

State of Georgia
Department of Transportation

Bridge and Structures Design Manual



Bridge and Structures Design Manual

10/26/2016

Revision 2.2

Atlanta, Georgia 30308



Disclaimer

This manual is intended to be an aid to designers working on projects for the Georgia Department of Transportation. It is not to be used as a substitute for sound engineering practice and will be used at one's own risk. The Georgia Department of Transportation and the authors of this document are not responsible for the consequences of the use and misuse of the contents of this document.

The latest version of this document is available at:

http://www.dot.ga.gov/PartnerSmart/DesignManuals/BridgeandStructure/GDOT_Bridge_and_Structures_Policy_Manual.pdf

Other helpful links:

GDOT Bridge Design Home Page:

<http://www.dot.ga.gov/PS/DesignSoftware/Bridge>

GDOT Bridge Design Software:

<http://www.dot.ga.gov/PartnerSmart/DesignSoftware/Pages/Bridge.aspx#tab-3>

GDOT Bridge Microstation Customization:

<http://www.dot.ga.gov/PartnerSmart/DesignSoftware/Pages/Bridge.aspx#tab-2>

GDOT Bridge Design Basic Drawings:

<http://www.dot.ga.gov/PartnerSmart/DesignSoftware/Pages/Bridge.aspx#tab-1>

Please send constructive comments to the Bridge Design LRFD Committee care of Stanley Kim: skim@dot.ga.gov.

Acknowledgement

The original Bridge and Structures Design Manual was created through the public-private partnership of the Georgia Department of Transportation and the Consulting Engineering Companies of Georgia. This document was modified from the original Design Manual for inclusion of LRFD material and general content by Georgia Department of Transportation personnel. The following people have donated their time and resources to contribute to the quality of transportation engineering in Georgia:

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Revision Summary

Revision Number	Revision Date	Revision Summary
LRFD Bridge Manual		
Original	7/8/13	Original Release Date
1.0	10/1/13	<p>Section 3.2.3.3 - Removed “after all necessary grinding” from 8” overhang thickness; Removed “(LRFD 13.7.3.1.2)” from 8” overhang thickness</p> <p>Section 3.5.2.1 - Changed LRFD reference from Table 4A-1 to Table A4-1</p> <p>Section 4.4.2 - Modified tower bent placement directive; Added pile fixity assumption</p> <p>Section 3.2.2.3 - Removed Commentary</p>
2.0	6/2/14	<p>Section 2.1 - Updated LRFD Specification to 6th edition, 2012; updated Georgia Standard Specification to 2013; defined all bridges as “typical”</p> <p>Section 2.2.2.2 - Allowed Standard Specification widening of Existing Standard Specification bridges</p> <p>Section 2.4 - Changed office responsible for Survey Manual</p> <p>Section 2.8 - Added LRFD software submittal requirements for consultants</p> <p>Section 3.1.1 - New section added - Set minimum beam requirement for bridges with vehicular traffic</p> <p>Section 3.2.2.1 - Added reference to online slab design program</p> <p>Section 3.2.2.4.2 - Changed placement and spacing of temperature steel in top mat of deck</p> <p>Section 3.3.2.2.1 - Clarified urban area locations</p> <p>Section 3.3.2.2.2 - Edited height of fence</p> <p>Section 3.4.3.15.4 - New section added – limiting coping thickness to 6”</p> <p>Section 3.12.2.3.1 - Check clearance between cap and PSC beam when plain pads are used</p> <p>Section 3.12.2.5.2 - Added new section - Directive to minimize number of pad designs for bridge</p> <p>Section 4.2.1 - Specified use of kips in lieu of tons or pounds for foundations</p> <p>Section 4.2.2.3, 4.2.2.4, 4.2.2.5 - Added maximum factored resistances and stresses for all pile types</p> <p>Section 4.2.3.4 - Restricted use of spirals in caisson; limited ties to maximum size of #6; Stated seismic detailing at fixity is not required in caissons</p> <p>Section 4.4.1.2.1 - Added limits for depth to width</p>

		<p>ratio of intermediate caps; Changed cap width increment to 3"</p> <p>Section 4.4.1.2.2 - Modified longitudinal rebar in riser of intermediate bents to # 5</p> <p>Section 4.4.1.3 - Removed railroad from vehicular collision consideration</p>
Bridge Design Manual		
Original	1/26/15	<p>General - Incorporated Standard Specification guidance from GDOT Bridge and Structures Design Manual into LRFD Bridge Manual to produce a consolidated manual</p> <p>Section 1.3.3 - Added requirement to submit design calculations in PDF format</p> <p>Section 1.4.3.1 - Added guidance for when a deck section is required on preliminary layouts</p> <p>Section 1.6.9.2.2 - Removed direction about railroad shoring review</p> <p style="padding-left: 40px;">Section 1.6.9.2.4 - Added reference to 8.2.10</p> <p style="padding-left: 40px;">Section 3.2.4 - Revised requirement for epoxy reinforcement</p> <p>Section 3.2.5 - Removed requirement for grooving under medians</p> <p>Section 3.3.2.2 - Modified description of new curved fence detail</p> <p style="padding-left: 40px;">Section 3.3.2.2.1 - Clarified directive for the use of handrail or fence on parapets</p> <p style="padding-left: 40px;">Section 3.4.1.2.1 - Removed restriction on use of 0.6" diameter strands</p> <p style="padding-left: 40px;">Section 3.4.2.6.2 - Limited coping thickness to be used for composite properties</p> <p>Section 3.4.2.7, 3.5.2.2 - Limited beam spacing to 9'-0"</p> <p>Section 3.6.2 - Added the use of "weathering steel"</p> <p>Section 3.9.1.1 - Added provisions for use of steel diaphragms for concrete beams</p> <p style="padding-left: 40px;">Section 3.15.1 - Revised Drainage Manual reference</p> <p style="padding-left: 40px;">Section 4.2.2.2 - Modified "Factored Axial Load" note</p> <p>Section 4.2.2.3 - Clarified directive on use of 50 ksi H-piles versus 36 ksi H-piles</p> <p style="padding-left: 40px;">Section 4.2.2.4 - Removed 12" PSC piles from Table</p> <p style="padding-left: 40px;">Section 4.2.2.5 - Added 20" and 24" metal shell piles to Table</p>

		<p>Section 4.2.3.4 - Added 5" clear spacing as minimum for stirrups and vertical bars in caissons</p> <p>Section 4.3.4 - Modified wingwall length requirement</p> <p>Section 4.4.1.2.4 - Increased minimum stirrup spacing to 5"</p> <p>Section 4.4.1.3 - Added 4" minimum stirrup spacing requirement for columns</p> <p>Section 5.1.1.1 - Revised Table to change Modular Walls to Modular Block Walls</p> <p>Section 5.5.5 - Limited Modular Block Wall design height to 20 feet</p> <p>Section 8.1.1.1 - Modified when bridge plans require a revision mark</p> <p>Section 8.2.10 - Added direction about railroad shoring review</p> <p>Section 9.2.1 - Added directive to include Seismic Zone and SD1 on General Notes sheet</p>
1.0	5/5/15	<p>Section 2.1 - Updated LRFD Specification to 7th Edition, 2014</p> <p>Section 2.1.3 - Removed Guide Specification reference; contact Bridge Office for guidance</p> <p>Section 2.3.3.1 - Added for vertical clearances to be satisfied for travelway</p> <p>Section 3.4.1.2.4 - Added that draped strands shall not be placed in the top 8" of beam</p> <p>Section 4.2.2.2 - Added guidance in reference to information needed in bridge plans for field measurement of driving resistance for piles for LRFD projects.</p> <p>Section 4.3.2, 4.4.2.1 - Added guidance that 5.10.8 need not apply to side faces of bent caps less than or equal to 2 foot high.</p>
2.0	7/31/15	Reformatted manual to standard template
2.1	1/25/16	<p>Section 1.3.3 – Added restriction for modifying title block</p> <p>Section 1.4.2 – expanded/clarified guidance for consultant QA/QC</p> <p>Section 1.6.7 - Added guidance for re-request for bridge condition surveys</p> <p>Section 2.9.4.4 - clarified span limit for pile bents for AASHTO PSC beams only</p> <p>Section 2.9.4.6 - Added reference to beam length limits</p> <p>Section 3.2.3.2.3 - changed title and added 1" difference limit for overhang</p> <p>Section 3.4.2.8 - Added section for beam length</p>

		<p>guidance</p> <p>Section 3.8 – Changed to include new precast beam types</p> <p>Section 3.10.1 - Added steel orientation guidance</p> <p>Section 3.11.2 - Added steel orientation guidance</p> <p>Appendix 3B – Changed beam charts for new beam length limits</p> <p>Section 4.3.2 – Waived LRFD 5.10.8 for bottom of caps</p> <p>Section 4.4.1.3 – Added 6” minimum stirrup spacing</p> <p>Section 4.4.2.1 – Waived LRFD 5.10.8 for bottom of caps</p> <p>Section 5.5.3.1(g) – revised coping names to match pay items</p> <p>Fig. 5.5.3.1-3 – revised to show sloping paving</p> <p>Fig. 9B-1 – Revised to show cross-ties for plastic hinge regions</p>
2.2	10/26/16	<p>Chapter 2 -Modified temporary vertical clearance for falsework</p> <p>Chapter 3 - Set maximum 28-day concrete strength for PSC beams to 10.0 ksi. Removed “with Bridge Office Approval” clause. Rewrote top strand pull force guidance for clarity</p> <p>Chapter 4 - Added guidance to place top mat of steel in all spread footings. Added guidance to place top mat of steel in seismic pile footings</p> <p>Chapter 8 - Defined lap splice requirements for welded wire fabric</p>

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Chapter 1. Administration

1.1 Bridge Office Organization

1.1.1 General

The Office of Bridges and Structures supplies structural plans to Project Managers and provides maintenance support for structures in the state. This Office is divided into two units: the Bridge Design Unit (BDU) and the Bridge Maintenance Unit (BMU).

1.1.2 State Bridge Engineer

The State Bridge Engineer is the head of the Office of Bridges and Structures and reports directly to the Director of Engineering.

1.1.3 Assistant State Bridge Engineers

The State Bridge Engineer and the Assistant State Bridge Engineers are referred to as the Front Office.

The Assistant State Bridge Engineers keep track of Special Provisions, manage sections of the construction specifications relating to bridges, serve as a liaison for non-GDOT bridge projects (for local governments who don't have bridge expertise but want to use GDOT guidelines or funding), track bridge costs using data from Contract Administration, and review plans. The Assistant State Bridge Engineers also manage design groups, oversee most design policies and review plans including hydraulic studies.

1.1.4 Bridge Design Unit

The Bridge Design Unit (also referred to as the Bridge Office) supplies bridge plans to Project Managers. The Bridge Design Unit also oversees the design of walls, culverts, sign supports and anything else requiring structural expertise.

There are 7 design groups within the Bridge Office plus a group dedicated to bridge hydraulics. The design groups prepare or review preliminary layouts for bridges over railroads or roadways as well as prepare or review all final bridge plans. The hydraulics group prepares or reviews all the preliminary layouts for bridges over streams as well as some culverts, though most culverts are sized by roadway engineers. Most bridge hydraulic questions should be addressed to that group.

1.1.5 Bridge Maintenance Unit

1.1.5.1 General

The State Bridge Maintenance Engineer serves as an assistant to the State Bridge Engineer and oversees the Bridge Maintenance Unit (BMU). This unit's responsibilities include inspecting all the bridges and bridge culverts in the State (including county bridges) every two years. It also maintains the historical bridge files including inventory, bridge inspection reports, maintenance records, BFI, plans, etc. This unit evaluates bridges and determines the load carrying capacity and establishes load posting requirements. Bridge Maintenance Unit also develops bridge maintenance projects using in-house and consultant engineering. It is

important to coordinate with the Bridge Maintenance Unit when doing work that will affect existing bridges.

For typical bridge design work, coordination is necessary with the Bridge Maintenance Unit for the following items: salvage material coordination, long and heavy load hauling coordination, bridge condition surveys (widening), maintenance on existing or parallel structures to be included with widening or paralleling plans. The Bridge Maintenance Unit also provides important feedback to the State Bridge Engineer on the effectiveness of certain design details.

1.1.5.2 Concept Coordination

During the Concept phase for any project that includes a bridge, the Project Manager should coordinate with Bridge Maintenance Unit to get a project justification statement on whether the bridge is suitable for widening or should be replaced (a bridge could also be replaced if the cost of widening would exceed the cost of replacement). Bridge Maintenance Unit also produces a project justification report for new projects.

1.2 Other Offices and Agencies with Bridge-Related Responsibilities

1.2.1 Office of Construction

The State Bridge Construction Engineer, in the Office of Construction, serves as a resource for district construction personnel regarding bridges, participates in training, troubleshoots construction problems, sets bridge construction policies, and makes recommendations to designers on the use of cofferdams and seals.

1.2.2 Geotechnical Bureau

The Geotechnical Branch Chief is head of the Geotechnical Bureau, which is part of the Office of Materials. The Geotechnical Bureau writes or reviews the Bridge, Wall and Culvert Foundation Investigation reports that recommend the type of foundation, pile capacity, special construction situations, etc., for each bridge in the state. They also deal with geotechnical issues that arise during construction. They are responsible for geotechnical special provisions such as drilled shafts and pile driving.

1.2.3 Office of Engineering Services

The Office of Engineering Services acts on behalf of the FHWA in reviewing projects and advising on constructability. They report directly to the Chief Engineer and are therefore independent of the Engineering Division. They coordinate and conduct Preliminary Field Plan Reviews (PFPR) and Final Field Plan Reviews (FFPR) as well as value engineering studies. They review all hydraulic studies (for PFPR) as well as bridge plans (for FFPR). They are the central coordinator for writing specifications.

1.2.4 Federal Highway Administration (FHWA)

FHWA participates in projects designated as “full oversight” (FOS). FHWA has a bridge specialist, Division Bridge Engineer, who provides expertise, direction, and reviews. For projects containing bridges, the Bridge Office will coordinate with the Division Bridge Engineer for review and approval

of preliminary bridge layouts, bridge hydraulic studies and final bridge plans. This coordination is also required for consultant-designed projects with the Bridge Office acting as liaison.

1.3 Quality Control and Quality Assurance (QC/QA)

1.3.1 General

In designing bridges and other highway structures our mission is to prepare safe and economical design solutions and produce a quality set of plans that meet the project requirements, use details that are consistent with GDOT Bridge Office practices, and are suitable for bidding and construction. To produce quality work requires collaboration between the designer or detailer and checker as well as a comprehensive review. The quality control and quality assurance process for bridges and other highway structures provided herein shall be followed by the GDOT Bridge Office and consultants designing structures for the Department. This process is required for preliminary layouts, bridge hydraulic studies, final bridge plans and other highway structures as necessary.

1.3.2 Quality Control

Quality control (QC) is a process in which a person designated as the “checker” evaluates the design or details prepared by a designer or detailer. In general, the checker shall be an engineer with relative experience for the work being checked. Collaboration between the checker and the designer/detailer is used to resolve any discrepancies found during the evaluation.

In the design of a bridge, the checker shall evaluate deck, superstructure and substructure. In general, this check shall be (1) a careful review of the design notes, program inputs and results or (2) an independent check of the design developed by the checker and comparison of results prepared by the designer. When checking final bridge plans, the checker shall obtain a current set of roadway plans, including utility plans, for a thorough check. The checker shall generate a geometry program based on the final bridge and roadway plans. The checker shall prepare an independent set of cap step elevations and this duplicate set shall be maintained throughout the design process should changes/revisions arise. The checker shall also prepare and maintain an independent set of quantities for all quantities included in the summary of quantities. For all highway structures, the use of a checker is required.

All bridge plans, preliminary layouts and other structural plans shall have a title block listing at a minimum the initials of the designer, detailer, checker, reviewer and approver. Under no circumstance should the designer be the same as the checker. Generally the checker’s initials shown in the plans reflect who checked the plan details. If a different checker is used to check the design, geometry and quantities then the design notes should clearly state the responsible checker by name or initials.

As part of the quality control process it is extremely important that the checker ensure the results of the design are appropriately shown in the plans. Therefore it is good practice for the checker to review the design with plans complete or nearly complete. Notes and other documentation prepared by the checker shall be initialed and retained in the bridge design notes.

1.3.3 Quality Assurance

Quality assurance (QA) is a process in which a person designated as the “reviewer” ensures that the design and details have been adequately checked. The reviewer resolves differences between designer/detailer and checker. The reviewer also evaluates the complete set of plans. As a matter of practice, the reviewer should spot check the design, geometry and quantities. In general, the reviewer is a Bridge Design Group Leader or senior engineer (consultant).

Once bridge plans or other structural plans are complete and have been checked and reviewed, they are submitted to the Front Office. Plans completed by consultants shall be submitted by the GDOT Project Manager to the Bridge Office at this time. For consultant projects, the consultant shall submit design notes including but not limited to geometry, superstructure design, substructure design, clearance calculations, elevations and quantities. This information shall be submitted in the Portable Document Format (.pdf). Consultant plans will generally be reviewed by a Bridge Design liaison and may be returned to the consultant for corrections prior to the Front Office review or submitted directly to the Front Office for review. It is important that the submission include the foundation investigation(s), documentation of the bridge stakeout / site inspection, salvage of materials, deck condition survey, bridge condition survey, etc.

The Front Office review consists of a complete review of the plans by the Assistant State Bridge Engineer(s). These reviewers may review other plans or consult with other offices such as Roadway Design, Utilities, Environmental Services, etc., to ensure the structural plans meet the requirements of the project. Geometry, elevations and quantities are routinely spot checked during this review. Compilations of the required special provisions are prepared during this review.

All structural plans are given a review by the State Bridge Engineer. At the conclusion of the Front Office review, the plans shall be corrected by the design groups (or consultant). In-house projects shall then be routed to the Program Manager or Roadway Design. Consultant design projects shall be checked by the Bridge Liaison to ensure final corrections are complete before submitting final plans to the Program Manager. For consultant projects, any revisions to the design notes stated above shall be submitted to the Bridge Office.

For projects that are under full oversight by FHWA, bridge plans that have been reviewed and approved will be forwarded to the Georgia Division of FHWA for review and approval. This coordination is conducted by the GDOT Bridge Office for both in-house and consultant projects.

The title blocks shall indicate the initials of the Assistant State Bridge Engineer(s) as “Reviewed”. The initials of the State Bridge Engineer shall be shown as in the title “Approved”. After completion of the QC/QA process, the review set of plans shall be retained by the design group, at a minimum, until the final plans are approved. Saving an electronic (scanned) copy of the review set is acceptable.

Once final plans are approved, the title block initials indicating “Reviewed” and “Approved” shall not be changed during any future modifications to the sheets.

1.3.4 Other Assurance Checks

In addition to the QC/QA process mentioned above, the Bridge Office routinely conducts additional QA checks for all bridge projects during the contract bidding process. One month prior to the Letting, plans are advertised to potential bidders. The Front Office checks the contract for special

provision and quantities relative to bridge projects. The review includes a check of the bridge general notes and details to ensure that the plans are up to date. The Bridge Office load rates the bridges using the Bridge Maintenance rating software as an independent check of the superstructure and substructure elements to ensure the proposed bridges meet the intended design loading. If discrepancies are found during this review then changes/revisions are made as an amendment to the contract.

1.4 Consultants and Bridge Office

1.4.1 General

Consultant projects are managed by a GDOT Project Manager assigned to the Office of Program Delivery even if the project consists primarily of bridge work. The Bridge Office occasionally issues task orders to consultants when the schedule or workload exceeds the capacity of the design groups. On projects with bridge work, a liaison from the Bridge Office will be assigned to the project. The liaison will be the point of contact for the bridge work on that project and will also coordinate with other GDOT offices on bridge activities. Much of the correspondence and coordination with other offices described below will be done by the liaison but consultants should be aware of this activity and make sure they incorporate the results in their plans.

Consultants are reminded that if their contract is with the Georgia Department of Transportation, all design questions and decisions regarding project requirements must be directed to the GDOT Project Manager for distribution to the appropriate office. Consultants shall not take direction from outside agencies for decisions regarding GDOT projects.

1.4.2 QC/QA for Consultants

Consultants are responsible for the quality and content of their plans. Prior to a final review by the Bridge Office, all QC/QA procedures must be followed in accordance with Section 1.3. All bridges, special design retaining walls and other special design structural components shall be detailed in accordance with Bridge and Structures Detailing Policy Manual (including Bridge Design Title Block) and reviewed by the Bridge Office.

1.4.3 Bridge Office Reviews of Preliminary Plans

1.4.3.1 Initial Submittal

The drawings must be stamped by the consultant when submitting for review even though the plans are not for construction. Plans must be stapled (if containing multiple sheets) and include pertinent roadway plans as well as correspondence relating to bridge and deck condition, hydraulic studies, etc. Include two full-size prints of bridge layouts (one for markups and one to keep on file). See the Drainage Manual for further submittal guidelines on Hydraulic Studies. Design notes, program runs, and calculations should be ready if they are requested.

Preliminary Layouts for bridges that cross over a railroad or involve staged construction shall include a deck section in addition to the plan and elevation views of the proposed structure.

Preliminary plans shall be submitted for review and accepted by the Bridge Office before requesting PFR.

1.4.3.2 Bridge Office Review

Typically the plans will be reviewed by a design group, followed by a Front Office review. The plans will then be returned to the consultant for corrections. If the review comments are extensive, the liaison may return the plans to the consultant for corrections before the Front Office review has been conducted.

1.4.3.3 Subsequent Reviews

Upon receipt, immediately incorporate review comments and return to the Bridge Office.

In subsequent submittals, include the original markups from the previous review as well as two full-size sets of corrected plans and any additional documentation necessary for the changes. Written responses are required for any markups not incorporated into the corrected plans.

1.4.3.4 Preliminary Plan Approval

The plans have not been approved by the Bridge Office for PFPR until all markups are addressed and an e-mail or letter accepting the plans is issued. The acceptance email or letter shall address distribution responsibilities of the approved layout.

1.4.4 Bridge Office Reviews of Final Plans

1.4.4.1 Initial Submittal

The drawings must be stamped by the consultant when submitting for review even though the plans are not for construction. Plans must be stapled and include pertinent roadway plans as well as BFI's and correspondence relating to cofferdams, salvage, bridge and deck condition, stakeout, etc. Include two full-size sets of bridge plans (one for markups and one to keep on file) as well as plans and Wall Foundation Investigations for any MSE or other contractor-designed walls on the project. Design notes, program runs, and calculations shall be submitted with final plans. Any corrections to the design notes, post Bridge Office review, shall be re-submitted for inclusion in the bridge record.

1.4.4.2 Bridge Office Review

Typically the plans will be reviewed by a design group, followed by a Front Office review. The plans will then be returned to the consultant for corrections. If the review comments are extensive, the liaison may return the plans to the consultant for corrections before the Front Office review has been conducted. A list of special provisions will be returned to the consultant which must be saved and given to the Project Manager to include in the final plans package for the Office of Bidding Administration.

1.4.4.3 Subsequent Submittals

In subsequent submittals, include the original markups from the previous review as well as two full-size sets of corrected plans and any additional documentation necessary for the changes. Written responses are required for any markups not incorporated into the corrected plans.

1.4.4.4 Final Bridge Plan Approval

The plans have not been approved by the Bridge Office for FFPR or construction until all markups are addressed and an e-mail or letter accepting the plans is issued. Upon approval of final plans, electronic CAD drawings shall be submitted to the Bridge Office.

1.4.4.5 Changes after Final Bridge Plan Approval

Once the final bridge plans are approved, any subsequent changes must be coordinated with the Bridge Office and indicated on the plans using the revision block.

1.5 Schedules for Bridge Design

All GDOT projects follow the Plan Development Process (PDP), which outlines project phases and activities during each phase. It is available on the GDOT website. Bridge designers should be aware of the process and their part in it to assure that project schedules are achieved. In general, the following activities are of particular importance:

1.5.1 Concept Phase

1.5.1.1 Initial Reports

Bridge designers should ensure that SIA's (Bridge Maintenance reports), Bridge and Deck Condition Surveys (if needed) have been requested by the Project Manager. The decision to widen or replace a bridge is determined during the concept phase.

1.5.1.2 Concept Structures

Bridge designers may be asked to provide conceptual bridge and/ or wall lengths, widths, and costs. Timely responses to these requests are needed in this phase. A bridge type study may be appropriate at this time. See Section 2.9.5.

1.5.1.3 Bridge Attendance at Concept Meetings

A bridge designer should attend the Concept Meeting at the Project Manager's request.

1.5.2 Preliminary Design Phase

1.5.2.1 Begin Preliminary Plans

The Project Manager will send a request to the Bridge Office for bridge or wall plans which should include preliminary roadway alignment and profile. However the final roadway profile may depend on structure depths and clearances relating to the bridge, so some collaboration can be expected.

Consultants should begin work on preliminary plans after Notice to Proceed (NTP) has been issued by the Project Manager.

1.5.2.2 Bridge Attendance at PFPR

In general, a bridge designer should attend the PFPR.

1.5.3 Final Design Phase

1.5.3.1 Begin Final Plans

Bridge designers should begin working on final plans after PFPR responses have been provided.

Consultants should begin work on final plans after Notice to Proceed (NTP) has been issued by the Project Manager.

1.5.3.2 Bridge Attendance at FFPR

In general, a bridge designer should attend the FFPR.

1.5.3.3 Final Plans to Office of Bidding Administration

At 10 weeks prior to the let date, final plans are due to the Office of Bidding Administration. Plans need to be stamped and signed. After this submission, any changes to the plans must be handled by formal revision.

At 5 weeks prior to the let date, one stamped and signed set of the final plans or revised final plans is sent to the GDOT print office to be scanned, printed, and sold to contractors. After this submittal, any changes to the plans must be handled by amendment.

1.5.4 Shop Drawings

It is important that shop drawings are reviewed and returned in a timely manner. Two weeks is considered the outside limit of time to review drawings. See Section 8.2 for more information on shop drawings.

1.6 Correspondence

1.6.1 Correspondence Involving Consultants

Any Interdepartment Correspondence or letters on GDOT letterhead must go through the Bridge Office liaison. All transmittals from consultants shall have the PI number, county, description (e.g. "SR 1 over Altamaha River"), and project number. Coordination letters with local governments, agencies, and officials shall go through GDOT.

1.6.2 Phone Number on Correspondence

All correspondence with members of the public shall have printed or typed thereon one or more telephone numbers to which responses or questions concerning such correspondence may be directed. Within the Bridge Office, all correspondence related to projects shall have a name of a contact person and that person's phone number (including area code) included in the body of the letter.

1.6.3 P.I. Number on Correspondence

On all correspondence related to a project, include the Project P.I. Number along with the Project Number in the heading of the letter.

1.6.4 State Bridge Engineer Signature on Correspondence

The following types of correspondence do not require the signature of the State Bridge Engineer:

- a) Transmittals of plans to various GDOT offices. These should be done using a transmittal letter (electronic green sheet) as a cover letter, not with Interdepartmental Correspondence.
- b) Requests for BFI, site inspection (stake-out), bridge and bridge deck condition surveys, salvage of existing bridge parts, recommendations for cofferdams and seals.

- c) Letters distributing and transmitting shop drawings will be initialed by the State Bridge Engineer.

Copies of letters for items a) and b) should be placed in the in-box of the Assistant State Bridge Engineer. Other correspondence should be given to the secretary by e-mail or hard copy for preparation for signature by the State Bridge Engineer.

When preparing correspondence on the PC that will require the signature of the State Bridge Engineer, put the word 'draft' on the page. The letter should be e-mailed to the secretary who will prepare it for signature by the State Bridge Engineer. A copy will be returned to the group.

1.6.5 Correspondence with Legislators and Citizens

When preparing correspondence concerning particular projects with members of Congress, state representatives and senators, and members of the public, send a copy of the letter to the GDOT Board member representing that district.

1.6.6 Correspondence with Contractors

1.6.6.1 Prior to Project Being Awarded

Once a project has been advertised for letting, it is under the control of the Office of Bidding Administration. If any contractor calls with questions on the project, they should be referred to the Office of Bidding Administration. The Office of Bidding Administration will contact the Bridge Office for the proper reply to any questions concerning a structure. The Office of Bidding Administration will then provide that information to all contractors who have purchased plans.

1.6.6.2 During Construction

Send a copy of all correspondence with the contractor to the proper District Office when the correspondence concerns the Contractor's plans and/or design notes. This procedure is an effort to help the District personnel evaluate the need for time extensions on projects where the Contractor proposes changes to the contract plans. When responding to questions from the Contractor, the response should be given to the Project Manager for transmittal to the Contractor.

1.6.6.3 Contractor Cranes on Bridges

Requests from Contractors to place cranes on bridges will be reviewed by the Assistant State Bridge Engineer.

1.6.7 Bridge Condition and Bridge Deck Condition Surveys

When beginning work in the concept phase of bridge widening projects, the designer shall request condition surveys on the existing bridge and the existing bridge deck. It is important to request these early on because it can take up to 6 months to get them completed. The request for a bridge condition survey should go to the Bridge Maintenance Unit. The request for a bridge deck condition survey should go to the Concrete Branch, Office of Materials. Each request should include:

- a) A description of the bridge (e.g., SR 16 over Flint River)
- b) The milepost location of the bridge
- c) A location map of the bridge site

- d) The proposed Management Letting Date for the project.
- e) The Bridge ID and Serial numbers.
- f) The deck condition survey request should ask whether the existing deck is grooved, and in which direction.
- g) The Project Number, County and P.I. Number.
- h) A description of any anticipated work beyond widening, such as placing an overlay or jacking of the existing bridge.

Request an updated bridge condition survey or an updated bridge deck condition survey if the date the letter was issued is older than 3 years. Additional deterioration may have occurred during this time that needs to be addressed.

1.6.8 Routes for Hauling Bulb-Tee PSC Beams

1.6.8.1 Gross Hauling Weight

When developing plans for bridges requiring long Bulb-T PSC beams, determine the gross haul weight of the beams, including the trucking apparatus that will carry the beam to the job site. If the gross haul weight is 150,000 lbs. or greater (allowing 45,000 lbs. for the trucking apparatus), investigate whether the beams can satisfactorily be trucked to the job site with the assistance of truck routing personnel from the Bridge Maintenance Unit.

1.6.8.2 Beam Length

If the beams are over 90 feet in length, provide the length and job site location to Bridge Maintenance truck routing personnel and request that a route for beam delivery be determined.

1.6.9 Transmittal Requirements

1.6.9.1 Preliminary Layouts

The following transmittals shall be made after the preliminary layout has been approved:

- a) Project Manager:
 - 2 full-size prints of the Preliminary Layout
- b) Office of Materials for BFI:
 - 2 prints of the Preliminary Layout
 - 1 print of Project Cover Sheet
 - 1 set of prints for Roadway Plan and Profile sheets
 - 1 copy of location sketch

Include the date the BFI is needed in order to complete the bridge plans on schedule.

- c) Site Inspection:
 - 2 prints of Preliminary Layout
 - 1 print of Roadway Typical Section at bridge location

All bridge sites are inspected by representatives of the District Engineer. Send the request letter to the District Engineer and to the attention of the District Preconstruction Engineer. The Statewide Location Bureau Chief shall be copied on the transmittal. Request that the results of the inspection be provided to the Bridge Office in writing. Requests should include the following, at a minimum:

For Stream Crossings:

- Request that the toes of the endrolls and any intermediate bents near or in the stream be staked.
- Clearance from the top of bank to the toe of the endrolls and to intermediate bents should be checked.

