RESEARCH news 2014

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Massena bridge slide

James Nelson, Office of Bridges and Structures, Iowa DOT

The Iowa DOT recently completed a demonstration project of a lateral bridge slide that was an accelerated bridge construction (ABC) technique. A lateral bridge slide is accomplished by constructing the new bridge superstructure on temporary supports adjacent to the existing bridge. Once the new bridge superstructure has been completed, the roadway is closed and the existing bridge is demolished to make way for the new bridge. New foundations are constructed and the new superstructure is laterally slid into its final position. This ABC technique has the benefit of significantly reducing the duration of the roadway closure for bridge construction.

The demonstration project, located just west of Massena on Iowa 9, was completed Oct. 6, 2013, and was accomplished in a nine-day roadway closure. During the closure, traffic was routed on a 13-mile detour, of which, 7 miles was out-of-distance travel. With traditional construction methods the detour would have been in effect for four to six months depending on weather conditions and contractor productivity. The design included details for sliding the bridge on stainless steel bearings and Teflon pads, but the specification was open to contractor proposal of alternate sliding methods.

The winning bidder for this project, Herberger Construction Co. Inc. from Indianola, Iowa, proposed using heavy-duty rollers to roll the bridge into position. The bridge roll started the evening of Sept. 30, 2013, and after 6.5 hours the roll was completed early in the morning on Oct. 1, 2013. With the new bridge in position, the contractor was able to place precast wing walls, backfill the approach excavation, cast concrete for the approach roadway, and install the safety guardrail to complete the construction.

The project included research performed by Iowa State University's Bridge Engineering Center to verify design assumptions related to the sliding pads and the pile to precast abutment footing connection. The static and kinetic coefficient of friction was tested for the slide system using both a plain Teflon pad and a lubricated Teflon pad. For the pile connection, the research testing built on testing previously conducted in 2006 to expand the base of knowledge to larger piling and also test pile anchor options. The current project utilized HP 14 x 117 steel piling, which were more than twice as large as the piling tested in the 2006 testing. Three different pile anchor options were tested, including using welded stud, a high-strength threaded rod, and finally a plain pile. The testing conducted was instrumental in answering questions for the bridge designers.

This demonstration project showed that the lateral bridge slide technique is a viable ABC technique for Iowa to reduce the duration of roadway construction inconvenience and save money. While the construction cost premium on this ABC technique was about $300,000, the Iowa DOT estimates it saved the roadway users more than $400,000 in costs associated with the out-of-distance detour travel, not to mention the time and inconvenience. After project completion, an online customer satisfaction survey completed by local road users and residents showed overwhelming support for this new way of building bridges faster, safer, and with less inconvenience.

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Additional information is available in the Massena bridge full report.

Photos taken during the Massena bridge project.

Rapid bridge deck joint repair investigation

James Nelson, Office of Bridges and Structures, Iowa DOT

There are 4,092 bridges on the Primary Road System that the Iowa DOT is responsible for and more than 24,000 bridges total in Iowa. Of the bridges that the Iowa DOT is responsible for, 1,065 have deck joints that accommodate thermal expansion and contraction of the bridge superstructure.

A sliding plate deck expansion joint with advanced deterioration.

Typically, the joints are constructed to be waterproof or to capture rain and snowmelt runoff in order to protect the underlying bridge beams and bridge substructure from moisture and deicing chemicals. Many bridge deck joints face harsh conditions with traffic impact and heavy exposure to moisture and deicing chemicals that can damage and degrade the joints and the concrete surrounding the joints.

Once the joints fail, the bridge beams and substructure are exposed to moisture and deicing chemicals that can degrade the structure and greatly shorten the bridge service life.

With average bridge age on the primary system approaching 38 years, many bridges face the need for deck joint repair or replacement. Additionally, many of these bridges are in high traffic areas or have narrow width that makes staged replacement difficult and inconvenient for the Iowa DOT's transportation customers. Quick and effective bridge deck joint repair and replacement techniques are needed now more than ever.

The Iowa DOT has teamed up with Iowa State University to develop rapid, effective, and economical approaches to repairing and replacing bridge deck joints. This new research includes investigating deterioration patterns, observing current repair and replacement construction practices, and hosting a rapid bridge deck joint repair investigation workshop.

The workshop held Dec. 4, 2013, brought together experts in bridge deck joint design, construction, and maintenance to identify best practices and brainstorm ideas for improvement. The research will benefit the Iowa DOT and local systems bridge owners with aging deck joints. The project's principal investigator is Dr. Charles Jahren from Iowa State University. Look for future research publications on this timely and important topic.

A sliding plate deck expansion joint being replaced using hydrodemolition technique.

Statewide heavy truck crash assessment

Zach Hans, InTrans, Iowa State University

In 2010, the percentage of fatal crashes in Iowa involving heavy trucks was nearly twice the national average, 16.5 percent compared to 7.8 percent, while heavy trucks represented less than 12 percent of the annual vehicle-miles traveled. Additionally, only approximately 16 percent of the resulting fatalities involved the occupants of the heavy vehicles. Given the severe nature of heavy truck crashes and the serious impact they can have on the general traveling public, the statewide heavy truck crash assessment was initiated in August 2012. The primary objective of this study was to investigate the causes and other factors associated with heavy truck crashes, both independently and in conjunction with pertinent commercial driver's licensing and enforcement-related efforts in the state. Law enforcement agencies may potentially be able to utilize the results of this study when establishing safety programs.

Descriptive analysis, statistical tests, and statistical modeling have been conducted to identify the factors that contribute to heavy truck crash severity outcomes and corresponding magnitude of the effect each factor possesses. These analyses were conducted separately for single- and multiple-vehicle crashes in Iowa involving two-axle, six-tire, single-unit trucks; three or more axle single-unit trucks; and combination trucks from 2007 and 2012.

Some of the factors contributing to heavy truck crash severity outcomes in Iowa include time of day, day of week, season, and roadway and environmental characteristics. For example, both early morning (5 to 8 a.m.) and midday hours (11 a.m. to 2 p.m.) where found to increase the probability of severe crashes involving multiple vehicles, while late afternoon and early evening hours (3 to 6 p.m.) were found to increase the probability of no injury crashes. Crashes at the beginning of the week and over the weekend were found to increase the probability of a severe, multiple-vehicle crash. Single-vehicle heavy truck crashes during the summer (June, July, or August) were also found more likely to result in an injury.

Winter weather road conditions, such as snow, slush, or ice, were found to increase the probability of lower-severity crashes. Moreover, the probability of fatal or major injury crashes decreased during rainfall events. In other words, there is a positive relationship between lower crash severities outcomes and adverse weather conditions.

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Lastly, speed-related factors increased the probability of injury crashes; specifically, in single-vehicle crashes in which the driver was reported as traveling too fast for conditions or speeding, and in any heavy truck crash occurring on roadways with higher posted speed limits. More details regarding other factors contributing to heavy truck crash severity outcomes and their corresponding magnitude will be available in the final report.

