IOWA HIGHWAY RESEARCH BOARD (IHRB)

Minutes of June 26, 2009

Regular Board Members Present

A. Abu-Hawash
J. Adam
D. Ahart
J. Alleman
J. Berger
V. Dumdei
M. Nahra
S. Rinehart

Alternate Board Members Present

D. Schnoebelen for Keri Hornbuckle

Members With No Representation

B. Moore
S. Gannon
J. Joiner
J. Krist
J. Waddingham
W. Weiss

Alternates Present as Guests

R. Younie

Secretary - M. Dunn

Visitors

Max Grogg	Federal Highway Administration
Ken Dunker	Iowa Department of Transportation
Edward Engle	Iowa Department of Transportation
John Hinrichsen	Iowa Department of Transportation
Sandra Larson	Iowa Department of Transportation
Mary Starr	Iowa Department of Transportation
Hao-Che Ho	The University of Iowa
Tiny Xia	The University of Iowa
Bart Bergquist	University of Northern Iowa

The meeting was held at the Iowa Department of Transportation's Ames Complex, Materials East/West Conference Room on Friday, June 26, 2009. The meeting was called to order at 9 a.m. by Chairperson Jim Berger with an initial number of 9 voting members/alternates at the table.

Agenda

Item 11 was removed from the Agenda and will be presented at the July 31, 2009 meeting.

Approval of the Minutes

Motion by J. Alleman to approve minutes from the May 29, 2009 meeting. 2nd by J. Adam.
Motion carried with 9 aye, 0 nay, 0 abstaining.

FINAL REPORT TR-545, "Development of Self-Cleaning Box Culvert Designs," Marion Muste, The University of Iowa ($144,785)

BACKGROUND

The main function of a roadway culvert is to effectively convey drainage flow during normal and extreme hydrologic conditions. This function is often impaired due to the sedimentation blockage of the culvert. This research sought to understand the mechanics of sedimentation process at multi-box culverts, and develop self-cleaning systems that flush out sediment deposits using the power of drainage flows. The research entailed field observations, laboratory experiments, and numerical simulations.

CONCLUSIONS

The fillet-based self-cleaning design developed through this study proved reliable and efficient in a variety of tests. The conditioned culverts (with fillets set in) displayed favorable flow behavior compared with the original ones. Some the fillets' main effects will:

- direct sediment through the central barrel of the multi-box culvert
- maintain effectiveness over a range of flows (even for the highest flows where small deposits are created, they do not obstruct the active area of the lateral culvert boxes)
- maintain overall sediment transport rates within the boxes of the conditioned culverts at levels comparable with those in the original culverts

The design is simple to implement during any stage of the culvert lifetime, i.e., at the time of construction or later on by retrofitting the area in the vicinity of the structure at the time of a cleanup. In the latter situation, the fillets can be mainly constructed with local material, i.e., the sediment deposited at the culvert is relocated in the area of fillets during the cleaning. Retrofitting using the actual sediment deposits are obviously the most efficient means from the cost perspective; the obtained fillets can be rip-rapped and, possibly, grouted to roughen surfaces for enhanced resistance to flow action.

C: It would be good to see a full field trial.
C: On page 75 of the report it appears that the fillet is elevated at the mid-portion.
A: Yes, the idea is to move sediment toward the center, but during performance tests a need to keep an unobstructed area with slope from the channel to the sides was indicated; slope is intrinsic to the design.
C: So nature is imitated, helping sediment along through the barrel, and then when it's sloped toward the middle, it's also being sloped toward the barrel invert.
A: Yes.
C: A little change in the inlet may make headwater depths better; I'm not sure if you looked specifically at this.
A: We didn't look at that, but we could.
Q: The 25-, 50- and 75% barrel fullness was looked at, most are designed to use a headwater depth equal to one foot (or the top of the box or a little above). Do you think if we looked at those higher queues that the geometry would perform better?
A: If you're talking about overtopping the barrel, there's not a lot in the literature that discusses this. This would involve a study beyond this research. At the beginning, we thought (based on sediment process) this would be a simple formulation, however, when we saw the model we realized we don't know a lot of things. The origin of the sedimentation process must be examined; these questions will be answered in phase II. We need to examine the range of flow.