For Grade Separations:

- For grade separations, request that the toes of the endrolls and intermediate bents adjacent to roads or railroad be staked.
- Horizontal clearances from the road or railroad to the bent should be verified as well as the location of the toe of the endroll.

d) Environment/Location (Stream crossings):

- 1 print of Preliminary Layout
- 1 print of Project Cover sheet
- 1 set of Roadway Plan & Profile Sheets at bridge location

Send to the attention of the NEPA-GEPA Section Chief.

e) FHWA for approval (Interstate bridges and full oversight projects):

- 1 half-size print of Preliminary Layout
- 1 half-size print of Roadway Plan and Profile sheets (mainline and crossroad)
- 1 half-size print of Typical Sections
- 1 half-size print of Project Cover Sheet
- 1 copy of the Hydraulic Study including the scour report

f) Railroad for approval (via Office of Utilities):

- 1 electronic copy (pdf format)

Send the electronic copy to the Project Manager after PFPR. The Project Manager will submit it as part of a larger package to the Office of Utilities.

For widenings of steel bridges, note on the preliminary layout if the existing structural steel will or will not be repainted. If repainting, note whether existing paint is lead based.

Norfolk Southern Corporation

Correspondence is sent to Norfolk Southern Corporation (only by the Office of Utilities) but plans and legal agreements all refer to their subsidiary companies, for instance Central of Georgia Railroad Company and the line shown on the plans would be Central

of Georgia Railroad. The other subsidiary lines (the company names are the same but end in Company) are: Norfolk Southern Railway; Georgia Southern & Florida Railway; Tennessee, Alabama & Georgia Railroad; Georgia Northern Railway; and Alabama Great Southern Railroad.

For Norfolk Southern lines, request that the name, address and telephone number of the person to contact before commencing subsurface investigation. Complete and include the Norfolk Southern bridge data sheet (in Appendix 1A).

CSX Transportation, Inc.

If the submittal is to CSX Transportation, Inc. (do not call it CSX Railroad), include a copy of the form letter, signed by the State Bridge Engineer, requesting permission for the Department to make borings on Railroad Right-of-way (in Appendix 1A). Complete and include the CSX bridge data sheet (in Appendix 1A).

There are no subsidiaries of CSX Transportation, Inc. Former railroads identified as Seaboard Coast Line Railroad, Louisville and Nashville Railroad, Georgia Railroad, Atlanta and West Point Railroad, Gainesville Midland Railroad, Atlantic Coast Line Railroad, and Seaboard System railroad are now part of CSX Transportation, Inc. and should be identified as CSX Transportation, Inc.

Other Railroads

In addition to the above two major railroads, there are about 20 “short line” or small railroads operating in Georgia. Call the Office of Utilities if there are any questions about the identification of these railroads.

1.6.9.2 Construction Plans for Approval

1.6.9.2.1 Preliminary Construction Plans

The following transmittals shall be made before the final plans have been approved:

a) Construction Office (Cofferdams and/or seal concrete):

- 1 print of Bridge Plan and Elevation Sheet
- 1 print of Bridge Intermediate Bent Sheet(s)
- 1 copy of BFI Report

Transmittal sheet should request the recommendation of the State Bridge Construction Engineer concerning the need for cofferdams and/or seals (See Appendix 1A).

b) Final Bridge Plans for Front Office Review:

- 1 *stapled* set of final bridge plans with Project Cover Sheet on top
- 1 copy of BFI Report
- 1 half-size copy of Preliminary Layout
- 1 copy of each of the following reports, as applicable:
 - Site Inspection Report

- Cofferdam Recommendations (cofferdams recommended in BFI)
- Bridge Salvage letter (If existing bridge at site)
- Bridge Condition Survey (for widening projects)
- Bridge Deck Condition Survey (for widening projects)
- Railroad approval of Preliminary Layout (for bridges over/carrying railroads)
- FHWA approval of Preliminary Layout (for interstate or full oversight projects)

1.6.9.2.2 Final Approved Plans (before FFPR)

The following transmittals shall be made after the final plans have been approved:

- a) Plans File (Section 1.7.2):
 - 1 set of final bridge plans with Project Cover Sheet
- b) Project Manager:
 - 1 set of final bridge plans
 - 1 copy of Specification Checklist provided by Assistant State Bridge Engineer
 - 1 copy of any required Special Provisions
- c) Railroad for approval (via Office of Utilities):
 - 1 electronic copy (pdf format)

Send the electronic copy to the Project Manager prior to, or at the time of FFPR. The Project Manager will submit it to the Office of Utilities.

1.6.9.2.3 Final Approved Plans (after FFPR)

The following transmittals shall be made after the final plans have been approved and FFPR comments have been addressed:

- a) FHWA for approval (full oversight projects):
 - 1 half-size set of final bridge plans
 - 1 copy of BFI Report
- b) Project Manager:
 - 1 set of any sheets revised after FFPR

1.6.9.2.4 Construction

- a) Shop Drawings:

Approved Shop Drawings:

- 1 set to the field (Area Office)
- 1 set to remain in the Bridge Office file
- 2 sets to contractor

- 2 sets to Office of Materials
 - Send shop drawings for concrete items to the Branch Chief for the Concrete Branch.
 - Send shop drawings for other items, except metal deck forms and detour bridges which are not sent to the lab, to the Branch Chief for the Inspection Services Branch.
- 1 set to remain with consultant, if applicable
- 1 copy of the transmittal letter to the appropriate District Office
- 1 copy of the transmittal letter to the project manager

See Section 8.10.2 for additional transmittal requirements for railroad shoring shop drawings.

Shop Drawings requiring correction:

- 2 sets to the contractor
 - Transmittal letter should indicate that the drawings be forwarded to the fabricator and how many corrected sets shall be returned.
 - 1 copy of the transmittal letter to the field
 - 1 copy of the transmittal letter to the appropriate District Office

Sometimes, GDOT field personnel will request that all shop drawings and correspondence go through their office. These requests should be complied with, but it should be pointed out to the field that this will slow down the review and approval process. Shop drawings being sent to the Lab should always be sent directly there.

b) As-Built Foundation Information Sheet(s)

Plans File:

- 1 full-size copy of revised As-Built Foundation Information sheet to replace previous sheet

Geotechnical Bureau:

- 1 half-size copy of revised As-Built Foundation Information sheet

Bridge Maintenance Engineer (for stream crossing only):

- 1 half-size copy of revised As-Built Foundation Information sheet
- 1 half-size copy of Bridge Plan and Elevation sheet

Bridge Hydraulics (for stream crossing only):

- 1 half-size copy of revised As-Built Foundation Information sheet
- 1 half-size copy of Plan and Elevation sheet
- 1 half-size copy of each substructure sheet

- 1 copy of BFI Report

Project Record Set:

- 1 full size copy of revised As-Built Foundation Information sheet

Send to the Office of Design Policy and Support, attention: Glenn Williams, for inclusion in the electronic record set with a copy of the transmittal letter to the Project Manager.

1.6.10 In-House Mailing Requirements

1.6.10.1 General

Plans may be transmitted to the Office of Roadway Design or to the District Offices using “green sheets” or computerized transmittal forms. If the item to be transmitted can be folded to approximately letter size, it can be placed directly in the Bridge Office out-box with the transmittal form. Copies of all transmittal forms should be placed in the in-box of the Assistant State Bridge Engineer.

1.6.10.2 Rolled Plans

1.6.10.2.1 No Mailing Label Required

Rolled plans being sent to the Office of Roadway Design, other offices within the General Office, the Office of Materials or the Office of Environment/Location can be sent using a “green sheet” or computerized transmittal form and can be placed directly in the Bridge Office out-box. Mail for Districts 6 and 7 is picked up by couriers, so rolled plans do not require a mailing label and can be placed directly in the Bridge Office out-box with the transmittal form.

1.6.10.2.2 Mailing Label Required

Rolled plans being transmitted to the other Districts require mailing labels before they will be picked up for mailing, so they should be put in the secretary’s in-box with the transmittal letter for a mailing label to be prepared.

1.6.11 Public Access to Project Records

All project records and correspondence are to be made available to the public when requested. The only exceptions are documents within which the Department and the Attorney General’s Office communicate on an attorney-client basis; all such documentation should be kept in a separate file from other project records. See MOG 3A-3 for additional requirements and forms to be used.

1.6.12 Construction Time Estimates

Do not send bridge plans to the District or to the Office of Construction for preparation of a construction time estimate. The District Construction Engineer should obtain a complete set of plans from the Project Manager to use in preparing the construction time estimate so that he can account for items not in the bridge plans which can affect the bridge construction time.

1.6.13 FHWA Review Requirements

Any project may be designated as a non-certification acceptance project, also known as full oversight (FOS) projects. This means that preliminary layouts, final plans and plan revisions shall be submitted to the FHWA Division Administrator for review and approval. See Section 1.6.9 for transmittal requirements.

1.6.14 Response to Field Plan Review Reports

Following the issuance of the final PFPR or FFPR report, it is the Design Group Leader's responsibility to provide response to any bridge related items in the report, as well as to address any additional items that might be relevant. This response can be made in the form of an e-mail with a copy being sent to the Assistant State Bridge Engineer. For more complicated issues it may be appropriate to route the response through the State Bridge Engineer for signature.

The e-mail or letter should be addressed to the Project Manager with a copy to the Office of Engineering Services. The response should be prepared promptly as the Project Manager is required to respond to PFPR comments within 4 weeks and to FFPR comments within 2 weeks. It is not necessary to concur or comply with recommendations in the PFPR or FFPR report, but a response is necessary for each. If the response is negative, provide an explanation. Consultants may be asked by the liaison to write responses to the comments.

1.7 Special Provisions and Plan Files

1.7.1 Special Provisions

Project Special Provisions dealing with special construction features or construction sequences are prepared by the Assistant State Bridge Engineer. The Group Leader will provide advice and information to the Assistant State Bridge Engineer. Consultants will be responsible for preparing Special Provisions to be reviewed by the Bridge Office for their projects when a specification is not available.

1.7.2 Plans File

A Project Cover Sheet shall be included with all bridge, wall, culvert or other plans inserted in the Plans File rack in the Bridge Office. Plans shall be placed in the Plans File as soon as possible once final plans are completed and approved. Plans shall be removed promptly when notice of final acceptance is given.

1.7.3 Files for Completed Projects

Once a bridge project has been constructed and accepted by the Department, the design file is condensed and should be prepared for transmittal to Bridge Maintenance Unit (or to the bridge liaison for consultant contracts).

- a) Remove all staples and clips.
- b) Remove (or provide reduced size copies of) all sheets that are not 8½" x 11" or 8½" x 14".
- c) Remove all quantity calculations and non-essential correspondence.
- d) Be sure all items are arranged in the file in the proper location and order.

- e) If the boring log location sketch in the BFI is on plan size sheets, remove it from the file. Otherwise, include it with the BFI.
- f) Include pile driving logs and load test reports. Include as-built foundation data if it is on 8½" x 11" or 8½" x 14" pages.
- g) Include the Hydraulic Study (unless it has been given to Bridge Hydraulics) and any permits, if applicable.
- h) Keep only enough of each computer program output to allow the program to be recreated. Keep geometry program input only if the bridge has unusual geometry. Do not include reinforcing bar program input or output.
- i) A CD with all pertinent electronic files should be kept on record as well.

It will be the responsibility of the Design Group Leader to determine what correspondence will be kept. In general, the correspondences should be kept if there is a possibility to have problems with the bridge or if the bridge is being widened. Do not keep shop drawing transmittal letters unless they contain details or information that would be needed.

Appendix 1A - Sample Letters

The following pages contain copies of sample letter that are typically used on bridge projects.

**DEPARTMENT OF TRANSPORTATION
STATE OF GEORGIA**

INTERDEPARTMENT CORRESPONDENCE

FILE **BRST-030-1(25), Stewart County**
 SR 27 over Bladen Creek
 P.I. No. 333160

OFFICE Atlanta

DATE August 1, 2005

FROM Benjamin F. Rabun, III, P.E., State Bridge Engineer

TO James K. Magnus, State Construction Engineer
 Attention: Melissa Harper

SUBJECT **COFFERDAM DETERMINATION REQUEST**

Attached for review please find one copy of the Bridge Plan and Elevation for the above referenced project. Also attached is a copy of the approved BFI. The two-year flood stage for the referenced project is Elev. 314.42. Please review and forward comments to this office in the next two weeks so that we can submit plans to Engineering Services for a Final Field Plan Review.

If you have any questions or require further information please call Ted Cashin at 404-463-6265.

BFR:EJC



October 2, 2010

FILE: STP00-0000-00(000_ FULTON COUNTY
SR 1 OVER RIVER 2
P.I. No. 1234567

FROM: Benjamin F. Rabun, III, P.E., State Bridge and Structural Engineer

TO: Southern Concrete, Inc.
Somewhere
Sometime

SUBJECT: PSC BEAM SHOP DRAWINGS

Type of drawings: PSC Beams Steel Beams Bearing Pads Metal Deck Forms
 Other

Please find enclosed:

Approved shop drawings bearing our Stamp of Approval. Please forward prints of the shop drawings to the fabricator.

Rejected shop drawings containing our Review Comments and bearing our Stamp of Review. Please furnish this office with ____ sets of corrected shop drawings for our further review and approval.

Additional Instruction/Comments

BFR:TEC

cc: Bill DuVall, attn: Ted Cashin
Bobby Hilliard, Office of Program Delivery
District 3 Engineer
Area 2 Engineer
David B. Millen
Mark Williams
1557 E. Lamar Street (SR 27)
Americus, GA 31709
(with one set of approved shop drawings)

Research Engineer
Georgene Geary, attn: Myron Banks
(with two sets of approved shop drawings)



One Georgia Center, 600 West Peachtree Street, NW
Atlanta, Georgia 30308

Telephone: (404) 631-1000

October 2, 2010

FILE: STP00-0000-00(000_ FULTON COUNTY
SR 1 OVER RIVER 2
P.I. No. 1234567

FROM: Benjamin F. Rabun III, P.E., State Bridge and Structural Engineer

TO: Southern Concrete, Inc.
Somewhere
Sometime

SUBJECT: **PSC BEAM SHOP DRAWINGS**

Type of drawings: PSC Beams Steel Beams Bearing Pads Metal Deck Forms
 Other

Please find enclosed:

Approved shop drawings bearing our Stamp of Approval. Please forward prints of the shop drawings to the fabricator.

Rejected shop drawings containing our Review Comments and bearing our Stamp of Review. Please furnish this office with ___ sets of corrected shop drawings for our further review and approval.

Additional Instruction/Comments

BFR:TEC

cc: Bill DuVall, attn: Ted Cashin
Bobby Hilliard, Office of Program Delivery
District 3 Engineer David B. Millen
Area 2 Engineer Mark Williams
1557 E. Lamar Street (SR 27)
Americus, GA 31709
(with one set of approved shop drawings)

Research Engineer Georgene Geary, attn: Myron Banks
(with two sets of approved shop drawings)

**DEPARTMENT OF TRANSPORTATION
STATE OF GEORGIA**

INTERDEPARTMENT CORRESPONDENCE

FILE **BRST-030-1(25), Stewart County**
 SR 27 over Bladen Creek
 P.I. No. 333160

OFFICE Atlanta

DATE October 26, 2010

FROM Benjamin F. Rabun, III, P.E., State Bridge Engineer

TO David B. Millen, District Engineer, Thomaston
 Attention: Bill Rountree

SUBJECT **BRIDGE SITE INSPECTION AND STAKE OUT REQUEST**

Attached for your use please find copies of the bridge preliminary layout and the roadway typical section. Please perform a bridge site inspection and stake out the clearance between the endrolls and creek banks. Please send the results of the site inspection, in writing, to this office. The 2 year floodstage elevation is 483.78 feet. This bridge is on new alignment to the West of the existing roadway.

If you have any questions or require further information please call Ted Cashin at (404)463-6135.

BFR:EJC

**DEPARTMENT OF TRANSPORTATION
STATE OF GEORGIA**

INTERDEPARTMENT CORRESPONDENCE

FILE **BRST0-0030-01(025) Stewart County** **OFFICE** Atlanta
 SR 27 over Bladen Creek
 P.I. No. 333160 **DATE** October 26, 2010

FROM Benjamin F. Rabun, III, P.E., State Bridge Engineer

TO Mike Clements, P.E., State Bridge Maintenance Engineer

SUBJECT **OVERSIZED TRUCK**

54 in. Bulb Tee PSC Beams are to be used on the above project. The beams are approximately 100 feet long and weigh approximately 68,650 lb. each. The total weight of the truck and beam will be approximately 113,650 lb.

Please let us know if there are acceptable shipping routes from the fabricator's plant to the project site. This project is scheduled for a December, 2002 letting.

If you have any questions or require further information please call Ted Cashin at (404)463-6135.

BFR:EJC

**DEPARTMENT OF TRANSPORTATION
STATE OF GEORGIA**

INTERDEPARTMENT CORRESPONDENCE

FILE **BRST0-0030-01(025), Stewart County**
 SR 27 over Bladen Creek
 P.I. No. 333160

OFFICE Atlanta

DATE October 26, 2010

FROM Benjamin F. Rabun, III, P.E., State Bridge Engineer

TO Brent A. Story, P.E., State Design Policy and Support Engineer
 Attention: Glenn Williams

SUBJECT **AS-BUILT BRIDGE FOUNDATION PLANS**

Attached for revision to the electronic record set please find one full-size print of the as-built foundation sheet. This sheet reflects actual conditions encountered during construction as relayed by the DOT project engineer.

If you have any questions or require further information please call Ted Cashin at (404)463-6135.

BFR:EJC

cc: Geotechnical Bureau (half-size)
 State Bridge Maintenance Engineer (half-size with P&E sheet)
 Bridge Design, Hydraulics (half-size with P&E sheet and BFI)

NORFOLK SOUTHERN CORPORATION
OVERHEAD GRADE SEPARATION DATA SHEET

Page 2

9. List piers where crashwalls are provided:

Pier:	Distance from centerline of track:
_____	_____
_____	_____
_____	_____

10. Describe how drainage from approach roadway is handled:

11. Describe how drainage from bridge is handled:

12. List piers where shoring is required to protect track:

13. Scheduled letting Date: _____

NOTE: Design Criteria for Overhead bridges apply to Items 7 through 12.

All information on this Data Sheet to be furnished by Submitting Agency and should be sent with initial transmittal of project notification.

Keith Golden, P.E., Commissioner



DEPARTMENT OF TRANSPORTATION

One Georgia Center, 600 West Peachtree Street, NW
Atlanta, Georgia 30308

Telephone: (404) 631-1000

March 15, 2013

BRST-0000-00(0) Appling County
SR 1 over CSX Transportation, Inc.
P.I. No. 0000000

Mr. Shelby Stevenson
Principle Manager, Public Engineer
CSX Transportation, Inc.
500 Water Street, J-301
Jacksonville, FL 32202

Dear Mr. Stevenson:

This is to request permission for the Department of Transportation's equipment and personnel to enter upon Railroad Right-of-Way for the purpose of making test borings to determine foundation requirements for the bridge as shown in the preliminary layout transmitted with our letter of _____ in accordance with the following conditions:

- (1) Drilling to be performed only during daylight hours with test borings not more than 4 inches in diameter and not nearer than 15 feet from centerline of track.
- (2) The Department will furnish the Division Engineer of the Railroad in Atlanta, Georgia, sufficient advance notice so that Railroad supervision can be provided.
- (3) At the completion of the test borings, the Department will promptly and completely fill-in and tamp and, in all respects, restore the right-of-way to its original condition, satisfactory to the Division Engineer of the Railroad.
- (4) Permission extended shall be subject to termination upon five days' notice in writing from either party to the other.

Subject to terms and conditions indicated above being satisfactory, please indicate your approval by signing and returning the original of this letter and retaining a duplicate of the original for your records.

Yours very truly,

Benjamin F. Rabun, III, P.E.
State Bridge Engineer

BFR:

cc: Assistant State Bridge Engineer,
attn:
Charles A. Hasty, State Material Engineer,
Attn: Glen Foster

Approved and agreed to this ____ day of _____, 20__

CSX TRANSPORTATION, INC.

By: _____

Title: _____

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Chapter 2. General Design

2.1 Design Specification/Method

2.1.1 Bridges, Culverts and Retaining Walls

All bridges, culverts and retaining walls designated as LRFD structures by the Department shall be designed in accordance with AASHTO LRFD Bridge Design Specifications, 7th Edition – 2014 (AASHTO LRFD Specifications), and the Georgia Standard Specifications, 2013 Edition (GDOT Standard Specifications), as modified by contract documents.

All bridges, culverts and retaining walls not designated as LRFD structures by the Department shall be designed in accordance with the AASHTO Standard Specifications for Highway Bridges, 17th Edition – 2002 (AASHTO Standard Specifications), and the Georgia Standard Specifications, 2013 Edition (GDOT Standard Specifications), as modified by contract documents.

For Standard Specifications structures involving curved steel members or steel boxes shall also be investigated using the AASHTO Guide Specifications for Horizontally Curved Bridges, 1993.

All bridges shall be classified as “typical” as related to LRFD 1.3.5, unless specified otherwise by the Bridge Office.

2.1.2 Pedestrian Structures

All pedestrian overpass structures should be designed in accordance with the AASHTO LRFD Guide Specifications for Design of Pedestrian Bridges, 2nd Edition, 2009.

2.1.3 Sign and Light Supports

The design of sign and light support structures is currently under review by the Bridge Office in order to be updated. Contact the Bridge Office for the applicable specifications to use for the design of these structures.

2.1.4 Sound Barriers

All sound barriers should be designed in accordance with the AASHTO Guide Specifications for Structural Design of Sound Barriers, 1989, with 2002 interims.

2.2 Loads

2.2.1 Dead Loads

2.2.1.1 Non-Composite Dead Loads

The non-composite dead load consists of:

- Slab
- Coping

- Diaphragms
- Metal Stay-In-Place (SIP) forms: 16 lbs./ft² – Do not include weight for Reinforced Concrete Deck Girders (T-beam bridges)

2.2.1.2 Composite Dead Loads

The composite dead load consists of:

- Sidewalks
- Barriers and parapets
- Medians
- Future Wearing Surface: .030 ksf – All Bridges
- Utilities

For bridges meeting the conditions of LRFD 4.6.2.2.1, these loads will be summed and distributed equally to all beams except in the case of very wide bridges (over 70 feet out-to-out). For very wide bridges, the sidewalk, barrier, and parapet loads should be distributed to the four exterior beams on each side, and the median load distributed to the beams under the median. The future paving allowance will be distributed to all beams.

2.2.2 Live Loads

2.2.2.1 Design Vehicular Load

For LRFD projects, the design vehicular load shall be AASHTO HL-93. The Dynamic Load Allowance (IM) shall be included as specified in LRFD 3.6.2.

For Standard Specification projects, the design vehicular load shall be AASHTO HS-20 and/or Alt. Military Loading.

2.2.2.2 Bridge Widening

When an existing bridge is to be widened, its structural capacity will be accepted if the live load capacity is HS-15 or greater and the bridge does not require posting for any of the State's legal loads. It is desirable to have at least 10% reserve capacity for each of the State's legal loads. For bridges that are to be widened on the Interstate system and State Grip System, the structural capacity will be accepted if the live load capacity is HS-20 or greater. The Bridge Maintenance Unit will make recommendations for replacement or widening of a bridge in the bridge condition report.

When widening an existing bridge designed under the AASHTO Standard Specifications, the widened portion may be designed using the AASHTO Standard Specifications, unless the Bridge Office requires it to be designed in accordance with the AASHTO LRFD Specifications.

2.2.2.3 Sidewalk Live Load

The sidewalk live load will be calculated according to LRFD 3.6.1.6 and distributed the same as the sidewalk dead load.

2.3 Horizontal and Vertical Clearances

2.3.1 Clearance Calculation

All vertical and lateral clearances for bridge sites shall be determined by mathematical calculation and checked with an independent calculation.

2.3.2 Stream Crossing

See the GDOT Drainage Manual chapter 14.

2.3.3 Grade Separations

2.3.3.1 Vertical Clearances

Vertical clearances shall be determined using Table 2.3.3.1-1. Ensure that vertical clearance is provided for the entire width of the travelway under the bridge, including any future lanes programmed to be added beneath the structure.

Table 2.3.3.1-1 Vertical Clearances for Bridges

Route and Bridge Type	Minimum	Permissible**
Interstates	17'-0"	16'-6"
State Routes (non-interstate)	16'-9"	16'-6"
Local Routes	16'-9"	14'-6"
Pedestrian Bridges	17'-6"	-
Bridges Not Easily Raised*	17'-6"	-

*Structures that cannot be easily raised include concrete box bridges or bridges with integral piers.

** Needs prior approval from the Bridge Office.

Where falsework is necessary, a minimum temporary vertical clearance of 15'-9" shall be provided. Coordinate with the Bridge Office if this clearance is not attainable.

2.3.3.2 Horizontal Clearances

Intermediate bents shall be located so as to provide the desirable clear zone as specified in the AASHTO Roadside Design Guide whenever practical. Where this is not practical, the designer shall coordinate with the Project Manager to determine how to protect the columns from traffic.

2.3.4 Railroad Crossings

2.3.4.1 CSX Transportation, Inc.

The following requirements should be met when dealing with CSX Transportation, Inc.:

- a) Provide a minimum vertical clearance of 23'-0" from top of high rail to bottom of beam. This clearance is measured along lines concentric with the centerline of the track and 10'-0" on either side.
- b) The desirable horizontal clearance from center of track to the face of the column is 25'-0" on each side, and this should be provided whenever possible. Where multiple tracks are present, measurements are from the outermost tracks. This allows the intermediate bents

adjacent to the railroad to be built without crash walls. The minimum clearance is 18'-0" for tangent tracks. Add 3½" of clearance for each inch of track superelevation on curved tracks.

- c) Crash walls are to be provided where horizontal clearance is less than 25 feet. The top of the crash wall should be 6'-0" above the top of the high rail. The crash wall should be 2'-6" in thickness and extend 2'-6" beyond the outside faces of the exterior columns. The face of the crash wall on the track side should extend 6" beyond the face of the column.
- d) Provide a chain link fence for all bridges over CSX Transportation facilities.
- e) Existing drainage facilities parallel to the track(s) must be maintained through the structure.
- f) Endrolls shall have slope paving.
- g) Overpass drainage must be directed away from the railroad right-of-way.
- h) See Figure 2.3.4.1-1 for railroad cross-section data for use in calculating bridge end locations. Allow 4'-9" for the depth of the ditch from top of rail to bottom of ditch. It should be noted that this work may never actually be done depending on the existing conditions, but the proposed bridge length shall be determined using Figure 2.3.4.1-1.

When these items cannot be achieved due to conditions, some items may be changed on a negotiated basis.

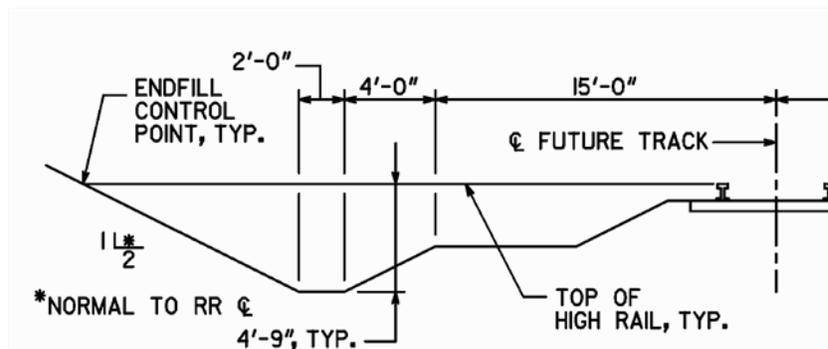


Figure 2.3.4.1-1 Endfill Control Diagram

2.3.4.2 Norfolk Southern Corporation

Subsidiaries of Norfolk Southern Corporation include:

- Norfolk Southern Railway Company
- Central of Georgia Railroad Company
- Georgia Southern & Florida Railway Company
- Tennessee, Alabama & Georgia Railroad Company
- Georgia Northern Railway Company
- Alabama Great Southern Railroad Company

The following requirements shall be met when dealing with Norfolk Southern Corporation and its subsidiaries:

- a) Provide a minimum vertical clearance of 23'-0" from top of high rail to bottom of beam. This clearance is measured along lines concentric with the centerline of the track and 10'-0" on either side.
- b) The desirable horizontal clearance from center of track to the face of the column is 25'-0", whenever possible, to avoid the use of crash walls. For a single track, minimum horizontal clearance is 18 feet on one side and 14 feet on the other side of the track for locations where the span adjacent to the span over the railroad is not the end span. If the span adjacent to the railroad is the end span, provide 22'-0". The railroad will advise which side requires the 18 feet based on the location and the direction of mechanized maintenance machinery. For double tracks, provide 18 feet on each side.
- c) Crash walls shall be provided if the horizontal clearance is less than 25'-0". Crash walls should be 2'-6" in thickness and extend 2'-6" beyond the outside edge of the exterior column. The face of the crash wall on the track side should extend 6" beyond the face of the column. The top of the crash wall should be 10'-0" above the top of the high rail.
- d) Endrolls shall have slope paving.
- e) Overpass drainage must be directed away from the railroad right-of-way.
- f) See Figure 2.3.4.1-1 for railroad cross-section data for use in calculating bridge end locations. Allow 4'-9" for the depth of the ditch from top of rail to bottom of ditch. It should be noted that this work may never actually be done depending on the existing conditions, but the proposed bridge length shall be determined using Figure 2.3.4.1-1.

See GDOT Policy 6865-7: Vertical Clearance of Bridges over RR Tracks, concerning procedures for determining accurate vertical clearances over railroad tracks during construction.

2.4 Survey for Bridge Design

Designers should assure that the survey includes all the information necessary. Surveyors should be directed to the GDOT survey manual available from the Office of Design Policy and Support for more detailed information.

2.4.1 Stream Crossing – Hydraulic Studies

2.4.1.1 Property Survey

A Property Survey covers the extents of the topographic corridor and stream traverse. As a minimum, this will include property owner's names and addresses, deeds, plats, and tax maps. The right-of-way should always be verified by deeds.

2.4.1.2 Existing Roadway Data

2.4.1.2.1 Alignment

The alignment of the existing roadway and bridge should be surveyed to the extents of the project limits. The beginning and ending centerline station should be established on the ground or pavement along with the beginning and ending centerline stations of the bridge and any PC's or PT's.

2.4.1.2.2 Profile

The profile of the existing roadway and bridge shall be determined for the same extents as the alignment. This profile shall include shots along the centerline, edges of pavement, outside edges of the roadway shoulder, and toe of the roadway embankment.

2.4.1.2.3 Intersecting Roads

Profiles are required for all intersecting roads that are located within the limits of the floodplain. These profiles shall extend 500 feet upstream and/or downstream of the intersection with the project road.

This data is also required for roadway and railroad embankments located along the stream and within the floodplain that are no further than 2000 feet upstream and/or downstream of the project site.