The research team is currently completing analysis of pertinent motor carrier enforcement-related data. Analyses include preparing descriptive statistics and statistically comparing common factors with heavy truck crashes. For example, enforcement-related activities and crash experience are being compared by road system, county, month, day of week, and time of day. A series of maps are also being completed to spatially present and compare enforcement-related activities and crash experience.

The final report for the statewide heavy truck crash assessment is now available:
http://lib.dr.iastate.edu/intrans_reports/68/

Big three universities collaborate with Iowa DOT and InTrans

Semiannual collaboration meeting held in Ames Oct. 30, 2013

Joining forces to "mutually advance the transportation research interests of Iowa" – that's the stated goal of the Iowa Transportation Research Collaboration Agreement signed in 2003 by representatives of the Iowa DOT, Iowa State University, The University of Iowa, University of Northern Iowa, and Center for Transportation Research and Education (now known as InTrans).

Peggi Knight, Iowa DOT's director of the Office of Research and Analytics, explained the benefit, "The agreement and resulting collaboration meetings provide a process to facilitate and further the support of transportation research for the benefit of Iowa. The group collaborates to identify, develop, and coordinate transportation research resources that could be used."

The agreement proposes using focus groups to develop research ideas and projects. According to the agreement, focus group topics may include aspects of traffic and safety, geotechnical research, maintenance, pavements, construction, hydraulics and drainage, roadside vegetation, structures, planning, environment, economics and finance, and transportation modes. The groups will include people from the collaborating organizations, industry, and other transportation specialties and will meet as often as deemed necessary. In addition to the focus groups, semiannual meetings of the collaborating organizations will review focus group activities and plan for the future topics. By working together, not only can ideas be shared, but resources can also be consolidated and new funding sources identified.

According to Knight, "Iowa leads the nation in many areas of highway research. This collaboration effort strengthens that leadership and allows Iowa to pursue national funding and leadership opportunities in transportation research."

Check out the collaboration website

Attendees of the semiannual collaboration meeting were (from left): Tim Strauss, UNI; Jim Berger, Iowa DOT; Linda Narigon, Iowa DOT; Sue Chrysler, U of I; Shauna Hallmark, ISU InTrans; Mark Dunn, Iowa DOT; Christy Twait, UNI; Lori Pflughaupt, Iowa DOT; Peggi Knight, Iowa DOT

A comparative policy analysis of seat belt laws

Michelle Reyes and Dan McGehee, The University of Iowa

Iowa implemented a primary enforcement seat belt law July 1, 1986. This law requires all adults in the front seat to be belted, and law enforcement can stop a vehicle if they observe unbelted occupants in the front seat (i.e., primary enforcement).

In 2004, legislation was passed requiring all children 10 and under to be restrained in age- and size-appropriate occupant protection in the form of child safety seats, booster seats, or seat belts.

On July 1, 2010, a law went into effect requiring all occupants under the age of 18 to be restrained.

Currently, occupants age 18 and older are not required by law to use restraints when they are riding in the rear seat.

In 2011, Iowa reported a seat belt use rate of 93.5 percent in the front seats for drivers and passengers. Despite this relatively high front seat use rate, in that same year 43 percent of the 265 passenger vehicle occupants who lost their lives on Iowa roadways were unrestrained. Restraint use was unknown for another 32 fatalities, or 12 percent (National Highway Traffic Safety Administration, 2013). The same NHTSA report states the use of lap/shoulder belts is associated with 45 to 60 percent reduction in fatal injuries for front-seat occupants.

Another analysis of safety belt effectiveness for rear-seated passengers reports that buckling up in the back seat can reduce the risk of fatal injuries by 55 to 75 percent (Zhu, Cummings et al., 2007).

The research activities described in this proposal collect data from a variety of sources to estimate the benefit of enhancing the current law to include the belting of all rear-seated occupants.

This proposal will also assess Iowans' attitudes toward enhancing Iowa's current seat belt law so all passenger vehicle occupants regardless of age or seating position would be required to use passenger restraints (i.e., a comprehensive law).

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Check out the full report

The proposed research activities address the following questions.

1. What does previous research show about the effectiveness of seat belt laws in terms of increasing seat belt use and potential life-saving and injury-reducing benefits?
2. Considering Iowa crash data, what are the potential benefits of enhancing the current seat belt laws in terms of fatalities and injuries?
3. What laws concerning the use of seat belts have been implemented in other states, particularly those that border Iowa? What is the language of their policies and how are the laws enforced?
4. Would Iowa's citizens support enhancements to the state's seat belt law?

The University of Iowa team proposes the following research activities.

1. Perform a literature review of seat belt laws in general and comprehensive (i.e., covering all vehicle occupants) laws in particular.
2. Analyze crash data to summarize seat belt usage in fatal and severe injury crashes in Iowa.
3. Conduct a legislative review, interview subject matter experts, and work with key stakeholders in Iowa to identify potential issues with implementation and enforcement of the law.
4. Conduct a public opinion survey of Iowans to quantify attitudes of safety belt laws.

Moving beyond teen crash fatality statistics: The Go-Team Study

Dan McGehee, The University of Iowa

Fewer teens have died in motor vehicle crashes over the past decade, yet crashes remain the leading cause of adolescent fatalities in Iowa. To address this pressing concern, the Iowa Department of Transportation and the Federal Highway Administration sponsored a study at The University of Iowa.

The GO-Team project created case studies of each fatal crash involving a driver under age 20 in Iowa in 2009, 2010, and 2011. The study gathered detailed information from a large number of sources, including the Iowa DOT, media sources, Iowa's court system, law enforcement, medical examiner, and hospitals. Data included driving records of the teens involved, license history, prior traffic citations, prior crashes, and data about charges filed as a result of the fatal crash. The GO-Team also recorded factors such as time of day and year when the crash occurred, whether there were teen passengers in the vehicle, and whether drugs and alcohol were involved.

From 2009 through 2011 in Iowa, there were a total of 126 crashes involving 131 teen drivers that resulted in 143 fatalities. The study found that teen drivers contributed to 74 percent of the fatal crashes they were involved in, nearly two-thirds of the teen drivers involved in fatal crashes were male, and the crashes were almost evenly split between single- and multiple-vehicle crashes. (See the sidebar on next page for more key findings.)

Factors contributing to fatal teen crashes included speeding (26 percent), recklessness (15 percent), and impairment from drugs or alcohol (25 percent). A unique analysis in this study considered how crashes varied by time of day, day of week, and time of year. Crashes were most likely to occur in the summer, and on the weekends – an unusual finding as it was expected that crashes would be more likely during the school year. During the school year, crashes were most likely to occur in the 7 a.m. hour on weekdays, and in the very early morning hours on weekends. Unlike the country as a whole, a significant proportion of teen fatalities in Iowa occurred between 9 a.m. and noon and between midnight and 6 a.m.

Fatal crash rates varied by age and gender. Thirty of the teens that died (53 percent) were male. A higher number of older teens were involved in fatal crashes, but this may have been due to the fact they did more driving.

