MINUTES OF 2002 STRUCTURE WORKSHOP

The 2002 Structure Workshop was held on April 4th in the Bridge Maintenance Unit Conference Room in Raleigh. Those in attendance included:

Greg Perfetti	State Bridge Design Engineer
Paul Simon	FHWA Division Bridge Engineer
Lin Wiggins	State Bridge Maintenance Engineer
David Henderson	State Hydraulic Engineer
Ron Hancock	State Bridge Construction Engineer
Cecil Jones	State Materials Engineer
Mohammed Mulla	State Soils and Foundations Engineer
Victor Barbour	State Design Services Engineer
Rodger Rochelle	State Research Engineer
Ricky Keith	Assistant State Bridge Design Engineer
Dewayne Sykes	Assistant State Roadway Design Engineer
John Emerson	Assistant State Bridge Maintenance Engineer
Mike Robinson	Bridge Construction Engineer
Max Buchanan	Bridge Construction Engineer
Billy Trivette	Bridge Construction Engineer
David Patton	Bridge Construction Engineer
John Olinger	Bridge Construction Engineer
Rick Nelson	Bridge Construction Engineer
Jeff Kidd	Construction Unit TEA
Kristian Agnew	Research Engineer
David Greene	Structural Members Engineer
Jack Cowsert	State Materials Quality Engineer
Todd Whittington	Materials and Tests Field Operations Engineer
John Frye	Structure Design Project Engineer
Tom Koch	Structure Design Project Engineer
John Erwin	Structure Design Project Design Engineer
Scott Hidden	Soils and Foundations Engineer
KJ Kim	Soils and Foundations Section Engineer
Nilesh Surti	Soils and Foundations Engineer
Jamey Batts	Soils and Foundations Section Engineer
Andrew Nottingham	Hydraulic Design Project Engineer
Stephen Morgan	Hydraulic Design Project Design Engineer
John Twisdale, Jr.	Hydraulic Design Project Engineer
John Williams	PDEA Bridge Replacement Unit Engineer
Bill Goodwin	PDEA Bridge Replacement Unit Engineer
Tommy Douglas	Geotechnical Special Projects Geologist
John Pilipchuk	Geotechnical Staff Engineering Geologist

Don Moore	Geotechnical Consultant Coordinator
Don Idol	Bridge Maintenance Inspection Engineer

The following items of business were discussed:

1. INTRODUCTION:

Mr. Simon welcomed all in attendance and reflected over past Structure Workshops noting many retirees over the last year and many new faces of those in attendance. Mr. Perfetti also welcomed all in attendance and encouraged all Units to participate in this and future Structure Workshops by submitting topics and openly discussing the topics presented throughout the workshop.

2. ***PRECAST BOX CULVERTS:*** *(STRUCTURE DESIGN)*

Mr. Koch reported that a task force consisting of representatives from the Construction Unit, Structure Design Unit, Materials and Tests Unit, contractors, and precasters had been assembled to discuss and improve the construction and maintenance issues regarding precast concrete box culverts. The most recent preliminary recommendations from the task force include the following:

- Limit the use of precast box culverts to Divisions 5, 7, and 9-14
- Disallow the use of precast wings
- Require the precast box units to be jacked together
- Encapsulate the foundation conditioning material in filter fabric
- Tighten the precast box fabrication tolerances
- Eliminate the internal butyl rope box joint
- Wrap the box joints with a 2’ wide external sealer wrap in addition to a 3’ wide filter fabric wrap

Mr. Hancock stated that the industry would be required to find a trial project in which the fabrication and installation of the precast box culvert would be governed by the new specifications. Mr. Nelson stated that often the external wrap does not adhere to the concrete when installed in cold weather. Therefore, consideration should be given to leaving the butyl rope joint within the specifications.

Mr. Patton stated that consideration should be given to disallowing the use of precast box culverts when the construction is staged and when the culvert grade exceeds 2%. In situations of this nature, problems including longitudinal box alignment, stream management, and jacking units together are very typical. Mr. Patton stated that if precast culverts are specified with stage construction, a statement should be included in the policy special provision requiring the contractor to submit a method of handling the stream water. Mr. Trivette agreed and also suggested that the use of precast headwalls be prohibited when

using multi-barrel precast box culverts due to alignment and fit-up problems. Mr. Trivette also stated that precast toe walls should be disallowed.