2.4.1.3 Existing Bridge Data

Top of deck elevations are required at several locations along the existing bridge. See Figure 2.4.1.3-1 for specific shot locations for replacement/paralleling projects and widening projects.

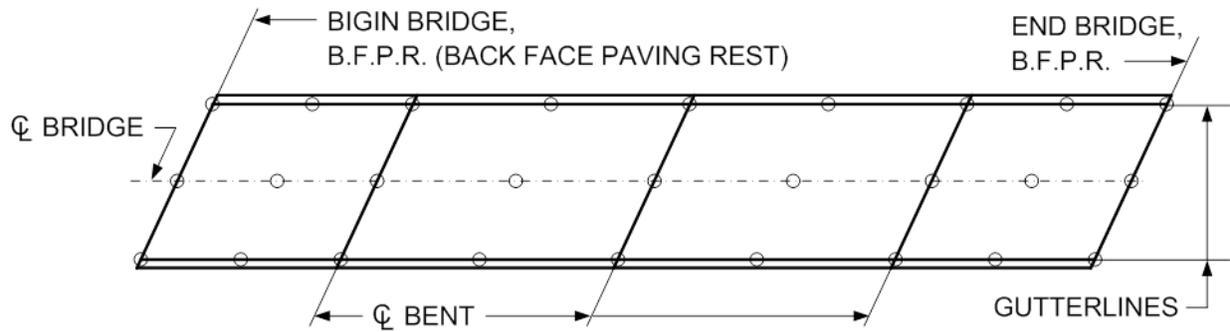
For all existing bridges within a project, elevation shots are required where centerline of bridge and gutter lines intersect each BFPR.

For Bridge widening project, additional elevation shots are required where the centerline of bridge and gutter lines intersect each centerline of bent and each mid-span line along the structure. Bottom of beam elevations for the outside beams at each bent shall be obtained.

The above data shall be provided for all bridges or culverts located within the floodplain that are no further than 2000 feet upstream and/or downstream of the project site.

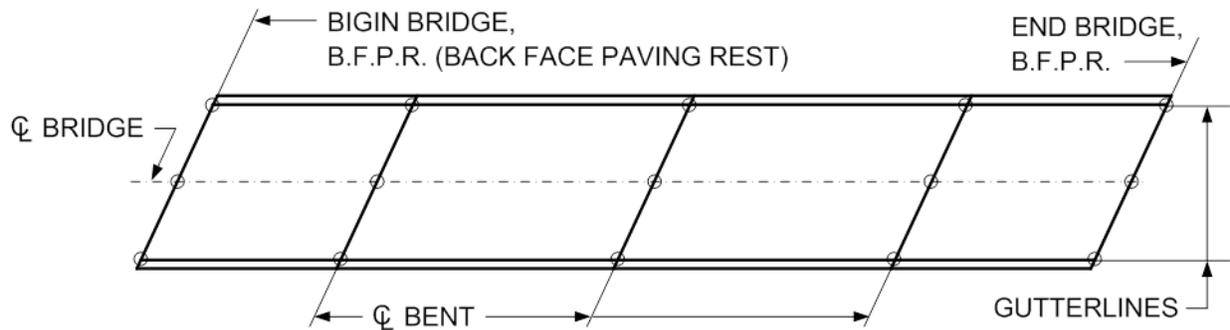
For bridge widening projects where the existing bridge plans are not available, a more detailed survey that gives a complete description of the superstructure and substructure will be required. Surveyor shall check with Project Engineer to determine availability of bridge plans.

- PROVIDE DECK ELEVATIONS AT BFPR, ϕ BENTS AND AT MIDSPAN ALONG THE ϕ BRIDGE AND GUTTERLINES



SURVEY SHOT LOCATIONS FOR BRIDGES TO BE WIDENED

- PROVIDE DECK ELEVATIONS AT BFPR AND ϕ BENTS ALONG THE ϕ BRIDGE AND GUTTERLINES



SURVEY SHOT LOCATIONS FOR ALL OTHER BRIDGES

Figure 2.4.1.3-1 Bridge Survey Shot Locations for Deck Elevations

2.4.1.4 Topographic Coverage

Topographic coverage shall extend at least 150 ft. each side of the centerline. These coverage limits shall apply to both the existing centerline and proposed centerline, if different.

It is preferred that the hydraulic survey data be taken in DTM format. The coverage shall be detailed enough to cover all required areas specified in the field report. These survey points should be included in the InRoads file that is provided to the roadway designer. All survey points should be labeled consistently and clearly identified. All survey data shall be referenced to NAVD88.

2.4.1.5 Benchmarks

A minimum of three benchmarks are required: One at the beginning of the survey, one at the end of the survey, and one for each bridge or stream site near the right-of-way. Benchmarks should be described with a sketch, which also shows the X, Y, and Z coordinates. Benchmarks shall be referenced to the project stations with a complete physical description and elevation. All elevations should be established with a spirit level, referenced to NAVD88. Benchmarks for bridge or stream site shall be located within a distance of 300 feet from the site.

2.4.1.6 Stream Traverse

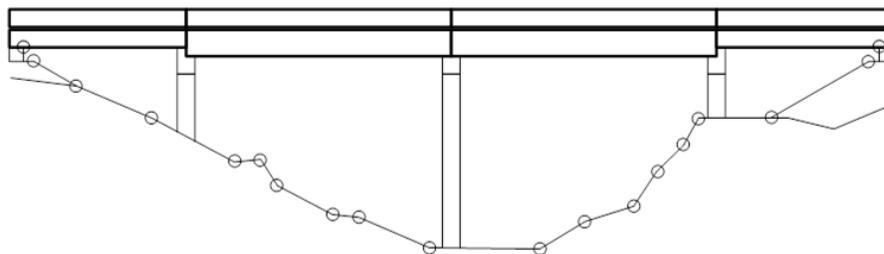
The stream traverse should begin at 500 feet upstream from the bridge centerline with Station 1+00.00 and then continue downstream to a station 500 feet below the bridge centerline. Cross sections of the stream channel are required at the following locations:

- Every 100 feet along the traverse
- Centerline of the existing bridge
- Centerline of the proposed bridge
- 50 feet and 100 feet upstream of the proposed bridge centerline
- 50 feet and 100 feet downstream of the proposed bridge centerline

These cross sections shall be detailed enough to accurately define the profile of the terrain, which usually includes end rolls, stream channel banks, streambed elevations, scoured areas, and any other breaks in the terrain (see Figure 2.4.1.6-1). A sufficient number of streambed shots shall be taken to ensure an accurate stream channel model can be created. Traverses and stream cross sections shall be provided for all stream channels in the floodplain. As stated above, the DTM method is preferred, as long as it is detailed enough to accurately define the location and cross section profile of the stream channel along the entire stream traverse.

- REQUIRED BRIDGE OPENING SHOTS, SEE SECTION II.E OF THE HYDRAULIC ENGINEERING FIELD REPORT.

A SUFFICIENT NUMBER OF STREAMBED SHOTS SHALL BE TAKEN TO INSURE AN ACCURATE STREAM CHANNEL CROSS SECTION.



TYPICAL SECTION – PROFILE OF BRIDGE OPENING

Figure 2.4.1.6-1 Bridge Survey Shot Locations for Streambed

2.4.1.7 Floodplain Cross Sections

2.4.1.7.1 General

Two floodplain cross sections are required, one at 100 feet on each side of the roadway. Each cross section should extend to a point 2 feet above the high water mark that has been established for the stream at the bridge site. The floodplain elevations should be taken at all breakpoints in the terrain within the Bridge Survey alignment and 500 foot intervals outside the alignment.

This data is also required for bridge and roadway sites located within 2000 feet upstream and/or downstream of the project site.

2.4.1.7.2 Parallel Bridges or Small Alignment Shifts

Parallel bridge projects and/or projects with the proposed alignment shifted a relatively small distance require a floodplain cross section be taken along the new and/or parallel alignment.

2.4.1.7.3 New Locations

New location projects require that a floodplain cross-section be taken along the new alignment.

2.4.1.7.4 Abnormal Flood Conditions

For projects with abnormal flood conditions (creeks that flow into one of the state's major rivers), a floodplain cross section is required of the major river below the confluence with the creek. Since this would be an extremely costly section to have surveyed, the cross section may be approximated from USGS maps.

2.4.1.8 Bridge Sketch

Bridge sketches shall be drawn showing the elevation and centerline plus the bottom of the bridge beam at each cap. This sketch also shows the centerline station plus an elevation on all terrain breaks beneath the bridges. The stationing used to show elevations on the bottom of the beam and the profile of the ground beneath the lowest bridge beam shall be the same as the stationing for the alignment of the bridge deck. On mapping surveys, which have no alignment, the stationing for the bridge sketch shall begin with station 0+00.

For structures located upstream or downstream that could have an adverse affect of the bridge at the survey site, a sketch is required. This distance could be as much as 2000 feet. For upstream drainage structures beyond this limit, the size and type should be plotted on a quadrangle map or county map.

The surveyor shall provide, on the bridge sketch, any overflow bridge or culvert within the floodplain with the distance to the project bridge, deck elevation or culvert size, and the flow line elevation.

2.4.1.9 Hydraulic Engineering Field Report

The surveyor shall provide a Hydraulic Field Report in accordance with GDOT Standards. See Hydraulic Engineering Field Report Form in Appendix 2A.

2.4.1.9.1 Normal Water Surface Data

Water surface elevations are required at the survey centerline and at 500 feet upstream and downstream of the survey centerline. These shots shall be taken in the same time period. For tidal sites, the normal high and low tide elevations are required.

2.4.1.9.2 Historical Flood Data

The extreme high water elevation (flood of record) shall be obtained along with the date of occurrence, location (distance upstream or downstream), and the source for this information. If the site is tidal, the highest observed tide elevation is needed.

The surveyor shall record the floor elevations and locations of any houses, buildings or other structures that have been flooded, or have floor elevations within 2 feet of the flood of record. For structures that have been flooded, the surveyor shall provide the flood information, including the number of times the structure has been flooded, the date(s), and the high water elevations.

Note: The high water elevations should be obtained from longtime local residents and/or city/county officials.

2.4.1.10 Miscellaneous Survey Data

2.4.1.10.1 Dams and Spillways

For sites affected by an upstream or downstream dam, survey shots are required that describe the location, length, width and elevation of the dam embankment and spillway opening. The water surface elevation of the impounded water shall be provided.

2.4.1.10.2 Guide Banks (Spur Dikes)

Shots shall be taken that will reflect the location, length and elevation of the guide bank.

2.4.1.10.3 Longitudinal Roadway Encroachments on Floodplains

Additional floodplain cross sections will be required to determine the effects of the longitudinal encroachment. The surveyor can contact the Project Engineer for guidance on the extent of additional survey data that will be required.

2.4.1.10.4 Upstream and Downstream Crossings

For all bridges and culverts that lie between 2000 feet and 1 mile upstream and downstream from the project bridge, the surveyor shall identify basic information for each structure, such as distance from proposed structure, type of structure, route location, and structure sizes in the Hydraulic Engineering Field Report.

2.4.1.10.5 Additional Cross Sections

If the hydraulics at the project site is affected by other factors such as confluence with other streams or narrow floodplain cross sections, additional floodplain cross sections may be required. The surveyor should contact the roadway designer if a question arises during the field survey of the project.

2.4.2 Grade Separations

The following items are needed for a bridge survey over an existing road:

2.4.2.1 Property Survey

A Property Survey that covers extents of all the roadway alignments' corridors. As a minimum, this will include property owner's names and addresses, deeds, plats, and tax maps. The right-of-way should always be verified by deeds.

2.4.2.2 Existing Roadway Data

2.4.2.2.1 Alignment

The alignment of the existing roadway and bridge should be surveyed to the extents of the project limits. The beginning and ending centerline station should be established on the ground or pavement along with the beginning and ending centerline stations of the bridge and any PC's or PT's.

2.4.2.2.2 Profile

The profile of the existing roadway and bridge shall be determined for the same extents as the alignment. This profile shall include shots along the centerline, edges of pavement, outside edges of the roadway shoulder, and toe of the roadway embankment.

2.4.2.2.3 Intersection Roads

Profiles are required for all intersecting roads that are located within the limits of the survey. These profiles shall extend at least 300 feet from the intersection with the project road. These profiles shall include shots along the centerline, edges of pavement, outside edges of the roadway shoulder, and toe of the roadway embankment.

2.4.2.3 Existing Bridge Data

Top of deck elevations are required at several locations along the existing bridge. See Figure 2.4.1.3-1 for specific shot locations for replacement/paralleling projects and widening projects.

For all existing bridges within a project, elevation shots are required where centerline of bridge and gutter lines intersect each BFPR.

For Bridge widening project, additional elevation shots are required where the centerline of bridge and gutter lines intersect each centerline of bent and each mid-span line along the structure. Bottom of beam elevations for the outside beams at each bent shall be obtained.

For bridge widening projects where the existing bridge plans are not available, a more detailed survey that gives a complete description of the superstructure and substructure will be required. Surveyor shall check with Project Engineer to determine availability of bridge plans.

2.4.2.4 Topographic Coverage

Topographic coverage shall extend at least 150 ft. each side of the centerline. These coverage limits shall apply to both the existing centerline and proposed centerline, if different.

2.4.2.5 Benchmarks

A minimum of three benchmarks are required: One at the beginning of the survey, one at the end of the survey, and one for each bridge site near the right-of-way. Benchmarks should be described with a sketch, which also shows the X, Y, and Z coordinates. Benchmarks shall be referenced to the project stations with a complete physical description and elevation. All elevations should be established with a spirit level, referenced to NAVD88. Benchmarks for bridge or stream site shall be located within a distance of 300 feet from the site.

2.4.2.6 Profile and Cross Sections

Profile and Cross Sections or DTM coverage should have the same limits as the Topographic limits.

2.4.2.7 Roadway beneath Bridge

The road beneath a bridge for 300 feet left and right of the bridge requires a complete survey which includes: Alignment, property, topographic, profile levels and cross sections or DTM survey data.

2.4.2.8 Bridge Sketch

A bridge sketch is required. On this sketch, show the vertical clearance from the bottom of the outside bridge beams to the roadway pavement at the centerline of the road and at each edge of pavement of the road.

2.4.3 Railroad Crossings

The following items are needed for a bridge survey over an existing railroad:

2.4.3.1 Property Survey

A Property Survey that covers extents of the roadway alignment and railroad corridors. As a minimum, this will include property owner's names and addresses, deeds, plats, and tax maps. The right-of-way should always be verified by deeds.

2.4.3.2 Existing Roadway Data

2.4.3.2.1 Alignment

The alignment of the existing roadway and bridge should be surveyed to the extents of the project limits. The beginning and ending centerline station should be established on the ground or pavement along with the beginning and ending centerline stations of the bridge and any PC's or PT's.

2.4.3.2.2 Profile

The profile of the existing roadway and bridge shall be determined for the same extents as the alignment. This profile shall include shots along the centerline, edges of pavement, outside edges of the roadway shoulder, and toe of the roadway embankment.

2.4.3.2.3 Intersecting Roads

Profiles are required for all intersecting roads that are located within the limits of the survey. These profiles shall extend at least 300 feet from the intersection with the project road.

These profiles shall include shots along the centerline, edges of pavement, outside edges of the roadway shoulder, and toe of the roadway embankment.

2.4.3.3 Existing Bridge Data

Top of deck elevations are required at several locations along the existing bridge. See Figure 2.4.1.3-1 for specific shot locations for replacement/paralleling projects and widening projects.

For all existing bridges within a project, elevation shots are required where centerline of bridge and gutter lines intersect each BFPR.

For Bridge widening project, additional elevation shots are required where the centerline of bridge and gutter lines intersect each centerline of bent and each mid-span line along the structure. Bottom of beam elevations for the outside beams at each bent shall be obtained.

For bridge widening projects where the existing bridge plans are not available, a more detailed survey that gives a complete description of the superstructure and substructure will be required. Surveyor shall check with Project Engineer to determine availability of bridge plans.

2.4.3.4 Topographic

Topographic coverage shall extend at least 150 ft. each side of the centerline. These coverage limits shall apply to both the existing centerline and proposed centerline, if different.

2.4.3.5 Benchmarks

A minimum of three benchmarks are required: One at the beginning of the survey, one at the end of the survey, and one for each bridge or stream site near the right-of-way. Benchmarks should be described with a sketch, which also shows the X, Y, and Z coordinates. Benchmarks shall be referenced to the project stations with a complete physical description and elevation. All elevations should be established with a spirit level, referenced to NAVD88. Benchmarks for bridge or stream site shall be located within a distance of 300 feet from the site.

2.4.3.6 Profile and Cross Sections

Profile and Cross Sections or DTM coverage should have the same limits as the topographic limits.

2.4.3.7 Railroad beneath Bridge

The railroad beneath the bridge for 500 feet left and right of the bridge requires a complete survey that includes:

Alignment – The alignment of the centerline on the main railroad tracks for 500 feet left and right of the bridge shall be surveyed. The intersection of the bridge alignment and the railroad alignment shall be tied to a railroad milepost.

Property survey – As described in section 2.4.3.1.

Topographic – The topographic coverage limit shall be 100 feet left and right on each side of the track. If the location has multiple tracks, coverage should be 100 feet beyond the centerline of the outermost track. The location of the existing bridge pilings should be located from the survey centerline.

Profile Levels and Cross Sections or DTM Survey Data – The profile and cross sections or DTM survey data shall be taken a minimum of 100 feet each side of the track. If the location has multiple tracks, coverage shall extend for 100 feet beyond the centerline of the outermost track. Elevations are to be taken on the top of each rail. If collecting elevations in the cross section format, a minimum of five (5) cross sections shall be taken between the proposed right-of-way limits. One at the proposed right-of-way, one halfway between the proposed right-of-way and the bridge centerline, one at the bridge centerline, and the same for the other side of the bridge. These cross-sections will be taken perpendicular to the railroad track centerline and extend for 100 feet beyond the centerline of the outermost track.

Drainage – All drainage structures and features within the 1000 feet Railroad Survey corridor shall be provided.

2.4.3.8 Bridge Sketch

A bridge sketch is required. On this sketch, show the vertical clearance from the bottom of the outermost bridge beams to the top of the railroad rail for each rail beneath the bridge.

2.5 Staged Construction

Staged construction may be required when widening bridges or circumstances require constructing the new bridge in nearly the same footprint as existing.

2.5.1 Temporary Shoring

Since it is difficult for designers to anticipate a contractor's exact method of construction, temporary shoring shall be shown wherever it is considered necessary. Show the temporary shoring with break lines at the ends to indicate indefinite limits. If shoring is shown on the plans, include a general note addressing the shoring or include temporary shoring in the list of incidental items. Do not use the temporary shoring pay item unless a substantial amount of shoring is required.

2.5.2 Pour Strips

Pour strips shall be considered for staged construction. See Section 3.13.1.1 for details.

2.5.3 Temporary Barrier

Temporary barrier shall be considered for staged construction. See Section 3.3.6 for details.

2.6 Bridge Jacking

2.6.1 General

Where bridges are to be raised, the designer shall provide jacking details in final construction plans. These details should provide 16'-9" minimum vertical clearance over the travel way and paved shoulders.

2.6.2 Utility Consideration

During the preliminary design phase, the designer should inform the District Utilities Engineer that the bridge is to be raised and that a field site inspection is needed to identify and locate the utilities

in place. The findings should be reported to the Bridge Office. The District Utilities Engineer shall alert the impacted utility companies and remind them of their responsibilities for coordinating satisfactory utility realignment.

2.6.3 Additional Work

A request should be made to the Bridge Maintenance Unit for a Bridge Condition Survey. Items reported in need of repair or replacement should be incorporated into the contract documents if practical.

2.6.4 Plans

Each set of bridge jacking plans should include a Plan and Elevation sheet and Jacking Details sheets sufficient to describe the overall scope of work and show the required Bridge Office details along with other pertinent data necessary to obtain accurate and competitive bids. These sheets are in addition to applicable roadway plans which would include the Cover, Index, Revision Summary, Summary of Quantities, Detailed Estimate, Typical Sections, and Plan & Profile sheets.

2.6.4.1 Plan and Elevation Sheet

The Plan and Elevation (P&E) sheet should clearly show a plan view that includes beginning and ending bridge stations, bent arrangements, deck widths, and the point of minimum vertical clearance. It should also clearly show an elevation view that includes the length of bridge, span lengths, locations of expansion and fixed bearings, bent numbers, and the minimum vertical clearance at completion. The P&E sheet should also contain the existing grade data for the bridge and any underpass roadways as well as the existing bridge Serial, I.D., and P.I. numbers.

The P&E sheet may also contain the following in accordance with the Bridge Office's standard General Notes formatting:

- An "EXISTING BRIDGE CONSISTS OF" tabulation describing the existing bridge
- A "UTILITIES" tabulation listing all existing utilities
- A "WORK CONSISTS OF" tabulation outlining the basic items of the work
- A "DESIGN DATA FOR DESIGN OF PEDESTALS" tabulation indicating the design specifications used, the typical loading, and the future paving allowance assumed
- A "CONSTRUCTION SEQUENCE" tabulation enumerating proposed steps necessary to complete the work. A note should be included immediately following these steps stating *"The aforementioned sequence shall be coordinated with the roadway operations, see roadway plans. In lieu of the above sequence, the contractor may submit a proposed sequence for approval."*
- A "TRAFFIC DATA" tabulation displaying traffic data for the existing bridge
- A "SUMMARY OF QUANTITIES" tabulation including a lump sum pay item for raising the existing bridge, pay items for joint re-sealing, and any other pay items for requested bridge rehabilitation work

- A “GENERAL NOTES” tabulation stating all applicable standard Bridge Office notes pertinent to bridge jacking operations as well as notes addressing protection of existing slope paving, removal and replacement of existing bridge joints and/or other rehabilitative work, amount of jacking and vertical clearance to be obtained with reference to special provisions, and responsibility for utility disconnects/reconnects/adjustments

The above tabulations may be included on a separate General Notes sheet if necessary or may be included on the Jacking Details sheets.

2.6.4.2 Jacking Details Sheet

Jacking Details sheets should include the following:

- Section views at endwalls/backwalls detailing required modifications including pedestals, new concrete and reinforcement, and approach slab modifications
- Schematics of utility adjustments
- Schematic plan and elevation views of bearing assemblies and pedestals
- Details of elastomeric bearings if required (may be shown on separate sheet if necessary)
- Details of wingwall modifications
- Details of expansion joints
- Steel specifications and finish requirements
- Details/requirements for anchor bolt replacement

2.6.4.3 Maintenance of Traffic

The engineer shall consider maintenance of traffic in the design and ensure adequate coordination with the roadway plans. The sequence of operations should limit elevation differences at lift points to 1-inch or less at any given time or as indicated in the Special Provision for this work.

2.6.4.4 Jacking Method

It is generally not necessary or desirable to specify a jacking method in the plans. The Special Provision for this work should contain the basic jacking requirements and the engineer should make sure that is the case. It is the intent that the contractor retains responsibility for the jacking method/details and damage to the structure. However, the engineer should fully consider all jacking loads to be placed on the structure. Members should be analyzed as necessary to ensure that the strength is adequate for jacking by conventional methods. If not, special notes or details should be developed so a method is clearly available for bidding.

2.6.4.5 Approach Slab

Detailing for bridge jacking should include provisions for retaining existing approach slabs with modifications for re-supporting on the paving rest after jacking is complete. The existing approach slabs should normally be overlaid with permanent asphalt as the bridge is jacked thereby maintaining a consistent traffic surface that will remain in place at the completion of the project. A note should be included in the plans to require the contractor to check for voids beneath the approach slab by sounding and coring prior to cutting it free of the paving rest. If

voids are detected, they should be grouted with flowable fill in accordance with GDOT Standard Specification Section 600 and a nominal quantity should be set up for this purpose to be used as directed by the engineer.

2.6.4.6 Concrete Pedestals

Concrete pedestals shall be specified when the pedestal height is over 1'-9". For bridges being jacked and widened on each side, so the existing portion of the bridge will be laterally restrained, concrete pedestals are required only when the pedestal height is over 2'-3". Steel pedestals may be used for heights equal to or lower than these limits.

2.7 Bridge Salvage

In the Preliminary Design Phase, the designer shall write a letter to the Bridge Maintenance Unit asking for a list of materials to be salvaged from the existing structure. The Bridge Maintenance Unit will respond by letter either stating that nothing will be salvaged, or with a list of items to be salvaged. The designer shall place a note on the Plans indicating either the existing bridge materials to be salvaged from the site or that no materials will be salvaged. Use Bridge Notes G072 through G075 as applicable.

2.8 Software

2.8.1 General

The following software must be used during the production of final bridge plans:

- a) **Geometry (BRGEOM)** – All bridges shall have a geometry program run showing the profile grade line, centerline construction, beam lines, gutter lines and edge of bridge. Transverse lines shall include end of bridge, centerline bents, centerline of bearing, and (for T-beams only) face of cap. This requirement may be waived for simple bridges.
- b) **General Notes (BRNOTES)** – Run this program to have the correct notes and pay items in the uniform format.
- c) **Reinforcing Steel (BRRBAR)** – Run this program to have the correct steel quantities and formatted rebar sheets.

2.8.2 LRFD Projects

Prior to beginning final bridge design, consultants shall submit, in writing, the LRFD design software they will be using for approval by the Bridge Office.

2.8.3 Standard Specification Projects

The Bridge Design Office has a variety of programs available for design using Standard Specifications that fall into the following categories:

2.8.3.1 Required Software

Required software must be used to at least check the final design of the appropriate items unless analysis of the structure is beyond the capacity of DOT programs:

1. Prestressed Beam (BRPSBM1) – All beams must analyze without overstress in the prestressed beam program. A run will be required for every different length or load condition.
2. Pier Program (BRPIER) – Each bent must have a pier program run. Seismic Performance Category B bridges are to be analyzed by BRNCPIER which provides input for seismic loads. There is no software required for pile bents.
3. Simple Span Beam (BRSPAN) – Required for simple span steel bridges. Note that the t-beam part of the program uses allowable stress and therefore is not required but can be helpful in generating loads.
4. Continuous Beam (BRCTBM) – Required for continuous steel beams.
5. Slab Design (BRSLAB07) – You can either run this or use the latest slab charts. The design of the slab uses allowable stress design.

2.8.3.2 Recommended Software

1. Bearing Pad (BRPAD1) – Provide a run for each size of pad and for each load case or expansion case. No design is required for half-inch unreinforced bearing pads
2. SEISAB – For bridges in the seismic zone B. Use in conjunction with NCPIER.
3. DESCUS (BRDESC) – For curved steel girders

2.8.3.3 Optional Software

- BRLLCA – Live load case program. Comes up with live load input for the pier program.
- BRPCAC – PCA Column Analysis
- BRCPFT – Continuous footing program
- BRSIGN – Sign base
- BRSPAN – GDOT simple span beam program
- Merlin-Dash – Proprietary simple span or continuous beam program

2.9 Preliminary Design

The Preliminary Design Phase is when the template for the Final Bridge Plans is set. Therefore, it is critical for the designer to consider all the known aspects that may affect the bridge design and plan for them during this phase.

2.9.1 Roadway Geometry

Early in the design process the designer may need to collaborate with the roadway designers to simplify the design and construction of the bridge. Some of the parameters that should be considered during this phase are discussed in the following subsections.

2.9.1.1 Low Points

When possible, low points should be kept off of the bridge spans and approach slabs. If a low point must be located on the bridge, the following locations should be avoided:

- Near a bridge joint due to long term maintenance issues
- On end spans so drainage won't fall onto unprotected slopes
- Near intermediate bents so drainage won't fall onto substructure elements

See Section 3.15 for details of deck drainage.

2.9.1.2 Superelevation Transition

Superelevation transitions on bridges should be avoided when practical. Particularly, transitions between normal crown and reverse crown should be avoided as this requires a more complex construction sequence and a longitudinal construction joint. If the roadway plans present a superelevation transition that falls within the limits of the bridge, request that the Project Manager consider the following alternatives:

- Move the entire superelevation transition completely off the bridge.
- Make a transition to a certain cross-slope, maintain it across the bridge, and then continue the transition.
- Complete the transition between normal crown and reverse crown off the bridge, then increase or decrease the superelevation on the bridge as necessary.

2.9.2 Bridge Widths

Bridge width is determined by the roadway classification and other parameters as specified in the following sub-sections, where TW is the traveled way (total width of lanes).

Note: The shoulder widths are based on A Policy on Geometric Design of Highways and Streets [AASHTO Green Book], 2004.

2.9.2.1 Bridges on the State and Federal System (non-Interstate)

a) Rural section (2 lanes):

Design Year ADT	Bridge Clear Width
0-399	4' + TW + 4'
400-2000	6' + TW + 6'
Over 2000	8' + TW + 8'

- b) Rural section (multilane undivided – 4 lanes or more): 8' + TW + 8'
- c) Rural section (multilane divided): 4' (inside shoulder) + TW + 8' (outside shoulder)
- d) Urban sections (with curb):

The clear width for all new or reconstructed bridges shall be the curb to curb width of the approach roadway. For two-lane, two-way bridges the minimum clear width shall be TW + 4 ft., unless an exception is obtained from the Chief Engineer. Sidewalks shall be provided on bridges where curb and gutter is provided on the approach roadway. Minimum sidewalk width on bridges shall be 5.5 ft. (see Section 3.3.3 - Sidewalks and Medians). When the roadway curb and gutter section is 2'-6", 2 ft. is considered gutter for calculation of the bridge width.

e) Ramps:

The width of bridges used on ramps shall be considered on a case-by-case basis. The designer should cooperate with the Project Manager and Bridge Office liaison to determine the bridge width for a ramp.

2.9.2.2 Bridges off the State and Federal System

a) Rural section (2 lanes)*

Design Year ADT	Bridge Clear Width
0-399	2' + TW + 2'
400-2000	3' + TW + 3'
Over 2000	8' + TW + 8'

*For low volume roads with an approach roadway width of one lane, a minimum bridge width of 18 ft. may be selected with approval from the Chief Engineer.

- b) Rural section (multilane undivided – 4 lanes or more): 8' + TW + 8'
- c) Rural section (multilane divided): 4' (inside shoulder) + TW + 8' (outside shoulder)
- d) Urban section (with curb):
- e) The minimum clear width for all new or reconstructed bridges shall be the curb to curb width of the approach roadway. For two-lane, two-way bridges the minimum clear width shall be TW + 4 ft., unless an exception is obtained from the Chief Engineer. Sidewalks shall be provided on bridges where curb and gutter is provided on the approach roadway. Minimum sidewalk width on bridges shall be 5.5 ft. (see Section 3.3.3 - Sidewalks and Medians). When the roadway section has a curb and gutter of 2'-6", 2 ft. is considered gutter for calculation of the bridge width.

2.9.2.3 Interstate Bridges

Lanes in One Direction	Bridge Width Clear Distance
Two Lanes	6' (inside shoulder) + TW + 12' (outside shoulder)
Three or More	10' (inside shoulder) + TW + 12' (outside shoulder)
Three or More with High Truck Traffic	12' (inside shoulder) + TW + 12' (outside shoulder)

Note: The philosophy on shoulder widths is that with two lanes drivers should be able to take refuge on the outside shoulder. When more lanes are present, they may have to take refuge on the inside shoulder. When there is high truck traffic, additional width may be needed to allow trucks to take refuge on the inside shoulder. If the shoulder widths shown above are different than the paved shoulders on the roadway plans, this should be addressed as early in the process as possible since these should generally match.

