TRANSMITTAL MEMORANDUM 08-01

TO: Division of Bridge Design Staff
Design Consultants

FROM: Allan W. Frank
Director
Division of Structural Design

DATE: July 18, 2008

SUBJECT: Chapter 4 in Guidance Manual

Below is the revised Chapter 4 of the Division of Structural Design Guidance Manual. It has been revised to reflect the LRFD Code. Although this revision will be considered as in effect, we will wait until July 1, 2009 to include it in the published version. During that period, designers should use the new code and bring any questions, inconsistencies, errors, etc to the attention of this office. Designers should frequently check our web site as we will be continuously updating the chapter to reflect comments received.

Chapter 4 Interpretation of AASHTO LRFD Specifications

This chapter lists the Division of Structural Design policies and interpretations of AASHTO Bridge Design Specifications on a paragraph by paragraph basis. For this reason, the sections in this chapter are referenced to the AASTO article by number and do not completely follow the numbering system for the rest of the Guidance Manual.

Within this chapter the term Director is defined as the Director, Division of Structural Design and the term “prior approval” is defined as the written approval of the Director, Division of Structural Design.

Many questions are provoked by the wording of the Specifications. These comments represent an attempt to answer some of the questions and represent an attempt to establish our preference where the wording of the Specifications is permissive.

If an AASHTO article does not have a corresponding section in this chapter, then the Division does not have a specific policy relating to the article and the article should be applied as written. Any questions regarding the interpretation of the AASHTO articles or the omission of any interpretation should be directed to the Director.

When structures are proposed of such a specific nature that AASHTO Specifications will not be adequate, then the Bridge Design Section or the consulting engineer shall submit an outline of the AASHTO paragraph revisions and addendum to the Director for approval prior to proceeding with the design of the structure.

Section 1. Introduction

1.1 Scope

In that the Specifications only state minimum requirements, for Design/Build projects the designer shall not use details and interpretations that result in a structure that differs significantly from one that was designed and reviewed in the normal process.

1.3.2.1

Load modifiers for ductility and operational importance shall be 1.0.

Section 2. General Design and Location Features

2.3 Location Features

In general, location features are dictated by the project requirements but avoiding curves, transitions and skews will result in a more economical structure.

2.3.3 .2 Highway Vertical

Vertical clearances for new structures should be 17 feet.

2.4 Foundation Investigation

Foundation Investigation shall be in accordance with the Geotechnical Manual

2.5 Design Objectives

2.5.2.3 Maintainability

Bridges should be designed to facilitate future deck replacement. If it is not practical to remove and replace the deck in phased construction, then provisions should be made for a full depth structural overlay.

2.5.2.5 Rideability

Approach slabs should be “buried” such that the top is even with the approach roadway DGA.

2.5.2.6.2 Criteria for Deflection

Live load deflection shall apply.

2.5.2.6.3 Optional Criteria for Span-to-Depth Ratios

The span to depths ratio criteria shall apply.

2.5.5 Bridge Aesthetics

Unless otherwise directed bridge aesthetics should be limited to form liners and avoiding abrupt changes in structure depth and structure type.

2.6 Hydrology and Hydraulics

Hydrology and hydraulics should be in accordance with the Drainage Manual.

Section 3. Loads and Load Factors

3.5.1. Dead Loads: DC, DW, and EV

For bridges where it is practical to remove and replace the deck in phased construction use 15 psf for future wearing surface.

For bridges where it is not practical to remove and replace the deck in phased construction, the bridge should be designed such that a full depth structural overlay can be added to the structure without additional design effort or retrofitting the basic structure. A note should be placed in the General Notes describing the loads used in the design, the amount of existing concrete to be removed and the reinforcement needed in the new deck. For typical spread, precast, pre-stressed beam type structures, designing the beams for 60 psf future wearing surface and the substructure for 75 psf will suffice. This assumes that 2" of the original deck will be removed, the new deck will be composite with the old and the original deck reinforcement repeated in the new deck.

3.6.1.2. Design Vehicular Live Load.

The HL-93 loads shall be increased 25%.

3.6.1.4. Fatigue Load

3.6.1.4.1 Magnitude and Configuration

Larger load factors should be considered when the nature of the structure and magnitude of the expected truck traffic indicate a likely hood that the standard truck would be exceeded on a regular basis. This would most likely occur on the main supports of wide long span interstate structures.

3.6.5.2. Vehicle and Railway Collision with Structures.

Do not apply to structures with fills behind them. Do not apply when the pier is outside the clear zone for the design speed and class of road. Do not apply to piers behind barriers. For railroads meet the requirements of the railroad.

3.8.1. Horizontal Wind Pressure

With the exception of tower type structures, do not adjust wind load for part of structures above 30'.

