Illinois Department of Transportation
2300 South Dirksen Parkway / Springfield, Illinois / 62764

December 15, 2008

CIRCULAR LETTER 2008-16

INSPECTION AND CORING OF REINFORCED CONCRETE STRUCTURES

COUNTY ENGINEERS/SUPERINTENDENTS OF HIGHWAYS
MUNICIPAL ENGINEERS/DIRECTORS OF PUBLIC WORKS
CONSULTING ENGINEERS

This circular letter provides information regarding the inspection of reinforced concrete structures and the possible need to core the structures to determine the integrity of the structural concrete. This information has been discussed at meetings with local agencies and is provided in more detail in the attached All Deputy Directors of Highways (ADD) Memoranda of August 10, 2007 (Deterioration of Reinforced Concrete Structures) and March 18, 2008 (Inspection and Coring of Reinforced Concrete Structures). These memoranda are still applicable except as modified herein.

When reinforced concrete structures are inspected, it is not always possible for personnel to directly observe the top surface of the structure. This condition is routinely encountered during the inspection of:

1) Reinforced Concrete (RC) Slab Bridges that have non-structural wearing surfaces placed on the superstructure; and
2) RC Box Culverts that support embankment materials and pavement.

When assessing the extent to which the superstructure of a RC Slab Bridge or the top slab of a RC Box Culvert is deteriorated, inspection staff must base their assessment on a visual examination of the underside of the slabs. While visual inspection of the underside of slabs is typically sufficient for structures functioning within their expected service life, older concrete structures that have been exposed to the elements and deicing agents for extended periods may have deterioration present in the upper portions of their slab that cannot be identified visibly from below.

Recent experiences indicate the need to include procedures for bridge inspections and project scoping for more thoroughly assessing the ability of aging or deteriorated concrete structures to carry traffic.

When considering staged removal and construction to replace a RC Slab Bridge or a RC Box Culvert, a staging feasibility evaluation shall be performed.

The Bridge Condition Report (BCR) for staged projects includes the staging feasibility evaluation, which must include testing of concrete cores obtained from a structure with Superstructure or Culvert condition ratings of “4” or less (poor or worse condition). For structures with higher condition ratings, cores may be taken. We recommend that the Local Bridge Unit or the agency’s approved Program Manager be consulted for a recommendation. When a BCR is not required during the Phase I portion of the project, a staging feasibility evaluation shall be performed with coring and testing procedures following these same criteria.

If it is determined that a structure cannot accept staged construction, other alternatives should be considered, such as the establishment of a detour route or the construction of a temporary span over the deteriorated bridge.

The department, through the Local Bridge Unit, may request that concrete cores be obtained for RC Slab Bridges and RC Box Culverts having Superstructure or Culvert condition ratings of “4” or less for more accurate determination of a structure’s load capacity. If provided, the instructions contained in the attached ADD Memoranda apply, except that contact should be made through the Local Bridge Unit.

A local agency may also perform concrete cores independent of the department requirements for their own use. A superstructure or culvert condition no higher than “4” shall be assigned when testing of the cores shows a 10-50% reduction in the original concrete compressive strength. A condition rating no higher than “3” shall be assigned for reductions in concrete compressive strength greater than 50%. The original concrete’s compressive strength may not be known for many older structures for which existing plans are not available. In these cases, the original concrete compressive strength can be assumed as 3,500 psi. Assignment of a condition rating of “4” or less will initiate a damage inspection by this office and a subsequent load rating. The local agency may also retain a consultant to perform this load evaluation, and these results should be provided to the department for concurrence with the Bureau of Local Roads and Streets Manual (Section 6.4) and the Structural Services Manual (Section 3).

After cores are taken from a structure, a core data form shall be completed. A blank form and an example, which illustrates the information required by this office, is included in the March 18, 2008 ADD Memorandum. Per the August 10, 2007 ADD Memorandum, at least one 4-inch diameter core should be obtained within each traffic lane for each span of the bridge, preferably along the centerline of a “wheel-path” at the mid-span point. After cores have been taken, full-depth repairs on the holes should be completed in order to minimize future exposure of the slab to moisture, deicing agents and other destructive elements. The core results should be provided to the Local Bridge Unit or consultant for review.