2.9.2.4 Design Exceptions

When a project is implemented using federal funds and the width characteristics do not meet the above criteria, a request for design exception shall be submitted to the Chief Engineer for approval, unless 23 CFR 625 – Design Standards for Highways applies. The following situations would require consideration for design exceptions.

2.9.2.4.1 Staging Considerations

In certain staging situations it might be more economical to build the bridge wider as opposed to building a temporary structure to hold the traffic.

2.9.2.4.2 Future Construction Considerations

When designing a replacement bridge that has a future parallel bridge programmed, it could be appropriate to apply multi-lane divided traffic criteria instead of the 2-way traffic criteria specified above.

2.9.2.4.3 Sharp Curves

The bridge width on roads with sharp curves and low traffic can be increased due to tracking requirements. See Section 4.2.3 - Pavement Widening on Curves of the GDOT Design Policy Manual.

2.9.3 Bridge Lengths

The bridge length is mostly determined by the obstacle that the bridge must span. For nearly all road projects the obstacle falls within two general categories – Bodies of Water (Stream Crossings) or Travelways (Grade Separations).

2.9.3.1 Stream Crossings

The guidelines for setting the span lengths for Stream Crossings are outlined in the GDOT Drainage Manual.

2.9.3.2 Grade Separations

Bridge spans over roads or railroads shall be long enough to span the travelway, drainage ditches, shoulders, sidewalks, clear zone for the travelway, and the offset distance from the toe of slope paving or face of abutment wall (See Sections 2.3.3 and 2.3.4).

2.9.4 Guidelines for Selecting Bridge Type

The following guidelines can be used, unless the cost of the bridge requires a Bridge Type Study (See Section 2.9.5).

2.9.4.1 Typical Bridge Cost

The following square foot costs for particular bridge types may be used in preparation of preliminary cost estimates:

Item	Square foot cost (out-to-out width)
RC/PSC beams on pile bents	\$70
PSC beams on concrete bents	\$85
Steel beams on concrete bents	\$115

2.9.4.2 Reinforced Concrete Deck Girders (RCDGs)

Historically, reinforced concrete deck girders (RCDG or T-Beam) on pile bents are some of the most economical bridges that GDOT has built. When economy governs, the designer should consider RCDG as the first choice. Typical spans are either 30 feet long (2'-3" deep) or

preferably 40 feet long (2'-9" deep). When running Hydraulics, uniform span lengths should be added until an acceptable hydraulic opening is found.

2.9.4.3 Contractor PSC Beam Substitution

GDOT Standard Specifications allows contractors to substitute PSC girder spans for RCDG spans as long as minimum bottom of beam elevations are met. A note should be placed on the plans if other conditions limit the contractor's option for the substitution.

Since many RCDG spans are being redesigned by the contractors to PSC girders, designers may now opt to utilize Type I Mod PSC girders. RCDG may still be more economical than Type I Mod PSC girders on low-lying bridges where the cost of falsework will be less.

2.9.4.4 PSC Beams on Pile Bents

The maximum span length for AASTHO PSC beam bridges on pile bents is 50 feet. If PSC piles are recommended in the approved BFI, spans up to 70 feet may be used. Because longer spans require heavier piling and pile hammers, spans longer than 50 feet may not be economical on small bridges.

2.9.4.5 Concrete Bents

Concrete bents should be used instead of pile bents for the following situations:

- Bridge requires longer spans
- Bridge height exceeds twenty feet where pile bents will not work

If the BFI recommends spread footings, drilled shafts or pilot holes at bent locations due to rock or hard layers close to the surface, the bridge layout should be re-examined utilizing longer span lengths on concrete bents for cost savings.

2.9.4.6 Prestressed Concrete Beams

Prestressed concrete beams are the most economical superstructure type when spans longer than 40 feet are required. Span length, beam type and beam spacing shall be considered together for the most economic design. PSC beam charts are provided in Appendix 3B for guidance. Beam spacing limits are specified in Section 3.4.2.7, and beam length limits are specified in Section 3.4.2.8. For bridges in visible areas, such as grade separations or stream crossings with significant adjacent development, same beam depths for adjacent spans should be considered (see Section 3.4.3.2).

2.9.4.7 Single Span Hydraulic Bridges

When the hydraulic opening requires a bridge that spans the stream with end spans of less than 30 feet, a single span bridge using longer beams could be the best alternative. However, it is difficult to set long beams across a stream, so a beam setting process needs to be provided in the hydraulic study. It may be possible to set them from the detour bridge or the adjacent bridge.

2.9.4.8 Steel Beams

Steel beam bridges are typically more expensive than PSC beams. However, steel beam bridges should be considered for the following situations:

- Span lengths exceeding 150' (Bridge Type Study may be appropriate)

- Bridges requiring a shallow superstructure depth for vertical clearance
- Widening existing steel bridges

2.9.4.9 Box Girders

Another option for long spans is steel or concrete box girder bridges. GDOT prefers not to use concrete box girders due to the extensive falsework required. However, cast-in-place box girders or segmental box girders should be considered in the Bridge Type Study for appropriate situations.

2.9.4.10 Beams in Curved Bridges

When the width of the bridge is constant, make the beams parallel within each span as practical. Also, the centerlines of exterior beams should meet at the centerlines of the intermediate bents. Use the following practice for placing beams on curved bridges as feasible:

- Place beams parallel to the chord of the bridge centerline from BFPR/centerline bent to centerline bent.
- Place exterior beams on chords of concentric circles, then parallel interior beams towards the centerline. For this case, ensure that the non-parallel beam spacing that occurs in the middle is smaller than the parallel spacing on either side, so it doesn't control the deck design.

Placing all beams on their own chords usually makes no beam parallel and leads to complicated deck formwork.

2.9.4.11 Scissor Bridges

On bridges with very sharp skews, known as "scissor bridges", it may be appropriate to use transverse girders rather than longitudinal beams. This results in many girders that only partially support the roadway. There is no definitive policy on whether to include a deck on the portion outside the roadway limits or leave the beams with an uncovered top flange. A Bridge Type Study may be necessary for cost comparison between many short transverse girders and a few long longitudinal beams.

2.9.4.12 MSE Wall Abutments

An MSE wall abutment should be considered as an alternative to an end roll on grade separations. It could be a more economic solution, especially for wide bridges.

2.9.5 Bridge Type Study

A Bridge Type Study should be performed whenever the estimated construction cost of a single bridge is expected to exceed \$10,000,000, or as directed by the Bridge Office. The study report serves as a reference supporting the choice of the structure type for a project.

2.9.5.1 Purpose

The Bridge Type Study establishes what alternative(s) will be carried forward in the Preliminary and Final Design phases. When alternate designs are considered, uniform design criteria, material requirements and unit costs should be applied.

2.9.5.2 Format

The report shall use 8 ½" by 11" pages with drawings on larger sheets, if necessary, folded to fit the report. The report shall be neatly written and the contents shall be presented in a logical sequence with narratives as necessary. An Executive Summary shall be included comparing the relative features and costs of the alternatives considered and recommending which alternative(s) to be carried forward into the Preliminary Phase.

The Bridge Type Study should be as self-contained as possible by including all arguments that establish, justify, support, or prove the conclusions. It is acceptable to make reference to other documents that will be included in the final submittal package. Any documentation, such as drawings, clear and concise views, or other illustrated information that assists in presenting design intent and solutions should be included in the package.

2.9.5.3 Contents

Provide cost data and other information that affects the selection of an alternative, including geotechnical survey data (if available), life cycle maintenance costs, construction time and staging assumptions, constructability, maintenance of traffic, aesthetics, etc. Various methods of handling traffic during construction should be thoroughly investigated. Data provided by others should be thoroughly reviewed and if deemed insufficient or in error should be brought to the attention of the provider. The major items that should be included are described in the following subsections.

2.9.5.3.1 Bridge Description

The Bridge Type Study should include a detailed description of each proposed alternate structure. This description should consider the following in its development:

- a) Span length: Span lengths are governed by column/pier locations that provide the required vertical and horizontal clearances, then economic and aesthetic considerations.
- b) Superstructure depth: Superstructure depths, particular for grade separation structures, shall be kept to the minimum as allowed by good engineering practice.
- c) Span continuity: The economic and engineering advantage of simple span vs. continuous spans should be addressed.
- d) Superstructure type: Consider prestressed concrete girders, steel rolled sections, steel plate girders, steel or concrete box girders, and other sections approved by the Bridge Office.
- e) Pier protection: Piers located in a divided highway median must be protected from traffic, typically by guardrail or concrete barrier, when located within the clear zone.
- f) Foundation: For piles and drilled shafts, assume size, length, and capacities from geotechnical information, if available. For spread footings, allowable bearing pressure should also be assumed from geotechnical information, if available.

2.9.5.3.2 Costs

The Bridge Type Study should include a cost estimate for each proposed alternate structure. This estimate should include the following:

- a) Quantity estimates: Quantities should be estimated to the accuracy necessary for comparing the alternatives. For minor bridges rough quantities, such as the amount of reinforcing steel estimated from historic steel-to-concrete ratios, may be sufficient. For major and complex bridges more detailed quantity calculations may be required.
- b) Unit costs: Unit costs should be derived using data available from GDOT or contractors/suppliers. The sources of all price data should be recorded for later reference. For major and complex structures it may be necessary to develop unit costs from an analysis of fabrication, storage, delivery and erection costs.
- c) Cost matrix: A cost matrix should be established for each alternative to reveal the most economic span arrangement.

2.9.5.3.3 Aesthetics

The Bridge Type Study should include a narrative explaining how aesthetics affected the design of each proposed alternate structure. This narrative should address the following considerations:

- a) Totality of structure: A bridge should be made aesthetically pleasing in and of itself by giving proper attention to shapes, proportions and continuity of forms and lines. The basic structure of the bridge itself should be the main focus in bridge aesthetics, not enhancements, additions, or other superficial touches.
- b) Compatibility with site: A bridge should be made aesthetically pleasing in context of its surroundings. Additional emphasis should be placed on the surroundings at interchanges where landscaping or unique features need to be considered.
- c) Conformity of theme: Conformity of theme and unifying appearance should be created or maintained in locations with multiple bridges, such as interchanges, where aesthetics are important because of high visibility to a large number of motorists.
- d) Inherently pleasing substructure shapes: Consideration should be given to structural systems that are inherently more pleasing, such as hammerhead or "T" shaped piers, oval or polygonal shaped columns, piers in lieu of bents, etc.

2.9.5.3.4 Constructability and Maintainability

All construction and maintenance requirements should be identified and appropriately reflected in any concept that is to be recommended for design.

- a) Constructability: Items such as member sizes/handling/fabrication, maintenance of traffic, construction staging, equipment requirements, etc. should be considered.
- b) Transportation: Special evaluation shall be made to insure against potential problems that may occur in obtaining permits and equipment to transport long and/or heavy members from point of manufacture to the project site.
- c) Maintenance: Considerations for future maintenance inspection shall be taken into account in the structure's design. Such considerations may include the need for 6 feet minimum headroom inside steel or concrete box girder superstructures.

2.10 Quantities

2.10.1 Quantities on General Notes

For Lump Superstructure Pay Items on the General Notes sheet, present the quantities in the brackets as shown in the following examples:

- LUMP SUPERSTR CONC, CLASS AA - BR NO 1 (465)
- LUMP STR STEEL - BR NO 1 (1465450)
- LUMP SUPERSTR REINF STEEL - BR NO 1 (265430)

All quantities shall be shown as whole number. Do not include decimals or commas.

Piling quantities shall be rounded up to the next even 5 feet.

2.10.2 Quantities on Detail Sheets

All superstructure quantities shall be itemized on the superstructure detail sheet as shown in Table 2.10.2-1. Do not include a TOTAL column in this table unless all of the spans in the bridge are shown in the table and the total includes all of the spans in the bridge. All substructure quantities shall be itemized on the substructure detail sheet as shown in Table 2.10.2-2. Show concrete quantities to one decimal place. Reinforcing steel and structural steel quantities should be integers.

Table 2.10.2-1 Superstructure Quantity Table

SUPERSTRUCTURE QUANTITIES				
ITEM	SPAN 1	SPAN 2	SPAN 3	TOTAL
LUMP – CY SUPERSTR CONCRETE, CLASS D	159.9	145.5	159.9	465.3
LUMP – LB SUPERSTR REINF STEEL	89,316	86,798	89,316	265,430
LUMP – STRUCTURAL STEEL	490,009	485,432	490,009	1,465,450

Table 2.10.2-2 Substructure Quantity Table

SUBSTRUCTURE QUANTITIES		
ITEM	BENT 2	BENT 3
CY CLASS AA CONCRETE	77.1	81.6
LB BAR REINF STEEL	15,642	16,552

2.10.3 Quantities for Staged Construction and Continuous Units

Bar schedules for continuous span units supported by structural steel shall be tabulated by pour. In this case, the quantity on the superstructure detail sheet shall be shown by continuous unit. Bar schedules for stage constructed bridges shall be tabulated by stage. In the case of stage constructed simple spans, the quantity on the superstructure detail sheet shall be shown by span. When a continuous span unit is stage constructed, the bar schedule shall be tabulated by pour and stage, i.e. Pour 1, Stage 1; Pour 1, Stage 2; etc.

Appendix 2A - Hydraulic Engineering Field Report

I. HYDRAULIC AND HYDROLOGICAL DATA REQUIRED FOR ALL EXISTING OR PROPOSED BRIDGE STREAM CROSSING PROJECTS

A. Project Location

District _____ County _____ Project No. _____
 P.I. No. _____ Route _____ Stream Name _____
 Surveyed By _____ Date _____

B. Site Information

Floodplain and Stream Channel description:

1. Flat, rolling, mountainous, etc. _____
2. Wooded, heavily vegetated, pasture, swampy, etc. _____

3. Stream channel description: well-defined banks, meandering, debris, etc.

4. Is there any fill in the upstream or downstream floodplain, which will affect the natural drainage or limit the floodplain width at this site? _____

C. Required Existing Bridge Information at Project Site

Bridge Identification No. _____
 Date Built _____
 Skew angle of bridge bents _____

Substructure Information:

Column type (concrete, steel, etc.) _____
 Size of column _____
 Number of columns per bent _____
 Height of curb, parapet or barrier _____
 Guide Bank (Spur Dike) length, elevation and location (if applicable) _____

Note any scour problems at intermediate bents or abutments: _____

D. Normal Water Surface Data

WS ELEV

500 feet upstream of the survey centerline _____
 At the survey centerline _____
 500 feet downstream of the survey centerline _____
 Normal high tide _____
 Normal low tide _____

E. Historical Flood Data

Extreme high water elevation at site _____ Date _____
 Highest observed tide elevation _____ Date _____
 Location where extreme high water elevation was taken (upstream or downstream face of bridge, distance upstream or downstream, centerline)
 Source of high water information _____

Location and floor elevation of any houses/buildings/structures that have been flooded.

Information about flood (number of times house/building/structure has been flooded, water surface elevation(s) and date(s) of flood _____

Location and floor elevation of any houses/buildings/structures that have floor elevations within 2 feet of the extreme high water elevation _____

F. Benchmark Information

Benchmark number _____
 Location (InRoads pt. no. or project station/offset) _____
 Physical description _____

Benchmark number _____
 Location (InRoads pt. no. or project station/offset) _____
 Physical description _____

Benchmark number _____

Location (InRoads pt. no. or project station/offset) _____

Physical description _____

G. UPSTREAM AND DOWNSTREAM STRUCTURES

Structure type (railroad or highway bridge, culvert) _____

Route number (if applicable) _____

Distance from proposed structure _____

Length of bridge or culvert size _____

Substructure information: _____

Column type (concrete, steel, etc.) _____

Size of column _____

Number of columns per bent _____

Note: The above information is required for all bridges or culverts, which lie between 2000 ft. and 1 mile upstream or downstream of the project bridge.

H. MISCELLANEOUS INFORMATION

Are there water surfaces affected by other factors (high water from other streams, reservoirs, etc.)? _____

Give location, length, width, and elevation of dam and spillway, if applicable _____

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Chapter 3. Superstructure

3.1 General Design Considerations

3.1.1 Minimum Number of Beams

For bridges that will carry vehicular traffic, provide a minimum of 4 beams in each span. When multi-stem girders are used, a minimum of 3 units shall be provided.

3.1.2 Connections

Each connection between the superstructure and substructure shall be indicated on the Plan and Elevation sheet as fixed (FIX) or expansion (EXP).

At least one bent cap to superstructure connection within a continuous deck unit (between expansion joints) shall be “fixed” to prevent any differential longitudinal movement between the superstructure and substructure. This fixed condition should be achieved by the dowel bars/anchor bolts connecting the superstructure and substructure through the bearing holes.

All other substructure/superstructure interfaces shall be “expansion” to allow for thermal movement and/or shrinkage of the superstructure. At these expansion connections, slotted holes or chase in the beam should be provided for free longitudinal movement of the superstructure.

For PSC beams a 1 ½” smooth dowel (ASTM A709 Grade 50) shall be grouted into the substructure cap to provide connection. Similarly, a No. 10 reinforcing bar shall be used as a dowel for RCDG connection. These dowels shall be sized to ensure 2” nominal vertical clearance between top of pin and recess in the girder.

3.1.3 Use of Chemical Anchors

The use of epoxy in structural connections is generally prohibited by the Department. However, epoxy use is acceptable for the installation of bridge joints and sidewalk dowel bars. It is also appropriate for use on staged construction joints as defined by the “EPOXY RESIN ADHESIVE” general note.

3.2 Deck Design

3.2.1 Materials

3.2.1.1 Concrete

For LRFD projects, use Class D concrete, as specified in Special Provision 500 – Concrete Structures, which has a 28-day design strength of 4.0 ksi as required by LRFD 5.4.2.1.

For Standard Specification projects, use Class AA concrete that has a 28-day design strength of 3.5 ksi.

3.2.1.2 Reinforcement

Use Grade 60 reinforcement.

3.2.1.3 PSC Deck Panels

PSC deck panels are no longer used and should not be accommodated in the bridge design.

3.2.2 Interior Slab

3.2.2.1 Standard Specification Projects

For simplicity and consistency, use the required slab charts located in Appendix C3 (output from GDOT program, BRSLAB07). When using the slab charts, the effective span length is measured between the stem faces for T-beams, the top flange edges for AASHTO Types I-IV beams and the top flange quarter points for steel beams, AASHTO Type V beams, and Bulb Tee beams. The slab charts use a continuity factor of 0.8 that assumes the slab is continuous over 3 or more supports.

For top concrete cover of slab, see Table 3.2.2.2-1 Slab Thickness and Concrete Cover.

3.2.2.2 LRFD Projects

3.2.2.2.1 Design Method

Use the Traditional Design (LRFD 9.7.3) utilizing the approximate method of analysis (LRFD 4.6.2.1.1), also known as the equivalent strip method, to design reinforced concrete slabs.

Use Class 2 exposure condition for LRFD equation 5.7.3.4-1.

The GDOT Bridge Office slab design program, RCSlab(2014-05-01).xmcd, is available on the Department’s website for download as a zip file.

Empirical Design (LRFD 9.7.2) will not be allowed for deck designs on bridges in the state of Georgia.

3.2.2.2.2 Loads

Use a future paving allowance of .030 ksf on all bridges.

3.2.2.2.3 Minimum Slab Thickness and Concrete Covers

Use Table 3.2.2.2-1 to determine the minimum slab thickness, the top concrete cover and the grinding/wearing thickness. Top cover includes grinding/wearing thickness.

Table 3.2.2.2-1 Slab Thickness and Concrete Cover

Case No.	Bridge Location	Minimum Deck Thickness	Top Cover	Grinding/Wearing Thickness
1	Below Fall Line* County Road with ADT<2000	7 ½"	2"	0"
2	Below Fall Line* All Other Routes	7 ¾"	2 ¼"	¼"
3	Above Fall Line* County Road with ADT<2000	8"	2 ½"	0"
4	Above Fall Line* All Other Routes	8 ¼"	2 ¾"	¼"

* See Appendix 3A for location of Fall Line.

Use 1" for the bottom cover on all deck slabs.

3.2.2.3 Detailing

3.2.2.3.1 Main Reinforcements

Place # 5 bars transversely in the top and bottom of the deck as main reinforcement. The maximum spacing allowed for these bars is 9". The minimum spacing is 5" to aid in the placement of the deck concrete.

For LRFD projects, detail the top and bottom main reinforcement at different spacings, as necessary.

3.2.2.3.2 Distribution Reinforcements

For LRFD projects, use #4 bars set longitudinally above the bottom main bars as distribution reinforcement. Place these bars at equal spaces in each bay with 3" offsets from the centerlines of beams.

For Standard Specification projects, use the middle half and outer-quarter information from the slab chart.

Use # 4 bars set longitudinally below the top main bars for temperature/shrinkage control. Place one bar over the centerline of each beam and then place additional bars at equal spaces between the beams and to the edges of the deck with a maximum spacing of 18".

3.2.2.3.3 Continuous Deck Reinforcement

In simple span bridges with decks made continuous at intermediate bents, provide #6 bars across the bent in the top mat of the deck. Place two #6 bars between each #4 bars. Only these #6 bars should be continuous through the construction joint at the bent. The length of these bars should be 10'-0" total, 5'-0" on each side of the bent. The #4 bars should end 2" from the construction joint.

3.2.2.3.4 Maximum Reinforcement Lengths

A single bar of reinforcement shall not exceed 60 feet in length. When a rebar in the deck exceeds 60 feet, use a lap splice in accordance with LRFD 5.11.5.3.1 or Standard Specification 8.32.3, as appropriate. Provide detailing and notes on the plans that correspond with the lap splice class selected.

3.2.2.3.5 Additional Reinforcement in Acute Corners

Provide 5 - #5 bars in a fan arrangement in the top of the deck just below the top mat in acute corners when the enclosed angle is 75 degrees or less. These bars, typically 5 to 10 feet long, are required at the following locations:

- Intermediate bents in simple span bridges
- Ends of continuous span units
- Construction joints in continuous span units
- Temporary acute corners adjacent to staged construction joints

The designer should ensure that these bars are shown at the corners and placed adjacent to the edges of the slab in the plans.

3.2.2.3.6 Placement of Transverse Reinforcement

On bridges with skew angles less than 85 degrees, place the transverse reinforcement normal to the centerline of the bridge then clip and bend near the joints. However on bridges with skew angles greater than or equal to 85 degrees, the transverse reinforcement can be placed parallel to the joints to avoid clipping.

For quantity calculations, detail the clipped bars as continuous across the joint, ignoring the increased length from clipping and bending.

3.2.3 Overhang Slab

3.2.3.1 Standard Specification Projects

Design the overhang in accordance with the AASHTO Standard Specifications.

The top cover of the overhang shall match the top cover for the interior slab. The overhang thickness shall not be less than the thickness of the interior slab.

3.2.3.2 LRFD Projects

3.2.3.2.1 Design Method

The overhang design shall be evaluated for Design Case 1 and Design Case 3 as defined in LRFD A13.4. Design Case 1 requires the designer to perform the barrier design in accordance with LRFD A13.2 and A13.3 in advance to determine the horizontal vehicular impact load transfer into the overhang. See Section 3.3.2 for barrier design.

3.2.3.2.2 Loads

Use the load transfer variables for standard GDOT barrier and parapet sections, as presented in Table. For barriers not shown in the table, use LRFD A13.2 and A13.3 to verify the barrier design and to determine the necessary parameters for overhang design.

3.2.3.2.3 Slab Thickness Limits and Concrete Cover

The minimum thickness of the overhang slab shall be the greater of:

- 8" (LRFD 13.7.3.1.2)
- the thickness of the interior slab

The overhang slab thickness should not be more than 1" thicker than the interior slab thickness.

The top cover of the overhang shall match the top cover for the interior slab.

3.2.3.3 Detailing

3.2.3.3.1 Cut-off Length for Additional Overhang Reinforcement

Extend additional overhang reinforcement steel (#4 or # 5 bars) 3'-0" beyond the centerline of the exterior beam.

3.2.3.3.2 Overhang Width

Slab overhangs shall extend a minimum of 6" beyond the exterior beam flange to provide room for the typical drip notch detail.

Maximum overhang width shall be the lesser of:

- 4'-7 1/2"
- 50% of the beam spacing

3.2.4 Epoxy Coated Reinforcement

Use epoxy coated bars for the following bridges located north of the fall line (see the map in Appendix 3A):

- Mainline interstate bridges
- Post-tensioned concrete box girder bridges
- Interstate ramp bridges
- Bridges over the interstate with direct interstate access

Epoxy coated bars in these structures shall be used in the top mat of the deck, the entirety of the barrier/parapet and endposts, and anywhere else where reinforcements have less than 4" cover from a surface facing traffic. Epoxy coated bars are not required in sidewalks and medians.

3.2.5 Grooving

All bridge decks will be grooved to within one foot of the barrier or curb face, as specified in Section 500 of the GDOT Standard Specifications. Grooving is a pay item. Grooving is not required under medians or sidewalks.

3.2.6 Overlays

When it is necessary to overlay a cast-in-place concrete deck, use a Portland Cement concrete overlay. The minimum thickness should be 2" and this should be shown on the Plans. If the overlay covers only part of the deck and the remaining part of the deck is grooved, the overlay should be grooved. Coordination with the Project Manager will be necessary to ensure that the approach slab elevations match the bridge deck.

Place a mat of #4 bars at 18 inches each way in the top of an overlay with thickness of 6 inches or greater to control cracking due to temperature effects. Measure the overlay thickness from the top of the existing deck reinforcing. Provide the same cover on the overlay steel as for deck steel (See Section 3.2.2.2.3).

3.2.7 Ride Quality

There is a discrepancy between GDOT Standard Specifications and the Bridge Office policy on bridges subject to profilograph testing. GDOT Standard Specification 500.3.06.E requires profilograph testing on the following bridges:

- 4 or more lane bridges on state routes

- 2 lane bridges on state routes with 2000 or more ADT in current year

Bridge Office policy requires profilograph testing on the following bridges:

- All bridges on state routes
- All bridges with 2000 or more ADT in design year

Therefore, the following general note shall be placed on the plans for bridges that are included in the Bridge Office requirements but not in the GDOT Standard Specifications requirements.

RIDING QUALITY - THE FINISHED BRIDGE DECK AND APPROACH SLABS SHALL MEET THE RIDE QUALITY REQUIREMENTS AS SPECIFIED IN SUB-SECTION 500.3.06.E OF THE GEORGIA DOT SPECIFICATIONS FOR STATE ROUTES WITH FOUR LANES OR MORE.

3.2.8 Deck Cross Slope

The cross-slope of the deck should match the roadway plans. Typically the cross-slope is 2% on a normal crown, but is sometimes shown as ¼ inch per foot.

3.3 Barriers, Railings, Sidewalks and Medians

3.3.1 Materials

3.3.1.1 Concrete

For LRFD projects, use Class D concrete that has a 28-day specified design strength of 4.0 ksi in accordance with LRFD 5.4.2.1. See Special Provision 500 – Concrete Structures.

For Standard Specification projects, use Class AA concrete that has a 28-day design strength of 3.5 ksi.

3.3.1.2 Reinforcement

Use Grade 60 reinforcement.

3.3.2 Barriers

3.3.2.1 Design Method

3.3.2.1.1 Standard Specification Projects

Design barriers in accordance with the AASHTO Standard Specifications.

Barrier stirrups are typically detailed at every other main transverse deck bar; however, the spacing shall not exceed 12".

3.3.2.1.2 LRFD Projects

Barriers shall be designed in accordance with LRFD A13.2 and A13.3. The LRFD barrier design data for some GDOT standard barriers is presented in Table 3.3.2.1-1.

Table 3.3.2.1-1 GDOT Standard Barrier

Barrier	GDOT “New Jersey” Barrier	S-Type Barrier	2’-3” Parapet with handrail *	2’-10” Parapet with fence *
f'_c (28-day concrete strength)	4000 psi	4000 psi	4000 psi	4000 psi
Test Level	TL-4	TL-4	TL-4	TL-4
F_t	54.0 kips	54.0 kips	54.0 kips	54.0 kips
L_t	3.5 ft.	3.5 ft.	3.5 ft.	3.5 ft.
Typical Stirrup Spacing	# 5 at 9”	# 5 at 11”	# 5 at 12”	# 5 at 10”
Design M_c at Base	19.67 kip-ft. / ft.	25.38 kip-ft. / ft.	16.21 kip-ft. / ft.	19.37 kip-ft. / ft.
Design L_c	7.51 ft.	9.91 ft.	9.51 ft.	10.39 ft.
Design R_w	94.73 kips	110.99 kips	105.73 kips	115.08 kips

* Numbers based on assumed 5’-6” sidewalk with 1% cross-slope and normal crown on deck.

3.3.2.2 Applications

3.3.2.2.1 Bridges with sidewalks

Bridges with sidewalks shall include a parapet adjacent to the sidewalk. The minimum pedestrian rail height of 3’-6”, measured from the top of sidewalk in accordance with LRFD 13.8 and 13.9 can be achieved by installing a handrail or a chain link fence on top of the parapet. Chain link fence details can be found in the GDOT Bridge Cell Library.

Use a 2’-10” high parapet and a chain link fence for bridges in an urban area (Metro Atlanta, Macon, Columbus, Savannah and Augusta) over an interstate or other limited access highway, for all bridges over railroads or as directed by the Bridge Office. See Section 3.3.5 for fence details.

Use a 2’-3” parapet and one pipe aluminum handrail (Georgia Standard 3626) for all other bridges. See Section 3.3.4 for handrail details.

These details are also used when a bicycle route is present, whether the bike traffic is on the road or on the sidewalk.

3.3.2.2.2 Bridges without sidewalks

When a bicycle route is present, provide a 3’-6” high S-type concrete barrier adjacent to the bicycle travelway. This replaces the previously used bike rail detail that consists of a widened New Jersey barrier with a pipe rail on top.

When a bicycle route is not present, provide a 2’-8” high New Jersey concrete barrier. However, if the roadway section uses a different barrier shape, the designer should match the roadway barrier.

If the bridge is over an interstate highway in Atlanta, provide a barrier with a minimum top width of 13" and install a curved chain link fence, measuring 8'-6" from the slab to the top of fence for New Jersey barriers or 8'-4" from the slab to the top of fence for S-type barriers. Coordinate with the Bridge Office if this situation exists. If the top width is widened, the barrier must be designed in accordance with LRFD A13.2 and A13.3 in lieu of the values in Table 3.3.2.1-1.

If the bridge is over a railroad, provide a barrier with a minimum top width of 13" and install a curved chain link fence, measuring 8'-6" from the slab to the top of fence for New Jersey barriers or 8'-4" from the slab to the top of fence for S-type barriers. If the top width is widened, the barrier must be designed in accordance with LRFD A13.2 and A13.3 in lieu of the values in Table 3.3.2.1-1.

3.3.2.2.3 Architectural rails

In historic areas, an architectural rail may be required. Texas C411 rail and Kansas Corral rail are typical architectural rails used in Georgia. The Texas C411 rail may be used when sidewalks are present and the speed limit is 45 mph or less. The Kansas Corral rail may be used for speed limits up to 55 mph. Do not use Kansas Corral rail adjacent to sidewalks or with bicycle routes. Because of the expense of these rails, use them only with permission of the Bridge Office.

