IOWA HIGHWAY RESEARCH BOARD

Minutes of January 28, 2000

Regular Board Members Present
M. Gardner J. George
L. Greimann D. Little
T. Myers C. Narotam
L. Smithson T. Stoner
W. Weiss J. Witt

Alternate Board Members Present
W. Nixon for J. Odgaard S. Peppler for R. Krauel
C. Van Buskirk for D. Osipowicz B. Belzer

With No Representation
None

Visitors
Bob Steffes Iowa Department of Transportation
Dave Heer Iowa Department of Transportation
Mohammad Mujeeb Iowa Department of Transportation
Larry Jesse Iowa Department of Transportation
Steve Gent Iowa Department of Transportation
Bob Stanley Iowa Department of Transportation
John Hart Iowa Department of Transportation
Nick Schram Iowa Department of Transportation
Heath Gieselman Iowa Department of Transportation
Andy Barnes Iowa Department of Transportation
F. Wayne Klaiber Iowa State University
David White Iowa State University
Terry Wipf Iowa State University
Ken Bergeson Iowa State University
Chuck Jahren Iowa State University
Omar Smadi Iowa State University - CTRE
Gordon Smith Iowa Concrete Paving Association

The meeting was held at the large Materials Conference Room at the Iowa Department of Transportation, Ames, Iowa. The meeting was called to order at 10:00 A.M. by T. Myers.

Approval of the Minutes
T. Stoner made a motion to accept the minutes and C. Narotam seconded the motion. It was approved by the Board with 11 yes, 0 no and 0 abstaining.

Final Report
T. Wipf of Iowa State University presented a final report for HR-397, "Field Laboratory

Testing of Damaged Prestressed Concrete (P/C) Girder Bridges." Due to frequent accidental damage to prestressed concrete (P/C) bridges caused by impact from over-height vehicles, a project was initiated to evaluate the strength and load distribution characteristics of damaged P/C bridges. A comprehensive literature review was conducted. It was concluded that only a few references pertain to the assessment and repair of damaged P/C beams. No reference was found that involves testing a damaged bridge(s) as well as the damaged beams following their removal.

Structural testing of two bridges was conducted in the field. The first bridge tested, damaged by accidental impact, was the westbound (WB) I-680 bridge in Beebeetown, Iowa. This bridge had significant damage to the first and second beams consisting of extensive loss of section and the exposure of numerous strands. The second bridge, the adjacent eastbound (EB) structure, was used as a baseline of the behavior of an undamaged bridge. Load testing concluded that a redistribution of load away from the damaged beams of the WB bridge was occurring. Subsequent to these tests, the damaged beams in the WB bridge were replaced and the bridge retested. The repaired WB bridge behaved for the most part, like the undamaged EB bridge indicating that the beam replacement restored the original live load distribution patterns.

A large-scale bridge model constructed for a previous project was tested to study the changes in behavior due to incrementally applied damage consisting initially of only concrete removal and then concrete removal and strand damage. A total of 180 tests were conducted with the general conclusion that for exterior beam damage, the bridge load distribution characteristics were relatively unchanged until significant portions of the bottom flange were removed along with several strands. A large amount of the total applied moment to the exterior beam was redistributed to the interior beam of the model.

Four isolated P/C beams were tested, two removed from the Beebeetown bridge and two from the aforementioned bridge model. For the Beebeetown beams, the first beam, Beam 1W, was tested in an "as-removed" condition to obtain the baseline characteristics of a damaged beam. The second beam, Beam 2W, was retrofit with carbon fiber reinforced polymer (CFRP) longitudinal plates and transverse stirrups to strengthen the section. The strengthened Beam was 12% stronger than Beam 1W. Beams 1 and 2 from the bridge model were also tested. Beam 1 was not damaged and served as the baseline behavior of a "new" beam while Beam 2 was damaged and repaired again using CFRP plates. Prior to debonding of the plates from the beam, the behavior of both beams 1 and 2 was similar. The retrofit beam attained a capacity greater than a theoretically undamaged beam prior to plate debonding.