It is imperative that a detailed description of the core be provided in the event it is not possible to obtain a solid core and a test cannot be performed. If the deterioration has advanced to a state where the concrete has fragmented or returned to an aggregate-like material, this is sufficient evidence that the slab has little or no compressive strength. In this case a load restriction will likely be required. The Local Bridge Unit should be notified immediately, and a core data form submitted as soon as possible so that a load-carrying capacity assessment can be made and load restrictions established.

If you have any questions, please contact Mr. Jack Elston at (217) 785-8748.

Sincerely,

Ralph E. Anderson

Ralph E. Anderson, P.E., S.E.
Engineer of Bridges and Structures

Charles J. Ingersoll

Charles J. Ingersoll, P.E.
Engineer of Local Roads and Streets

Attachments

cc: Dan Brydl, Federal Highway Administration
Elias Ajami, Illinois Toll Highway Authority
Gary Iles, Illinois Department of Natural Resources

Illinois Department of Transportation

Memorandum

To:	ALL DEPUTY DIRECTORS OF HIGHWAYS
From:	Ralph E. Anderson
Subject:	Deterioration of Reinforced Concrete Structures
Date:	August 10, 2007

When reinforced concrete structures are inspected, it is not always possible for personnel to directly observe the top surface of the structure. This condition is routinely encountered during the inspection of:

1) Reinforced Concrete (RC) Slab Bridges that have non-structural wearing surfaces placed on the superstructure
2) RC Box Culverts that support embankment materials and pavement

When assessing the extent to which the superstructure of a RC Slab Bridge or the top slab of a RC Box Culvert is deteriorated, inspection staff must base their assessment on a visual examination of the underside of the slabs. While visual inspection of the underside of slabs is typically sufficient for structures functioning within their expected service life, older concrete structures that have been exposed to the elements and deicing agents for extended periods may have deterioration present in the upper portions of their slab that cannot be identified visibly from below.

Conditions encountered during two recent projects for the removal and replacement of small RC Slab Bridges illustrated situations where visual inspection of the underside of the slab was not sufficient for assessing the condition of the superstructures. Both bridges had functioned far beyond what would be considered their expected service life, one having been built in 1917 (90 years old) and the other in 1928 (79 years old). The top surface of the concrete slabs were not visible for inspection on either bridge, and the underside of both bridges exhibited deterioration that required inspection staff to assess the superstructures as being in poor condition. The contract plans for both structures called for staged removal, with a portion of the existing superstructure carrying traffic during the first stage of construction for the new structure. While performing the first stage of structure removal, severe concrete deterioration was discovered in the top portion of the concrete slabs, to the extent that both bridges were immediately closed to all traffic for the duration of the bridge replacement operations. These experiences illustrate the need for bridge inspections and project scoping to include procedures that thoroughly assess the ability of aging or deteriorated concrete structures to carry traffic.

Subsequent to evaluating the conditions encountered during the removal of the two RC Slab Bridges previously described, the Bureau of Bridges and Structures (BBS) requested that concrete cores be taken for a sampling of older RC Slab Bridges and RC Box Culverts, with 4 structures being tested under the general direction of each Region/District Bridge Maintenance Engineer. The structures chosen for sampling were constructed prior to 1940 (at least 67 years old), which is the accepted/established date for the routine use of air entrained concrete in bridge construction. Based on the testing of the concrete cores, approximately 20% of the structures exhibited concrete deterioration that would 1) not be conducive to Staged Removal & Construction and, 2) could require a load restriction to be placed on the bridge.

To provide the BBS with information needed for load-carrying capacity analysis and to provide programming/planning personnel with information necessary for project scoping, Regions/Districts shall establish programs to obtain and test concrete cores from older and deteriorated RC Slab Bridges and RC Box Culverts.

Concrete cores should be obtained as soon as possible from all RC Slab Bridges and RC Box Culverts that have Superstructure or Culvert condition ratings of “4” or less (poor or worse condition), with priority given to structures that may be removed in stages and utilized to carry traffic during a construction project. Subsequent to the testing of the structures in poor or worse condition, all RC Slab Bridges and RC Box Culverts constructed prior to 1940 with Superstructure or Culvert condition ratings greater than “4” should also have concrete cores obtained, as resources become available.