Mr. Nelson questioned whether sills could be used in precast box culverts. Mr. Koch stated that Structure Design needed to investigate using precast culverts in low flow situations and if sills were possible, the producer would be required to detail the sills in the precast culvert shop drawings. *Structure Design committed to investigating and considering all comments prior to composing the final special provision governing precast box culverts.*

3. PIPE PILES IN CORROSIVE ENVIRONMENTS: *(STRUCTURE DESIGN)*

Mr. Perfetti stated that an Interagency Jetting Committee had been formed to look into methods that would make jetting of prestressed piles acceptable to the agencies. One of the tasks identified was to work with the Hydraulics Unit in identifying areas throughout the state in which jetting of concrete piles would not be permitted, may be permitted and would be permitted. The development of these areas could reduce the need for use of steel pipe piles in corrosive environments. Mr. Goodwin agreed with the importance of determining these areas and stated that he would like to work with the agencies in order to get this task initiated.

Mr. Hidden requested that in highly corrosive or environmentally sensitive areas, the Soils and Foundations Unit be included in the design process as early as possible so that the foundation type may be included in the permits. Mr. Kim also requested that the Structure Design Unit develop a policy regarding the use of steel pipe piles in corrosive environments as an option to P/S concrete piles. Mr. Kim stated that a policy of this nature would eliminate uncertainties in specifying pile types. Mr. Perfetti stated that until the allowable jetting areas were determined, the decision of pile type would unfortunately be on a case by case basis.

Mr. Wiggins stated that when steel pipe piles are required in corrosive environments the piles should always be coated. Mr. Wiggins stated that an aluminum coating of maximum thickness has proven to be most effective, but stated he was also in favor of galvanizing whenever practical.

4. RCBC WINGLESS OUTLETS: *(STRUCTURE DESIGN)*

Mr. Perfetti questioned why wingless outlets were not being recommended by the Hydraulics Unit. Mr. Twisdale stated that the agencies are more frequently requiring benched channels with sills throughout the culvert length. For multi-barrel culverts, with the wingless option, the interior walls do not extend to the end of the apron. Therefore, detailing the benched channel with sills is not possible in this section of the culvert. Mr.

Trivette suggested that the interior walls of multi-barrel culverts extend to the end of the apron and parallel the wings.

Mr. Nottingham also stated that the concrete apron of the wingless outlet detail is considered fill in the stream by the agencies. Therefore, in some cases, the increase in stream impact would require stream mitigation whereas the use of turn back wings in the same culvert would not require stream mitigation. Mr. Perfetti explained that the concrete apron eliminated the potential for scour undermining the wing foundations and reported several instances of this occurrence. Mr. Nelson inquired if the concrete apron could be installed with turned back wings. After some discussion, Structure Design committed to investigating the various recommendations and suggestions.

5. CORED SLAB DRAINAGE SYSTEM: *(STRUCTURE DESIGN)*

Mr. Erwin distributed details of a proposed open drainage system to be attached to cored slab bridges spanning environmentally sensitive waters. The purpose of the drainage system is to prevent bridge runoff from falling directly into the sensitive water.

Mr. Erwin stated that in bridge projects of this nature, other options should be evaluated by the engineer prior to specifying this detail. The first option available to engineers is to increase the shoulder width and allowable spread by adding an extra cored slab unit. The second option would be investigating the use of a prestressed concrete girder superstructure with a closed drainage system. The last option would be the open drainage system.

Mr. Greene stated that precasters preferred not to drill holes in side forms and inquired if bolts could be drilled and epoxied in the cored slab unit in lieu of precasting anchor mounts. Mr. Koch replied that a policy existed that prohibits drilling into precast units. Mr. Simon inquired about placing the drains at a 45^{O} angle to the barrier rail to increase the runoff flow from the deck into the gutter. After some discussion, Mr. Nottingham stated that placing the drains at a 45^{O} angle would not substantially increase the flow rate off the bridge.