Analytical models were created for the undamaged and damaged center spans of the WB bridge; stiffened plate and refined grillage models were used. Both models were accurate at predicting the deflections in the tested bridge and should be similarly accurate in modeling other P/C bridges. The moment fractions per beam were computed using both models for the undamaged and damaged bridges. The damaged model indicates a significant decrease in moment in the damaged beams and a redistribution of load to the adjacent curb and rail as well as to the undamaged beam lines.

T. Stoner - You mentioned that you repaired one of the damaged beams with carbon fiber and failure was immediate or catastrophic. Was that substantially higher than the failure of the unrepaired beam? My point is we would be concerned if you had a sudden failure at a bridge rather than a gradual failure you could detect.

T. Wipf - We put the design loads on the beam to come up with the design strength value and it was half of the design moment. That design moment that is suppose to be at the limit state was half of what the applied moment was when it failed. Further, when we use some basic behavior type relationships, we find that strength tested was a little greater than what you would expect at the ultimate. It was beyond what the design was asking for by a factor of 2.

If you put plates just on the bottom of the flange for strengthening, you will still see something that may be occurring. There is a lot of cracking going on in the concrete as you move up to the failure.

T. Stoner - If you release the load, that cracking is not visible any more. Doesn't that go back up?

T. Wipf - I don't think it would behave much differently than if you had the fiber on it.

T. Stoner - I think my concern is beyond this research. If we decide that we are too conservative on our designs, one way to eliminate some of the depth of the bridge is to replace some of this customary material with carbon fiber; we may be looking at a different problem in having failures we can't predict or we can't foresee. It is way beyond the realm of this research, but it is just the way I'm thinking of it. I want to be able to see if a bridge has damage and be able to see the results of that damage and predict where we are going to go with that. There is a thought for your next research project.

T. Myers - The other concern I would have is you are using that fiber material under a controlled circumstance and if you have your damage in the wintertime, you would have temperature problems in that location of the bonding of the fiber. There would be certain times of the year when it would be better to allow that kind of material.

T. Wipf - We are actually looking at some of the materials' issues on that one current project that is going on. I don't know if Wayne can answer the question on whether the repair in the winter would be more of a problem than repair in the summer.

Wayne Klaiber - There is a window of temperatures that you have to work with. Temperatures in the winter would be a problem.

The funding was 70% Primary, 10% Secondary and 20% Street.

The Board approved the final report with 13 yes, 0 no and 0 abstaining.

Final Report

K. Bergeson of Iowa State University presented a final report for TR-401, "Embankment Quality." Originally, the Iowa Department of Transportation (Iowa DOT) initiated this research project from an internal investigation relative to an increasing frequency of rough pavements developing early in the service life of grade and pave projects. Pavement roughness would typically be caused by differential settlement of the pavement supporting the embankment; (2) within the constructed embankment itself; (3) through softening of subgrade soils immediately under the pavement due to water infiltration; or (4) differential frost heave and shrink/swell. Although all of these are potential causes of differential settlement, this research focused on the one factor that we have the most control over, which is the embankment itself. Phase I of the research program outlined problems associated with rough pavement as a result of poor embankment quality. Phase II research included the following: (1) develop and evaluate alternative soil design and embankment construction specifications based on soil type, moisture, density, stability, and compaction process; (2) assess various quality control and acceptance procedures with a variety of in-situ test methods including the Dual-mass Dynamic Cone Penetrometer (DCP); and (3) develop and design rapid field soil identification methods. At the start of the research, soils were divided into cohesive and cohesionless soil types, with each category being addressed separately. Cohesionless soils were designated as having less than 36% fines content (material passing the No. 200 sieve) and cohesive soils as having greater than 36% fines content. Subsequently, soil categories were refined based not only on fines content but soil plasticity as well.

Research activities included observations of fill placement, in-place moisture and density testing, and dual-mass DCP index testing on several highway embankment projects throughout Iowa. Experiments involving rubber-tired and vibratory compaction, lift thickness changes, and disk aeration were carried out for the full range of Iowa soils. By testing for soil stability the DCP was found to be a valuable field tool for quality control, whereby shortcomings from density testing (density gradients) were avoided. Furthermore, critical DCP index values were established based on soil type and compaction moisture content.