Q: Is the model still available?
A: Yes.
C: The sponsoring agency does not need to pay to use the model; it is in the agreement language between the Iowa Department of Transportation and the research institutions.

C: I want to recommend Phase II.

Mark: We would need to receive the scope and proposal if there's interest. We can look at the current project and how some of these questions might be addressed under a separate project.
C: Twin culverts need to be looked at in Phase II. These are a challenge; you don't have the same symmetric angles. I'd be happy to see the twin barrels with straight skew examined.
C: Counties could pick some sites and other could select other sites for field testing.

Motion to Approve by A. Abu-Hawash. 2nd by M. Nahra.
Motion carried with 9 aye, 0 nay, 0 abstaining.

FINAL REPORT HR-239, "Load Rating for Standard Bridges – PHASE IV," Scott Neubauer, Iowa DOT Office of Bridges and Structures ($105,357)

BACKGROUND
There are federal load rating requirements (from the Federal Highway Administration, or FHWA) that require every state to load rate all of their bridges. In the past, the Iowa DOT has provided the manual with a table for the standard ratings of bridges for the counties and cities to use. A load rating states the load in tons which a vehicle can impose on a bridge. Changes in guidelines, standards, and customary uses of bridges require analyses of bridges to be updated and revaluated. In this report, sixteen secondary and primary bridge standards for two types of bridges are rated for AASHTO vehicle configuration utilizing Load Factor methodology.

CONCLUSIONS
In 1993, FHWA released a memorandum stating that any bridge built after 1994 had to be rated using the load factor method of rating. Previous manuals used the allowable for ratings and standards. Initially, the FHWA was most concerned about the national highway system and getting those bridges rated using the load factor method. We are now at the point where nearly all of our NHS bridges are rated for load factor. None of the county roads or city streets are in the NHS system; however, now is the time that these ratings and standards need to be developed for county and city bridges built after 1994, so we'll start moving forward with those.

The standards we chose to rate for prestressed and reinforced concrete slab standards from 1987 to present are those probable built after 1994. These standards were only required to be rated for inventory and operating units; there were no requirements to rate these standards for legal trucks. For posting purposes, the FHWA allows any load rating method for rating bridges for legal trucks and posting bridges. Most bridges built with 1987 standards have issues with posting anyway, so there was no need to do all of those calculations. The tables we are going to produce and provide to local agencies are for operating ratings for these structures.

C: The Federal Highway Administration requires that all bridges designed and built after 2010 use the LRFD method of design and rating; any standards we develop using LRFD will now have to rate using that method. So in 2010 we will come back and develop tables for all the ratings for those standards. We won't need to do legal trucks but will still be allowed to use whatever method we choose.

Motion to Approve by S. Rinehart. 2nd M. Nahra.
Motion carried with 9 aye, 0 nay, 0 abstaining.

FINAL REPORT TR-533, "Evaluation of Design Flood Frequency Methods for Iowa Streams," Allen Bradley, The University of Iowa ($99,544)

BACKGROUND
Recommended urban design standards for Iowa flood flow determination are published in the Iowa Statewide Urban Design and Specifications (SUDAS) manual. The Rational Method is the recommended procedure for

watersheds with drainage areas of 160 acres or less. The NRCS (SCS) runoff curve number approach is recommended for all basin sizes; however, there are two implementations of the NRCS curve number approach and the recommendation of each is determined by the drainage area.

Many applications in stormwater management require a complete flood hydrograph for design and/or predictions of the impact of land use changes on flood magnitudes, so flood frequency estimates for small drainages are often based on the Rational Method or NRCS curve number approach rather than the Iowa Runoff Chart.