Mr. Wiggins stated that the open drainage system would be very difficult to maintain and suggested increasing the shoulder width by two cored slab units before specifying the open drainage system. Mr. Williams concluded the discussion by stating that the need to prevent runoff from falling directly into a body of water would increase with future projects and therefore, expect to use these options on a more frequent basis.

6. PIPE PILE BID ALTERNATE FOR P/S PILES: *(STRUCTURE DESIGN)*

Mr. Perfetti stated that he was considering allowing steel pipe piles as an alternate to prestressed concrete piles in noncorrosive environments. Mr. Perfetti reasoned that if the alternate was available on the plans then the Department would be assured of getting the most inexpensive pile. Mr. Kim questioned how the Soils and Foundations Unit would

know when to evaluate the pipe pile option. Mr. Perfetti stated that currently, the Soils and Foundations Unit would have to inquire of Structure Design on a project by project basis.

7. INVERSEAL OPTION TO EVAZOTE JOINTS: *(STRUCTURE DESIGN)*

Mr. Koch distributed a specification and a sample of an inverseal joint to the attendees. Inverseal joints consist of a closed cell with a dense neoprene skin layer. Mr. Koch stated that the inverseal joint had been installed in several locations by Bridge Maintenance with good performance, and it was the intention of Structure Design to use it as an alternate to evazote joints in the near future. Mr. Koch reported that currently the price of the inverseal joint is roughly 10% higher than evazote but should decrease upon increased use.

Mr. Buchanan inquired if the inverseal joint could be spliced. Mr. Koch replied that the inverseal could be spliced on site just as the evazote joints. Mr. Simon inquired if the inverseal was produced in a role or in strips. Mr. Simon stated that if the joint was manufactured in strips, the splices should be at a minimum on new construction. Mr. Koch stated that the inverseal joint was manufactured in strips and the splice policy would be the same as that for evazote joints.

Mr. Simon also questioned whether the inverseal joint would perform as well as the evazote joint when used in heavily skewed bridges. Mr. Idol concluded that this could be a problem since the joint to bridge bonding surface of the inverseal joint was less than that of the evazote joint.

8. BARRIER RAIL TRANSITION: *(STRUCTURE DESIGN)*

Mr. Erwin distributed details and provided an update on the status of the barrier rail transition designed to satisfy the NCHRP 350 requirements. The barrier rail transition essentially transitions the New Jersey shape barrier rail on the bridge to a vertical face parapet wall over the length of the approach slab. At the end of the approach slab a Type III guardrail anchor unit will attach a thrie beam guardrail to the flat face parapet.

9. OTHER STRUCTURE ITEMS: *(STRUCTURE DESIGN)*

Jointless Bridges

Mr. Koch reported that Structure Design was continuing to finalize jointless bridge details for use in upcoming projects. Mr. Trivette inquired about the benefits of jointless bridges. Mr. Koch stated that jointless bridges are easier to construct and require less maintenance. Mr. Idol asked Structure Design to investigate closely the use of integral bridges in granular soils due to recent problems in the eastern portions of the state.

10. GEOPHEX PILE MONITORING DEVICE: *(GEOTECHNICAL UNIT)*

Mr. Douglas gave a presentation of a new device developed by Geophex, Ltd. capable of providing real time scour monitoring. The device will be installed in piles with a high potential for scour. Currently, the device is being used on a trial project in North Carolina. It is the intention of the Geotechnical Unit to use the system in the future for scour critical foundations such as those expected at the Oregon Inlet Bridge.

11. EROSION FUNCTION APPARATUS: *(GEOTECHNICAL UNIT)*

Mr. Pilipchuk gave a presentation on an Erosion Function Apparatus (EFA). This new apparatus, owned by NCDOT, has been designed and built to measure the erosion rate of different types of soil, ranging from clay to gravel and from soft soils to soft rocks. Mr. Philipchuk stated that a Shelby sample can be taken from a bridge site and be used as a specimen in the EFA. The EFA is capable of measuring the erosion rate vs. the shear stress of the specimen as well as the critical shear stress. Subsequently, the Geotechnical Unit can incorporate the test results into a local scour prediction model.