Fourteen of the 78 teen drivers (18 percent) who were at fault had a prior "at-fault" crash, and there appeared to be an association between having received a prior violation and being at fault in a fatal crash. This finding was important in that it revealed a possible point of intervention. Working to address poor driving habits after a teen receives a traffic violation or has an at-fault crash might be a way to help prevent subsequent fatal crash involvement.

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Moving beyond teen crash fatality statistics ...
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More study is needed. The next phase of this project will consider how many teens with prior moving violations and prior crashes do not go on to have a fatal crash.

A great deal of research has begun to highlight the extremely dangerous form of distraction; that is teen passengers. While 67 (51 percent) of the 131 crashes involved a lone teen driver, in 25 (19 percent) there was one passenger, and in 39 (30 percent) there were two or more. A previous analysis estimated that 16- to 17-year-olds increase risk of a fatal crash by 44 percent in carrying one teen passenger, double it with two, and quadruple it with three (Tefft, Williams et al., 2012).

The results of the GO-Team study will be used to help inform lawmakers regarding Iowa's graduated driver's licensing (GDL) system. Two GDL components that have been proven effective at reducing fatal crashes for teen drivers are limiting nighttime driving and reducing the number of passengers newly licensed teens are allowed in their vehicle.

Iowa's current GDL system limits 16- and 17-year-olds with intermediate licenses from driving between 12:30 and 5 a.m., but this is weak compared to limits in other states. It particularly warrants consideration in light of the fact that the study found that one-third of the fatal crashes in Iowa occurred during these hours.

Iowa's GDL system has just recently changed to limit teen passengers during the first six months of driving. One-third of all fatalities in this analysis were the passengers of the teen drivers. The number of passengers also seems to be factor in single-vehicle crashes; when passengers were on board during a single-vehicle crash, almost three-quarters of the time there were two or more.

In conclusion, while the trends concerning safety and teen driving in Iowa are encouraging, there is still much work to be done. The most common factors involved in teen fatal crashes were driving too fast for conditions/speeding and driving while impaired by alcohol and/or drugs. Motivating teens to refrain from driving when impaired, to drive at appropriate speeds, and to buckle up every time continue to be the primary challenges to reducing teen fatalities. Younger teens were found to have higher rates of fatal crashes after controlling for vehicle-miles traveled, and most of their crashes are road departures, likely indicating lack of experience. Thus, encouraging families to increase the amount of supervised driving teens do and to constrain driving to limited, lower-risk situations when teens begin to drive independently could help reduce the rate of fatal crashes for 15-, 16-, and even 17-year-old drivers.

Key findings

- Crashes were just as likely to involve a single vehicle as multiple vehicles.
- 63 percent of teens involved in fatal crashes were male – rates were 2.5 times higher for 16-year-old males than for females.
- Teens contributed to 74 percent of the fatal crashes they were involved in.
- Crashes were most likely to occur in the late afternoon (between 2 and 6 p.m.) or very early morning (between midnight and 4 a.m.).
- Driving too fast for conditions or speeding contributed to about one-fourth of the crashes in which the teen contributed to the crash.
- Alcohol or drug impairment was a factor in about one-fourth of all crashes, in 42 percent of crashes caused by speeding, and in 29 percent of crashes caused by running off the road.
- High vehicle occupancy was associated with single-vehicle crashes – there were 32 single vehicle crashes with passengers, and two or more passengers were present 72 percent of the time.
- There was an association between prior crashes and prior speeding violations and the teen being at fault in the fatal crash.

Check out the full report

Epoxy injection of bridge deck overlays

Brent Phares, P.E., InTrans, Iowa State University

The Iowa Department of Transportation has been using concrete overlays on its bridge decks since the 1970s to restore the concrete deck surface and to lengthen the bridge deck's service life. The bridge deck overlays inhibit chloride and water intrusion into the bridge deck and have proven effective as a maintenance treatment on Iowa bridges. Bridge deck overlays typically last 15 to 20 years before delamination at the bond interface requires repairs to or replacement of the overlay. The delamination of the overlay is often repaired by Iowa DOT maintenance staff by injecting the deck overlay cracks and voids with epoxy.

Anecdotal observation by Iowa DOT field staff suggests that the epoxy-injection process can delay repair of the overlays by another five to 10 years but currently there is no documentation to substantiate this. The process for epoxy injecting bridge deck cracks and delaminations is also not formally documented resulting in variations in materials, equipment, and procedures used in the various districts.

The objective of this research will cover three main focus areas: 1) determination of the effectiveness, durability, and typical service life of epoxy-injected delaminated bridge decks; 2) evaluation of the current state of the practice in the epoxy-injection industry; and 3) development of procedures and specifications for epoxy injection.

Approach

One of the original intents of this study was to identify and conduct a performance evaluation of 30 bridge decks epoxy injected in 2003. The year was selected due in part to observable degradation of previously injected decks at or around seven years postinjection.

As it turns out, fewer than 30 bridges were injected during 2003, thus requiring bridges injected in additional years to be included in the performance evaluation.

Once the bridges that were reinjected, reconstructed, or reoverlaid were removed from consideration, the final sample was taken from bridges injected in 2003 through 2006. During fall 2010, 26 bridges identified as being injected between 2003 and 2006 were visited

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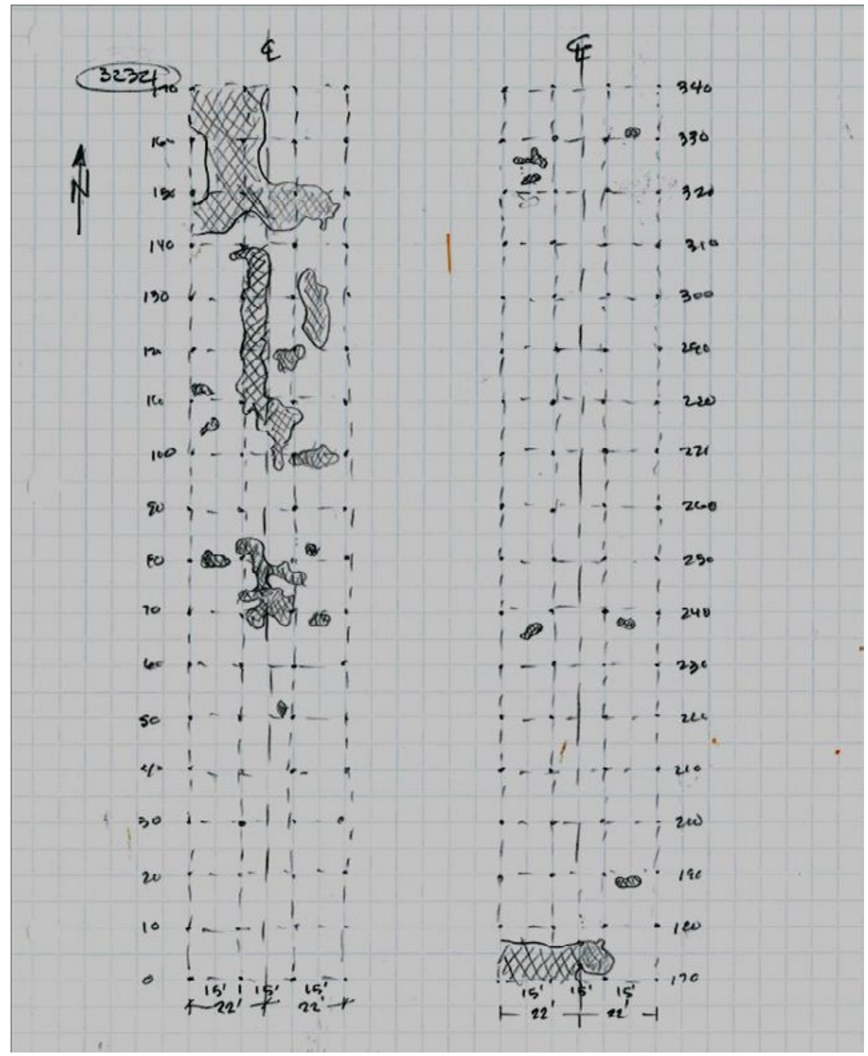