3.9 Ice Loads.

Do not consider Ice Loads. Historical experience has shown that ice has never cause structural issues in Kentucky.

3.10 Earthquakes.

3.10.2.1 General Procedures

Design for the Maximum Credible Earthquake (MCE) from the seismic hazard maps contained in the Kentucky Transportation Center report KTC-07-07/SPR246-02-6F.

3.11.6.4 Live Load Surcharge.

Live load surcharge should be 2’ for all cases involving vehicular traffic.

3.12.2 Uniform Temperature

Use procedure A and consider Kentucky as a moderate climate.

Section 4. Structural Analysis and Evaluation

4.4 Acceptable methods of Structural Analysis

Designers do not need to include computer program information in the contract documents.

4.6.2.2. Slab-Beam Bridges

4.6.2.2.1 Application

Distribution factor for side-by-side box beams without a structural overlay shall not be less than 0.5.

4.6.2.2.2. Distribution Factor Method for Moment and Shear

4.6.2.2.2d Exterior Beams.

Use Lever Rule

4.6.2.2.3 Distribution Factor Method for Shear

4.6.2.2.3b Exterior Beams.

Use Lever Rule

4.7.4.3.4. Time-History Method

Time-History Method shall not be used in Kentucky until such time as there is a realistic basis for the selection of the input time history.

Section 5. Concrete Structures

5.5 Limit States

5.5.3 Fatigue Limit State

For normal structures the fatigue limit state need not be checked.

5.7 Design for Flexural and Axial Force Effects

5.7.1 Assumptions for Service and Fatigue Limit States

Modular ratio "n" need not be rounded to the nearest integer.

5.7.2.2 Rectangular Stress Distribution

A rectangular stress distribution should not be assumed within the development length of the reinforcement or strand.

5.7.3 Flexural Members

5.7.3.1 Stress in Prestressing Steel at Nominal Flexural Resistance.

Stress shall be reduced where available development length is less than the value given in 5.11.4.2-1.

5.7.3.4 Control of Cracking by Distribution of Reinforcement.

Class 2 exposure condition shall be assumed for bridge decks and culverts, Class 1 shall be used elsewhere.

5.7.4 Compression Members

5.7.4.1 Columns should not be designed where $kl/r > 100$

5.8 Shear and Torsion

5.8.1.1 Flexural Regions

In designing pier caps, the strut and tie method does not have to be used when a beam reaction within 2d of the face of the column generates more than half of the load.

5.8.2.4. Regions Requiring Transverse Reinforcement

Stems of retaining walls shall be considered slabs when applying this provision

5.8.3.2. Sections near supports

Concentrated loads or parts of concentrated loads within d/2 of the face of the support shall be considered as acting on the section. This generally would apply to beam reactions and piles. The reaction may be distributed over a length equal to the bearing pad or the pile width.

5.8.3.3. Nominal Shear Resistance

Whichever procedure results in the least amount of shear reinforcement should be used.

5.9 Prestressing and Partial Prestressing

5.9.1.1 General Design Considerations

Unstressed prestressing tendons or reinforcing bars should not be used together. (This may seem advantageous when a beam is being controlled by strength limit state and adding fully stressed strands generates excessive release stresses. This is not necessarily effective since the prestressing process induces compression and therefore compression strains into the unstressed reinforcement or strands. This can lead to low strain levels in those strands/bars at ultimate so their contribution per strand/bar is small. A better solution is to stress all strands at a lower jacking stress.)

Debonded strands should not be used.

5.9.5.2.3 Elastic Shortening.

Steel relaxation during fabrication and curing of the concrete shall be considered. It may be calculated for typical strands by the following equation.

Loss = [LOG(T)/A] x [(FSI/FY) – 0.55] x FSI
Where T = Time in hours between stressing and release (usually taken as 18 hours)
A = 45 for low relaxation strands and 10 for stress relieved
FSI = Jacking Stress
FY = 0.9 x catalog ultimate for low relaxation strands and
0.85 x catalog ultimate for stress relieved strands.

5.9.3.4 Refined Estimates of Time-Dependent Losses

Do not use this method without prior approval.

5.12 Durability

5.12.3 Concrete Cover

Use 2” to centerline of bottom row of ½ in (nominal) prestressing strands in precast beams

5.14.1.3. Splice Precast Girders

Spliced precast girders shall not be used without prior approval.

5.14.1.4. Bridges Composed of Simple Span Precast Girders Made Continuous

5.14.1.4.2 Restraint Moments

When bridges are fabricated with normal dimensions and detailed using the office standard beam connection details restraint moment need not be considered in the design.

5.14.1.4.8 Negative Moment Connections

In addition to meeting the strength limit state, negative reinforced shall be extended and or sized such that crack control criteria in Section 5.7.3.4 is met. For crack control, only the loads from live load and the composite dead load need to be considered.