Prior to utilizing staged removal and construction to replace a RC Slab Bridge or a RC Box Culvert, a staging feasibility evaluation shall be performed. When a Bridge Condition Report (BCR) is prepared, the staging feasibility evaluation, which includes testing of concrete cores obtained from the structure, is required to be included in the BCR. When a BCR is not required during the Phase I portion of the project, a staging feasibility evaluation, which includes coring and testing, shall be performed by the Region/District. If it is determined that a structure cannot be utilized for staged construction, other alternatives should be considered, such as the establishment of a detour route or the construction of a temporary span over the deteriorated bridge.

A sufficient number of concrete cores should be obtained from each identified structure, with at least one core being obtained within the limits of each traffic lane and within each span of the bridge. If possible and without causing undue disruptions of traffic, concrete cores should also be taken in the proximity of the centerline of the roadway. In all cases the concrete cores should be located at the midspan point (halfway between the substructure elements or walls supporting the slab). To facilitate testing, the concrete cores should have a nominal diameter of 4-inches. The information submitted should include a plan view of the structure indicating the location and numbering of the cores, photos of the cores and the tested compressive strength of each core. If it is not possible to obtain a solid core and a test cannot be performed, a description of the remaining concrete and/or a reason that a test could not be performed should be included. Some examples: the core may have cracked during retrieval; the core was all aggregate; the core was aggregate for the top

4 inches and the remaining core wasn't sufficient for testing. All information should be forwarded to Tim Armbrecht of this office for compilation and analysis.

Regions/Districts should establish screening procedures for use in establishing priorities for obtaining concrete cores among the structures to be tested. The BBS has discussed possible screening procedures with statewide personnel who have used hammer drills and/or coring-bits to assess the condition of concrete, but a best practice has not been identified. We request that Regions/Districts employ the tools/equipment available to them for the purpose of screening and that they document the effectiveness of their screening procedures. We anticipate that best practices for screening procedures will be established after Department personnel share their experiences at future Bridge Maintenance Engineer meetings.

Based on the results of the testing that has been accomplished to date, we anticipate that Regions/Districts will encounter, on some structures, deterioration that has advanced to a state where the concrete has fragmented or returned to an aggregate-like material. In these cases, intact cores will not be obtainable. When this condition is encountered, the BBS should be informed so that a load-carrying capacity assessment can be made and load restrictions established.

Since the two bridge projects described earlier in this memorandum were both addressing the replacement of existing Small Bridges, it is readily apparent that the inclusion of Small Bridge inventory and inspection information in the Illinois Structure Information System (ISIS) is an essential element for identifying and tracking bridges that shall be included in concrete coring and testing programs. In order for all affected structures to be readily identified, all Regions/Districts shall expedite the inclusion of inventory and inspection information for Small Bridges within the ISIS. Two memoranda from Ralph E. Anderson to "ALL DEPUTY DIRECTORS OF HIGHWAYS" were issued in regard to the establishment of the Small Bridge Inspection Program, with the first being distributed on April 8, 2005 and the second on July 2, 2007. These memoranda provide the guidance necessary for establishing records within the ISIS for Small Bridges.

If you have any questions, please contact Tim Armbrecht at (217) 782-6266.

JAM/TAA/2007.8

cc- Milt Sees
Dick Smith
Priscilla A. Tobias
Joseph Hill
Charles J. Ingersoll
Brian McPartlin (Illinois State Toll Highway Authority)
Sam Flood (Illinois Department of Natural Resources)
Norman R. Stoner (FHWA)

Illinois Department of Transportation

Memorandum

To:	ALL DEPUTY DIRECTORS OF HIGHWAYS
From:	Ralph E. Anderson Ralph E. Anderson
Subject:	Inspection and Coring of Reinforced Concrete Structures
Date:	March 18, 2008

This memorandum is a supplement to our August 10, 2007 memorandum "Deterioration of Reinforced Concrete Structures" to ALL Deputy Directors of Highways, in which procedures for evaluating older reinforced concrete slab and culvert structures were detailed. Since the distribution of that memorandum, it has become clear that the effort required to perform the tasks outlined in that memorandum will quickly overwhelm the resources of the Districts and the Bureau of Bridges and Structures. As a result, the intent of this memorandum is to outline new procedures and criteria that will prioritize the investigation of these structures based on recent study and evaluation. It is also anticipated that the new criteria may reduce the number of structures requiring cores to be taken. Note that these items apply to RC Slab Bridges and RC Box Culverts only.