An example of a delamination map.

and a performance evaluation of each was conducted.

In addition to visual inspection of the deck surface, sounding of the concrete overlay was completed. Sounding the deck was performed by dragging chains and hammer tapping; delaminated portions of the overlay are revealed by tonal fluctuations. Though this process cannot be considered highly scientific, it has been widely accepted as a standard practice for locating delaminated sections.

A map locating the delaminated portions of the overlay was generated upon completion of sounding. This was achieved by creating a grid of the entire bridge deck surface and transferring the located delaminations to a corresponding grid created on the map. The map shows the locations and sizes of delaminated portions of overlay, and generally gives a snapshot of the overall health of the surface. From these maps, data were collected and used to analyze the group of bridges. An example of a delamination map is provided on previous page.

In addition to sounding the deck, photographs were taken to visually document the surface condition. The photographs on this page show an example of conditions seen at many of the bridges. It was common to find delaminated portions of the overlay at or very near locations where both longitudinal and transverse surface cracking was present. It appears that cracking often results in delamination and vice versa, as intuition would suggest. Additionally, delaminated portions of the deck often appeared to originate where cold joints are present, such as at the centerline of bridge. This agrees with the cases of cracking as cold joints are another port of entry for water and chloride ions. Even more, the condition

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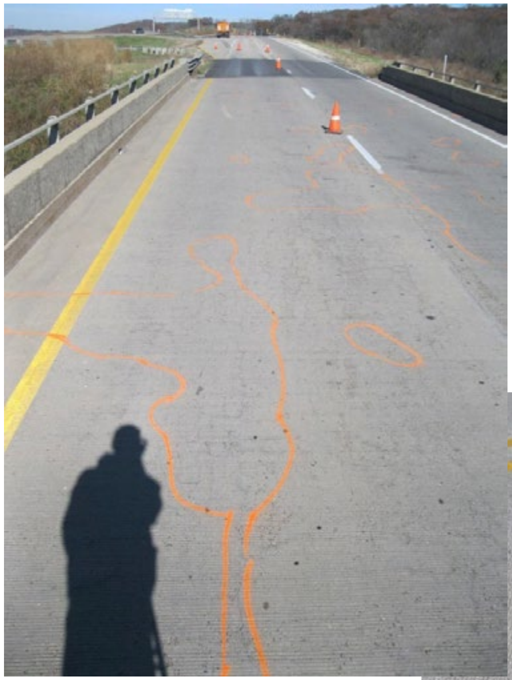
Best Practices Guide

Early in the project, the research team sought to capture information on the state-of-the-practice for bridge deck epoxy injection. Information was collected by interviewing the crews currently completing Iowa's injections, via a literature review, and through an online survey of all state DOTs. The collected information was then synthesized and a best practices guide prepared.

Best Practices Guide



Photographic documentation of delamination is shown in these images.

of the overlay was commonly the poorest where the bridge approach slab met the overlay. This may be due to several factors, including water entry at approach slab-overlay interface, snowplow impact, or magnified localized stresses attributable to thermal behavior (especially at acute angle portions of skewed decks).

It should be noted that there was valuable information gleaned from the field evaluations even though statistically significant relationships between condition and years of service, annual average daily traffic, or bridge age were not discovered. The general condition of epoxy-injected overlays is revealed through some key metrics that are presented below. Knowing that on average only 11 percent of the total deck surface is delaminated may give evidence for the effectiveness of the epoxy-injection procedure. This is especially evident knowing that each of the bridges evaluated in this study has been injected between five and eight years ago. Overall, the injections collectively appear to be performing well through eight years of service. This observation agrees with that by the Iowa DOT bridge crews. As was previously stated, the bridge crews have suggested the epoxy injection can delay repair of the overlays by five to 10 years.

Notable information from field evaluations

Maximum percentage of delaminated overlay	30.6 percent
Average percentage of delaminated overlay	11.2 percent
Maximum number of individual delaminations per sq. ft.	1.17

In summer 2011, all bridges that were epoxy injected in the state of Iowa were inspected prior to and immediately after injection to document their condition. Like the 2010 inspections, this included capturing deck delamination and photographic information. Every summer since 2011, the same bridges have been reinspected in the same manner. The goal is to capture at what point in time, if at all, the deck epoxy begins to lose its effectiveness.

Moving forward

The bridges inspected in 2011 will continue to be inspected for an additional seven years to document changes in condition. In addition, as there is a desire to allow contractors to perform these repairs, a material's instructional memorandum (I.M.) will be created that will provide guidance, measurements, etc. At the conclusion of the project, a report documenting the entire effort will be created.

Western Iowa Missouri River flooding

Pavana Vennapusa, David White, and Kelly Miller, Iowa State University

The 2011 Missouri River flooding caused significant damage to levees, bridge abutments/foundations, paved and unpaved roadways, culverts, and embankment slopes along the Missouri River in several Iowa counties. More than 100 miles of secondary roads were closed in Iowa because of the flood. In some cases, the extent of damage was directly observable (i.e., where segments of the roadway were washed away), but in many cases the damage was undetermined (i.e., where the damage was below the pavement surface or around bridges).

This research project was set up to assist county and city engineers by deploying and using advanced technologies to rapidly assess damage to geoinfrastructure, and developing guidance for repair and mitigation strategies and solutions for use during future flood events in Iowa. Nationally, very limited studies have been documented on this topic and there are virtually no documented studies to date on postflood assessment of secondary unpaved roadways.

The Iowa State University research team visited selected sites in

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Pavement damage due to erosion.

Pottawattamie and Fremont counties in western Iowa to conduct field reconnaissance. Testing was conducted on bridge abutment backfills that were affected by floods, flooded and nonflooded secondary roadways, and culverts. In situ testing was conducted shortly after the flood waters receded (in September and October 2011), and several months after flooding (in April, May, and June 2012) to evaluate recovery and performance. Road test segments were selected with an objective to monitor performance of the flooded versus nonflooded areas by evaluating their subsurface foundation layer characteristics over time.