Section 6: Steel Structures

6.4.1 Structural Steels

Use unpainted 50W or 70W.
Grade 100 shall not be used without prior approval.

6.4.3.5 Load Indicator Devices

Direct Tension Indictors (DTI's) shall be used on all HS bolted connections.

6.6.1.1.5 Fatigue Resistance

When determining the single lane ADTT assume that the average daily traffic is 20,000 vehicles per lane per day.

6.6.2 Fractures

Use Zone 2

6.7.4 Diaphragms and Cross Frames

6.7.4.1 General

Diaphragms spacing shall be such that the deck can be cast without false work.

6.7.4.2 I-Section Members

The ends if I-Sections shall be encased in concrete and serve as end diaphragms.

6.7.5 Lateral Bracing

6.7.5.1 General

Lateral bracing should be investigated for the final condition only, the contractor will be responsible for any lateral bracing needed for construction.

6.10.1.3 Hybrid Sections

Hybrid sections should not be used without prior approval.

6.10.1.9.2 Webs with Longitudinal Stiffeners

Longitudinal stiffeners shall not be used without prior approval.

6.10.12 Cover Plates

Cover plates should not be used without prior approval.

6.11 Box Section Members

Box sections should not be used without prior approval.

6.13 Connections and Splices

6.13.1 General

When determining factored flexural, shear or axial resistance of a member where the member or element is larger or a higher grade for reasons not connected with the design, then the section that would be required by design can be used to calculate the factored resistance.

6.13.2.7 Spacing of Bolts

Minimum spacing should preferably not less than the following:

- 3.50 in for 1 in bolts
- 3.00 in for 7/8 in bolts
- 2.50 in for ¾ in bolts
- 2.25 in for 5/8 in bolts

6.13.2.6.6 Edge distance.

Use distanced for Kentucky Standard Specifications if less.

6.14.2.8. Gusset Plates

Gusset plates shall be at least as thick as the thickest main plate framing into a connection.

Section 7: Aluminum Structures

With the exception of sign supports, aluminum structures should not be designed without prior approval.

Section 8: Wood Structures

Wood structures should not be designed without prior approval.

Section 9: Decks and Deck Systems.

9.4.3 Concrete Appurtenances

Barrier shall be continuous.

9.6 Analysis

9.6.1 Method of Analysis

The approximate method of 4.6.2.1 shall be used.

9.7.4 Stay in place Formwork

Stay in place form shall not be considered as part of the structure and if used are the responsibility of the contractor.

9.7.5 Precast Deck Slabs on Girders

Precast deck slabs on girders should not be used without prior approval.

Section 10: Foundations

10.1 Scope

Successful foundation design requires coordination between the geotechnical engineer and the structural engineer. The following contains some guidelines in the respective roles but project requirements will dictate the actual roles of each discipline.

For spread footings on soil the geotechnical branch (or geotechnical consultant) should generally provide the soil parameters needed to calculate the bearing resistance using equation 10.6.3.1.2a-1 and provide a maximum (i.e. allowable) bearing pressure necessary to control settlement.

For spread footings on rock the geotechnical branch (or geotechnical consultant) should generally provide the factored bearing resistance.

For footings on friction piles the geotechnical branch (or geotechnical consultant) should generally provide the maximum service load necessary to control settlement and the factored geotechnical resistance. They should also provide the controlling tip elevation. The designer shall show in the plans the method used to determine the factored geotechnical resistance and if the method used requires field methods other than what is specified in the Kentucky Standard Specifications for Road and Bridge Construction, then that shall also be included in the plans.

For footings on point bearing piles the geotechnical branch (or geotechnical consultant) should generally provide the nominal geotechnical resistance, resistance factor and tip elevation for the strength limit state if there is a possibility that it is less than the structural limit.

For piles of any sort, the geotechnical branch (or geotechnical consultant) should generally provide the drivability analysis.

For structures on point bearing drilled shafts the geotechnical branch (or geotechnical consultant) should generally provide the nominal geotechnical resistance, resistance factor and tip elevation for the strength limit state.

10.4 Soil and Rock Properties.

See Geotechnical Guidance Manual

10.5 Limit States and Resistance Factors

10.5.2 Service Limit State

Settlements shall be controlled for soil designs by keeping the service pressures under the recommended pressure.

10.5.2.1 General

Overturning and excessive loss of contact shall be checked at the Service Limit State.

10.5.3 Strength Limit State

10.5.3.2 Spread Footings

Overturning and excessive loss of contact shall be checked at the Service Limit State.

10.7.1.6.2 Downdrag

For steel piles driven to rock the pile shall be checked using the resistance factor for a steel column (0.9).

10.8 Drilled Shafts

10.8.3.9.3 Reinforcement

The casing shall not be considered as load bearing.