12. STANDARD DETAILS FOR CLOSED END STEEL PIPE PILES: *(SOILS AND FOUNDATIONS)*

Mr. Kim stated that in highly corrosive environments the Soils and Foundations Unit would like to specify closed end pipe piles filled with reinforced concrete. The pipe pile would be sacrificial and hopefully prolong the life of the reinforced concrete pile. Mr. Kim requested that Structure Design develop details for 18", 20", 24", and 30" piles of this type. Mr. Mulla stated that he had received details from FDOT and would convey these to Structure Design for reference.

Mr. Perfetti questioned when this pile type would be specified. Mr. Mulla replied that this pile would be specified only in corrosive sites and that the P/S concrete piles would be the first option if permissible. Mr. Perfetti stated that the Structure Design Unit would consult with other states and consider creating composite pile details.

13. BRIDGE END BENT SLOPES: *(SOILS AND FOUNDATIONS)*

Mr. Kim stated that hydraulic and structure design engineers typically request preliminary end bent slopes in order to initiate the preliminary bridge layout. By the time the Soils and Foundations Unit receives the relevant information to verify the preliminary slopes, the structure design may be too advanced to issue a change. Therefore, slope stabilization measures are specified. Mr. Kim stated that in order to eliminate this problem, it is the intention of the *Soils and Foundations Unit to develop a set of criteria in which the Hydraulics Unit and Structure Design Unit could accurately anticipate the end bent slopes in advance of the final foundation recommendations.* This set of criteria would

include the height of the embankment and whether the embankment was a cut or fill slope. Structure Design and Hydraulic Design representatives agreed with Mr. Kim in that this criteria would be very beneficial.

14. RETAINING WALL ENVELOPE: *(SOILS AND FOUNDATIONS)*

Mr. Hidden expressed problems with finding retaining wall envelopes on different projects and questioned what unit was responsible for providing the wall envelope. Mr. Koch stated that, in most cases, Roadway Design develops the retaining wall envelope for all walls and the wall type dictates whether it is included in the structure or roadway plans. Mr. Hidden suggested that all walls, with the exception of gravity walls, be included in the structure plans. Mr. Hancock went further to suggest that all walls be included in the structure plans to eliminate confusion. Mr. Sykes stated that Roadway Design had no objections to the previous suggestion, but responded that some projects contain walls but do not contain structures of any type. Mr. Sykes emphasized the use of electronic plans between units in order to reduce coordination problems such as this. *After some discussion, it was decided that a committee, headed by Mr. Hidden and composed of the various units, would be formed in order to create a policy that would outline each Units responsibility in a wall design and the location of the wall within the complete set of plans.*

Mr. Buchanan asked if the Soils and Foundations Unit could develop a segmental block wall standard that could be used as an aesthetically pleasing option to gravity walls. Mr. Mulla replied that with so many segmental block wall manufacturers it was very difficult to develop a standard and specification that was not proprietary. In addition, research has to be completed to ensure that segmental block walls are designed for a 75 year lifespan. Mr. Kim concluded by stating that roadway Design should consult with Soils and Foundations when specifying a wall less than 10' in height to question if a segmental block wall could be an option.

15. PERMANENT SHEET PILE ABUTMENT WALLS *(SOILS AND FOUNDATIONS)*

Mr. Hidden stated that abutment walls at streams must extend to an elevation 2' below the critical scour elevation, which would require the use of temporary shoring for construction. However, the construction and shoring required may violate permit restrictions. Mr. Hidden stated that the last minute resolve to this issue is to use permanent sheet piling which can not be extended deep enough to provide adequate stability. Mr. Mulla stated that the option to the permanent sheet piling is a drilled shaft wall which is very expensive. Mr. Hidden requested that the Soils and Foundations unit be contacted during the planning stages when abutment walls at stream crossings are being considered.