The research team relied on measurements obtained in nonflooded areas to compare with measurements in flooded areas to assess the damage or strength loss that occurred under roadways. In situ testing involved conducting falling weight deflectometer,

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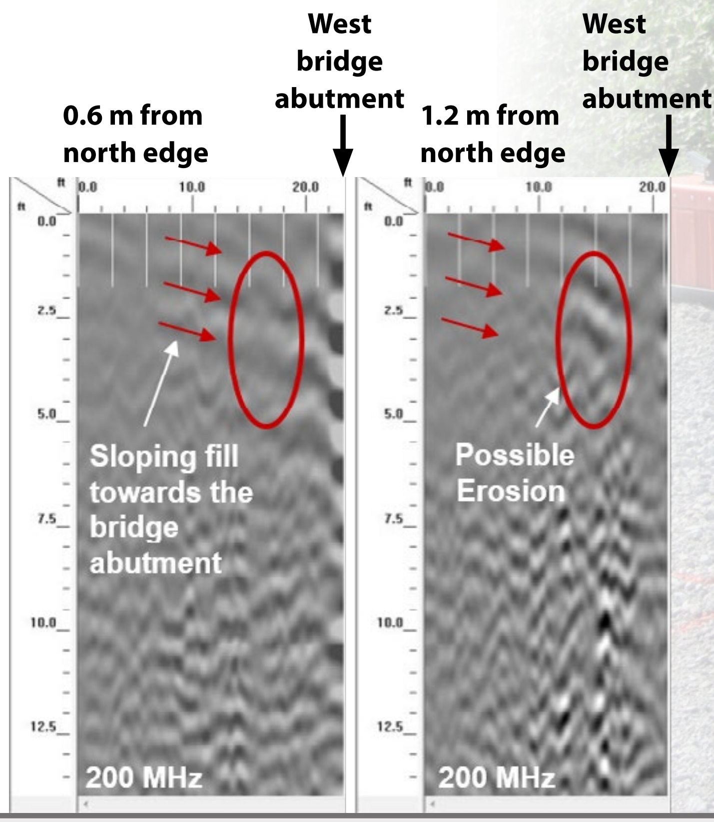
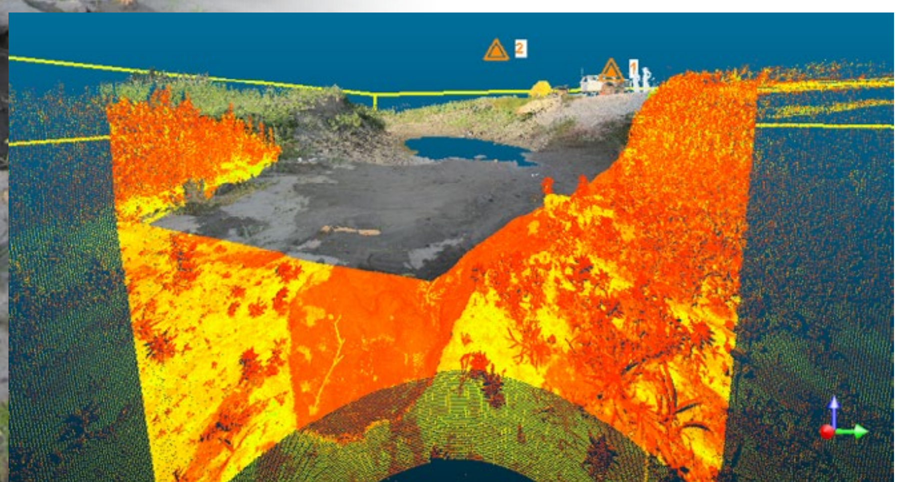


Ground penetrating radar scanning at a bridge site to identify subsurface voids/erosion in approach backfill.

A laser scanning at a bridge site collecting raw point cloud data is shown to the left. The merged point cloud data is then placed onto the photo of the bridge site is shown below.



dynamic cone penetrometer, ground penetrating radar testing, 3-D laser scanning, and performing hand auger soil borings.

Field results indicated statistically significant differences over time in roadway support characteristics between flooded and nonflooded areas. Support characteristics in some flooded areas did not recover over the duration of the study (seven to eight months after flooding). Multivariate statistical analysis indicated that the dynamic composite stiffness of the flooded unpaved roads was highly dependent on the stiffness of the underlying subgrade layer. Voids were detected in culvert and bridge abutment backfill materials shortly after flooding, and several months after flooding in spite of reconstruction. The results showed that damage from flooding can cause extended problems after the event and secondary infrastructure systems are typically not designed to withstand flood events.

A catalogue of nine different field assessment techniques, and 20 different potential repair/mitigation solutions are provided in this report. A flow chart relating the damages, assessment techniques, and potential repair/mitigation solutions is provided. These options are discussed for paved/unpaved roads, culverts, and bridge abutments, and are applicable for both primary and secondary roadways.

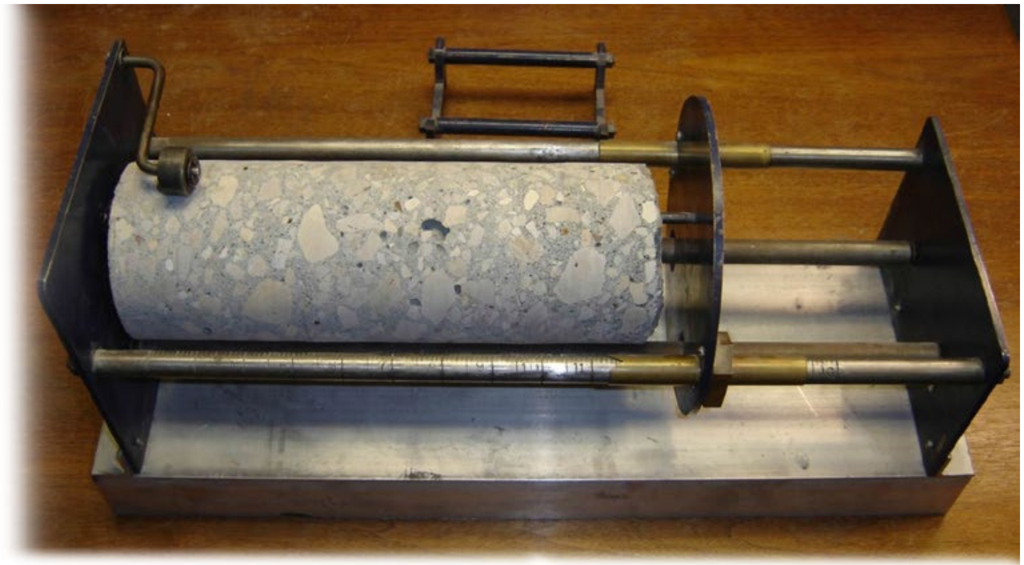
Check out the full report.

