information and other pertinent research topics.

If you have comments or need additional information regarding any of the topics discussed in this issue, please contact the Research Section.
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