3.3.2.3 Detailing

3.3.2.3.1 End Posts

When the end post is on the superstructure, details for the reinforcement need not be shown, but the weight of the bar reinforcement must be included in the lump sum superstructure bar reinforcement quantity. The concrete for an end post on the bridge superstructure shall be included in the lump sum superstructure concrete quantity.

When the end post is an integral part of the substructure, detail the reinforcement in the bar reinforcement schedule and include the weight of the reinforcement in the quantity for the substructure element. Include the concrete in the quantity for the substructure element as well.

On the superstructure or substructure details, as appropriate, refer to Georgia Standard 3054. Also, specify the length, width and height of the end post under "Bridge Consists Of" on the General Notes sheet.

When the end post is on the superstructure and the end bent is skewed, the end post must be lengthened to extend beyond the limit of the paving rest. If the length of the end post exceeds 6'-6", additional P701 and P401 bars should be added so that the spacing of these bars does not exceed 12". In this case, include the Standard Plan Modification (Endpost) note on the General Notes sheet using the BridgeNotes program.

3.3.2.3.2 Expansion Joints in Barriers

Expansion joints shall be placed in parapets and barriers at all deck joints including construction joints, dummy joints and expansion joints. Additional expansion joints shall be added to maintain a maximum spacing of 20 feet and a minimum spacing of 10 feet.

3.3.2.3.3 Barrier Width Modifications

The top dimension should be changed to 13" when necessary to accommodate a fence, railing or glare screen.

3.3.3 Sidewalks and Medians

3.3.3.1 General Requirements

Sidewalks shall be used on all bridges where the approaching roadway section has curb and gutter. Except for special cases, all sidewalks shall be 5'-6" wide, measured from the gutter line to the inside face of the parapet. This accommodates a 5'-0" roadway sidewalk and incorporates a 6" curb. Special cases could include sidewalks where there is an excessive amount of pedestrian traffic or sidewalks where bicycle traffic is allowed on the sidewalk. The designer shall receive approval from the GDOT Project Manager before proceeding with design of a sidewalk that is wider than 5'-6".

3.3.3.2 Cross-slope

Sidewalks shall be sloped towards traffic at 1% cross-slope. However, on the high side of a superelevated bridge, the designer may need to increase the cross-slope on the sidewalk to provide a minimum sidewalk thickness of 3½" at the face of the parapet.

3.3.3.3 Detailing

3.3.3.3.1 Joints

Construction joints shall be provided in sidewalks and medians at deck construction joints and dummy joints. Expansion joints shall be provided in sidewalks and medians at deck expansion joints.

3.3.3.3.2 Removable Sidewalk and Median Details

All sidewalks and raised medians shall be detailed as removable.

3.3.4 Handrailing

3.3.4.1 Aluminum Handrail Post Spacing

Post spacing for aluminum handrail shall comply with Georgia Standards 3626 (one pipe aluminum handrail) or 3632 (two pipe aluminum handrail). Georgia Standard 3632 railing is rarely used, and only with permission of the Bridge Office. While satisfying the post spacing requirements on the Standards, the following characteristics are desirable:

- a) Other than end spaces adjacent to the "Y" segment (see Standards), the maximum change from one space to the next should be 1'-0".
- b) End spaces adjacent to the "Y" segment should be approximately one-half of the length of the first full space.
- c) The minimum post spacing for full spaces should be 6'-0".
- d) The "Y" segment should be between 0'-9" and 2'-3".

Arrange the post spacing and the parapet joint spacing at the same time, rather than selecting the parapet joint spacing and then trying to fit the post spacing to it. Sidewalk joints have no effect on the post spacing.

3.3.4.2 Modification of Existing Aluminum Handrail

When preparing plans for an existing bridge with aluminum handrail that is to remain, the handrail shall be modified to achieve the following essential elements of the current Standards:

- a) The railing should be anchored to the endpost.
- b) The spacing of the posts in the first two spaces adjacent to the endpost should not exceed 4'-0".

Details for handrail modifications shall be included in the plans.

3.3.5 Chain Link Fence

Chain link fence on bridge parapets/barriers shall be galvanized fence fabric with 2" square openings. Galvanized fence post locations shall be shown on the plans with a maximum spacing of 10'-0" and a minimum spacing of 7'-0". No post shall be placed with its center within 1'-0" of a parapet/barrier joint. Epoxy coated chain link fence is not allowed.

3.3.6 Temporary Bridge Barrier

Temporary barriers are required on projects with staged construction. Temporary barriers will be designated as Method 1 or Method 2 for payment. Method 1 shall be used when there is 6'-0" or more distance from the centerline of the temporary barrier to an unprotected edge of the deck. Method 2 shall be used when this distance is less than 6'-0". A special provision is required for either method since the GDOT Standard Specifications are not updated for the current temporary barriers. Use a 2'-6" wide barrier in examining staging options.

When preparing bridge plans where temporary barrier is to be used, the following procedure shall be followed:

- a) Estimate the quantity needed. Refer to Georgia Standard 4960 for allowable taper rates.
- b) Request that the roadway designer include that quantity in the roadway plans and quantities.
- c) In the event that quantities cannot be shown on the roadway plans, the quantity required should be shown in the Bridge Plans Summary of Quantities under Pay Item 620-0100 Temp Barrier Method No 1 or Pay Item 620-0200 Temp Barrier Method No 2.

3.3.6.1 Method 1

This method requires the contractor to provide, use, relocate and remove the temporary barrier according to the plans and in accordance with GDOT Standard Specification 620. The barrier remains the property of the contractor.

When using Method 1 be sure to add the following note to the General Notes:

"TEMPORARY BARRIERS, METHOD 1 – PLACE TEMPORARY BARRIERS AS SHOWN ON THE PLANS AND GEORGIA STANDARD NO. 4960 TO PROVIDE FOR TWO 12'-0"

TRAFFIC LANES. SUPPLY AND USE THE BARRIER IN ACCORDANCE WITH SECTION 620 OF THE GEORGIA DOT SPECIFICATIONS.”**3.3.6.2 Method 2**

This method requires the contractor to furnish barrier that is certified to meet NCHRP 350 standards for impact testing. This method includes positive connectivity of the barrier to the deck, which typically involves anchoring the barrier to the deck using through bolts. Therefore, locate the traffic face of the barrier at least 9 inches from the edge of the beam flange. Also locate the barrier so the outside barrier face is at least 9 inches from the temporary edge of deck. This should be identified early in the design since it could affect staging or beam spacing.

This method also requires the contractor to use, relocate and remove the temporary barrier according to the plans and in accordance with GDOT Standard Specification 620. The barrier remains the property of the contractor.

When using Method 2 be sure to add the following note to the General Notes:

“TEMPORARY BARRIERS, METHOD 2 – PLACE TEMPORARY BARRIERS AS SHOWN ON THE PLANS AND GEORGIA STANDARD NO. 4960 TO PROVIDE FOR TWO 12’-0” TRAFFIC LANES. SUPPLY AND USE THE BARRIER IN ACCORDANCE WITH SECTION 620 OF THE GEORGIA DOT SPECIFICATIONS.”

3.4 Prestressed Concrete (PSC) Beams

3.4.1 Materials**3.4.1.1 Concrete****3.4.1.1.1 Concrete Final Strength (Design Strength = $f'c$)**

The minimum 28-day concrete strength for PSC beams is 5.0 ksi. The maximum 28-day concrete strength for PSC beams is 10.0 ksi.

Concrete strengths of 9.0 ksi and above require a High Performance Concrete special provision..

Final concrete strengths shall be specified in 0.5 ksi increments.

3.4.1.1.2 Concrete Release Strength (Initial Strength = $f'ci$)

The minimum concrete release strength for PSC beams is 4.5 ksi.

The concrete release strength should be limited to 7.5 ksi to facilitate typical fabrication schedules. However, PSC beams using final design strengths over 8.0 ksi may require higher release strengths.

Release strengths shall be specified in 0.1 ksi increments.

3.4.1.1.3 Concrete Stress Limits

For LRFD projects, concrete stress limits in PSC beams shall be calculated in accordance with LRFD 5.9.4 and are summarized in Table 3.4.1.1.3-1.

For Standard Specification projects, concrete stress limits in PSC beams shall be calculated in

accordance with Standard Specification 9.15.2 and are summarized in Table 3.4.1.1.3-2.

Table 3.4.1.1.3-1 Concrete Stress Limits for PSC Beams for LRFD Projects

Stress/Limit State	LRFD Reference	Limit Stress Formula	Conditions
Initial Compression before Losses	5.9.4.1.1	$= 0.60 f'_{ci}$ (ksi)	At Release
Initial Tension before Losses	Table 5.9.4.1.2-1	$= 0.0948 \sqrt{f'_{ci}}$ (ksi) ≤ 0.200 ksi	At Release
Final Compression, Service I	Table 5.9.4.2.1-1	$= 0.45 f'_c$ (ksi) $= 0.60 f'_c$ (ksi)	Without Transient Load With Transient Load
Final Tension, Service III	Table 5.9.4.2.2-1	$= 0.19 \sqrt{f'_c}$ (ksi) $= 0.0948 \sqrt{f'_c}$ (ksi)	Normal Exposure Severe Exposure

NOTES:

- a) f'_c and f'_{ci} shall be in the units of ksi for the above equations.
- b) Severe-exposure criteria shall apply to any bridge over waterways located partially or completely within a coastal county. The coastal counties are Chatham, Bryan, Liberty, McIntosh, Glynn, and Camden. Normal-Exposure criteria shall be used for all other bridges.

Table 3.4.1.1.3-2 Concrete Stress Limits for PSC Beams for Standard Specification Projects

Stress Limit	Standard Spec. Reference	Limit Stress Formula	Conditions
Initial Compression before Losses	9.15.2.1	$= 0.60 f'_{ci}$ (psi)	At Release
Initial Tension before Losses	9.15.2.1	$= 3 \sqrt{f'_{ci}}$ (psi) ≤ 200 psi	At Release
Final Compression*	9.15.2.2	$= 0.60 f'_c$ (psi) $= 0.40 f'_c$ (psi) $= 0.40 f'_c$ (psi)	Prestress+DL+LL Prestress+DL LL+1/2 * (Prestress+DL)
Final Tension	9.15.2.2	$= 6 \sqrt{f'_c}$ (psi) $= 3 \sqrt{f'_c}$ (psi)	Normal Exposure Severe Exposure

*BRPSBM1 uses $0.4f'_c$ for all final compression stress checks. Engineer is responsible for justifying any overstress shown in the program but is within the AASHTO Specification limits presented above.

NOTES:

- a) f'_c and f'_{ci} shall be in the units of psi for the above equations.

- b) Severe-exposure criteria shall apply to any bridge over waterways located partially or completely within a coastal county. The coastal counties are Chatham, Bryan, Liberty, McIntosh, Glynn, and Camden. Normal-Exposure criteria shall be used for all other bridges.

3.4.1.1.4 Unit Weight and Elastic Modulus

- a) For LRFD projects, the unit weight of plain concrete shall be calculated according to the formula presented in LRFD 3.5.1-1 and will be used in the calculation of elastic modulus as specified in LRFD 5.4.2.4. This unit weight shall be increased by .005 kcf to account for reinforcement and strands in determining the self-weight of the beam.
- b) For Standard Specification projects, the unit weight of plain concrete shall be 145 pcf for use in the calculation of elastic modulus as specified in Standard Specification 8.7.1. This unit weight shall be increased by 5 pcf to account for reinforcement and strands in determining the self-weight of the beam.

3.4.1.2 Prestressing Strands

3.4.1.2.1 Selecting Proper Strand Type

Use 0.6-inch diameter low-relaxation strands in Bulb Tee PSC beams. 0.5-inch diameter special low-relaxation strands or 0.6-inch diameter low-relaxation strands may be used in AASHTO PSC beams.

All prestressing strands shall be the same size within any one PSC beam shape for a bridge site.

3.4.1.2.2 Strand Properties

For LRFD projects, use $E_p = 28,500$ ksi for the strand Modulus of Elasticity in accordance with LRFD 5.4.4.2.

For Standard Specification projects, use $E_p = 28,000$ ksi for the strand Modulus of Elasticity.

Data for prestressing strands for use on PSC beam sheets are shown in Table 3.4.1.2.2-1.

Table 3.4.1.2.2-1 Properties of Prestressing Strands

TYPE	DIAMETER (in.)	AREA A_{ps} (in ²)	JACKING FORCE* P_{jack} (kip)
0.5" Regular	0.5	0.153	30.983
0.5" Special	0.5	0.167	33.818
0.6"	0.6	0.217	43.943

* $P_{jack} = 0.75 A_{ps} f_{pu}$ for low-relaxation strands, where $f_{pu} = 270$ ksi

3.4.1.2.3 Strand Arrangement

Detail all straight strands in a 2-inch center-to-center grid, beginning 1" on each side of the centerline of the beam.

Put two strands per row in the web (see GDOT PSC Beam Sheets for maximum strand patterns).

Do not use straight strands in the bottom 3 rows of the beam in the two center strand lines (1" on either side of the centerline of the beam) in order to provide space for the 7-inch high dowel bar chase at each end of the beam.

3.4.1.2.4 Draped Strands

The two center strand lines may be draped to control eccentricities along the beam length. A hold down point for draping is typically located at the mid-point of the beam. However, dual hold down points may be used if a single point will not work. Raise draped strands high enough to clear the dowel bar chase at the ends of the beam. Do not place draped strands within the top 8" of a PSC beam.

Do not use draped strands in Type I Mod PSC beams.

3.4.1.2.5 Top Strands

AASHTO Type I through IV beams shall be designed with the top two strands fully stressed. The prestressing force in the top strands may be reduced only if necessary to make the beam work, not to save strands in the bottom.

AASHTO Type V beams and Bulb Tee beams may be designed with a reduced prestressing force in the four top strands of 10 kips each.

3.4.1.3 Reinforcement

Use Grade 60 for all reinforcing bars.

3.4.2 Design Method

3.4.2.1 Loads

Use a future paving allowance of 0.030 ksf on all bridges.

For LRFD projects, HL-93 vehicular live loads (LRFD 3.6.1.2.1) shall be applied in accordance with LRFD 3.6.1.3, including all applicable modifications for Dynamic Load Allowance (IM: LRFD 3.6.2), Multiple Presence Factor (m: LRFD 3.6.1.1.2) and Live Load Distribution Factors (LRFD 4.6.2.2).

Distribution factors for deflection shall be the number of whole 12-foot lanes that will fit on the bridge divided by the number of beams.

For Standard Specification projects, HS-20 vehicular live loads, lane loads and military loads shall be applied in accordance with Standard Specifications 3.7.4 and 3.7.6, including all applicable modifications for Impact (Standard Specification 3.8), Reduction in Load Intensity (Standard Specification 3.12) and Live Load Distribution Factors (Standard Specification 3.23).

Distribution factors for deflection shall be calculated by multiplying the number of whole 12-foot lanes that will fit on the bridge by 2 and dividing by the number of beams. The distribution factor should not be less than 1.

All beams must analyze without overstress in the BRPSBM1. See Section 2.8.3.1.

3.4.2.2 Transformed Section

Do not use transformed section properties for PSC beam design.

3.4.2.3 Prestress Losses

For LRFD projects, prestress losses shall be calculated in accordance with LRFD 5.9.5 but elastic gains shall be ignored.

For Standard Specifications, prestress losses shall be calculated in accordance with Standard Specification 9.16.

3.4.2.4 Shear Design

For LRFD projects, PSC beam shear design shall comply with one of the following methods:

- General Procedure using $\beta-\theta$ table as specified in LRFD 5.8.3.4.2 and LRFD Appendix B5
- General Procedure using equations as specified in LRFD 5.8.3.4.2
- Simplified Procedure as specified in LRFD 5.8.3.4.3

For Standard Specification projects, PSC beam shear design shall be performed in accordance with Standard Specification 9.20.

3.4.2.5 Anchorage Zone Reinforcement

For LRFD projects, provide the minimum amount of reinforcement at girder ends as required by LRFD 5.10.10.

For Standard Specification projects, provide the minimum amount of reinforcement at girder ends as required by Standard Specification 9.22.

3.4.2.6 Composite Section Considerations

3.4.2.6.1 Composite Slab

The thickness of the composite slab for strength calculation shall be decreased by 1/4" from plan thickness to accommodate the section loss from grooving and grinding of deck surface. However, the weight of the 1/4" shall be included in the design loads.

Commentary: Although not all decks are required to meet Ride Quality Control, grooving and the general deck smoothness requirements of GDOT Standard Specification 500.3.06.D could reduce the total deck thickness available for composite action. Therefore, removing 1/4" from the deck thickness shall be used for all cases.

3.4.2.6.2 Composite Coping

The coping thickness considered in composite section property calculations (i.e., "DF" in BRPSBM1) should be conservatively set as 0 inches. A maximum value of 1" may be used with adequate justification.

3.4.2.7 Beam Spacing

The maximum beam spacing is 9'-0".

For LRFD projects, PSC Beam Charts are provided in Appendix 3B to assist the designer in selecting preliminary PSC beam spacing.

For Standard Specification projects, PSC Beam Charts are provided in Appendix 3D to assist the designer in selecting preliminary PSC beam spacing.

3.4.2.8 Beam Lengths

The maximum beam lengths for the PSC beams are:

- 50 feet for AASHTO Type I Mod. beams
- 65 feet for AASHTO Type II beams
- 85 feet for AASHTO Type III beams
- 125 feet for 54" Bulb Tee beams
- 135 feet for 63" Bulb Tee beams
- 150 feet for 72" and 74" Bulb Tee beams

AASHTO Type II beams are preferred for span lengths between 40 to 50 feet.

3.4.3 Detailing

3.4.3.1 Concrete Clearances

All strands must be contained within stirrups. Provide 1" minimum concrete cover in PSC beams (see GDOT PSC Beam Sheets).

3.4.3.2 Fascia Beams

A fascia beam is an exterior beam that is selected for uniform appearance rather than structural efficiency. When a multi-span bridge is in a visible area and beams of different spans have different depths, a fascia beam shall be used on the exterior of the shorter spans to match the deeper beams of the longer span. Fascia beams are not required on bridges crossing water or railroads.

3.4.3.3 Cheek Walls

A cheek wall is typically a 4" thick concrete wall built up on the end of a bent cap to hide a joint in the superstructure for improving the appearance of the bridge. The cheek wall length shall extend from cap face to cap face. The gap between the face of the bottom flange of the beam and the cheek wall shall be 6" or less. In a skewed bridge, the end of the cap shall be skewed so the cheek wall can be parallel to the beam face.

3.4.3.4 Longitudinal Beam Dimensions

Do not account for vertical grades when detailing longitudinal dimensions of beams on bridge plans. Effects of vertical grades are to be included in the beam shop drawings provided by the contractor.

3.4.3.5 Additional Bulb Tee Shapes

The Bridge Office has allowed the use of 56", 65" and 74" Bulb Tee shapes. These shapes have two-inch thicker bottom flanges than the original 54", 63" and 72" Bulb Tee shapes to accommodate another row of strands. The Bridge Design [Reference](#) website has dimensions and properties for these beams. Use of these beam shapes shall be approved by the Bridge Office during preliminary design.

3.4.3.6 Stay-In-Place Deck Forms

Stay-in-place metal deck forms are used regularly and therefore the beam design shall include an additional 0.016 ksf load to account for the weight of the forms including the concrete in the corrugations.

3.4.3.7 Deflections on Beam Sheets

On the beam sheet, do not include the diaphragm weight in the non-composite deflection since that deflection will have already occurred prior to pouring the deck. Also, do not include deflection due to future paving in the composite dead-load deflection since it might never occur.

3.4.3.8 Strand Forces on Beam Sheets

Make sure that the total jacking force is the actual sum of the jacking force per strand, including the top strands that are specified on the beam sheets.

3.4.3.9 End Slots and Holes

Provide a 1.75" wide, 6" long and 7" deep slot at the expansion ends of PSC beams. Provide a 1.75" diameter, 7" deep hole at the fixed ends. Strands in the web near the bottom of the beam will conflict with these locations. Therefore, remove the 3 bottom rows of undraped strands in the web area to avoid conflict or raise draped strands high enough to clear the conflict area.

3.4.3.10 Diaphragm Holes

When diaphragms are necessary as specified in Section 3.9.1.1, provide holes for the diaphragm bars and 5" diameter block-outs for the nut and washer as shown on the GDOT PSC Beam Sheets. The designer shall ensure that the stands do not conflict with the diaphragm holes or block-outs.

Diaphragm bars shall be located to avoid interference with strands and utilities.

3.4.3.11 Beveling Top Flange

For skewed bridges, only the top flange of PSC beams shall be beveled to match the skew of the bent. See the GDOT PSC Beam Sheets.

3.4.3.12 Beam Dimensions

Detail girders to 1/16" increments and state on the plans that the lengths given are horizontal dimensions for in-place girders and that the fabricator shall adjust those lengths for grade and fabrication effects such as shrinkage and elastic shortening.

The dimensions from centerline of bent or BFPR to centerline of bearing should be calculated along the beam centerline first. The bearing-to-bearing length is calculated by subtracting these

dimensions from the span length. The beam length is calculated by adding the dimensions between centerlines of bearing and beam ends.

If the beam length contains a sixteenth of an inch, the half-length shown should be rounded to a sixteenth or an eighth of an inch.

3.4.3.13 Exterior Beam Bracing

To avoid rotations of exterior beams during deck pours, the following note shall be placed on the deck section sheet or on the general notes sheet for bridges with Type I, Type I Mod, or Fascia beams where no diaphragms are present:

The Contractor shall provide bracing between the exterior beam and the first interior beam until the deck has been poured and the overhang forms removed. All costs for designing, providing, installing and removing bracing shall be included in price bid for Lump – Superstructure Concrete.”

3.4.3.14 Bearing Pad Clearance

Provide a minimum of 2" for all PSC beams from the end of the beam to the edge of the bearing pad. This is to accommodate the chamfer at the end of the beam (up to 3/4" for AASHTO beams and 1" for Bulb Tee beams) and a 3/4" tolerance on the length of the beam.

3.4.3.15 “D” Dimension and Coping

3.4.3.15.1 “D” Dimension

The “D” dimension is the distance measured from top of slab to top of beam at the centerline of bearing and is the sum of the slab thickness, minimum coping and additional coping. The “D” dimension should be provided on the plans for the contractor’s use.

The “D” dimension should be calculated separately for exterior and interior beams in each span and rounded to the nearest 1/8 inch. For a group of “D” dimension values that are within 1/4 inch, it is acceptable to use the largest value for the entire group. However, it should be noted that this could increase concrete quantities and loads significantly on wide-flanged PSC beams.

3.4.3.15.2 Minimum Coping

Use a 3/4 inch minimum coping on AASHTO Type-I Mod, Type-II and Type-III PSC beams and 1½ inches on AASHTO Type-IV and Type-V PSC beams and Bulb Tee PSC beams to accommodate potential elevation or deflection variations during construction.

3.4.3.15.3 Additional Coping

The designer shall consider additional coping due to vertical curve, cross-slope, beam throw, beam camber and beam deflection by dead load except for future paving load.

3.4.3.15.4 Maximum Coping

Total coping (minimum plus additional) at any point along a beam centerline shall not exceed 6”. Modifying the PSC beam design or adding an additional beam to the cross-section are acceptable methods for controlling the coping.

3.4.3.15.5 Coping Reinforcement

Where coping exceeds 4 inches, provide additional reinforcement as shown in the COPING cell of the GDOT Bridge Cell Library.

3.5 Reinforced Concrete Deck Girders (RCDGs or T-BEAMS)

3.5.1 Materials

3.5.1.1 Concrete

For LRFD projects, use Class D concrete that has a 28-day specified design strength of 4.0 ksi in accordance with LRFD 5.4.2.1. See Special Provision 500 – Concrete Structures.

For Standard Specification projects, use Class AA concrete that has a 28-day design strength of 3.5 ksi.

3.5.1.2 Reinforcement

Use Grade 60 reinforcement.

3.5.2 Design Method

3.5.2.1 Loads

Use a future paving allowance of 0.030 ksf on all bridges.

For LRFD projects, HL-93 vehicular live loads (LRFD 3.6.1.2.1) shall be applied in accordance with LRFD 3.6.1.3, including all applicable modifications for Dynamic Load Allowance (IM: LRFD 3.6.2), Multiple Presence Factor (m: LRFD 3.6.1.1.2) and Live Load Distribution Factors (LRFD 4.6.2.2).

For Standard Specification projects, HS-20 vehicular live loads, lane loads and military loads shall be applied in accordance with Standard Specifications 3.7.4 and 3.7.6, including all applicable modifications for Impact (Standard Specification 3.8), Reduction in Load Intensity (Standard Specification 3.12) and Live Load Distribution Factors (Standard Specification 3.23).

3.5.2.2 Beam Spacing

The maximum beam spacing is 9'-0".

Standard beam spacing for typical bridge widths are as follows:

- a) 38-foot wide (gutter to gutter): 5 beams spaced at 8'-6"
- b) 40-foot wide (gutter to gutter): 5 beams spaced at 9'-0"
- c) 44-foot wide (gutter to gutter): 6 beams spaced at 8'-0"

3.5.2.3 Beam Depths

A standard beam depth of 2'-3" from top of deck to the bottom of beam is used on spans of 30' while 2'-9" is used on 40' spans.

3.5.3 Detailing

3.5.3.1 Diaphragms

Diaphragms will not be required on RCDG bridges with spans equal or less than 40 feet.

3.5.3.2 Bearings

There are special rules for bearing pads under RCDG (see section 3.12).

3.5.3.3 Stirrups

Use No. 4 stirrups placed perpendicular to the beam centerline along the length of the RCDG. At the end of RCDGs on skewed bridges, place 3 stirrups at varying angles to transition from perpendicular to the beam centerline to parallel to the skewed end.

3.5.3.4 "T" Dimension

"T" dimension is the distance measured from the bottom of the beam to the top of the cap at the cap faces and is used to maintain the design beam depth for the full beam length. The minimum "T" dimension is the bearing pad thickness plus an additional 1/2 inch thickness for construction tolerance. When bridge deck elevations are different from one cap face to the other, the "T" dimension on the higher side shall be the minimum plus elevation difference.

The "T" dimension is detailed to the nearest 1/8 inch on the plans.

3.6 Steel Beams

3.6.1 General

Steel superstructures are generally not preferred due to the high cost of fabrication and long-term maintenance in comparison to concrete bridges of similar span lengths. However, long span lengths or the widening of existing bridges may require the use of steel beams. The use of steel superstructures shall be approved by the Bridge Office prior to development of the preliminary layout. A higher level of scrutiny will be placed on projects in Chatham, Bryan, Liberty, McIntosh, Glynn and Camden counties due to their coastal environment.

3.6.2 Materials

Structural Steel:

- Main Members: ASTM A709, Grade 50 (Fy=50 ksi)
- Bearing Assemblies and non-structural components: ASTM A709, Grade 36 (Fy=36 ksi)

The use of Grade 70 High Performance Steel (HPS) shall be approved by the Bridge Office prior to proceeding with any design. The use of Grade 100 or higher HPS is prohibited.

The use of unpainted "weathering steel" on highway bridges is acceptable. The engineer must take measures to minimize section loss in areas exposed to wet-dry cycles and ensure staining of the structure will not detract from the aesthetics of the bridge.

3.6.3 Design Method

For LRFD projects, steel superstructure shall be designed in accordance with LRFD Section 6, Steel Structures.

For Standard Specification projects, steel superstructure shall be designed in accordance with Standard Specification Section 10, Structural Steel.

The strength contribution of negative moment reinforcement in the slab is generally ignored.

3.6.4 Fatigue

For LRFD projects, steel beams shall be designed for fatigue based on Detail Categories and Average Daily Truck Traffic in a single lane (ADTT_{SL}) in accordance with LRFD 6.6.1. The design life for the structure for fatigue calculations shall be 75 years. ADTT_{SL} shall be calculated by extrapolating the traffic data and modifying in accordance with LRFD 3.6.1.4.2, as shown in the example below.

For Standard Specification projects, steel beams shall be designed for fatigue in accordance with Standard Specification 10.58. The design life for the structure for fatigue calculations shall be 60 years. ADTT shall be calculated as shown in the example below, excluding steps 5 and 6.

GIVEN:

- ADT(2013) = 20000
- ADT(2033) = 30000
- % Trucks = 5%
- Directional = 60%
- Number of Traffic Lanes in Direction of Interest = 2

FIND: ADTT_{SL} to be used for fatigue design life of 75 years (60 years for Standard Specification)

SOLUTION:

1. $ADT(2088) = ADT(2013) + 75 / 20 \times [ADT(2033) - ADT(2013)] = 20000 + 75 / 20 \times [30000 - 20000] = 57500$
2. Average ADT in Design Life = $[ADT(2013) + ADT(2088)] / 2 = 38750$
3. ADT in Single Direction = $38750 \times 60\% = 23250$
4. ADTT in Single Direction = $23250 \times 5\% = 1162.5$
5. Fraction of Truck Traffic in Single Lane, $P = 0.85$ (LRFD 3.6.1.4.2 for 2 lanes)
6. $ADTT_{SL} = 1162.5 \times 0.85 = 988$

For LRFD projects, the fatigue limit state, either Fatigue I or Fatigue II, shall be selected based on ADTT_{SL} and the Detail Category, as specified in LRFD 6.6.1.2.3.

3.6.5 Detailing

3.6.5.1 Plate Sizing

3.6.5.1.1 Flanges:

The following plate dimension limits shall be applied:

- Minimum thickness: 3/4"
- Maximum thickness: 2" (Up to 4" with Bridge Office approval)
- Minimum width: 12"
- Maximum width: 36"

Designers should minimize the number of changes to flange dimensions along a beam to reduce the cost of labor during construction. A minimum length of flange plate is recommended to be 12 feet. It is also recommended to make changes to flange thicknesses rather than flange widths. The larger flange thickness at any transition should be limited to 1.5 times the thinner flange thickness.

Due to welding and fatigue considerations, designers should avoid a thick tension plate by decreasing beam spacing and/or increasing plate width.

3.6.5.1.2 Webs:

The following plate dimension limits shall be applied:

- Minimum thickness: 3/8"
- Maximum thickness: 1 1/4"
- Minimum height: 36"
- No maximum height (120" may be a practical limit)

Changes to web thickness are discouraged due to high cost. The designer should evaluate increasing the web thickness versus using transverse stiffeners for economy. Thickened webs are generally more economical for web depths of 72 inches and less, while stiffened webs are generally more economical for web depths greater than 72 inches.

Use of longitudinal stiffeners is prohibited.

3.6.5.2 "D" Dimension and Coping

3.6.5.2.1 D" Dimension

The "D" dimension for steel beams is the distance measured from top of slab to top of web at the centerline of bearing and is the sum of the slab thickness, top flange thickness, minimum coping and additional coping. The "D" dimension should be provided on the plans for the contractor's use.

The "D" dimension should be calculated separately for exterior and interior beams in each span and rounded to the nearest 1/8 inch. For a group of "D" dimension values that are within 1/4 inch, it is acceptable to use the largest value for the entire group. However, it should be noted that this could increase concrete quantities and loads significantly on wide-flanged beams.