During fill placement, much of the fill material (cohesive and cohesionless) was typically very wet and compacted at high levels of saturation, which caused soil instability. It was observed that earthwork construction processes, including lift thickness and roller passes, were not consistent on several embankment projects. Compacted lift thickness was measured to vary from 7 to 22 inches and compaction effort averaged 4 to 5 roller passes. For cohesionless materials the research shows that sheepsfoot compaction is inadequate and that vibratory compaction increases uniformity and relative density. Also, it was observed that reduction of clod size for cohesive soils and aeration of wet soils by disking, which is currently a part of the Iowa DOT specifications, increases embankment quality, but is rarely enforced in the field.

Subsurface explorations involving Cone Penetration Tests (CPT), Standard Penetration Tests (SPT), and Shelby tube sampling operations were performed at selected locations to

obtain information on actual finished embankment conditions. From these investigations, engineering evaluations for the project were developed.

As a result, moisture control and soil design charts were developed to improve soil design specifications and field construction methods. Swell potential, susceptibility to frost heave, and performance under load are soil engineering properties related to pavement subgrade performance and were included in newly developed and proposed Iowa Soil Design and Construction (SCD) charts and Iowa Moisture Content Construction (MCC) charts. To better establish proper moisture contents for granular soils, the Iowa Modified Relative Density test was developed.

S. Peppler - Currently, does the DOT require a specific barrow pit and test the material to make sure it is right? A long time ago, I was in the Army and we had to have a specific barrow pit and they also provided us with how they wanted the compaction done. Then the guys would come out there with their nuclear gauges and test to make sure it was doing what we were suppose to be doing. Wouldn't that be a simpler way of doing it?

K. Bergeson - Soils Design group goes through and identifies the soils within a particular barrow location. They identify how much select, unsuitable and suitable soils are there. They also designate where those materials go. From the Soils Design aspect that information is available for construction. When we get out on the actual construction, the DOT doesn't require any testing, they only require sheepsfoot walkout and indicator that you have compaction. We don't have the nuclear density testing that you are talking about from the construction aspect, but we do have the other information.

S. Peppler - How are you going to make sure that you have the proper moisture if you aren't going to go out there and check the density?

K. Bergeson - It isn't being done now. Problem Statement for Phase III, we are proposing that it be done. We are proposing that the soils be identified out in the field so you know what is actually being used. They can't do that now. All they are going by is what they have outlined in the barrow pit on the Soils Design sheets. We are proposing that they do testing during construction and classification.

G. Smith - I think the other thing we need to look at as you go out into other phases, we need to look at things that will help us characterize, and I think you will be able to, what is already there. We build a lot of pavements, especially on the county and city site, with existing material where we may go in and take 12 inches out, recompact and come on up, but we never have a good methodology to determine whether or not that material is any good, whether we should be doing some cross mixing or something of that nature. I think that would sure be another step that we ought to look at on down the road. There is a lot of it that is done that way. When you are dealing with the DOT you are bringing new embankment in a lot of the time and you have control of that. We probably go over more pavement that is on stuff that has been there 10-15 years than we do on new grades.

K. Bergeson - That is a good point and there is no reason with Dave White's classification method that he has built up that you couldn't do that on the roads. It doesn't take extensive equipment; it doesn't take extensive time. You could do that in a couple hours out there.

C. Narotam - About 3 years from now we are looking at material characterization in terms of resilient modulus. Is there an opportunity somewhere along the line where we could start developing a data base for constructed embankments for quality in terms of resilient modulus?

K. Bergeson - I would think you could, maybe on a pilot project we could try it.

S. Gent - Has your advisory group bought into the recommendations?

K. Bergeson - I'm pretty sure from the DOT Construction side it has. The Soils Design has already utilized this in designing a project, so it has been tested out there. We have been working pretty closely with the Construction and Design side from the DOT through our steering committee. We are working with them right now. The contracting side has been involved with the steering committee. I think we are proposing during Phase III here, if the Research Board accepts this and moves ahead with Phase III, we need to get involved more with the AGC groups, just to get the information out to the construction sites.

Funding was 70% Primary, 15% Secondary and 15% Street.

C. Narotam made a motion to accept the final report. J George seconded the motion and it carried with 13 yes, 0 no and 0 abstaining.