MIT-SCAN-T2

Kevin Jones and Todd Hanson, Office of Construction and Materials, Iowa DOT

Sufficient Portland cement concrete (PCC) pavement thickness is critical to achieving the design service life of the pavement. Iowa has an incentive-disincentive specification to encourage contractors to strive to reach the target pavement thickness consistently. To measure thickness, cores must be drilled at random locations throughout the project. This is costly to both the contractor and the Iowa DOT. The MIT-SCAN-T2 is a device used to measure pavement thickness nondestructively. The equipment uses pulse induction technology to determine the thickness by measurements taken over a metal target placed on the subbase during paving. A study comparing the MIT-SCAN-T2 device measurements with core thicknesses at those locations determined that the MIT-SCAN-T2 is accurate enough to perform acceptance testing of pavement thickness on Iowa DOT projects. Iowa now has eight gauges to perform acceptance testing on most PCC paving projects.

Check out the full report **here**.



The Iowa DOT is using the MIT-SCAN-T2 device for determination of concrete pavement thickness to replace the traditional coring method.

Evaluation of RapidAir 457 Automated-Air-Void-Analyzer

Todd Hanson, Office of Construction and Materials, Iowa DOT

The ability of concrete to withstand a freeze-thaw environment relies on a well entrained air void system. The RapidAir 457 Automated-Air-Void-Analyzer instrument is an automated measuring system for analyzing the air content and distribution in hardened concrete. The system can replace the manual tests performed as described in the American Society for Testing and Materials (ASTM) designation C 457: "Standard Test Method for Microscopical Determination of Parameters of the Air-Void System in Hardened Concrete." The standard ASTM manual test will normally require 4 to 6 hours for a trained technician operating the microscope. The analysis time required with RapidAir 457 is 12 minutes for the linear traverse analysis, without operator interference.

The sample preparation is the same as linear traverse, except the sample receives a black and white enhancement to highlight the air voids. The sample is covered with a black marker and barium sulfate is pressed into the air voids. The sample is placed on a moving stage under a digital camera. As the line crosses the air voids, individual chord lengths are measured and tallied to generate air content and spacing factors.

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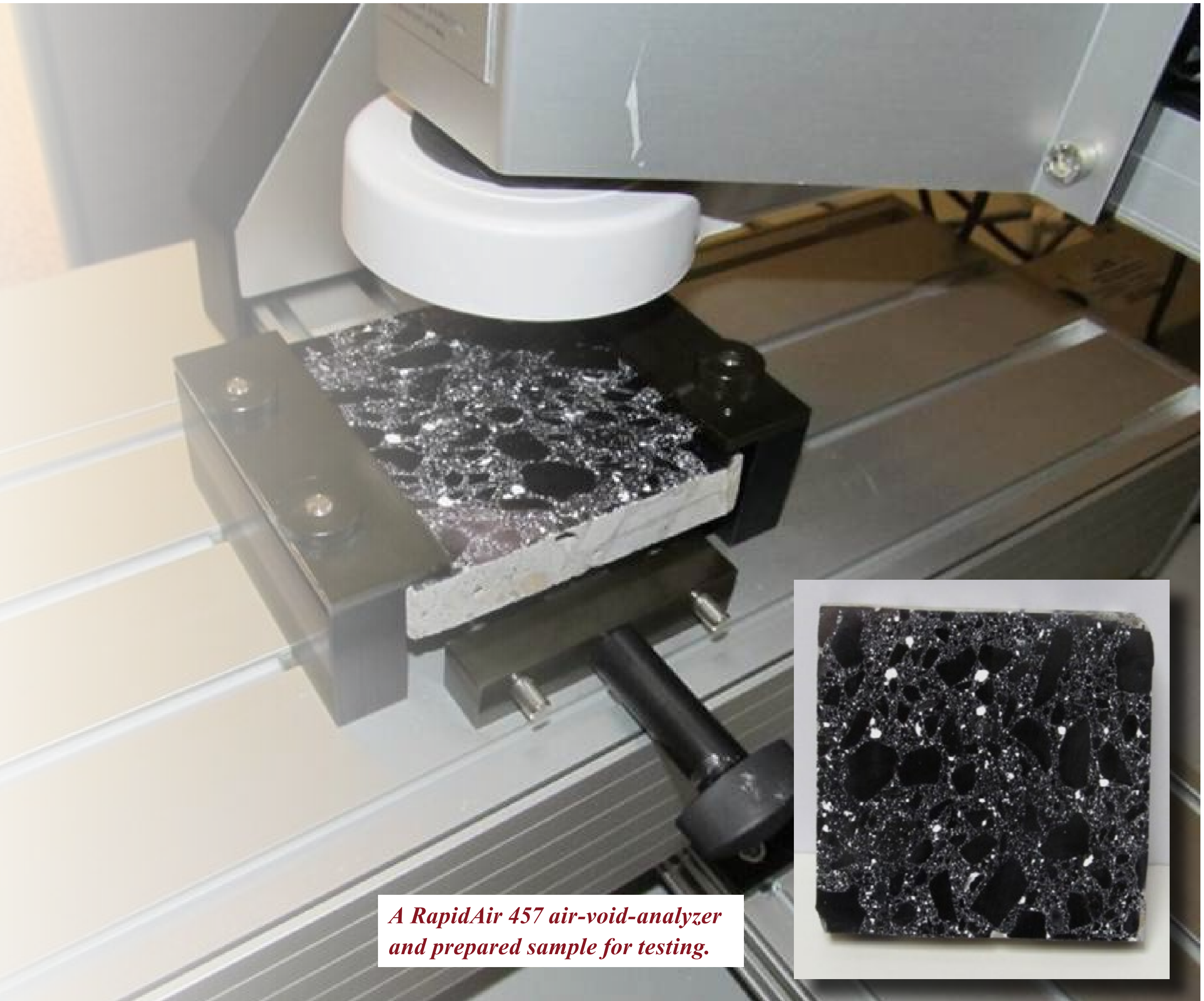
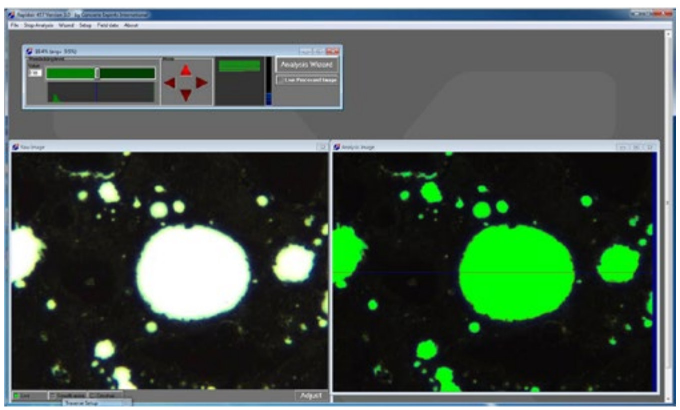


A RapidAir 457 air-void-analyzer and prepared sample for testing.