3.6.5.2.2 Minimum Coping

Use a 3/8 inch minimum coping on steel beams to accommodate potential elevation or deflection variations during construction.

3.6.5.2.3 Additional Coping

The designer shall consider additional coping due to vertical curve, cross-slope, beam throw, beam camber and beam deflection by dead load except for future paving load.

3.6.5.3 Members Subject to Tensile Stresses

The following note shall be included on the General Notes sheet for steel beam or girder bridges:

“CHARPY V-NOTCH TEST - ALL W-BEAMS AND ALL COMPONENTS OF ALL PLATE GIRDERS ARE MAINLOAD CARRYING MEMBERS SUBJECT TO TENSILE STRESS AND SHALL MEET THE CHARPY V NOTCH TEST REQUIREMENTS AS SPECIFIED BY SECTION 851 OF THE GEORGIA DOT SPECIFICATIONS.”

The beam details sheets should also have a symbol (CVN) indicating which components require Charpy V-Notch testing.

3.6.5.4 Shear Connectors

Use 3/4 inch diameter end-welded studs for shear connectors. Shear connectors shall penetrate into the slab at least 2 inches, but the top of the stud head shall be 3 inches below the top of the deck. Use of the same height stud throughout the bridge is recommended. Shear studs shall not be located in negative moment regions.

When replacing the deck on existing steel beams that are non-composite, add shear connectors in pairs 18 inches apart in the positive moment regions of continuous beams and throughout simple span beams.

3.6.5.5 Stiffeners and Gusset Plates

Stiffeners shall be sized and attached to the girders in accordance with LRFD 6.10.11 or Standard Specifications 10.33.2, 10.34.4, 10.34.5 and 10.34.6, as appropriate.

Gusset plates for diaphragms shall be welded to the web, top flange and bottom flange. Web stiffeners shall be welded to the web and tight fit to the compression flange. Bearing stiffeners shall be welded to the web and milled to bear against the load bearing flange.

3.6.5.6 Beam Camber

Camber diagrams are only required for continuous spans. The following note should be included with camber diagrams:

“CAMBER ORDINATE SHOWN INCLUDES DEAD LOAD DEFLECTION DUE TO THE BEAM, SLAB, COPING, RAILING, SIDEWALK AND MEDIAN, AND INCLUDES THE VERTICAL CURVE ORDINATE.”

3.6.5.7 Splices

On long-span bridges, the designer shall consider how the beams will be transported to the project site. The maximum length of beam that may be transported on state routes is limited to

about 170 ft. The maximum legal load is 180,000 lbs., including 45,000 lbs. for the truck. Therefore, most long-span bridges will require field splices.

All field splices shall be welded with full-penetration butt welds. Bolted splices are not recommended, except for box girders.

Field splices shall be located near points of contra-flexure for dead loads.

All built-up girders shall be designed with stiffeners adjacent to the splice point. To provide room for welding, grinding and testing, stiffeners shall be located 12 inches from the splice. Studs should not be placed within 12 inches of a splice.

3.6.5.8 Fascia Girders

A fascia beam is an exterior beam that is selected for uniform appearance rather than structural efficiency. When a multi-span bridge is in a visible area and beams of different spans have different depths, a fascia beam shall be used on the exterior of the shorter spans to match the deeper beams of the longer span. Fascia beams are not required on bridges crossing water or railroads.

When fascia beams are used in short end spans, the dead load deflections may vary considerably, with the fascia beams having much less deflection than the interior beams. Construction problems may occur when these spans are poured, such as thin cover on slab steel if interior beams do not deflect as noted.

The designer shall examine if the use of equal-depth beams is economically viable. In cases where equal-depth beams are not feasible, the designer shall detail increased cover over the slab steel to ensure that adequate cover is obtained during construction.

3.6.5.9 Existing Extension Tabs and Back-Up Strips

For widening projects including structural steel members, Bridge Maintenance Unit may request that any old extension tabs and/or back-up strips be removed. The designer shall ensure that this work is included in the plans.

3.6.5.10 Cover Plates for Rolled Steel Beams

The use of cover plated members is prohibited. When widening a bridge that has cover plated members, the use of a larger member is suggested.

3.6.6 Welding

The designer shall indicate on the plans if the diaphragms and cross frames shall be welded before or after the placement of the deck. Diaphragms or cross frames that are not placed parallel to the centerline of bent shall be welded after pouring the deck.

Do not use groove welding for connection between a gusset plate and diaphragm/cross frame because of the need for back-up plates and special welding procedures. Use a bent plate for the attachment of skewed diaphragms or cross frames to the gusset plates.

In order to prevent cracks in the groove weld from developing where backing strips are discontinuous, the designer shall note that all backing strips are continuous for the length of the

weld or that any joints in the backing strip are connected by full penetration butt welds on structural steel shop drawings.

No intersecting welds will be allowed on structural steel bridge plans or shop drawings to prevent crack propagation from welds in that area. Base metal in the intersection area of welds shall be coped 4 times the thickness of the web or 2 inches, whichever is greater.

Electro-slag welding is not permitted on bridge members.

When designing for fatigue, all welds shall be classified as Category C or better as defined in LRFD 6.6.1.2.3 or Standard Specification Table 10.3.1B, as appropriate.

3.6.7 Paint

All new structural steel shall be painted with System VII regardless of the bridge location in the state. Existing structural steel outside the non-attainment areas shall be painted with System VII and existing structural steel inside non-attainment areas shall be painted with System VI. For painting of H-piles, see Section 4.4.2.3.

3.6.8 Salvage of Structural Steel

Structural steel from plate girders will not be salvaged.

When the Bridge Maintenance Unit recommends salvaging structural steel from a rolled beam continuous unit, the designer shall ensure that directions for disassembly are included with the recommendation. See Section 2.7.

In cases where existing structural steel is to be reused on the project, the following note shall be placed on the General Notes Sheet:

“EXISTING STRUCTURAL STEEL - ALL EXISTING STRUCTURAL STEEL WHICH IS DISTURBED OR DAMAGED IN ANY WAY DURING CONSTRUCTION SHALL BE STRAIGHTENED AND/OR REPAIRED UNDER THE SUPERVISION OF THE INSPECTION SECTION OF THE OFFICE OF MATERIALS, AND CLEANED AND REPAINTED PER THE GEORGIA DOT SPECIFICATIONS.”

3.6.9 Beam Corrections

When structural steel fabricators place holes at the wrong location in bridge members, the fabricators will be required to fill the misplaced holes with high-strength bolts (A-325 or A-325 weathering) tightened in accordance with the GDOT Standard Specifications.

All corrective work utilizing heat procedures to obtain acceptable tolerances pertaining to sweep and camber, or to repair damaged structural steel beams shall be documented and filed in the appropriate project file. These documents shall contain a sketch showing the locations, temperature and duration of the heat applied. The amount of sweep, camber or damage shall be documented both before and after the heat corrective work. If possible, photographs of the beams should be taken before and after all corrective work utilizing heat procedures.

3.7 Post-Tensioned Box Girders

3.7.1 General

Post-tensioned box girders shall be designed in accordance with LRFD Specification Section 5 – Concrete.

3.7.2 Dimensions

The maximum cantilever overhang beyond the exterior web shall be 9'-6". The designer shall consider providing adequate vertical and horizontal clearance for required falsework for construction.

3.7.3 Materials

3.7.3.1 Concrete

Post-tensioned concrete boxes should be designed with Class AA-1 concrete as a minimum, but Class AAA concrete may be necessary if higher 28-day strength is required.

3.7.3.2 Epoxy Coated Reinforcement

Epoxy coated reinforcing steel shall be used as specified in Section 3.2.4.

3.7.4 Use of Stay-In-Place Deck Forms

Do not use stay-in-place concrete or steel deck forms or panels for the top slab of the box girder.

3.7.5 Cell Drains

4" diameter cell drains shall be provided at the low point of all closed cell boxes.

3.7.6 Post Tensioned Ducts Detailing

Clearances, duct spacing and duct support saddles shall be fully detailed on the bridge plans as shown in Section 509, Figures 1 & 3 of the GDOT Standard Specifications, except that the clear spacing between ducts shall not be less than 1.5 inches in accordance with LRFD 5.10.3.3.2.

3.7.7 Detailing of Anchorage Blisters

The dimensions, clearances, and reinforcing steel shall be fully detailed on the bridge plans as shown in Section 509, Figure 2 of the GDOT Standard Specifications.

3.7.8 Open Grate Access Doors

Concrete box girders carrying water mains shall have open grate access doors in every bay at each end of the bridge to provide emergency water run out if the water main leaks or breaks.

3.7.9 Gas Lines on Post-Tensioned Box Girders

The designer shall not detail gas lines inside the closed cell of box girders unless specifically instructed by the Bridge Office. In this case, the designer should be aware of the following criteria and should consider accommodating them in the plans where applicable:

- a) Increase the wall thickness of the present pipe being used on bridge structures.
- b) Ensure all welded lines are completed by certified welders.
- c) Require a hydrostatic test of the pipe.
- d) Detail a 6” vent in each end cell.
- e) Detail a malleable iron test insert with replaceable rubber plug in each cell.
- f) Provide access to allow for gas leak detection, pipe inspection and repair.
- g) Verify that all lines are low pressure.

3.7.10 Segmental Construction Alternate for PT Boxes

When a segmental construction alternate is to be allowed on post-tensioned box girder bridges, the following note shall be included in the Bridge Plans:

“SEGMENTAL CONSTRUCTION – PROPOSALS FOR CONSTRUCTION BY SEGMENTAL METHODS MAY BE SUBMITTED FOR CONSIDERATION AS AN ALTERNATE TO THE METHOD SHOWN IN THE PLANS. ALL PROPOSALS SHALL INCLUDE A SET OF CONSTRUCTION DRAWINGS AND COMPLETE DESIGN CALCULATIONS. ALL PROPOSALS SHALL CONFORM TO THE LATEST AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS AND NO TENSION STRESS IN THE CONCRETE AFTER LOSSES SHALL BE ALLOWED. ALL PROPOSALS SHALL ALSO CONFORM TO THE GEORGIA DOT SPECIFICATIONS AND WILL BE SUBJECT TO APPROVAL BY THE STATE BRIDGE ENGINEER. IF APPROVED FOR USE, THE ALTERNATE SEGMENTAL CONSTRUCTION METHODS SHALL BE AT NO EXTRA COST TO THE DEPARTMENT AND WITH NO INCREASE IN CONTRACT TIME.”

3.8 Other Precast Concrete Beams

3.8.1 General

Several new precast beam types are being utilized by the Bridge Office to provide options for rapid delivery and rapid construction for select bridges in the state. These beam types are the cored slab beam, box beam and Next-F beam. Table 3.8.1-1 shows general guidance for appropriate use of these beam types.

If any of these beam type are selected, contact the Bridge Office for current standard details and drawings.

Table 3.8.1-1 Guidance For Use of New Precast Beam Types

Criteria	Bridge Type		
	Cored Slab	Box Beam	Next Beam
Span Lengths	20 ft. to 50 ft.	40 ft. to 70 ft.	40 ft. to 70 ft.
ADT	<= 3000 vpd	<= 3000 vpd	Not limited
Truck Volume	<= 100 vpd	<= 100 vpd	Not limited
Minimum Width	26’ gutter to gutter	26’ gutter to gutter	30’ gutter to gutter

Asphalt/Concrete Overlay	Use concrete for NHS	Use concrete for NHS	N/A
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3.8.2 Box Beams

Designate span lengths in 1-foot increments. Do not use more than 2 different span lengths for any single bridge location. Use the same beam depth for all spans at any single bridge location.

3.8.3 Next-F Beams

Designate span lengths in 5-foot increments. Do not use more than 2 different span lengths for any single bridge location.

3.8.4 Cored Slab Beams

Designate span lengths in 1-foot increments. Do not use more than 2 different span lengths for any single bridge location. Use the same beam depth for all spans at any single bridge location.

3.9 Diaphragms and Cross Frames

3.9.1 Concrete Girders

3.9.1.1 Diaphragm Requirements

One line of diaphragms shall be provided on or near beam mid-points for spans over 40 feet long and detailed in accordance with the GDOT Bridge Cell Library. Steel diaphragms are not preferred. Contractors may substitute steel diaphragms for bridges not over traffic or for bridges over traffic when there is minimal risk of impact by over-height loads (vertical clearance 20'-0" or greater).

3.9.1.2 Location of Diaphragms on Skewed Bridges

On skewed bridges, diaphragms shall be placed perpendicular to the beam and located so that a line through the beam mid-points crosses the diaphragm at mid-bay. This results in a beam that has two sets of diaphragm holes equally spaced on each side of the beam mid-point. In cases when the skew angle approaches 90 degrees, these diaphragm holes will be too close together to fabricate independently and the diaphragm may be cast on a skew to intersect each beam mid-point.

Show the distance from B.F.P.R. or centerline of bent to the diaphragm on the deck plan sheet or beam layout as appropriate.

3.9.2 Steel Girders

3.9.2.1 Diaphragm and Cross Frame Requirements

Diaphragms or Cross Frames for steel girder bridges shall be designed in accordance with LRFD 6.7.4 or Standard Specification 10.20, as appropriate, and detailed in accordance with the GDOT Bridge Cell Library. Where necessary, X-type cross frames are preferred.

3.9.2.2 Bracing for Exterior Steel Beams

To prevent buckling of exterior beams during deck pours, the following note shall be placed on the deck section sheet for bridges with steel beams or girders:

“The Contractor shall provide bracing between the exterior beam (girder) and the first interior beam (girder) until the deck has been poured, the overhang forms have been removed and the diaphragms (cross-frames) have been welded. All costs for designing, providing, installing and removing bracing shall be included in price bid for Lump – Structural Steel.”

3.10 Edge Beams

3.10.1 General

Edge beams shall be used at the discontinuous edges of the deck. Stirrups in the edge beam shall extend into the deck. Standard edge beam size and reinforcing can be found in the GDOT Bridge Cell Library.

When the depth of edge beam needs to be adjusted to accommodate utilities or to match an adjacent span, the designer shall ensure a minimum depth of 18 inches measured from top of beam. When utilities pass through edge beams, provide additional reinforcement (typically No. 4 bars) around the opening.

In staged construction, conflicts may occur between the existing structure and exposed edge beam reinforcement required for lapping. In this case the designer shall detail bar couplers at the stage line. Couplers are not paid for separately but require a special provision.

When the bottom of the edge beam does not extend to the bottom of web (e.g. when matching an adjacent span's edge beam) or when the bridge skew is less than 75 degrees, include the following note on the Deck Section Sheet of all multispan bridge plans:

“Do not remove edge beam forms until deck is poured and reaches 28-day concrete strength”

Detail shear stirrups in the edge beam perpendicular to the centerline of the bent.

3.10.2 Detailing for PSC Beam Bridge

PSC beams shall penetrate into the edge beam such that the centerline of the PSC beam is embedded a minimum of 4". Increase the thickness of the edge beam when necessary to achieve this requirement.

For reinforcement of an edge beam at an exterior Bulb Tee beam, add a 5-foot long horizontal No. 3 bar just below the top of the beam and a vertical No. 4 L-shaped bar along the beam centerline with the 90-degree bend over the top of the beam. See Figure 3.10.2-1 for details.

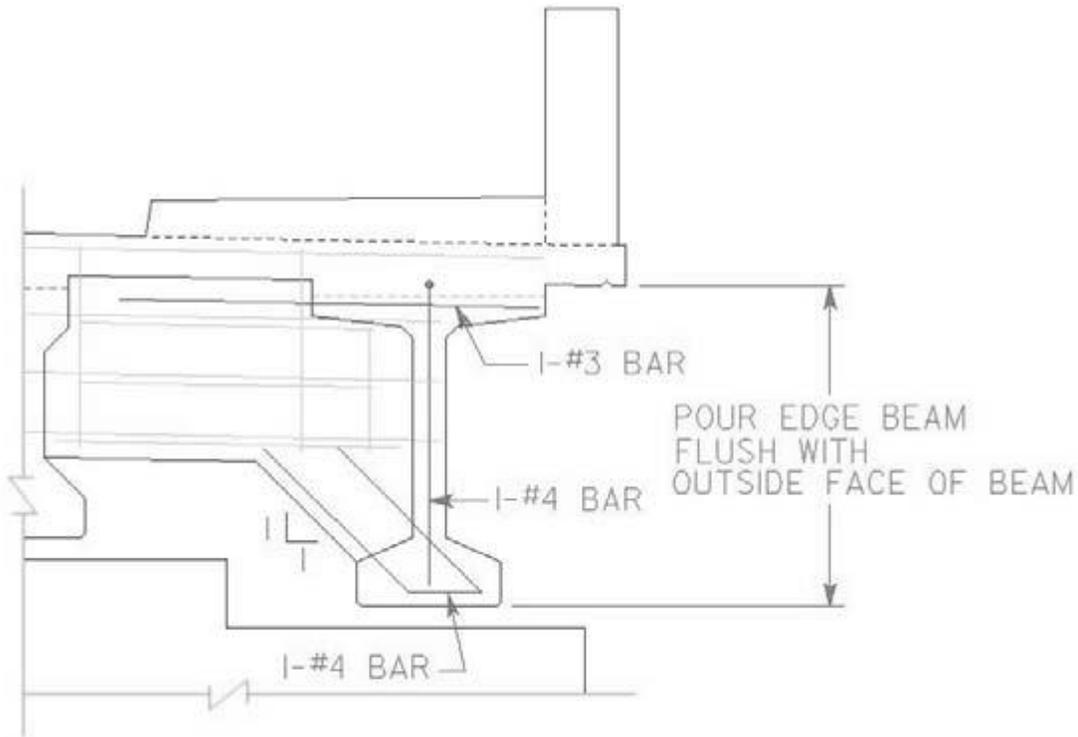


Figure 3.10.2-1 Additional Reinforcement for Edge Beam

In visible areas the designer shall ensure the edge beam is flush with the entire exterior beam face to the bottom of the beam for a smooth continuous look to the beams. In the exterior bay, detail a 1:1 sloped fillet from the bottom of the edge beam to the top of the bottom flange of the exterior beam. This allows the concrete to flow into the bottom flange area of the beam. Add a No. 4 slanted U-shaped bar along the sloped fillet into the area behind the bottom beam flange. See also Figure 3.10.2-1 for details.

3.10.3 Detailing for Steel Beam Bridge

When replacing edge beams on existing rolled steel beam/plate girder bridges that require new holes be provided in the existing beams for edge beam bars, place a note on the plans that the contractor shall drill 3" holes at each bar location.

3.10.4 Detailing for RCDG Bridge

Because RCDGs are constructed span-by-span, it may be difficult to install transverse 800 bars in the edge beam with the 600 continuity bars in place from the previous span. In this case, place the following note on the deck section sheet:

“At contractor’s option, 800 bar in edge beam may be spliced. One 5’-0” lap splice will be allowed at CL bridge. No additional payment will be made for optional splices.”

If there is a beam at the bridge centerline, modify the note above to locate the splice between beams.

When contractors replace RCDGs with precast stems/beams, the designer shall ensure that edge beams comply with the details from the GDOT Bridge Cell Library.

3.11 Endwalls

3.11.1 General

Endwalls shall be provided at end bents to retain the fill below the approach slab and between the wingwalls.

Endwall length is typically the same as the length of the end bent cap. Endwall width is typically one-half the width of the end bent cap between beams (18" minimum) and the full width of the end bent cap between the exterior beam and wingwall. PSC beams shall penetrate into the endwall such that the centerline of the PSC beam is embedded a minimum of 4".

3.11.2 Detailing

Typical endwall reinforcing is provided in the GDOT Bridge Cell Library.

Detail steel extending into the paving rest, through the fillet, or into the deck perpendicular to the centerline of the bent.

In staged construction, conflicts may occur between the existing structure and exposed endwall reinforcement required for lapping. In this case the designer shall detail bar couplers at the stage line. Couplers are not paid for separately but require a special provision.

At expansion endwalls in a skewed bridge, the end bent cap steps are typically not skewed. However, the designer should be aware that the movement of the endwall could be impeded by the cap steps in a highly skewed bridge. See Section 4.3 for end bent detailing requirements.

Two feet of waterproofing shall be placed on the joint between the endwall and cap, in accordance with GDOT Standard Specification 530. This detail is shown on the endwall cells in the GDOT Bridge Cell Library.

3.12 Bearings

3.12.1 Bearing Selection

The general preference for bearing selection is shown in Table 3.12.1-1.

Table 3.12.1-1 Bearing Selection by Bridge Type and Span

Bridge Type	Distance, d, from point of fixity to bearing	Recommended Bearings	Remarks
T-Beam and Type I-Mod beam	$d \leq 40'$	U	
	$40' < d \leq 160'$	R	For d in excess of 160' bearings typically become unstable in sliding.
Other AASHTO Type and Bulb Tee beams	$40' < d \leq 200'$	R	Limited by length of chase, seismic shear on dowel, and beam stability

Steel Beams or Plate Girders	$d \leq 50'$ $50' < d \leq 160'$ $d > 160'$	R, SB R, SBL P	
Steel Beam Widening		Match existing bearings	

Glossary:

- U: Plain elastomeric pad
- R: Steel reinforced elastomeric bearing
- SB: Plate bearings with sole and bearing plates only
- SBL: Plate bearings with sole, bearing, and lube plates at expansion ends
- P: Pot Bearing

Use of different bearings from those shown in Table 3.12.1 1 shall be approved by the Bridge Office at the start of final design phase. The Bridge Office has no standard details for reinforced elastomeric pads under steel beams.

3.12.2 Plain Elastomeric Pads and Steel Reinforced Elastomeric Bearings

3.12.2.1 Materials

3.12.2.1.1 Neoprene

Use 60 Durometer Shore A hardness neoprene, grade 2 or higher as specified in AASHTO M251, with a shear modulus between 130 psi and 200 psi.

3.12.2.1.2 Reinforced Plates (For Steel Reinforced Elastomeric Bearings)

- a) Load Plates: Use 3/16" thick load plates meeting ASTM A 709 Grade 36 or ASTM A 1011 Grade 36.
- b) Internal Plates: Use 10-gage, 12-gage or 14-gage internal plates, if necessary, meeting ASTM A 709 Grade 36 or ASTM A 1011 Grade 36.

3.12.2.2 Dimensions and Clearances

Detailing of elastomeric pads can be found on the GDOT Elastomeric Bearing sheets.

3.12.2.2.1 Basic Shape

Elastomeric pads should be rectangular and should be placed flat with the pad length parallel to the beam centerline. Length and width are incremented by whole inches and thickness is incremented by 1/8". The use of tapered pads is prohibited.

3.12.2.2.2 Width

The width of the pad shall be at least 2" narrower on each side than the nominal width of the bottom flange of AASTHO Type III and larger PSC beams and at least 1" narrower with smaller PSC beams, RCDGs and steel beams. This will allow for beam chamfers, tolerance in fabrication of the beam, and the use of a shim plates if necessary.

3.12.2.2.3 Sealing Ribs

A 3/16" sealing rib shall be used on the top and bottom of pads for precast beams and shall not be used for cast-in-place beams.

3.12.2.3 Plain Elastomeric Pad (U)

3.12.2.3.1 Application

Plain elastomeric pads shall be provided for RCDGs and Type I Mod beams where the distance from the bearing to the point of fixity is 40 feet or less. For Type I Mod beams, when the bridge is on a grade, ensure that the bottom of beam maintains a minimum 1/4 inch clearance above the top of cap for the entire width of the cap.

3.12.2.3.2 Dimensions

The pads shall be 9"x16"x 1/2" and no further analysis is required.

3.12.2.3.3 Contractor Redesign of RCDG Bridge

A note shall be placed on the bearing sheet stating that if the Contractor redesigns a RCDG bridge to use precast beams, plain elastomeric bearing pads shall remain as shown on the plans.

3.12.2.3.4 Use on Existing Bridges

When widening or paralleling a T-beam bridge, the designer shall review the existing bridge condition survey for recommendations on installing plain elastomeric pads under the existing beams. If this recommendation is agreed to by the State Bridge Engineer, then 9"x 14" x 1/2" unreinforced pads with slots to pass around the dowel bar shall be specified. Pay item 518-1000 – Raise Existing Bridge, Sta. – should be included in the Summary of Quantities to cover all costs for supplying and installing these pads. This requires a special provision.

3.12.2.4 Steel Reinforced Elastomeric Bearings (R)

3.12.2.4.1 Application

Steel Reinforced Elastomeric bearings are preferred for use with prestressed concrete beams, rolled steel beams, and RCDG bridges where the distance to point of fixity is greater than 40 feet.

3.12.2.4.1 Contractor Redesign of T-Beam Bridges

A note shall be placed on the bearing sheet stating that if the Contractor redesigns a RCDG bridge to use precast beams, the steel reinforced elastomeric bearings shall be redesigned accounting for the new loads and rotations in accordance with this section.

3.12.2.4.3 Design Method

For LRFD projects, bearing pads shall be designed in accordance with LRFD 14.7.6, Elastomeric Pads and Steel Reinforced Elastomeric Bearings – Method A.

For Standard Specification projects, bearing pads shall be designed in accordance with Standard Specification 14.6.6, Elastomeric Pads and Steel Reinforced Elastomeric Bearings – Method A, except as follows:

Thermal Movement

Bearings shall be designed for thermal movements based on temperature rise of 30° F and temperature fall of 40°F above or below nominal setting temperature. No adjustment shall be made for actual or anticipated setting temperature. By default BRPAD1 uses a 70° temperature range so the distance to fixity in that program should be reduced to 4/7 of the actual.

Combined Compression and Rotation

Bearings shall be sized such that the total rotation in the bearing as given by the sum of:

- Rotation due to superimposed dead load deflection
- Rotation due to live load deflection
- Rotation due to beam camber (self weight + prestress + time)
- Bridge grade (unless shims are used)

3.12.2.5 Detailing**3.12.2.5.1 Anchorage Holes**

A 3" diameter hole shall be provided at the center of the bearing to allow for a 1 ½" smooth dowel (ASTM A709 Grade 50) for PSC beams or No. 10 bar for RCDGs connecting the superstructure and substructure.

3.12.2.5.2 Uniform Design

In order to reduce construction errors and the number of test pads required for a project, the engineer should minimize the number of pad designs. This requirement does not relieve the engineer from performing analysis to ensure the design adequacy of each pad.

3.12.2.5.3 Shim Plates for PSC Beams and Steel Beams

If a steep longitudinal grade produces an elevation change of 1/8" or greater across the length of a pad, a galvanized steel shim plate shall be used. Steel shim plates shall have 1/4" minimum thickness on the thin edge with the thick edge detailed to the nearest 1/8" thickness. Shim plates shall be 2" larger than the pad in each plan dimension with holes fabricated to match the holes in the pad and shall be placed on top of the pad.

3.12.2.5.4 Anchor Bolts

Anchor bolts shall be stainless steel, ASTM A 276 Type 304. On bridge widening or jacking projects, any new or replacement anchor bolts shall also be stainless steel. Seismic requirements shall be applied as appropriate.

3.12.3 Pot Bearings**3.12.3.1 Application**

Pot bearings are preferred for use with steel plate girders, large rolled steel beams or box girders.

3.12.3.2 Design Method

Pot bearings are to be designed by the Contractor in accordance with AASHTO LRFD Specifications or AASHTO Standard Specifications, as appropriate. A note shall be provided requiring the Contractor to provide shop drawings for the bearings. The following note shall be provided on the substructure sheets to allow for cap elevation adjustments:

“Elevations shown for the top and bottom of the cap are based on the “X” dimension shown on the Pot Bearing Details sheet. These elevations shall be adjusted by the Contractor to account for the actual height of the pot bearing to be used. Bent cap concrete shall not be poured until the pot bearing shop drawings have been approved and necessary adjustments have been made.”

3.12.3.3 Loads

The designer shall provide the required capacity, translation and rotation for bearings on the GDOT Pot Bearing Details Sheet.

3.12.3.4 Detailing

3.12.3.4.1 Bearing Seat Elevations

Bearing seat elevations shall be calculated and provided based on the assumed height of the bearing assembly (“X” dimension) shown on the plans.

3.12.3.4.2 Elastomeric Pad under Pot Bearing

A 1/8” elastomeric pad shall be used under the bearing in lieu of the cotton duck called for in the GDOT Standard Specifications. The pad shall be 50 to 60 Durometer Shore A hardness neoprene and be 1” larger than the base plate in each plan dimension.

A note should be added to the plans that all costs for supplying and installing this elastomeric pad should be included in the price bid for Lump – Structural Steel.

3.12.3.4.3 Anchor Rods

Anchor rods shall be stainless steel, ASTM A 276 Type 304. On bridge widening or jacking projects, any new or replacement anchor bolts shall also be stainless steel. Seismic requirements shall be applied as appropriate.

3.12.4 Self Lubricating Bearings

3.12.4.1 Application

Self-lubricating bearings are preferred for use with steel plate girders and large rolled steel beams.

Limitations: Sliding plate type bearings shall not be used where the anticipated total movement (expansion plus contraction) exceeds 3 inches for assemblies without anchor bolts through the flange and 2 inches for assemblies with anchor bolts through the flange.

3.12.4.2 Materials

Bronze plates shall conform to AASHTO M 107 (ASTM B22), Alloy C91100 and shall have an allowable unit stress of 2.0 ksi in compression.

For design purposes, a value of 0.1 shall be used for the coefficient of friction.

3.12.4.3 Bronze Plate Size Selection

Use Table 3.12.4.3-1 for the sizing of self-lubricating bronze plates.

Table 3.12.4.3-1 Plate Size Selection by Load

Size (in)			Maximum Load in Service Limit States (kips)		
Length	Width	Thickness	With 2 Slots 3" x 1 ³ / ₁₆ "	With 2 Holes 1 ³ / ₁₆ " Dia.	Plain
10	7	1			140
10	8	1¼			160
10	9	1¼			180
10½	7	1			147
10½	8	1¼			168
10½	9	1¼			189
12	6	1	131	140	144
12	7	1	155	164	168
12	8	1¼	179	188	192
12	9	1¼			216

3.12.4.4 Detailing

3.12.4.4.1 Beveling Sole Plate

When the gradient of the girder at the bearing exceeds 4.0%, the top of the upper plate (sole plate) shall be beveled to match the girder gradient.

3.12.4.4.2 Anchor Bolts

Anchor bolts shall be stainless steel, ASTM A 276 Type 304. On bridge widening or jacking projects, any new or replacement anchor bolts shall also be stainless steel. Seismic requirements shall be applied as appropriate.

3.13 Deck Joints

3.13.1 Construction Joints

3.13.1.1 Pour Strips

A pour strip is a longitudinal deck segment cast between two previously cured bridge deck portions to avoid stresses caused by differential deflection. Pour strips are required in bridge widening and in stage construction with one of the following girder types:

- a) RCDG: All falsework must be removed before casting the pour strip.

- b) Continuous steel beam: If the concrete amount for widening the deck is less than 100 CY and the maximum dead load deflection is less than 1", the deck over the entire continuous unit can be placed in one pour and a pour strip is not required.
- c) Post-tensioned cast-in-place concrete box girder: The pour strip shall be placed after post-tensioning the box, removing the falsework, and waiting approximately one month to allow for creep.