Problem Statement
Ken Bergeson of Iowa State University presented a problem statement entitled, "Embankment Quality - Phase III." The results of Phase I and Phase II research indicates that design and construction specifications of embankments need to be changed. Recommendations for change have been suggested. Before considering statewide specification changes for design and construction of embankments, however, it would be desirable to test the feasibility of the proposed design and construction specifications on an actual project.

The objective of the research is to design a project using the recommended design specification and to construct a project using the recommended construction guidelines. The intent is to

(1) field test and refine the proposed design and construction specifications and (2) evaluate the feasibility of implementing a contractor Quality Control (QC) and Iowa DOT Quality Assurance (QA) program in the future.

The project cost is estimated to range from $75,000 to $85,000.

T. Stoner - I kind of want to carry on what Gordon Smith said, rather than just kind of matter of fact including city or county people in this result. I think Gordon made a pretty strong case that there is a different construction environment in counties and probably cities than there are in the state. I would like to see some, at least county and I would think city people too involved in this committee to provide their input. It is very unusual for county construction to use anything other than the soil that is right there in front of you. We build what we got there; we know what we have because we didn't move anything, we just churned it up a little bit. I think there are enough differences that I think we should have some people involved in the committee.

K. Bergeson - I don't have a problem with that at all. If the counties and cities would pick a representative to be on the committee that would be fine.

T. Myers - Can we also incorporate Champ's request to do resilient modulus testing?

K. Bergeson - Yes, we can.

T. Stoner made a motion to change the funding to 83% Primary, 10% Secondary and 7% Street. S. Peppler seconded the motion and it carried with 13 yes, 0 no and 0 abstaining.

T. Stoner made a motion to approve the problems statement with a city and county representative included on the steering committee and do resilient modulus testing of shear strength of soil.

M. Gardner seconded the motion and it carried with 13 yes, 0 no and 0 abstaining.

Construction Report
J. Cable of Iowa State University had a construction report for TR-420, "Field Evaluation of Alternative Load Transfer Device Locations in Low Traffic Volume Pavements distributed to the board. The purpose of dowel bars is to transfer a load across the transverse joint from one pavement slab to the adjoining slab. Typically, dowel bars are spaced on 12 inch centers for the full length of the transverse joint.

TR-420 is the analysis of load transfer at transverse joints based on the number and location of dowel bars in the joint. For this research, tests sections were constructed and tested in an actual field service pavement. Test sections included areas with assemblies having 3 and 4 dowels in the outer wheel path only, full lane width assemblies, and joints with no dowels. Two paving projects provided both rural and urban settings and differing base materials.

Funding for this project is 80% Secondary and 20% Street.

No action was needed on the construction report.

Oral Reports on TRB
J. George and W. Weiss gave a short oral report on their trip to TRB. Jim and Wade felt it

was interesting and something worth going to at least once. They felt it was a little hard to find the type of sessions in which there would be an interest to counties. They felt it is a meeting in which university and DOT personnel should go to every year.

Annual Report
The annual report was distributed in the board members' packet. It will also be distributed to all county engineers, city engineers, etc.

New Business
T. Myers - Mentioned a letter to the IHRB from American Public Works Association (APWA) (attached) regarding the obligation of Street funds from future fiscal year allocations. It was the general consensus of the Board that it was not the Board's position to commit funds into the next fiscal year. The new business plan should alleviate this problem by looking at projects up front and basing funding on the priorities set by the Board. A letter will be drafted by Mark Dunn and Tom Myers to respond to APWA stating this position.

M. Dunn - Asked Board members and alternates what input was wanted from the department prior to the Strategic Agenda Brainstorming that will be done at the March meeting. A list of some possibilities (attached) was distributed. It was felt that items on the list would be good background information for the March brainstorming. That material will be distributed and discussed at the February meeting. Information regarding national research is available at the TRB home page at www4.nationalacademies.org/trb/homepage.nsf.

M. Dunn - Asked that IHRB members and alternates to return any copies of reports mailed to them for review if they are not needed. The number of reports being provided by principal investigators has been reduced to cut printing costs. The reports can be reused if no marks have been made in them.