The objective of this project was to assess the predictive accuracy of flood frequency estimation for small Iowa streams based on the Rational Method, the NRCS curve number approach, and the Iowa Runoff Chart. The evaluation was based on comparisons of flood frequency estimates at sites with sufficiently long streamgage records in the Midwest, and selected urban sites throughout the United States

CONCLUSIONS
Results show some sensitivity to the hydrologic soil group, an important parameter for both the Rational Method and NRCS curve number approach. For high runoff potential soils, the Rational Method and NRCS methods produce higher flood frequency estimates than for low runoff potential soils. However, the magnitude of increase for high runoff potential soils appears to be greater than that observed at streamgages. These results suggest that the hydrologic soil group is not as good a predictor of flood potential as one might expect. Indeed, the Iowa Runoff Chart, which does not make any distinction between hydrologic soil groups (it uses only land cover and slope factors), does not display the sensitivity to hydrologic soil group as seen (and predicted) by the Rational Method and NRCS curve number approaches. One overall consistent trend for the Rational Method and NRCS curve number approach is the change in systematic differences between the Midwest and Urban sites. If the results for Midwest sites are indicative of pre-developed conditions, and results for the Urban sites are indicative of post-developed conditions, then changes in flood frequency due to land development would tend to be over-predicted for both methods (even if the absolute flood magnitudes are under-predicted).

Motion to Approve by J. Alleman. 2nd V. Dumdei.
Motion carried with 9 aye, 0 nay, 0 abstaining.

PRESENTATION OF INNOVATIVE PROPOSALS FY 2009-2010

PROPOSAL *Wireless Sensor Networks for Infrastructure Monitoring*, Zin Zhu (M.D. Salim), University of Northern Iowa Department of Industrial Technology ($74,842)

BACKGROUND
This research will evaluate the use of distributed wireless sensor networks instead of PC-based systems for transportation infrastructure monitoring. Each sensor node, consisting of an embedded microprocessor, sensing module, and a communication module, is able to process the data locally and transmit only the aggregated information back. Recent progress in miniature Fiber-Bragg Grating (FBG) sensor interrogators and high performance silicon vibration/temperature/pressure sensors, and low-cost low-power radio transceivers make it possible to implement a distributed sensor network at lower cost with improved reliability. To address the third problem, interfacing with the Wireless Access in Vehicular Environment (WAVE) system to utilize vehicles to disseminate the information will be investigated.

OBJECTIVES
The objectives of the proposed research project will:
1. Establish a listing of physical quantities that need to be monitored, and the requirements on monitoring from the practical, technical and financial aspects.

2. Investigate sensor and data acquisition technologies salient to these quantities and select likely technologies for field implementation.
3. Establish the needed characteristics of mobile computers and wireless communication adapters.
4. Based on these characteristics test the available technologies and select the best fit.
5. Deploy a prototype test-bed unit in the field.
6. Acquire data and observations from this unit under a variety of climatological conditions.
7. Investigate the feasibility of integrating existing infrastructure monitoring system into the Intelligent Transportation System using WAVE interfaces.
8. Evaluate the suitability and scalability of these technologies for practical deployment in other bridges and further investigation based on data and observation analysis and direct testing.

Q: Will this work be in collaboration with the Iowa DOT's current structural health monitoring efforts?
A: Yes, there will be cooperation but this is a pilot test for prototypes.
Q: So your plan is to utilize some of the bridge testing hardware that's already been used by Iowa State University and connect this to your software?
A: Yes, the sensors will be connected using server variables on previous projects.
Q: Do you have a bridge selected?
A: No.
Q: Will this use field or lab testing?
A: This will be a field test.

Q: How will this system interrelate with actual bridge health monitoring?
A: That depends on how sensors are connected. That is to be determined.

C: We (Iowa DOT) met last Monday and talked about how this research through UNI will be both independent yet correlated with Iowa State research and how future collaboration will benefit the scope of bridge health monitoring in Iowa.

Q: There was discussion regarding using MEMS sensors in pavement in a dense pattern; is there a limit in the number of nodes you can bring into this process?
A: The limit is 60,000 for connecting to the network.
Q: Can you daisy-chain those so you have more than that?
A: A number closer to the exact estimate is 66,000.

*** One Member Left the Table***

PROPOSAL *On-the-Spot Damage Detection Methodology for Highway Bridges During Natural Crises*, Salam Rahmatalla, The University of Iowa/CEE ($69,092)

BACKGROUND
Structural health monitoring algorithms based on static and dynamic characteristics of structures have shown great potential for application to the health monitoring of bridges. These methods can address some or all of the four damage issues in bridges: 1) detecting damage; 2) locating regions of damage; 3) quantifying the severity of damage; and 4) predicting remaining service life. With health monitoring approaches that use dynamic response measurements for damage detection, both time domain and frequency domain approaches have been used.