Concrete cores should continue to be obtained as soon as possible from all RC Slab Bridges and RC Box Culverts that have Superstructure or Culvert condition ratings of "4" or less (poor or worse condition). However, if a "poor or worse" culvert condition rating is not due to the condition of the top slab of the culvert, cores are not required. In order to expediently complete the effort of obtaining the necessary cores and submitting reports to this office for those structures currently rated "4" or less, we are recommending a target date of April 30, 2009.

If staged removal of an RC slab bridge or RC Box Culvert is anticipated, cores must be taken as part of preparing a Bridge Condition Report (BCR). When a BCR is not required during the Phase I portion of the project, a staging feasibility evaluation, which includes coring and testing, shall be performed by the Region/District. If it is determined that a structure cannot be utilized for staged construction, other alternatives should be considered, such as the establishment of a detour route or the construction of a temporary span over the deteriorated bridge.

Personnel from this office have taken the opportunity to study a large number of core samples taken by District personnel. Based on this investigation, it appears that there may be a correlation between the visual condition of slabs and the concrete strength of cores taken from the slabs. As a result, for structures with condition ratings of "5" or greater, the Districts should be able to identify bridges for which cores should be taken, and those that would not require that a core be taken.

The primary visual quality of the slab that indicates that there is a high probability of a significant reduction in concrete strength is evidence of leaching, efflorescence and/or moisture in and around multiple closely-spaced cracks that run longitudinally along the soffit of the slab. If these conditions are detected during a routine NBIS inspection, a core should be scheduled as soon as possible to verify the strength of the concrete, and the results forwarded to this office. It is anticipated that engineering judgment will be necessary to determine if the conditions warrant that a core be taken. If there are any questions about the necessity of taking a core, please do not hesitate to contact this office. If the core results indicate that there is a significant reduction in concrete strength, the superstructure or culvert condition rating should be lowered to a "4" or less, which will initiate a damage inspection by this office, and a subsequent load rating.

The August 10, 2007 memorandum to All Deputy Directors of Highways indicated that "all RC Slab Bridges and RC Box Culverts constructed prior to 1940 with Superstructure or Culvert condition ratings greater than "4" should also have concrete cores obtained". Based on the coring information that has been obtained to date, the need for obtaining cores is no longer to be based on the age of the structure. The need for taking cores is to be determined solely on visual observation of the underside of the slab, the condition rating assigned to the Superstructure or Culvert; and anticipated Staged Construction, as previously described in this memorandum.

After cores are taken from a structure, a core data form shall be filled out. A blank form and a completed example, which illustrates the information required by this office, are attached for your use. As discussed in the previous memorandum, at least one 4-inch diameter core should be obtained within each traffic lane for each span of the bridge, preferably along the centerline of a "wheel-path" at the midspan point. After cores have been taken, steps should be taken to perform full depth repairs on the holes in order to minimize future exposure of the slab to moisture, deicing agents and other destructive elements. All information should be forwarded to Mr. Steven Negangard of this office for review.

It is imperative that a detailed description of the core be provided in the event that it is not possible to obtain a solid core and a test cannot be performed. If the deterioration has advanced to a state where the concrete has fragmented or returned to an aggregate-like material, this is sufficient evidence that the slab has little or no compressive strength. In this case a load restriction will likely be required. Immediately notify this office in these cases and submit a core data form as soon as possible so that a load-carrying capacity assessment can be made and load restrictions established.

If you have any questions, please contact Carl Puzey at (217) 782-2125.

TAA/kktRCslabsADD-20080318

cc: Milt Sees, Christine Reed, Dick Smith, Joseph Hill, Charles J. Ingersoll, Brian McPartlin (ISTHA), Sam Flood (IDNR), Norman R. Stoner (FHWA)