10.8.3.9.4 Transverse Reinforcement

The casing, minus a 1/8" sacrificial layer, may be considered effective when applying seismic provisions.

10.9 Micropiles

Micropiles shall not be used without prior approval.

Section 11: Abutments, Piers and Walls.

11.5.1 General

In order to provide for their reuse and in recognition that foundations are difficult to inspect, the design life shall be 150 years for abutments, piers and walls that support bridges.

11.5.2 Service Limit State

Excessive loss of base contact shall be checked at the service limit state.

11.5.3 Strength Limit State

Excessive loss of base contact shall be checked at the service limit state.

11.5.5 Load Combinations and Load Factors

A component should not be split so as to have different load factors, i.e., a soil mass should either use the maximum or minimum load factor.

10.6.3.3 Eccentric Loading Limitations

Eccentric loadings at the Service Limit State shall not exceed:

For foundations on soil, the location of the reaction forces shall be within the middle one-third of the base width.

For foundations on rock, location should be in the middle one-half.

11.6 Abutments and Conventional Retaining Walls

11.6.1.2 Loading

Lateral live load and vertical live load from superstructure need not be applied simultaneously.

11.6.1.3 Integral Abutments

Unless otherwise directed, integral abutments may be designed for vertical load only. The webs axis of steel piles should be parallel to centerline bearing.

Approach slabs should be provided such that the top of the approach slab is even with the top of the DGA.

11.6.1.4. Wingwalls

Wingwalls should generally be attached to the abutment.

11.6.1.6. Expansion and Contraction Joints

Do not use expansion or contraction joints in front faces of abutments.

11.6.2 Movement and Stability at the Service Limit State

Overturning should be checked at the Service Limit State. For foundations on soil, the location of the reaction forces shall be within the middle one-third of the base width. For foundations on rock, location should be in the middle one-half.

11.6.3 Bearing Resistance and Stability at the Strength Limit State

Overturning should be checked at the service limit state.

11.6.4 Safety Against Structural Failure.

Actual pressure distribution should be used in the structural design of the footing.

11.10 Mechanically Stabilized Earth (MSE) Walls

Due to the difficulties in inspecting a system the needs to have a life span of 150 years, MSE should not be used as bridge abutments without prior approval although they may be used as wing walls. If they are used, the abutment should sit on piles extending below the base of the MSE wall.

11.11 Prefabricated Modular Walls

Prefabricated modular walls should not be used as bridge abutments without prior approval.

Section 12: Buried Structures and Tunnel Liners

12.2 Definitions

A buried structure as defined in 12.2 remains a buried structure if additional fill is added at some time in the future even if it is retrofitted with tunnel liner plates.

12.8 Long-Span Structural Plate Structures

Long–span structural plate structures should not be used without prior approval.

12.9 Structural Plate Box Structures

Structural Plate Box Structures should not be used without prior approval.

12.11 Reinforced concrete cast-in-place and precast box culverts and reinforced cast-in-place arches

12.11.2 Loads and Load Distribution

12.11.2.1 General

Culvert should be designed assuming embankment installation with Fe = 1.15.

Section 13: Railings

13.7.3.1.1 Application of Previously Tested Systems

Division of Structural Design Railing Systems Type 2 & 3 shall be assume to meet TL-3 and TL-4 criteria respective.

Section 14 Joints and Bearings

14.4.1 General

Use of tabulated form will not be required for standard bearings.

14.4.2 Design Requirements

14.4.2.1 Elastomeric Pads and Steel Reinforced Elastomeric Pads

For live load rotations, use the fatigue limit state.

14.5 Bridge Joints

14.5.3.2 Design Movement

For determining “W”, W = Opening at 60 ^F + contraction to 10^ for steel bridges and 20^ for concrete bridges.

14.5.6.9 Modular Bridge Joint Systems (MBJS)

MBJS’s should not be used without prior permission.

14.6 Requirements for Bearings

Except for lead plates in Integral Abutments, steel rocker plates for fixed steel bridge bearings and where shown in Standard Drawings, steel reinforced elastomeric bearings shall be used. Prior approval is required to utilize any other type.

14.6.3 Force Effects Resulting from Restraint of Movement at the Bearing

Designer should design for a shear modulus of 4 x shear modulus at 73^ unless a note is placed in the plans restricting the shear modules to 2 x shear modulus at 73^.

14.6.3.2. Moment

In general, substructures and superstructures need not be designed for moment transferred by the bearing.

14.7.5 Steel-Reinforced Elastomeric Bearings - Method B

Use for larger, non-standard bearings. In general, specify G as 95 psi.

14.7.6 Steel-Reinforced Elastomeric Bearings - Method A

Use for smaller and standard bearings. In general, specify G as 95 psi.