In this project, the FRF curvature method and the Gapped-Smooth-Method (GSM) will be modified and tested in a laboratory setting and subsequently on Iowa highways in rural areas. Different normalization schemes will be used to improve the efficiency and the efficacy of the methods. The lab study will also investigate optimizing the number of sensors and their locations and the effects of noise level on the results. The methodology will be

verified and validated in the lab using structural scale models. The field study will measure the dynamic responses of the bridge several times to create a baseline and begin a damage history of the bridge.

OBJECTIVES
To develop and assess the effectiveness of an experimental approach to a damage detection methodology that can be applied to highway bridges in Iowa during natural disasters such as flooding and assisted bridge inspectors in their endeavors. The research will 1) verify and validate the proposed methodology using structural models in the lab, and 2) apply the methodology on one of Iowa highway bridges in rural areas, such as Iowa highway 22 and visually validate the finding.

Q: Please elaborate on flood monitoring applications and explain how you would conclude you have a problem?
A: We will try to measure small structure movement using sensors on both superstructure and substructure.

Q: Is this laboratory work?
A: Stage One will be laboratory work; Stage Two will be in the field.

PROPOSAL *Field Testing of a Small-Scale, Segmentally Precast Bridge Pier for Accelerated Construction*, Jon Rouse, Iowa State University/InTrans

BACKGROUND
The segmentally precast pier provides the economic and aesthetic advantages usually ascribed to any precast concrete system. Because the concrete is cast at a plant rather than in the field, environmental conditions that are crucial to freshly placed concrete may be more closely monitored and controlled. The usual result is higher quality concrete that is more durable over the life of a structure. The precast pieces may be cast early in the project schedule and then be rapidly assembled in the field even during temperature extremes that normally pose problems for cast-in-place structures. Architectural finishes may also be expediently applied in the plant providing a wider range of appearances for the completed structure. By casting the pier columns in segments, shipping and handling costs will be reduced and smaller, lighter equipment will be required for field assembly.

OBJECTIVES
The objective of the proposed research is to design, construct, test, and evaluate a small-scale bent incorporating the most effective details and construction techniques identified in the feasibility study. Erecting the pier in the field will allow a quantitative evaluation of material, equipment, and labor costs as well as time savings. Field testing will give a comprehensive view of realistic structural performance that can be used, if warranted, in the design of a full-scale pier for a bridge in service.
Q: Do you expect any maintenance problems with all of these plates? What about corrosion?
A: The big issue is the external fuse plates, but there are coatings you can apply. All you need to do is unbolt it and replace it. For the internal tendon, there are now fully encapsulated systems.

Q: You plan to use a three-segmented column; what's controlling that?
A: The joints can be placed anywhere depending on what kind of impact you may be concerned about; if you want to make it as inexpensively and quickly as possible and there is no concern about a loaded top, you could use a single or a two-section pier like we tested in the lab. The location of the joints is not a strength issue but is a construction issue.

Q: Are you limited to how long the segments can be?
A: There's no limit, but the longer segments are the more exposed it is to staying intact and it becomes more like a conventional pier.

DISCUSSION OF INNOVATIVE PROPOSALS FY 2009-2010
Mark: $200K is set aside annually, but if the Board votes to fund all three the budget can accommodate that amount (about $220K).

C: That money is kept if we don't fund all three proposals. We do have the first round RFP review today and have a lot of those projects that will be presented in upcoming months. We've always stated that as a target, the amount for Innovative Proposals is $200K, but it depends on what comes in.

Q: Has there been much feedback from contractors on the precast units?
A: We have had feedback, yes. One thing they don't like is that there are too many steps in the process; those need to be taken down to a manageable level. The other thing we've heard is that they could do it at less cost with additional construction. They said the labor rate is low enough to compensate the hours of overtime. However, with information sharing they will eventually see benefits.

C: Some of the feedback I've heard from contractors is that precasters tend to use up what is formerly viewed as profit; the cure time, particularly on bearing items (like the abutment sections).