When pour strips are not required, a simple construction joint can be used. Try to locate pour strips out of the wheel path of traffic to avoid inferior ride quality.

3.13.1.2 Transverse Construction Joints

A transverse construction joint is required in the deck at each bent where the deck is continuous in a simple span bridge, as well as between deck pours for a continuous steel unit. A shallow saw cut is required to control cracking at the joint. Detail "A" of the GDOT Bridge Cell Library shows this detail and shall be included on the plans as applicable.

3.13.1.3 Longitudinal Construction Joints

When a longitudinal construction joint is required for staging, place the joint along the edge of the top flange of the beam or the stem face for RCDGs, as practical. Do not place the joint within the limits of the beam top flange since water could be trapped in the joint and freeze.

3.13.2 Expansion Joints

3.13.2.1 General

The designer should minimize the number of expansion joints in a bridge deck to reduce maintenance problems such as leaking. However, expansion joints may be unavoidable on bridges longer than approximately 400 feet.

3.13.2.2 Silicone Joint Seals

A silicone joint seal is detailed on the approach slab standard (Georgia Standard 9017) to be used for the 3/4 inch joint at the end of the bridge between the bridge deck and the approach slab.

If the joint width at the end of the bridge is calculated to require more than 3/4 inch, then the bridge plans shall detail an Evazote joint to replace the silicone joint seal shown on the Standard.

3.13.2.3 Evazote Joint Seals

An Evazote joint seal is the preferred type of expansion joint for bridge decks. Evazote is the brand name for a closed-cell polyethylene seal as described in GDOT Standard Specification 449.2.D. It is preformed but can be compressed and stretched easily. It is glued in place into a clean joint between two concrete decks. No pay item is necessary for an Evazote joint seal except when it is used as a joint replacement on an existing bridge.

The size of the Evazote joint should be selected based on the expansion range at the joint. Use Equation 3.13.2.3-1 to calculate the expansion range, R.

$$R = \alpha \times L \times \Delta T$$

(3.13.2.3-1)

Where:

α = coefficient of thermal expansion = 0.000006 in/in/oF for concrete

ΔT = maximum variation in temperature = 70oF

L = summation of distances from the last fixed joint back and the next fixed joint ahead (ft)

Once R is determined, select a joint from Table 3.13.2.3-1 that has a range value equal to or greater than R. For instance, when L equals 350 feet, R equals 1.764 inches, so use the E 2.1875 joint.

Table 3.13.2.3-1 Evazote Joint Selection

Product	Opening at 68° (in)	Material width at 60% compression (in)	Material width at 30% tension (in)	Range (in)	Seal Size WxH
E 1.00	0.75	0.40	1.30	0.90	1" x 1"
E 1.25	1.00	0.50	1.63	1.13	1.25" x 2"
E 1.875	1.50	0.75	2.43	1.68	1.875" x 2"
E 2.1875	1.75	0.88	2.85	1.97	2.1875" x 2"
E 2.50	2.00	1.00	3.25	2.25	2.5" x 2"

When the expansion range exceeds 2.25 inches, the designer should use a Preformed Silicone Joint seal, as described in Section 3.13.2.5, in lieu of an Evazote joint.

Except for joints at the approach slab, the plans should show joint openings for 40, 70 and 100 degrees to allow for varying ambient temperatures at the time of joint construction. Use the 68 degree joint opening from Table 3.13.2.3-1 for the 70 degree opening. The 40 and 100 degree openings should be calculated by adjusting the 70 degree joint opening for the corresponding temperature differences. Using the same example from above, the adjustment in joint opening for 100 degree is calculated as .756 inches (350' x 0.000006 x 30oF x 12 in/ft. = .756"). Subtracting this number from the 70 degree opening yields 1 inch, as shown in Table 3.13.2.3-2.

Table 3.13.2.3-2 Example Joint Opening Table for Plans

JOINT OPENING	
TEMPERATURE (°F)	W (in)
40	2 ½
70	1 ¾
100	1

The joint at the end of the bridge is shown for an opening of 60 degrees without a temperature table. A general note must be added modifying the GDOT Approach Slab Standard and the plans should include a detail with a cross-section of the joint including opening size and the

material size. Joint sizes of up to 1.75 inches (distance to fixity of 380 feet) can be used at the end of the bridge with permission of the Bridge Office.

The designer shall use cell EXJTBT from the GDOT Bridge Cell Library and edit the seal size in the cell (seal size from Table 3.13.2.3-1) to notify the contractor of the product size to order.

3.13.2.4 Preformed Silicon Joint Seals

For joints on steel bridges and for any joint where the Evazote size would be 2 inches or greater at 70 degrees, use a preformed silicone joint. These can be sized using design criteria for the Silicoflex joint, and there is a cell available. Show opening sizes for 40, 70, and 100 degrees as with Evazote joints.

3.13.2.5 Strip Seals

A strip seal is a preformed elastomeric profile seal that can be used when expansion range exceeds the limit allowed for an Evazote joint. The designer shall use cell JENEJT from the GDOT Bridge Cell Library for detailing and pay item 449-1800 - ELASTOMERIC PROFILE BRIDGE JOINT SEALS for payment of this joint. Due to the high cost of this joint seal, it may be more economical to provide additional expansion joint locations so that Evazote joint seals can be utilized. When the expansion range exceeds 3 7/8 inches, the designer should use a modular joint system.

3.13.2.6 Modular Joint Systems

A modular joint system is a manufactured joint that can accommodate large expansion ranges. The use of a modular joint system requires Special Provision 447 – Modular Expansion Joints. A modular joint system is preferred over a finger joint because the finger joint is not “sealed” and allows water and debris into the joint area and onto the substructure.

3.13.2.7 Longitudinal Expansion Joints

Expansion joints in the longitudinal direction of the bridge should be used on bridges wider than 150 feet. Do not detail an open longitudinal joint where bicycle traffic is expected since it can catch narrow bicycle wheels.

On steel beam bridges in urban areas carrying high-volume routes where traffic will stand on the bridge, such as a bridge with traffic signals near the ends, a 1-inch longitudinal joint shall be used at the high point of the crown so that vibration caused by traffic moving on one side of the bridge will not be felt by traffic sitting on the other side.

Longitudinal joints shall not be placed in locations where water will run across the joint. The joint shall be sealed with an Evazote joint seal. Do not include a pay item for the seal.

3.14 Utilities on Bridges

3.14.1 General

3.14.1.1 Utility Information Request

When utilities are to be placed on a bridge, the designer shall request that the Office of Utilities obtain the following information from the utility companies:

- Descriptions (i.e. 10" water main, four 6-inch diameter telephone conduits)
- Owner (i.e. Early County Water System, AT&T)
- Weight of the utility per foot including contents
- Opening size required through endwalls, backwalls, edge beams and diaphragms
- Maximum diameter of the pipe bell or flanges for water and sewer mains
- Hanger spacing (actual or maximum)
- Hanger details if a particular hanger system is desired
- Location on the bridge (right side, left side)

3.14.1.2 Utility Conflicts

When a utility conflict occurs, it must be resolved by bridge design modification or by utility relocation. It is not acceptable to notify the contractor that a conflict exists by a note in the plans.

3.14.1.3 Utility Attachments

Gas lines, electrical conduits, ATMS conduits, and telecommunication conduits can be supported using cast-in-place deck inserts. Water/sewer mains up to 8 inches in diameter can be supported in the same manner. Larger water/sewer mains shall be supported by channels bolted to the adjacent beams, as shown in the GDOT Bridge Cell Library. When possible, the water/sewer main shall be placed above the support channels. These utilities should not be located in exterior bays where the supporting hardware will be visible outside the exterior beam.

Supports for water mains are usually located 2 feet on each side of a joint. Hangers should be spaced to accommodate standard 18-foot or 20-foot pipes and to avoid locating a bell at the diaphragm, edge beam, or endwall.

Water mains usually require casing under the approach slab. Casing is available in diameters of 6-inch increments and must be large enough to accommodate the water pipe bell.

3.14.1.4 Estimated Utility Weights

In lieu of more accurate weights provided by the utility company, the typical utility weights in Table 3.14.1.4-1 can be used.

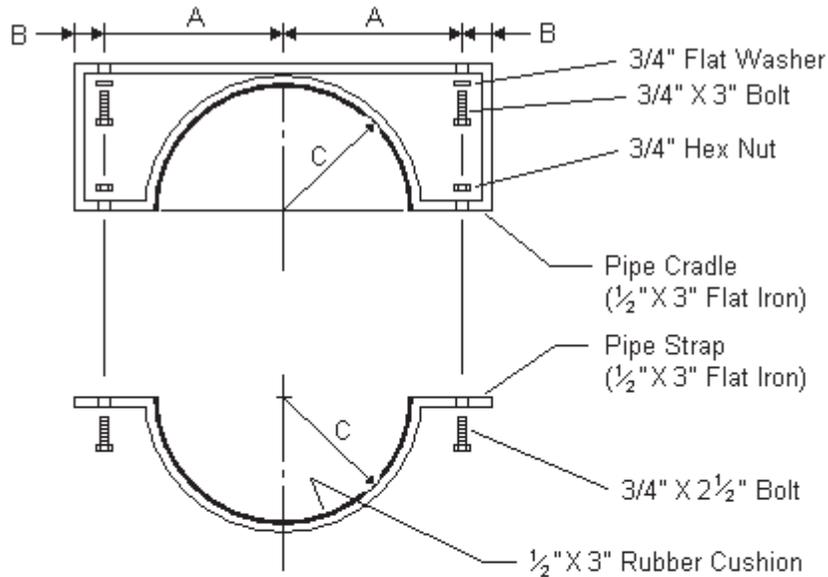
Table 3.14.1.4-1 Utility Weights (from BIMS manual)

Water/Sewer Mains		Gas Mains	
Diameter (in.)	Weight (lbs/ft)	Diameter (in.)	Weight (lbs/ft)
6"	41.0	2"	3.7
8"	60.1	4"	10.8
10"	87.1	6"	19.0
12"	118.8	8"	22.4

16"	194.4	10"	28.1
30"	472.3	12"	32.4
		16"	47.0

Weight of communication conduit can be estimated at 9 lbs/ft per duct.

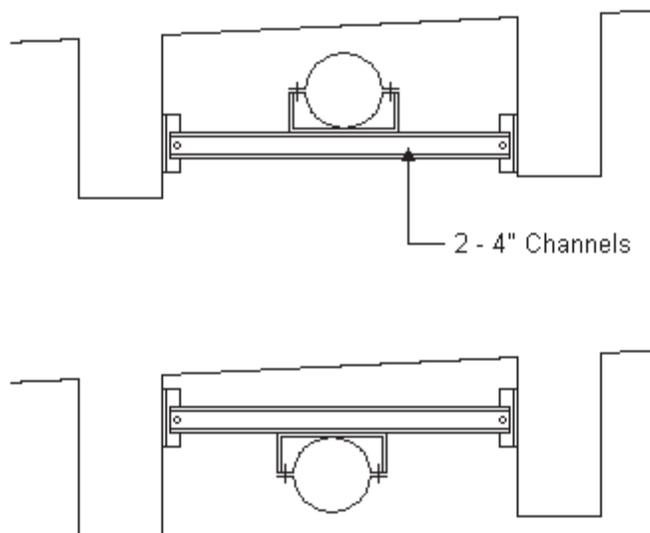
Figure 3.14.1.4-1 and Figure 3.14.1.4-2 show typical details for City of Atlanta Bureau of Water requirements.



PIPE SIZE	A	B	C RADIUS	PIPE WEIGHT PER FT. WITH WATER
8"	6.53	2.00	4.53	62 lbs
12"	8.60	2.00	6.60	119 lbs
16"	10.70	2.00	8.70	195 lbs
20"	13.00	2.00	11.00	250 lbs

Atlanta Water Works Pipe Saddle

Figure 3.14.1.4-1 Water main saddle details



Typical Details

Atlanta Water Works Pipe Saddle

Figure 3.14.1.4-2 Water main hanger details

3.14.1.5 Placement of Utilities

Utilities must be fully enclosed within a bay and must not hang below the bottom of the lowest beam.

In locating the utility and openings, the designer must ensure that conflicts with the endwall, edge beam, and diaphragms have been addressed, including possible conflicts with the diaphragm bar.

The designer must ensure there are no conflicts with cap risers on the substructure.

3.14.2 Designation of Utility Owners on Bridge Plans

All bridge plans shall have the caption, UTILITIES, added to the Preliminary Layout or General Notes sheet and list underneath the names of all owners of utilities that are located on the bridge. Do not list utilities which are in the vicinity of the bridge but are not located on the bridge.

If a future installation is proposed, the designer shall indicate this by placing “(FUTURE)” after the name of the owner. If there are no utilities, it shall be indicated by placing “NO UTILITIES ON BRIDGE” below the caption UTILITIES.

These requirements are in addition to all details, dimensions, etc., necessary to locate and support the utility on the bridge.

3.14.3 Hangers for Electrical Conduits

Hangers for electrical conduits on bridges shall be specified at a maximum spacing of 10'-0".

3.14.4 Revisions to Utilities

The designer shall send any revisions of the plans dealing with utilities through the normal revision channels and to the District Utilities Engineer. The designer shall also ensure that the utility company is made aware of the changes.

3.14.5 Gas Lines on Post-Tensioned Box Girders

See Section 3.7.9.

3.14.6 Permits for Bridge Attachments

See MOG 6850-11. Contact the Office of Utilities.

3.15 Deck Drainage

3.15.1 General

The designer shall ensure that the bridge deck will freely drain water to minimize gutter spread or ponding. This is normally accomplished by some combination of the bridge cross-slope, bridge profile and openings in either the deck or the barrier that allows the water to flow off the bridge.

For more details on deck drains and drainage, see Chapter 13 - Bridge Deck Drainage Systems of the GDOT Drainage Manual.

3.15.2 Bridge Profile

Location of the low-point of a vertical curve on a bridge or approach slab is strongly discouraged, and should only be considered when there is no feasible alternative. Before proceeding with a design that has a low point on a bridge or approach slab, the designer should consult with the roadway designer and then the Bridge Office to confirm that no other feasible option exists.

When a low-point is located on a bridge, it shall not be located within 10 feet of the BFPR or centerline of bent, and scupper spacing shall be reduced to 2'-6" within 10 feet of the low point.

If the bridge grade is less than 0.5%, the designer should consult with the roadway designer about increasing the grade to provide more efficient drainage.

3.15.3 Open Deck Drainage

3.15.3.1 Deck Drains

For bridges with a 2.0% normal crown, the designer shall detail a 4" diameter hole through the bridge deck spaced at 10 feet along the gutter line. Deck drain spacing may need to be reduced to 5 feet to assure adequate drainage on super-elevated structures. However, deck drains shall not be located within 5 feet of the BFPR or centerline of bent, over non-rip-rapped end fills, railroads, or traffic lanes.

When the top flange of the exterior beam interferes with the placement of deck drains, use a 3"x6" open slot in the bottom of the barrier in lieu of deck drains. Deck drain and barrier slot details can be found in the GDOT Bridge Cell Library.

3.15.4 Deck Drainage System

3.15.4.1 General

When drainage of the deck is required and cannot be accommodated by conventional scuppers or barrier openings, a deck drainage system is required. The deck drain system shall be made of ductile iron and/or PVC pipe Schedule 40 and consist of scuppers, drain pipes, clean-outs, and downspouts.

3.15.4.2 Bridge Deck Hydraulic Study

The Hydraulics Section of the Bridge Office will perform a bridge deck hydraulic study when requested by the designer. The request should include the bridge Plan and Elevation, Deck Plan, Deck Section, roadway plan and profile sheets, and details of any preferred drainage structures.

3.15.4.3 Scuppers

Scuppers should be spaced along the bridge as per the deck hydraulic study. Scuppers should have a steep sloped bottom because it is self-cleaning. Outlet should be 5 inches minimum but preferably 6 inches in diameter. The drainage grate must be bicycle safe. See Neenah product number R-3921-V1 for an example of an acceptable bridge scupper. Increase the depth of the deck to get reinforcement under the drain and around the outlet. Additional reinforcement may be required to distribute forces around the drain.

3.15.4.4 Drain Pipe

All scuppers will connect to a drainage pipe of a size and slope calculated in the deck hydraulic study. Where the underside of the bridge is visible, longitudinal drain pipes should not be attached to the overhang, but instead shall be placed in a bay between beams. Include cleanouts at each scupper location and near each bent including end bents. The drainage pipe may or may not connect to a downspout. The system must accommodate any differential movement between the pipes attached to the superstructure and the downspouts attached to the substructure. Downspouts may be placed at intermediate bents and drain into roadway drainage system. Downspouts may be cast into the substructure or may be attached to the outside. Do not attach downspouts to the traffic face of a column.

Appendix 3A - Fall Line Map

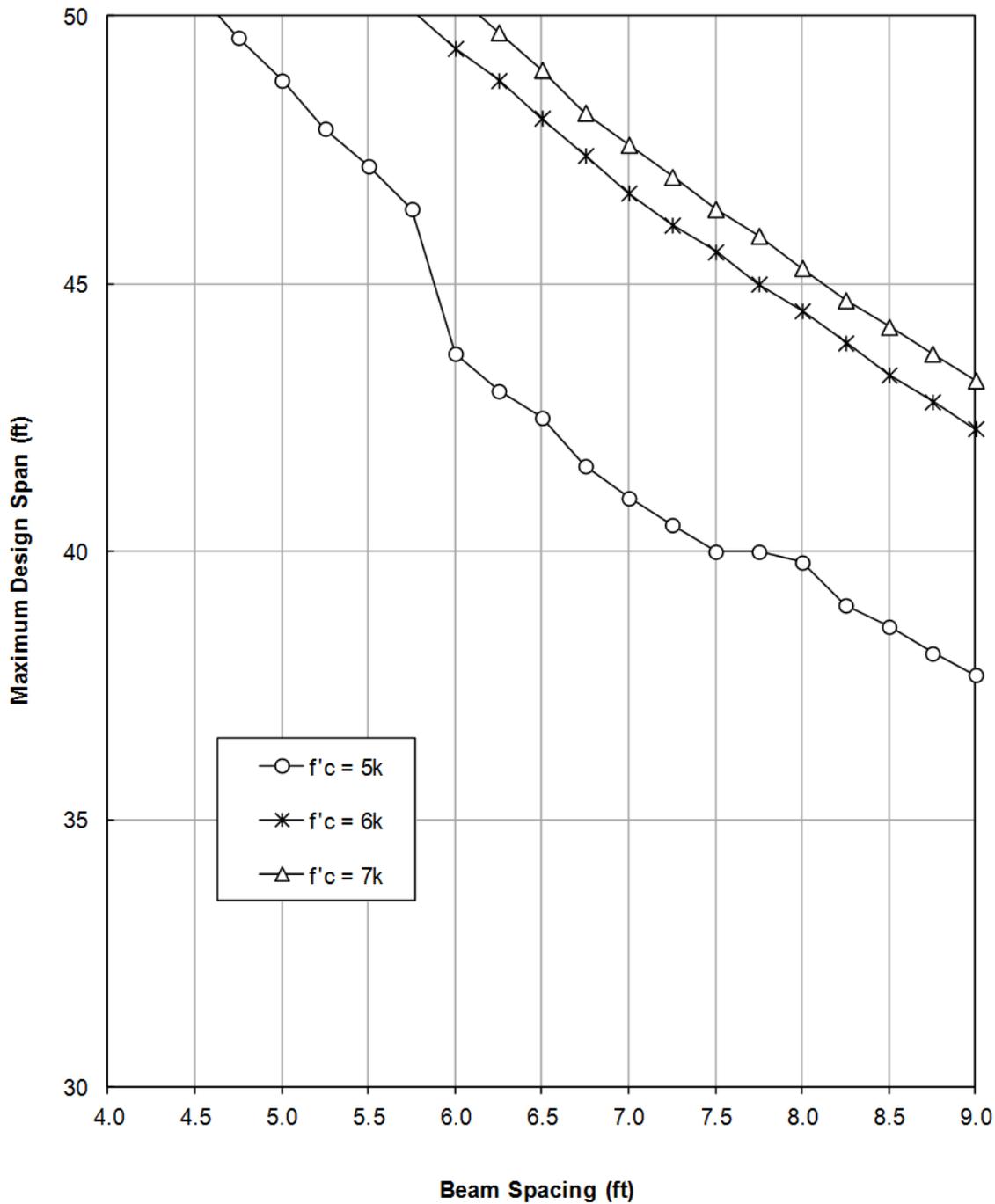


Appendix 3B – LRFD Beam Charts

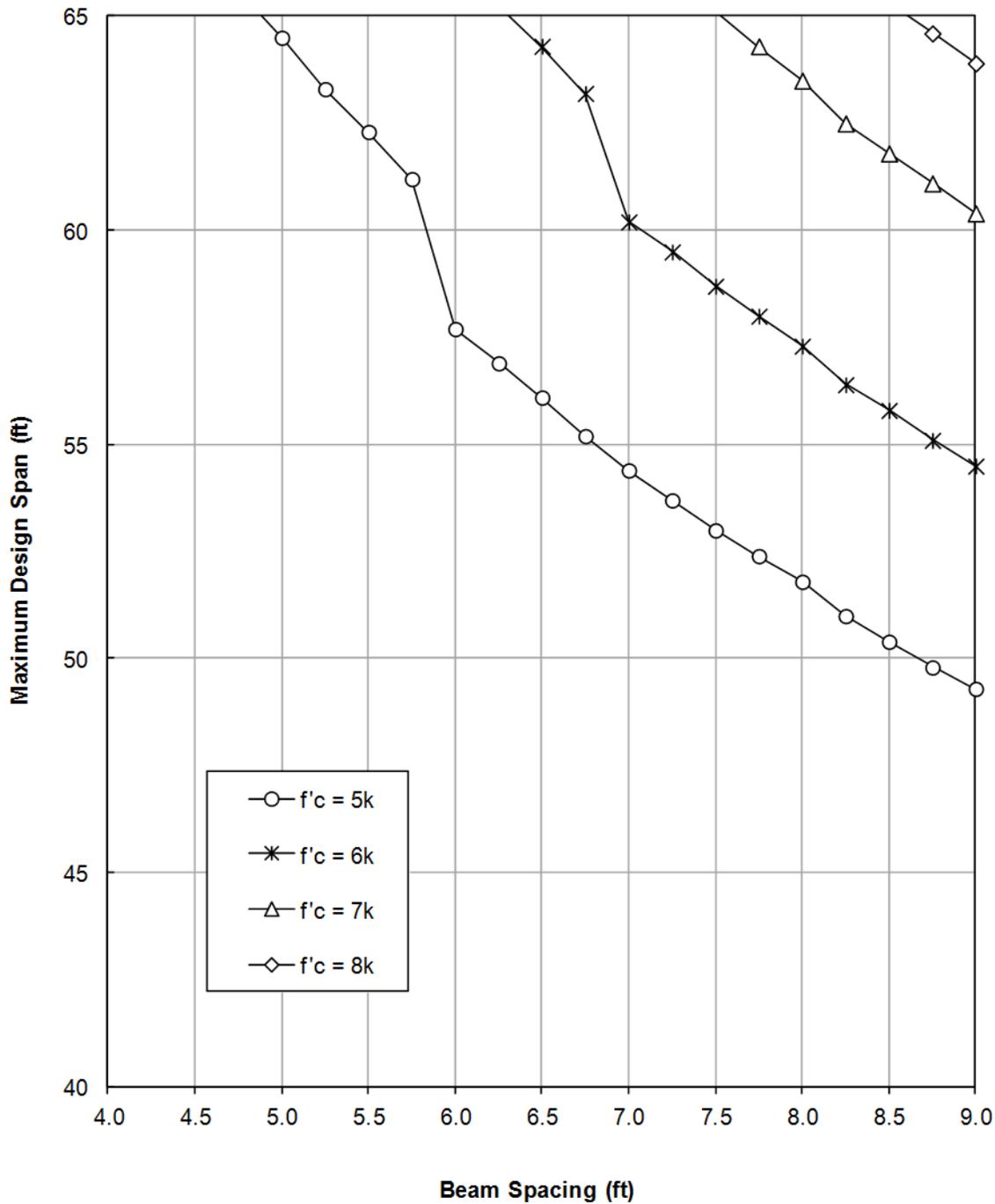
Assumptions

- a) Beam location: Interior beam
- b) Skew angle: 90° (no skew)
- c) Design length (CL bearing to CL bearing): Span length – 24 in.
- d) Slab width: 43'-3" (roadway width: 40'-0")
- e) Number of lanes: 3
- f) 28-day strength of slab concrete: 4.0 ksi
- g) Slab thickness for non-composite loading calculation: Determined using GDOT slab design program with 2 $\frac{3}{4}$ " top concrete cover (Case 4)
- h) Slab thickness for composite section property: $\frac{1}{4}$ " less non-composite slab thickness
- i) Diaphragm: 10-in. thick diaphragm at mid-span when span length is greater than 40 ft, no diaphragm otherwise
- j) Average coping thickness: 2" for AASHTO type beams and 3" for Bulb Tees
- k) Coping thickness is included in non-composite loading calculation, but not in composite section property calculation.
- l) Release strength is 0.5 ksi less than 28-day strength for PSC beam concrete.
- m) Strands (low relaxation type): 0.5" diameter (0.167 in² area) for AASHTO type beams and 0.6" diameter (0.217 in² area) for Bulb Tees
- n) Prestressing forces: (0.75 x 270 ksi) to bottom and top strands for AASHTO type beams and (0.75 x 270 ksi) to bottom strands and (0.17 x 270 ksi) to top strands for Bulb Tees
- o) Draping of strands: No draping for AASHTO type I-MOD beam and two middle strands draped as necessary for other AASHTO type beams and Bulb Tees
- p) Exposure condition is set as normal for allowable stress calculation.