16. DESIGN CRITERIA FOR LATERAL DEFLECTION OF PILE BENTS: *(SOILS AND FOUNDATIONS)*

Mr. Batts stated that due to new analysis software and new pile types, the design criteria for lateral deflection of pile bents needs to be reviewed and potentially updated. Mr. Batts stated that a software entitled Florida Pier is capable of analyzing the pile bent while considering the soil interaction upon the pile. This type of design process would allow our design to be less conservative and more accurate. Mr. Koch stated that the Structure Design Unit has reviewed Florida Pier and agreed that the pile analysis was more accurate than our current program. However, due to several design considerations, the software would be difficult for the Structure Design Unit to implement. Mr. Koch stated that Florida Pier is merely an analysis program. Therefore, the program does not generate live loads nor design the piles or columns. Mr. Perfetti suggested that Florida Pier be used as an analysis tool to create the new design criteria. *The Soils and Foundations Unit and Structure Design Unit agreed to form a committee to evaluate the existing criteria.*

17. MAJOR BRIDGE PROJECTS: *(STRUCTURE DESIGN)*

Mr. Frye provided a brief synopsis of upcoming major bridge projects as follows:

- B-0682 - Sunset Beach, scheduled for a July 2004 letting
- R-2507A – US158 over Chowan River, post years
- R-2545 – US64 over Alligator River, scheduled for a 2009 letting,
- R-2576 - Mid-Currituck Sound, scheduled for a 2008 letting
- R-2633B - US17 Bypass over Cape Fear River, post years
- R-3307 - US70 Beaufort Bypass, post years
- X-0004 - NC306 over Pamlico Sound, post years
- R-2245B – Bridge to Oak Island, scheduled for 2005 letting
- B-2532 – US17 Business – Swing Span over Trent River, 2006 letting
- I-2513 – I-26 Connector – French Broad River
- B-2500 – Oregon Inlet, not programmed

18. BRIDGE DECK RIDEABILITY SPECIFICATION: *(CONSTRUCTION)*

Mr. Hancock stated that he favored implementing a rideability specification on long bridges. The proposed specification would mandate a profilograph test of the bridge deck, where currently North Carolina only tests with a rolling straight edge. Mr. Hancock stated that currently he was gathering information from other states as well as requesting comments from the AGC committee in order to develop a criteria for including the specification in the contract.

Mr. Perfetti suggested that when the rideability specification is included in the contract, the slab deck could be designed for an additional ½" depth, which would allow grinding of the deck without reducing the concrete cover over the reinforcement. Mr. Perfetti also expressed concern that increasing the cover may increase crack size. Mr. Simon stated that adding ½" of concrete to the deck may encourage below average deck construction. Mr.

Patton stated that in his experience, when extra concrete is added to the deck for final grinding, the quality of the deck construction decreases. Mr. Hancock responded that additional deck thickness could be added but the specification could be written to require the contractor to pay for grinding if necessary in order to encourage good quality deck construction.

Mr. Simon questioned if NCDOT would perform the profilograph test. Mr. Hancock stated the original specification required the contractor to hire someone to perform the test. Mr. Greene stated that for concrete pavements in North Carolina the paving contractor is allowed to perform the profilograph test.

Mr. Simon stated that the in the majority of bridge projects, the approach slab has not been constructed at the time of the profilograph test. Consequently, the approach slab, joint, and first section of the deck does not get tested. Mr. Olinger suggested that the test limits be set in the specification to include the structure and 100' on either side of the structure. Mr. Hancock stated that he would continue to research and receive feedback before initiating the rideability specification.