C: Items could be built in the shop during the winter months.
C: Counties won't be putting in a bridge with piers; most are single span and not in a water environment.

Motion to Fund the First Two Proposals –

1. *Wireless Sensor Networks for Infrastructure Monitoring* and
2. *On-the-Spot Damage Detection Methodology for Highway Bridges During Natural Crises*

Motion by A. S. Rinehart. 2nd by M. Nahra.
Motion carried with 8 aye, 0 nay, 0 abstaining.

PROPOSAL PHASE III, *Curing Criteria for Cold In-Place Recycling*, Hosin "David" Lee, The University of Iowa [TR-553 (Phase I) & TR-590 (Phase II)] ($104,140)

BACKGROUND
The current practice for overlay of Cold In-Place recycling limits the maximum moisture content in the CIR to 1.5 percent, while many CIR projects, struggling with unfavorable climate, have been overlaid successfully with higher levels of moisture. Questions about the curing criteria generally fall into two categories: 1) After construction, when can the CIR layer handle the placement of the wearing surface? and 2) If and how much of the moisture in the CIR layer is detrimental to a HMA overlay?

Phase I (TR-553) explored more effective ways to identify minimum in-place CIR properties necessary to permit placement of the HMA overlay and focused on laboratory experimentation simulating field curing conditions and determined how various moisture levels affect the indirect tensile strength of both CIR-foam and CIR-emulsion. Phase II: 1) Measured the moisture levels throughout a CIR layer in the field, 2) Developed a relationship between field moisture measurements and laboratory moisture measurements, and 3) Developed a curing index to determine the optimum curing time of CIR layer before overlay.

OBJECTIVES
Phase III main objectives will: 1) Measure the moisture contents and temperature throughout a CIR layer at six CIR project sites, 2) Calibrate the developed moisture loss indices using the field measurement from six CIR project sites, and 3) Develop a stiffness/density gain model to supplement (or replace) the moisture criteria.

The main product from this research will be a moisture loss index and/or a stiffness/density gain model that the industry and the agency can apply for a timely placement of the wearing surface. A set of curing indices and/or a stiffness/density gain model that can determine an optimum timing of an overlay are expected to come out of the phase 3 for implementation.

Motion to Approve by M. Nahra. 2nd J. Adam.
Motion carried with 8 aye, 0 nay, 0 abstaining.

FIRST ROUND RFP REVIEW FY 09-10
Mark: After looking at the final ranking for projects that were voted on, the top five were selected for RFP development. These projects are:

IHRB 09-01 Proposal for Study of the Effects of Implements of Husbandry on Iowa Bridges
IHRB 09-02 Evaluation of Separation Railing Systems in Iowa (*Postponed*)
IHRB 09-03 Maintenance and Design of Steel Abutment Piles in Iowa Bridges
IHRB 09-04 Timber Abutment Piling and Back Wall Rehab and Repair (*Postponed*)
IHRB 09-05 Use of Ultra-High Performance Concrete in Geotechnical and Substructure Applications Phase II: *Connection Details and Field Implementation of UHPC Piles*

RFPs IHRB 09-01, IHRB 09-03, and IHRB 09-05 are completed. RFPs IHRB 09-02 and IHRB 09-04 have been postponed:

> IHRB 09-02: I'm working with the Iowa DOT Office of Design and the Bridge Office to develop the project scope. This should be ready for review at next month's meeting. It's almost complete, but there are still questions regarding what type of field testing should be done and some issues on the crash test facility.
>
> IHRB 09-04: This project will also be postponed. I had a late start on that but am working with Mark Nahra who submitted the topic several years ago. However, we're not quite ready to move on this RFP.

FIRST ROUND RFP DISCUSSION FY 09-10
IHRB 09-01 Proposal for Study of the Effects of Implements of Husbandry on Iowa Bridges

C: The county engineer association as part of their legislative package for 2010 is looking at this very closely. It's pertinent and timely.

Mark: Any issues with the funding level and/or timing on this RFP? There is currently a Pooled Fund project being done at the MNRoads facility by MN DOT.