BRIDGE CORE

Core Number _____ **Element Cored** _____

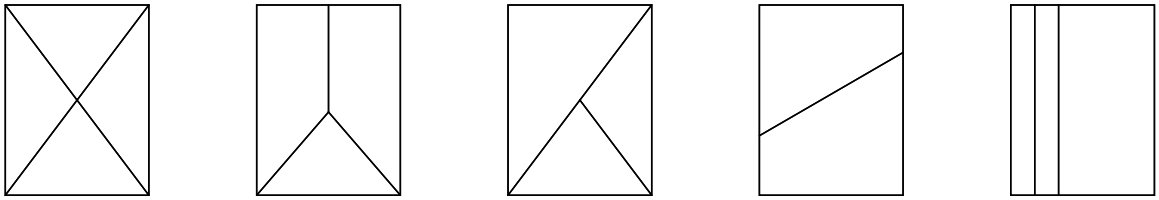
Length and Description

Segment	Length	Description
A		
B		
C		
D		
E		
F		
G		
H		
I		
J		
K		
L		
M		

Test Length _____ **Correction Factor** _____ **Diameter** _____ **Area** _____

Factored Compressive Strength _____**psi** **Actual Maximum Load** _____**pds.**

Type of Fracture _____

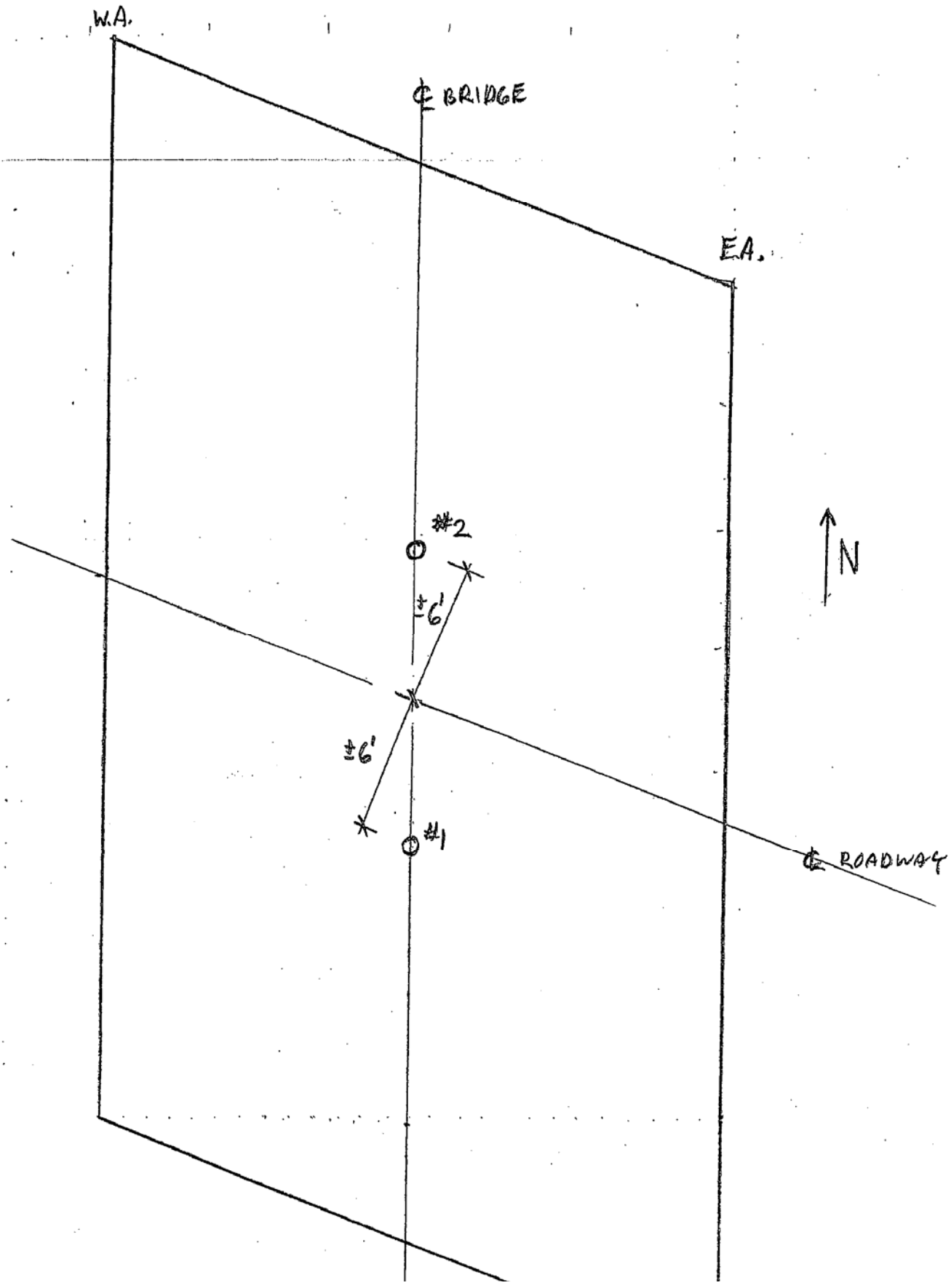


Cone **Cone & Split** **Cone & Shear** **Shear** **Columnar**

Age of Specimen _____ **Defects in Specimen** _____

Coring report
Structure Number 090-0040

DISTRICT 4
10-10-2007
BY: Mark Eckhoff


W.A.
℄ BRIDGE
E.A.
#2
±6'
±6'
#1
N
℄ ROADWAY

090-0040
District 4
10-10-2007

BRIDGE CORE

Core Number 1 **Element Cored** slab

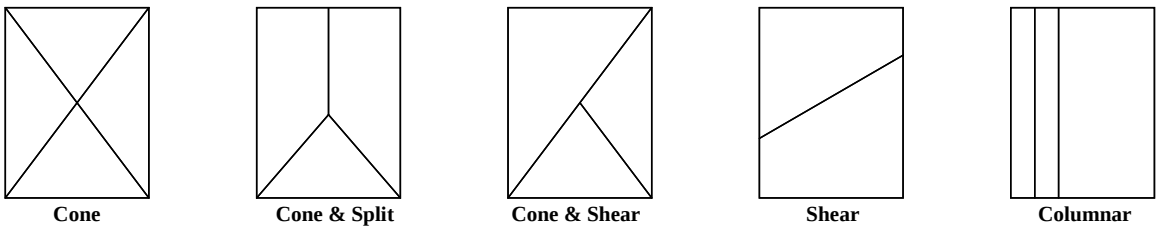
Length and Description

Segment	Length	Description
A	5”	Bituminous overlay
B	1.5”	Bituminous overlay
C	7.5”	Concrete pavement-sound
D	9”	Top of concrete slab- gravel
E	6”	Slab- sound- test