The investigation of RapidAir 457 showed it is an excellent tool used to obtain hardened air-void parameters in concrete. Cylinders were cast from batches of concrete produced at 3, 5, 7, and 9 percent air content. The air content between plastic, high pressure air, image analysis air, and the RapidAir 457 showed good correlation.

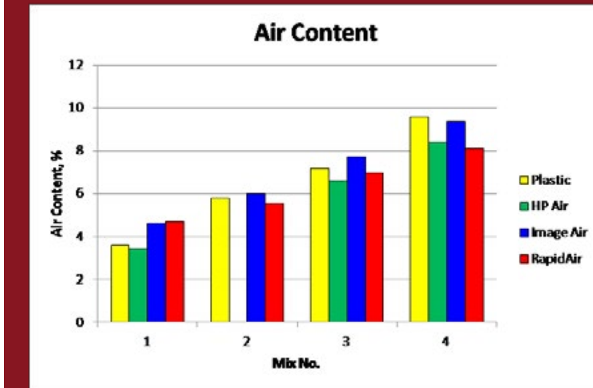
Air void parameters were compared between RapidAir 457 method and the image analysis technique. Both methods were in close agreement for air content and spacing factors.

From sawing to air-void enhancement, the total time for sample preparation was approximately 40 minutes with actual test time of less than 15 minutes. Multiple samples can be tested in one day. Qualified laboratory technicians were able to use the system with minimal training. Linear traverse testing at a private lab can cost as much as $700 per sample, whereas the RapidAir 457 cost at the Iowa DOT lab is approximately $100 per sample. Samples can be tested within a day at the Iowa DOT lab, while samples sent to other labs can take a week or longer to obtain results. The RapidAir 457 is a fast, accurate, and repeatable method of obtaining hardened air void parameters.

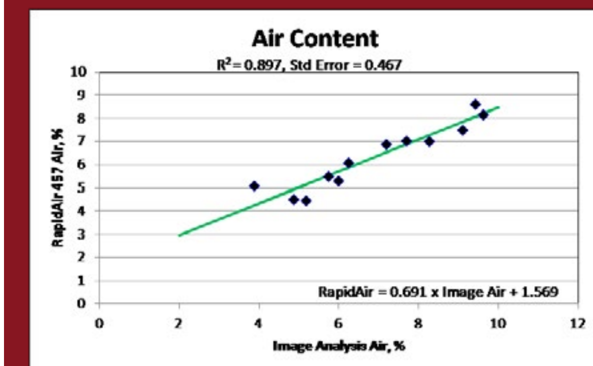


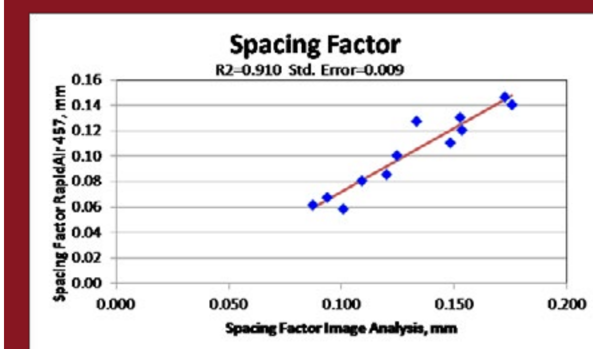
The image on the left shows software displaying the line crossing the air void.

Check out the full report **here**.



Results of air content by various methods.





The RapidAir 457 produces repeatable, accurate results, and is far less time consuming than linear traverse method.

School bus safety study: Kadyn's Law

Shauna Hallmark, InTrans, Iowa State University; Susan Chrysler, The University of Iowa

In 2012, the Iowa Legislature passed a bill relating to school bus safety, including providing penalties for failure to obey school bus warning lamps and stop signal arms, providing for a school bus safety study and administrative remedies, and making an appropriation. The bill, referred to as Iowa Senate File 2218 or "Kadyn's Law," became effective March 16, 2012.

Project scope

A multiagency committee requested assistance from a team comprised of researchers from both Iowa State University and The University of Iowa in addressing the safety study elements of Kadyn's Law, including:

- Use of cameras mounted on school buses to enhance the safety of children riding the buses and aid in enforcement of motor vehicle laws pertaining to stop-arm violations.
- Feasibility of requiring school children to be picked up and dropped off on the side of the road on which their home is located.
- Inclusion of school bus safety as a priority in driver training curriculum.

Key findings and recommendations for each study element are included in the final report and also summarized in this document.

Findings and recommendation

Do cameras reduce stop-arm violations?

Stop-arm cameras by themselves are of little value without a supporting process that results in violations for those who break the law. The technology needed to record and process violations varies. However, the technology is becoming much easier to acquire, given that many school districts have already equipped their buses with internal cameras and, therefore, adding an additional camera for stop-arm violations is a logical next step.

Twenty Iowa school districts confirmed they are using stop-arm cameras as a deterrent. Districts ranged from one or two cameras up to 56 cameras (one for every route bus used) within a specific district.

Although some district personnel felt it was too early to tell, most commented that the stop-arm cameras are considered to be effective and assist in verifying violations. Although the literature search did not provide a detailed field evaluation on the effectiveness of using cameras as a deterrent, other studies did document the effectiveness of other bus strategies (to increase awareness).

Stop-arm cameras do aid in enforcement of motor vehicle laws and enhance safety if there is an effective and sustainable process to turn camera images into violations. Whether or not Iowa school districts currently have an effective and sustainable process to rely on is up for debate. Currently, they do. However, as more cameras are added each day, they probably do not.

Processing violators is a laborious task for all parties involved. It is currently up to the school bus driver to note each stop-arm violation. The school district must then isolate the images and provide this to the local law enforcement agency. Law enforcement then has to verify and deliver the violation to the motorist.

As noted in the report, North Carolina went through a decade of increased penalties and fines for stop-arm violations, yet little progress was made until they enacted a law that allowed for automation and third-party involvement.

If the stop-arm violation rates are even close to that reported by the National Association of State Directors of Pupil Transportation Services – with 100,000 bus drivers reporting that 88,025 vehicles passed their buses illegally on a single day – the addition of stop-arm cameras on a fraction of the

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school buses in Iowa could swamp the school district and law enforcement agency abilities to prosecute these dangerous violations.

As with any new law, some enhanced judicial outreach will help to align convictions with the revised penalties. Given that the law was enacted in March 2012, a review of the "failure to stop for a school bus" convictions between Aug. 15 and Oct. 31, 2012, showed that even though Kadyn's Law requires a minimum fine of $250 for the first offense, 105 of the 162 convictions (65 percent) had a fine amount of less than $250.

Thinking forward, the research team suggests consideration be given to modifying the current Iowa model and penalties to be more aligned with the administrative model commonly used for red-light running.