C: Because we have worked with ISU's Bridge Center and Terry Wipf so successfully in the past and he has this expertise, it may be less expensive to Sole Source this project. They could bring in some other ISU researchers that we believe are the right team.
C: There would be advantages to moving quickly on this to the counties.
C: Something we're going to want to look at are the main bridge types, including the steel beam, a precast beam bridge and a slab bridge. When looking at ratings in the past, it seems there are issues with slab bridges the beam bridges do not have.

Motion to Approve Sole Sourcing IHRB 09-01 to Iowa State University's (InTrans) Bridge Center by M. Nahra. 2nd D. Ahart.
Motion carried with 8 aye, 0 nay, 0 abstaining.

IHRB 09-03 Maintenance and Design of Steel Abutment Piles in Iowa Bridges

Mark: This RFP deals with exposure issues of the top portion of piles under the abutments and corrosion; it will develop methods for addressing the problem and cost-effective details to prevent the problem on new bridges. Also, in discussions with the Iowa DOT Bridge Maintenance Office, previous work to determine the condition of steel abutment piles through Wiss Janney Elstner Associates (WJE) was presented. A statement of support for Sole Sourcing this project to WJE has been added to the RFP.

C: Because they did Phase I, they are definitely well qualified and have all of the expertise to examine corrosion aspects and also, find new ways of protecting piles.
Mark: In talking with Bridge personnel, it was emphasized that there are others who also have corrosion expertise, but combined with their knowledge of bridges and problem-specific corrosion experience, WJE is uniquely qualified to complete the work.
C: Are they going to take a look at some bridges that have this problem to see if they were built on fill as opposed to being built on an older road grade? Few of our bridges, especially in the county road system, are built in a well-consolidated road grade. Generally, we have to raise the elevation of that bridge four-to-five feet, so we have that compacted fill as opposed to being in a deep cut. I would like to be sure that they're taking a look at correlating that.

Motion to Approve Sole Sourcing IHRB 09-03 to Wiss Janney Elstner Associates (WJE) by A. Abu-Hawash. 2nd M. Nahra.
Motion carried with 8 aye, 0 nay, 0 abstaining.

IHRB 09-05 Use of Ultra-High Performance Concrete in Geotechnical and Substructure Applications Phase II: *Connection Details and Field Implementation of UHPC Piles*

Mark: We had a previous phase presented in December 2008. This project will examine a few more details that are needed in order to implement this research, namely, connection details between the pile cap and the pile and also, any type of extension for those if we need to splice them in the field. This will look at a design methodology for considerations of displacement or non-displacement piles and installation under long-term loading conditions in the field and also, some driving issues with different types of bedrock.

Q: Is this Sole Source?
C: This is Phase II, so do we go back to the Phase I researcher?
Mark: It's a little unusual that it was submitted in the ranking rather than just making a presentation.
C: It would be difficult to have someone else take over this project at this time. It should be Sole Source.

Q: Are we limiting opportunity for other entities through Sole Sourcing? It makes sense to me because of project expertise and involvement, but all three of these are Sole Source.
Mark: This is a unique situation where these projects happen to fall into a narrow category. We've hesitated to do this in the past in order to keep opportunities open, but there are strong reasons for Sole Sourcing.
C: Keep in mind previous research by these researchers. No one else is doing this type of specific research.

C: In administrative process, in both the Staff Action and the Contract, there is a required justification stating exactly why the entity selected was chosen to do the work..

Motion to Approve Sole Sourcing IHRB 09-05 to ISU by A. Abu-Hawash. 2nd A. Ahart.
Motion carried with 8 aye, 0 nay, 0 abstaining.

NEW BUSINESS
The annual IHRB Travel Meeting for 2009 will be held in September. Several options will be considered for the Travel Meeting destination at the July 31, 209 meeting.

ADJOURN
Motion to Adjourn
Motion by S. Rinehart. 2nd by M. Nahra.
Motion carried with 9 aye, 0 nay, 0 abstaining.

The July 2009 meeting of the Iowa Highway Research Board will be held **FRIDAY, July 31, 2009 at 9:00 a.m. in the East/West Materials Conference Room at the Iowa DOT.**

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Mark J. Dunn, IHRB Secretary