19. BARRIER RAIL SLIP FORMING AND QUALITY CONTROL ISSUES: *(CONSTRUCTION)*

Mr. Hancock reported that the use of Class A concrete and contraction joints in the barrier rail had reduced the number of cracks. However, a longitudinal crack on the back of the barrier rail continues to exist. Mr. Patton suggested that there be more concrete cover on the back of the barrier rail to eliminate this crack. Mr. Patton also stated that vibration due to construction traffic on the deck, primarily the slip former, prior to the hardening of the concrete barrier rail causes the majority of cracks. Mr. Perfetti suggested adding 1" of cover to the back of the barrier rail and questioned if the contractors would have to purchase a new form. *Mr. Patton agreed to inquire with contractors about this issue and report back to Structure Design.*

20. DECK POUR ISSUES: *(CONSTRUCTION)*

Mr. Hancock distributed a detail from the Bidwell screed manufacturer pertaining to the direction of pour on skewed bridges with superelevation. The handout asserted that the screed should be set up with the leading edge of the screed on the low side of the deck and the trailing end on the high side. The normal procedure is to finish the concrete from the low side to the high side of the deck.

Mr. Hancock stated that on continuous for live load concrete bridges, the deck pours can be very small. Mr. Hancock suggested setting the minimum deck pour at 75 yd^3. Mr. Perfetti stated that the Structure Design Unit is looking into the possibility of increasing the size of deck pours.

21. EXPANSION JOINTS IN SIDEWALKS: *(CONSTRUCTION)*

Mr. Trivette asked if Structure Design could include a plan note pertaining to the location of contraction joints within the sidewalks. Mr. Trivette stated that the joints were definitely needed to reduce cracking but there were always questions as to their location. Mr. Trivette also asked if Structure Design could investigate a method of draining the water off raised medians other than through the joint.

Mr. Buchanan asked if some of the many vertical dowels could be eliminated from the sidewalk detail. Currently, 6-#4 dowels are located every 5'-0" in the sidewalk. Additionally, Mr. Buchanan stated that detailing the dowels at different heights is impossible to achieve considering the contractor is pushing the dowels into green concrete from a work bridge. *Structure Design committed to investigate and improve the details for sidewalks and median barriers.*

22. PRECAST COPING ON MSE WALLS: *(CONSTRUCTION)*

Mr. Trivette reported several instances of cracking in the cast in place coping along the top of MSE walls. In many cases, the cracks migrate from the coping into the panels of the wall. Mr. Trivette suggested that Structure Design specify contraction and expansion joints in the coping that align with the wall panel joints. Mr. Robinson alternately suggested that roofing felt be placed between the coping and the wall in order to break the bond and eliminate the migration of the cracks into the wall. *Structure Design committed to include verbiage in the special provision to require contraction and expansion joints in the cast in place coping.*

23. BLOCKOUT OF ANCHOR BOLT AREA IN CONCRETE DIAPHRAGMS: *(CONSTRUCTION)*

Mr. Trivette questioned why a blockout was needed around the anchor bolts in full depth concrete bent diaphragms. Mr. Wiggins responded that for maintenance reasons it was necessary to have access to the anchor bolts. Mr. Trivette replied that in order to have access to the bolts, the current blockout needed to be enlarged. *Mr. Koch stated that Structure Design would inform designers of the purpose of the blockout and improve the details*. Mr. Perfetti stated that hopefully in the future, the increase use of link slabs would eliminate the need for full depth diaphragms and the blockout detail.

24. LOCATION TOLERANCES OF DRILLED SHAFTS: *(CONSTRUCTION)*

Mr. Buchanan suggested reducing the 3" allowable construction tolerance for vertical plumbness in drilled shafts. When the drilled shaft is not completely plumb, the reinforcement extending from the drilled shaft through the column often does not fit in the cap. Consequently, reinforcing steel must be bent or the column concrete cover is reduced. Mr. Hancock stated that in his opinion the contractors needed the 3" tolerance for

construction. However, based on the current cap design details, the contractor can be within tolerance and still have difficulty fitting the column reinforcing steel into the cap. Mr. Perfetti suggested that the 3" construction tolerance remain but increase the cap width. *Structure Design committed to implementing a policy to increase the cap overhang by 3" on each side of the column when drilled piers are required.*

25. REBAR CLEARANCES ON PRECAST DECK PANELS: *(CONSTRUCTION)*

Mr. Buchanan stated that the slab detail on concrete deck panels does not provide enough clearance for a 1 3/4" maximum aggregate between the deck panel and the "B" bars. Mr. Perfetti stated that this was not a new issue and that the "B" bars may lie on the deck panel.