M. Dunn - The Materials Research Section has been working on a web page that will make abstracts of all previous Iowa Highway Research Board projects available. There will also be a calendar of research related events and possibly copies of entire recently released reports. More information will be made available as we get closer to finalizing the web page.

W. Nixon - Raised the question about why the proposal from Dr. Lee, University of Iowa, regarding "Development of an Automated Crack Measurement System for Iowa's Cities and Counties" was not on the agenda for the January meeting at the request of Dr. Lee. Dr. Lee was concerned that the open discussion with a visitor in the audience from Center for Transportation Research and Education (CTRE) had led to the removal of the project.

M. Dunn - In reviewing the agenda prior to distribution, Ian MacGillivray felt that the Iowa DOT needed more feedback from staff in order to determine the level of

participation from the Iowa DOT. There has been prior work done in Arizona and Texas that the Iowa DOT has participated in that is similar in scope.

T. Stoner - There was a lot of discussion at last month's meeting about this and it was enthusiastically supported by the county engineers. I know that the IHRB is an advisory board, but if the Iowa DOT needed additional input then why aren't the county engineers asked to provide the input as well? The county engineers are 6 of 13 members of the Board and no one was asked to provide additional input or concerns on that particular topic.

M. Dunn - As far as the Iowa DOT's support, percentage wise for this project, it wasn't felt that we had enough input to address it at the next meeting.

T. Stoner - The opposition to the project did not come from the Iowa DOT at the meeting. The opposition came from Omar Smadi at CTRE.

T. Myers - I agree with Tom. Do the county engineers or city engineers have the same authority to table a project simply by calling and saying that they want to get more input? Is that in the best interest of the IHRB?

T. Stoner - I think that if there is additional discussion regarding the topic, it should be in front of the IHRB.

D. Little - We have developed a culture in our meetings in which visitors can be free to interject their thoughts into the business of the Board. Dr. Lee's problem statement should stand or fall based on its own merits in terms of what he knew about the Iowa DOT's pavement management systems. If he did not know how to answer a question from the Board, it should have been left there. If an Iowa DOT staff person understood the mechanisms of it, that would be fine, but asking a competitor to, such as a CTRE person, was not proper.

J. George - It was my comment that what Dr. Lee was presenting was similar to what I had seen CTRE putting together and I was somewhat soliciting Omar Smadi's opinion.

D. Little - I think that if he kept his comments to the point of how it interacted with the other data collection efforts that were there, maybe it would have been alright.

T. Stoner - I think it is important that the Board has the input and they request the input from the visitors as they need it.

D. Little - If Dr. Lee wasn't exactly sure how the Iowa DOT does their pavement management data collection, then we should have asked him, as a Board, to investigate that and to report back later, as opposed to shooting it back and forth from different ends of the room.

W. Nixon - There is Iowa DOT representation on the Board and it was a 12-0 vote in favor of approving the problem statement. Dr. Lee's concern was that he had understood that there is a certain process that he had to go through and that process seems to have changed. He is new to Iowa and the IHRB and he thought he had made a good first step. He does not know what issues and concerns have been raised about his proposal so he has no way of addressing these. It was his understanding that concerns were to be addressed at the IHRB meetings and I think that is where they need to be addressed.

T. Stoner - Dave Little used the word "competitor" and that is exactly what we are looking at here. There is a serious concern that this large project, that is already in place, is being threatened by a lean and mean project that might accomplish the same thing.

L. Greimann - I was not sure that Dr. Lee had talked to anyone at the Iowa DOT prior to presentation of the problem statement.

W. Nixon - I think he had some contact, but he is new to this process and has not had a chance to develop contacts.

T. Stoner - One comment that was made was whether or not Dr. Lee had any financial interest in the software. I think he was specific that he did, but that it was very limited and he would allow for free distribution of the software. If the CTRE project is $500,000 and Dr. Lee's project is $100,000, I don't care if he makes money from this. I think it is appropriate that the Board encourages that that item be brought back up at the next meeting for discussion.

Date of Next Meeting

DATE OF THE NEXT MEETING WILL BE FEBRUARY 25, 2000 AT 10:00 AM, IN THE LARGE MATERIALS CONFERENCE ROOM AT THE IOWA DOT.

Mark Dunn, Secretary