F	6”	Slab- concrete chunks
G	1”	Bottom of slab- sound- rebar not rusted
H		
I		
J		
K		
L		
M		

Test Length 4” **Correction Factor** .87 **Diameter** 3.95” **Area** 12.25 sq. in.

Factored Compressive Strength 5945 psi **Actual Maximum Load** 83730 pds.

Type of Fracture Cone & split



Age of Specimen 1927 **Defects in Specimen** HORIZ. CRACKS

Printed BBS (draft)

090-0040
District 4
10-10-2007

BRIDGE CORE

Core Number 2 **Element Cored** SLAB

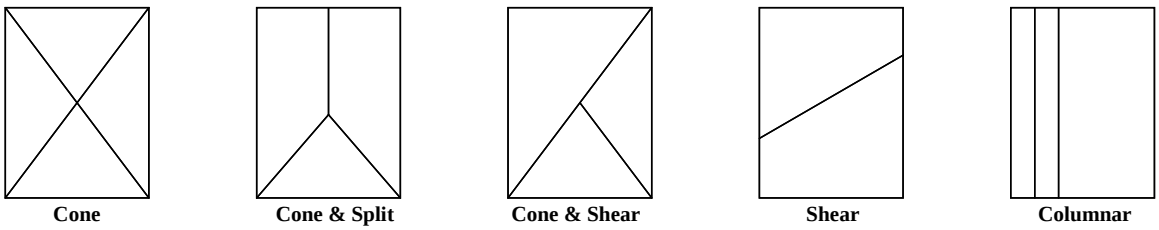
Length and Description

Segment	Length	Description
A	5.5”	Bituminous overlay
B	8.5”	Pavement-sound
C	10”	Top of slab-concrete chunks
D	8.5”	Slab- sound- test
E	2.5”	Bottom of slab- sound- rebar not rusted
F		
G		
H		
I		
J		
K		
L		
M		

Test Length 7.75” **Correction Factor** 1.0 **Diameter** 3.95” **Area** 12.25 sq. in.

Factored Compressive Strength 3651 psi **Actual Maximum Load** 33190 pds.

Type of Fracture Cone & split



Age of Specimen 1927 **Defects in Specimen** none

Printed BBS (draft)