Enhancing child safety by reducing the frequency of stop-arm violations begins with swift and effective enforcement. Enforcement should not be limited by bus driver capabilities or the time restraints of each school district or law enforcement agency. A forward-looking model would provide flexibility for smaller districts to work with law enforcement to process violations manually and at the same time allow larger districts the option of third-party involvement to assist with higher numbers of violations and vigorous compliance with the law.

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Feasibility of requiring home-side loading

As a general rule, the research team found that many school districts use home-side loading when possible and are conscientious about every stop made where children must cross the street to load or unload from the bus.

In an effort to evaluate the impact requiring home-side loading for all stops, the research team worked with a school district to evaluate both an urban and rural route scenario. The existing bus routes were revised to comply with home-side loading and a comparison was made in terms of number of student stops, distance traveled, and student ride time.

The results show that requiring home-side loading for all stops has dramatic effects on routing efficiency (33 more student stops on the urban route and 17 more miles of travel on the rural route) and considerable cost impacts. At a minimum, this requirement resulted in more than $8,000 and $24,000 in additional annual costs for the single urban and rural routes, respectively. At the district level, this had an impact on the district operating costs by a factor of 1.6.

Although a more detailed evaluation across multiple districts study could refine these estimates, home-side loading has the potential to affect the cost per pupil transported significantly without a defined quantifiable benefit to justify these costs.

Looking forward, districts should continue to be encouraged to consider home-side loading as a matter of best practice and discretion and stop short of a specific requirement. The decisions made regarding every bus stop and route should be derived, reviewed, and modified using the local knowledge and resources from the district.

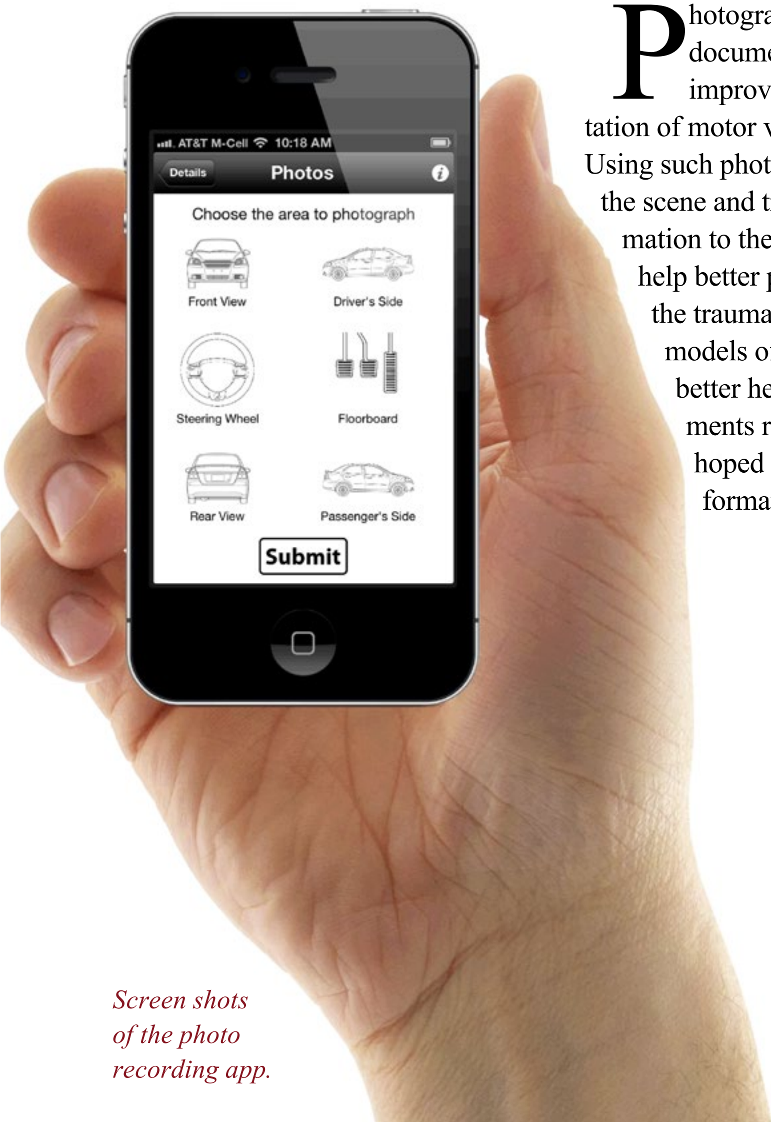
Driver training curriculum

Based on review of other state driver manual content, the researchers noted several illustrations that could possibly be used to improve driver comprehension of school bus stop requirements. However, no research has been done to verify the public's understanding or opinion of the illustrations. Including similar illustrations in driver training manuals are suggested as best practices based on the expert opinion of the researchers.

Check out the full report on Kadyn's Law **here**.

Improving patient outcomes through photographic trauma site documentation

Daniel McGehee, The University of Iowa

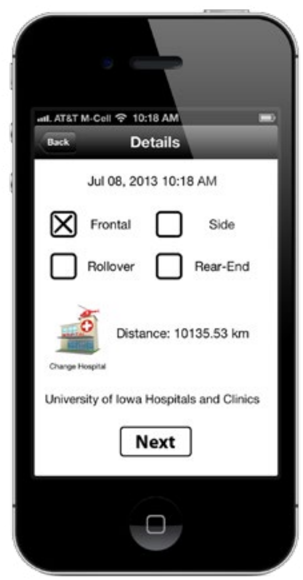


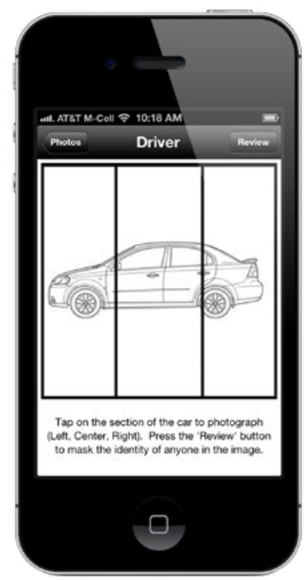
Photographic scene and vehicle documentation can be used to improve triage and transportation of motor vehicle crash victims. Using such photographic evidence of the scene and transmitting the information to the trauma center may help better predict injuries, assist the trauma staff develop mental models of treatment options, and better help implement treatments remotely. Together, it is hoped that this real-time information will result in better outcomes in treating crash trauma.

In the new proposed Iowa model, we go beyond just sending photos to the emergency department (ED). The advantages of photographically documented crash scenes are that they allow the trained trauma professional to assess patterns of injury based on crush and intrusion and patterns of the damaged vehicle. Developing "apps" jointly with field and ED personnel and following through with each case will provide vital outcomes data on how such systems can be made more efficient and sustainable. Training of both field and ED personnel is also crucial for sustaining such a program.

With the advantage of prehospital trauma scene photos, healthcare providers will have the ability to prepare for the patient with information that will help dictate diagnostic and treatment procedures. Looking for type of crash, intrusion, force, and damage location assist the trauma provider in assessing for injury.

Check out the ongoing process here.





Screen shots of the photo recording app.