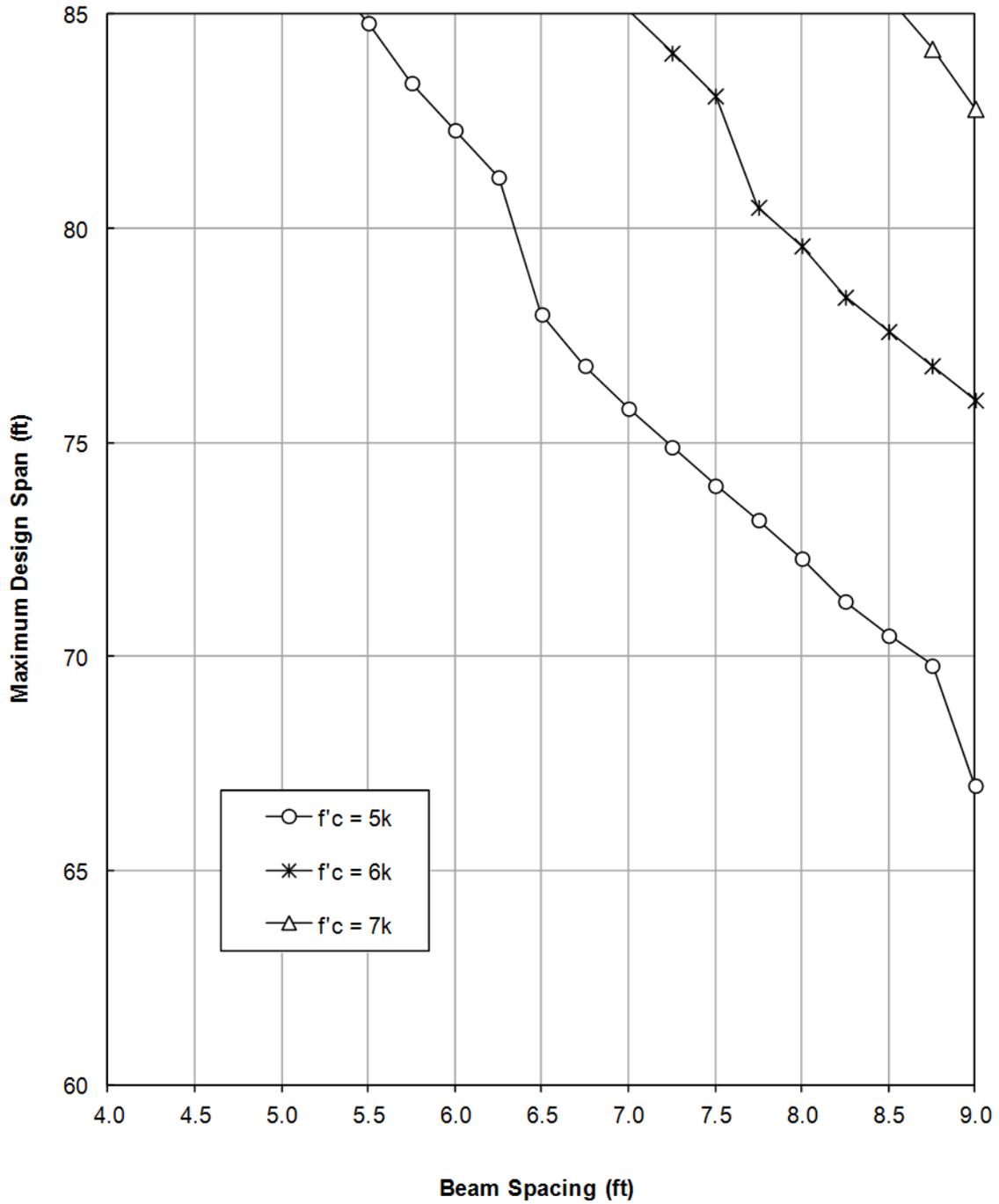
Type I-MOD Beam



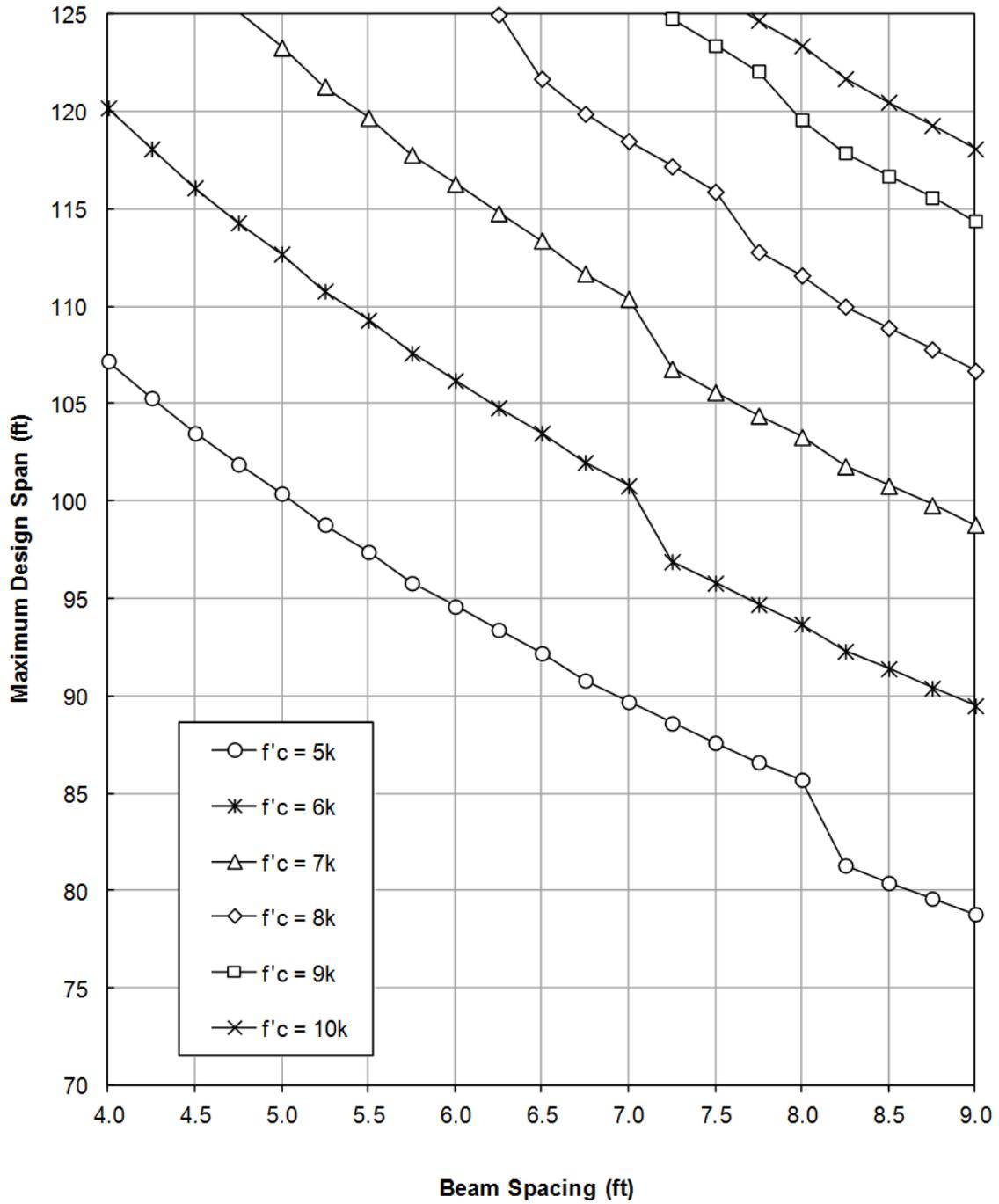
Type II Beam



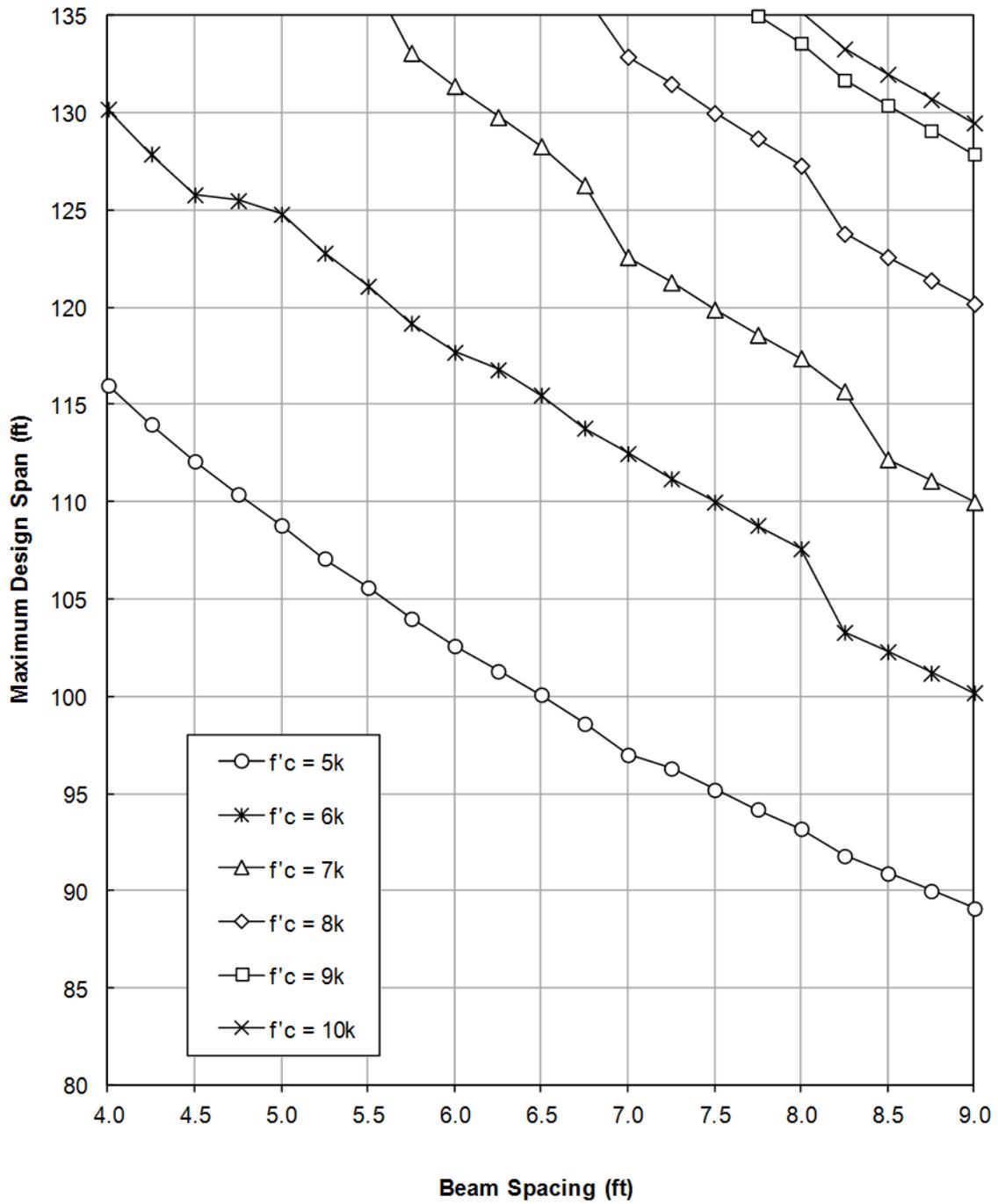
Type III Beam



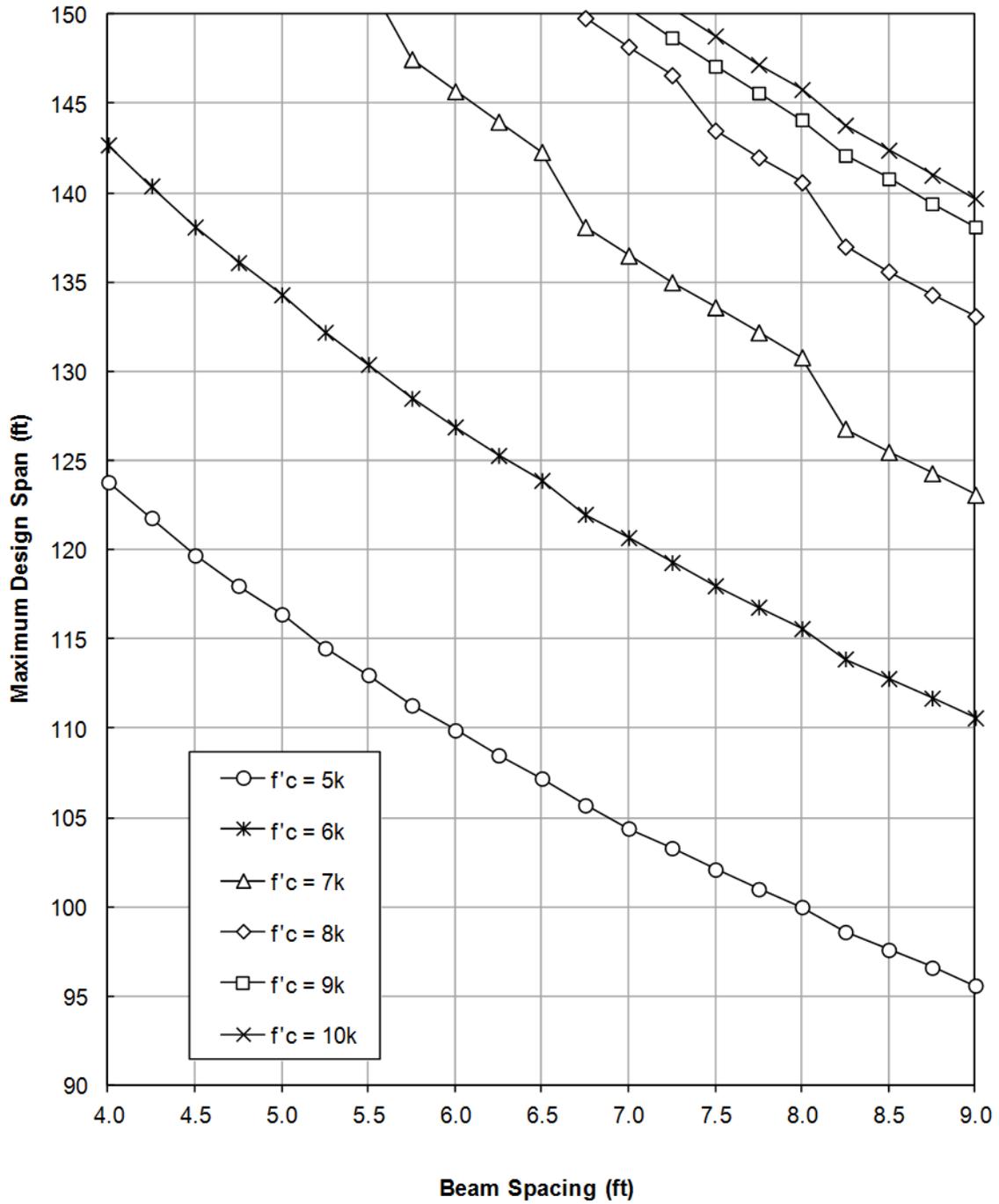
54" Bulb Tee Beam



63" Bulb Tee Beam



72" Bulb Tee Beam



Appendix 3C – Standard Specification Deck Design Charts

SERVICE LOAD DESIGN OF BRIDGE SLAB
 Minimum slab thickness is 7"
 Maximum main reinforcement spacing is 9"

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=====						
WHEEL LOAD (Kips)	fc (ksi)	fs (ksi)	n	SLAB COVER (in)	FUTURE PAVING (kips/ft^2)	CONTINUITY FACTOR
=====						
16.00	1.400	24.000	9	2.000	0.030	0.8
=====						
EFFECTIVE SPAN LENGTH (ft-in)	SLAB THICKNESS (in)		SIZE AND SPACING OF MAIN REINFORCEMENT (in)		DISTRIBUTION REINFORCEMENT (MIDDLE HALF OUTER QUARTERS)	
	MINIMUM	ACTUAL				
3- 6	6.0650	7.000	# 5 at	9.000	3-# 4	2-# 4
3- 7	6.0963	7.000	# 5 at	9.000	3-# 4	2-# 4
3- 8	6.1274	7.000	# 5 at	9.000	3-# 4	2-# 4
3- 9	6.1583	7.000	# 5 at	9.000	3-# 4	2-# 4
3-10	6.1891	7.000	# 5 at	9.000	3-# 4	2-# 4
3-11	6.2198	7.000	# 5 at	9.000	3-# 4	2-# 4
4- 0	6.2503	7.000	# 5 at	9.000	3-# 4	2-# 4
4- 1	6.2807	7.000	# 5 at	9.000	3-# 4	2-# 4
4- 2	6.3110	7.000	# 5 at	9.000	3-# 4	2-# 4
4- 3	6.3411	7.000	# 5 at	8.875	3-# 4	2-# 4
4- 4	6.3711	7.000	# 5 at	8.750	4-# 4	2-# 4
4- 5	6.4009	7.000	# 5 at	8.625	4-# 4	2-# 4
4- 6	6.4307	7.000	# 5 at	8.500	4-# 4	2-# 4
4- 7	6.4603	7.000	# 5 at	8.375	4-# 4	2-# 4
4- 8	6.4898	7.000	# 5 at	8.250	4-# 4	2-# 4
4- 9	6.5192	7.000	# 5 at	8.125	4-# 4	2-# 4
4-10	6.5484	7.000	# 5 at	8.000	4-# 4	2-# 4
4-11	6.5776	7.000	# 5 at	7.875	4-# 4	2-# 4
5- 0	6.6067	7.000	# 5 at	7.750	4-# 4	2-# 4
5- 1	6.6356	7.000	# 5 at	7.625	5-# 4	4-# 4
5- 2	6.6644	7.000	# 5 at	7.625	5-# 4	4-# 4
5- 3	6.6932	7.000	# 5 at	7.500	5-# 4	4-# 4
5- 4	6.7218	7.000	# 5 at	7.375	5-# 4	4-# 4
5- 5	6.7503	7.000	# 5 at	7.250	5-# 4	4-# 4
5- 6	6.7788	7.000	# 5 at	7.250	5-# 4	4-# 4
5- 7	6.8071	7.000	# 5 at	7.125	5-# 4	4-# 4
5- 8	6.8354	7.000	# 5 at	7.000	5-# 4	4-# 4
5- 9	6.8635	7.000	# 5 at	6.875	6-# 4	4-# 4
5-10	6.8916	7.000	# 5 at	6.875	6-# 4	4-# 4
5-11	6.9196	7.000	# 5 at	6.750	6-# 4	4-# 4
6- 0	6.9475	7.000	# 5 at	6.625	6-# 4	4-# 4
6- 1	6.9753	7.000	# 5 at	6.625	6-# 4	4-# 4
6- 2	7.0060	7.125	# 5 at	6.625	6-# 4	4-# 4
6- 3	7.0337	7.125	# 5 at	6.625	6-# 4	4-# 4
6- 4	7.0613	7.125	# 5 at	6.500	6-# 4	4-# 4
6- 5	7.0889	7.125	# 5 at	6.500	7-# 4	4-# 4

SERVICE LOAD DESIGN OF BRIDGE SLAB
 Minimum slab thickness is 7"
 Maximum main reinforcement spacing is 9"

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 May 2007

WHEEL LOAD (Kips)	fc (ksi)	fs (ksi)	n	SLAB COVER (in)	FUTURE PAVING (kips/ft^2)	CONTINUITY FACTOR
16.00	1.400	24.000	9	2.000	0.030	0.8

EFFECTIVE SPAN LENGTH (ft-in)	SLAB THICKNESS		SIZE AND SPACING OF MAIN REINFORCEMENT (in)		DISTRIBUTION REINFORCEMENT	
	MINIMUM (in)	ACTUAL (in)			MIDDLE HALF	OUTER QUARTERS
6- 6	7.1164	7.125	# 5 at	6.375	7-# 4	4-# 4
6- 7	7.1470	7.250	# 5 at	6.500	7-# 4	4-# 4
6- 8	7.1744	7.250	# 5 at	6.375	7-# 4	4-# 4
6- 9	7.2018	7.250	# 5 at	6.375	7-# 4	4-# 4
6-10	7.2290	7.250	# 5 at	6.250	7-# 4	4-# 4
6-11	7.2597	7.375	# 5 at	6.375	7-# 4	4-# 4
7- 0	7.2869	7.375	# 5 at	6.250	7-# 4	4-# 4
7- 1	7.3140	7.375	# 5 at	6.125	8-# 4	4-# 4
7- 2	7.3410	7.375	# 5 at	6.125	8-# 4	4-# 4
7- 3	7.3680	7.375	# 5 at	6.000	8-# 4	4-# 4
7- 4	7.3988	7.500	# 5 at	6.125	8-# 4	4-# 4
7- 5	7.4257	7.500	# 5 at	6.125	8-# 4	4-# 4
7- 6	7.4525	7.500	# 5 at	6.000	8-# 4	4-# 4
7- 7	7.4793	7.500	# 5 at	5.875	8-# 4	4-# 4
7- 8	7.5102	7.625	# 5 at	6.000	8-# 4	4-# 4
7- 9	7.5369	7.625	# 5 at	6.000	9-# 4	6-# 4
7-10	7.5636	7.625	# 5 at	5.875	9-# 4	6-# 4
7-11	7.5902	7.625	# 5 at	5.875	9-# 4	6-# 4
8- 0	7.6167	7.625	# 5 at	5.750	9-# 4	6-# 4
8- 1	7.6477	7.750	# 5 at	5.875	9-# 4	6-# 4
8- 2	7.6742	7.750	# 5 at	5.750	9-# 4	6-# 4
8- 3	7.7007	7.750	# 5 at	5.750	9-# 4	6-# 4
8- 4	7.7271	7.750	# 5 at	5.625	10-# 4	6-# 4
8- 5	7.7582	7.875	# 5 at	5.750	10-# 4	6-# 4
8- 6	7.7846	7.875	# 5 at	5.625	10-# 4	6-# 4
8- 7	7.8109	7.875	# 5 at	5.625	10-# 4	6-# 4
8- 8	7.8372	7.875	# 5 at	5.625	10-# 4	6-# 4
8- 9	7.8635	7.875	# 5 at	5.500	10-# 4	6-# 4
8-10	7.8948	8.000	# 5 at	5.625	10-# 4	6-# 4
8-11	7.9210	8.000	# 5 at	5.500	10-# 4	6-# 4
9- 0	7.9471	8.000	# 5 at	5.500	11-# 4	6-# 4
9- 1	7.9732	8.000	# 5 at	5.375	11-# 4	6-# 4
9- 2	7.9993	8.000	# 5 at	5.375	11-# 4	6-# 4
9- 3	8.0308	8.125	# 5 at	5.375	11-# 4	6-# 4
9- 4	8.0569	8.125	# 5 at	5.375	11-# 4	6-# 4
9- 5	8.0829	8.125	# 5 at	5.375	11-# 4	6-# 4

SERVICE LOAD DESIGN OF BRIDGE SLAB
 Minimum slab thickness is 7"
 Maximum main reinforcement spacing is 9"

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 Office of Bridge and Structural Design 16:53:08
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=====
WHEEL          SLAB    FUTURE    CONTINUITY
LOAD           COVER   PAVING    FACTOR
(Kips)         (in)    (kips/ft^2)
16.00         2.000   0.030     0.8
=====
    
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EFFECTIVE      SIZE AND      DISTRIBUTION
SPAN           SPACING OF MAIN REINFORCEMENT
LENGTH        REINFORCEMENT MIDDLE OUTER
(ft-in)       (in)           HALF  QUARTERS
MINIMUM ACTUAL
(in)         (in)
    
```

EFFECTIVE SPAN LENGTH (ft-in)	SLAB THICKNESS MINIMUM (in)	SLAB THICKNESS ACTUAL (in)	SIZE AND SPACING OF MAIN REINFORCEMENT (in)	DISTRIBUTION REINFORCEMENT MIDDLE HALF	DISTRIBUTION REINFORCEMENT OUTER QUARTERS
9- 6	8.1088	8.125	# 5 at 5.250	12-# 4	6-# 4
9- 7	8.1405	8.250	# 5 at 5.375	12-# 4	6-# 4
9- 8	8.1665	8.250	# 5 at 5.250	12-# 4	6-# 4
9- 9	8.1924	8.250	# 5 at 5.250	12-# 4	6-# 4
9-10	8.2183	8.250	# 5 at 5.250	12-# 4	6-# 4
9-11	8.2441	8.250	# 5 at 5.125	12-# 4	6-# 4
10- 0	8.2761	8.375	# 5 at 5.250	12-# 4	6-# 4
10- 1	8.3019	8.375	# 5 at 5.125	13-# 4	8-# 4
10- 2	8.3277	8.375	# 5 at 5.125	13-# 4	8-# 4
10- 3	8.3535	8.375	# 5 at 5.125	13-# 4	8-# 4
10- 4	8.3856	8.500	# 5 at 5.125	13-# 4	8-# 4
10- 5	8.4114	8.500	# 5 at 5.125	13-# 4	8-# 4
10- 6	8.4371	8.500	# 5 at 5.000	13-# 4	8-# 4
10- 7	8.4628	8.500	# 5 at 5.000	14-# 4	8-# 4
10- 8	8.4884	8.500	# 5 at 5.000	14-# 4	8-# 4
10- 9	8.5209	8.625	# 5 at 5.000	14-# 4	8-# 4
10-10	8.5466	8.625	# 5 at 5.000	14-# 4	8-# 4
10-11	8.6416	8.750	# 6 at 7.000	9-# 5	6-# 5
11- 0	8.6673	8.750	# 6 at 7.000	9-# 5	6-# 5
11- 1	8.6930	8.750	# 6 at 6.875	9-# 5	6-# 5
11- 2	8.7186	8.750	# 6 at 6.875	10-# 5	6-# 5
11- 3	8.7442	8.750	# 6 at 6.875	10-# 5	6-# 5
11- 4	8.7771	8.875	# 6 at 6.875	10-# 5	6-# 5
11- 5	8.8026	8.875	# 6 at 6.875	10-# 5	6-# 5
11- 6	8.8282	8.875	# 6 at 6.750	10-# 5	6-# 5
11- 7	8.8537	8.875	# 6 at 6.750	10-# 5	6-# 5
11- 8	8.8869	9.000	# 6 at 6.750	10-# 5	6-# 5
11- 9	8.9125	9.000	# 6 at 6.750	10-# 5	6-# 5
11-10	8.9380	9.000	# 6 at 6.625	10-# 5	6-# 5
11-11	8.9635	9.000	# 6 at 6.625	10-# 5	6-# 5
12- 0	8.9890	9.000	# 6 at 6.625	10-# 5	6-# 5

SERVICE LOAD DESIGN OF BRIDGE SLAB
 Minimum slab thickness is 7"
 Maximum main reinforcement spacing is 9"

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=====
WHEEL          SLAB    FUTURE    CONTINUITY
LOAD           fc       fs        n    COVER    PAVING    FACTOR
(Kips)        (ksi)   (ksi)
16.00         1.400   24.000   9    2.250    0.030    0.8
=====
    
```

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=====
EFFECTIVE      SIZE AND      DISTRIBUTION
SPAN           SPACING OF MAIN REINFORCEMENT
LENGTH        REINFORCEMENT
(ft-in)      (in)
MINIMUM      ACTUAL
(in)         (in)
MIDDLE      OUTER
HALF        QUARTERS

3- 6      6.3150  7.000   # 5 at 9.000   3-# 4   2-# 4
3- 7      6.3463  7.000   # 5 at 9.000   3-# 4   2-# 4
3- 8      6.3774  7.000   # 5 at 9.000   3-# 4   2-# 4
3- 9      6.4083  7.000   # 5 at 9.000   3-# 4   2-# 4
3-10     6.4391  7.000   # 5 at 9.000   3-# 4   2-# 4
3-11     6.4698  7.000   # 5 at 8.875   3-# 4   2-# 4
4- 0     6.5003  7.000   # 5 at 8.750   3-# 4   2-# 4
4- 1     6.5307  7.000   # 5 at 8.625   3-# 4   2-# 4
4- 2     6.5610  7.000   # 5 at 8.500   4-# 4   2-# 4
4- 3     6.5911  7.000   # 5 at 8.375   4-# 4   2-# 4
4- 4     6.6211  7.000   # 5 at 8.250   4-# 4   2-# 4
4- 5     6.6509  7.000   # 5 at 8.125   4-# 4   2-# 4
4- 6     6.6807  7.000   # 5 at 8.000   4-# 4   2-# 4
4- 7     6.7103  7.000   # 5 at 7.875   4-# 4   2-# 4
4- 8     6.7398  7.000   # 5 at 7.750   4-# 4   2-# 4
4- 9     6.7692  7.000   # 5 at 7.625   4-# 4   2-# 4
4-10     6.7984  7.000   # 5 at 7.625   4-# 4   2-# 4
4-11     6.8276  7.000   # 5 at 7.500   5-# 4   4-# 4
5- 0     6.8567  7.000   # 5 at 7.375   5-# 4   4-# 4
5- 1     6.8856  7.000   # 5 at 7.250   5-# 4   4-# 4
5- 2     6.9144  7.000   # 5 at 7.125   5-# 4   4-# 4
5- 3     6.9432  7.000   # 5 at 7.125   5-# 4   4-# 4
5- 4     6.9718  7.000   # 5 at 7.000   5-# 4   4-# 4
5- 5     7.0028  7.125   # 5 at 7.125   5-# 4   4-# 4
5- 6     7.0313  7.125   # 5 at 7.000   5-# 4   4-# 4
5- 7     7.0597  7.125   # 5 at 6.875   5-# 4   4-# 4
5- 8     7.0880  7.125   # 5 at 6.875   6-# 4   4-# 4
5- 9     7.1162  7.125   # 5 at 6.750   6-# 4   4-# 4
5-10     7.1471  7.250   # 5 at 6.875   6-# 4   4-# 4
5-11     7.1752  7.250   # 5 at 6.750   6-# 4   4-# 4
6- 0     7.2032  7.250   # 5 at 6.625   6-# 4   4-# 4
6- 1     7.2311  7.250   # 5 at 6.625   6-# 4   4-# 4
6- 2     7.2619  7.375   # 5 at 6.625   6-# 4   4-# 4
6- 3     7.2898  7.375   # 5 at 6.625   6-# 4   4-# 4
6- 4     7.3175  7.375   # 5 at 6.500   6-# 4   4-# 4
6- 5     7.3452  7.375   # 5 at 6.375   7-# 4   4-# 4
    
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SERVICE LOAD DESIGN OF BRIDGE SLAB
 Minimum slab thickness is 7"
 Maximum main reinforcement spacing is 9"

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WHEEL LOAD (Kips)	fc (ksi)	fs (ksi)	n	SLAB COVER (in)	FUTURE PAVING (kips/ft ²)	CONTINUITY FACTOR
16.00	1.400	24.000	9	2.250	0.030	0.8

EFFECTIVE SPAN LENGTH (ft-in)	SLAB THICKNESS		SIZE AND SPACING OF MAIN REINFORCEMENT (in)		DISTRIBUTION REINFORCEMENT	
	MINIMUM (in)	ACTUAL (in)			MIDDLE HALF	OUTER QUARTERS
6- 6	7.3728	7.375	# 5 at	6.375	7-# 4	4-# 4
6- 7	7.4036	7.500	# 5 at	6.500	7-# 4	4-# 4
6- 8	7.4311	7.500	# 5 at	6.375	7-# 4	4-# 4
6- 9	7.4586	7.500	# 5 at	6.250	7-# 4	4-# 4
6-10	7.4859	7.500	# 5 at	6.250	7-# 4	4-# 4
6-11	7.5168	7.625	# 5 at	6.250	7-# 4	4-# 4
7- 0	7.5441	7.625	# 5 at	6.250	7-# 4	4-# 4
7- 1	7.5713	7.625	# 5 at	6.125	8-# 4	4-# 4
7- 2	7.5985	7.625	# 5 at	6.125	8-# 4	4-# 4
7- 3	7.6294	7.750	# 5 at	6.125	8-# 4	4-# 4
7- 4	7.6565	7.750	# 5 at	6.125	8-# 4	4-# 4
7- 5	7.6835	7.750	# 5 at	6.000	8-# 4	4-# 4
7- 6	7.7105	7.750	# 5 at	6.000	8-# 4	4-# 4
7- 7	7.7374	7.750	# 5 at	5.875	8-# 4	4-# 4
7- 8	7.7684	7.875	# 5 at	6.000	8-# 4	4-# 4
7- 9	7.7953	7.875	# 5 at	5.875	9-# 4	6-# 4
7-10	7.8221	7.875	# 5 at	5.875	9-# 4	6-# 4
7-11	7.8489	7.875	# 5 at	5.750	9-# 4	6-# 4
8- 0	7.8800	8.000	# 5 at	5.875	9-# 4	6-# 4
8- 1	7.9067	8.000	# 5 at	5.875	9-# 4	6-# 4
8- 2	7.9333	8.000	# 5 at	5.750	9-# 4	6-# 4
8- 3	7.9599	8.000	# 5 at	5.750	9-# 4	6-# 4
8- 4	7.9865	8.000	# 5 at	5.625	10-# 4	6-# 4
8- 5	8.0178	8.125	# 5 at	5.750	10-# 4	6-# 4
8- 6	8.0443	8.125	# 5 at	5.625	10-# 4	6-# 4
8- 7	8.0708	8.125	# 5 at	5.625	10-# 4	6-# 4
8- 8	8.0972	8.125	# 5 at	5.500	10-# 4	6-# 4
8- 9	8.1235	8.125	# 5 at	5.500	10-# 4	6-# 4
8-10	8.1550	8.250	# 5 at	5.500	10-# 4	6-# 4
8-11	8.1813	8.250	# 5 at	5.500	10-# 4	6-# 4
9- 0	8.2076	8.250	# 5 at	5.500	11-# 4	6-# 4
9- 1	8.2339	8.250	# 5 at	5.375	11-# 4	6-# 4
9- 2	8.2655	8.375	# 5 at	5.500	11-# 4	6-# 4
9- 3	8.2918	8.375	# 5 at	5.375	11-# 4	6-# 4
9- 4	8.3180	8.375	# 5 at	5.375	11-# 4	6-# 4
9- 5	8.3441	8.375	# 5 at	5.250	11-# 4	6-# 4

SERVICE LOAD DESIGN OF BRIDGE SLAB
 Minimum slab thickness is 7"
 Maximum main reinforcement spacing is 9"

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WHEEL LOAD (Kips)	fc (ksi)	fs (ksi)	n	SLAB COVER (in)	FUTURE PAVING (kips/ft ²)	CONTINUITY FACTOR
16.00	1.400	24.000	9	2.250	0.030	0.8

EFFECTIVE SPAN LENGTH (ft-in)	SLAB THICKNESS		SIZE AND SPACING OF MAIN REINFORCEMENT (in)		DISTRIBUTION REINFORCEMENT	
	MINIMUM (in)	ACTUAL (in)			MIDDLE HALF	OUTER QUARTERS
9- 6	8.3702	8.375	# 5 at	5.250	12-# 4	6-# 4
9- 7	8.4021	8.500	# 5 at	5.375	12-# 4	6-# 4
9- 8	8.4282	8.500	# 5 at	5.250	12-# 4	6-# 4
9- 9	8.4542	8.500	# 5 at	5.250	12-# 4	6-# 4
9-10	8.4803	8.500	# 5 at	5.125	12-# 4	6-# 4
9-11	8.5123	8.625	# 5 at	5.250	12-# 4	6-# 4
10- 0	8.5383	8.625	# 5 at	5.125	12-# 4	6-# 4
10- 1	8.5643	8.625	# 5 at	5.125	13-# 4	8-# 4
10- 2	8.5903	8.625	# 5 at	5.125	13-# 4	8-# 4
10- 3	8.6162	8.625	# 5 at	5.000	13-# 4	8-# 4
10- 4	8.6485	8.750	# 5 at	5.125	13-# 4	8-# 4
10- 5	8.6744	8.750	# 5 at	5.000	13-# 4	8-# 4
10- 6	8.7003	8.750	# 5 at	5.000	13-# 4	8-# 4
10- 7	8.7261	8.750	# 5 at	5.000	14-# 4	8-# 4
10- 8	8.7587	8.875	# 5 at	5.000	14-# 4	8-# 4
10- 9	8.7845	8.875	# 5 at	5.000	14-# 4	8-# 4
10-10	8.8728	8.875	# 6 at	7.000	9-# 5	6-# 5
10-11	8.9056	9.000	# 6 at	7.000	9-# 5	6-# 5
11- 0	8.9314	9.000	# 6 at	7.000	9-# 5	6-# 5
11- 1	8.9572	9.000	# 6 at	6.875	9-# 5	6-# 5
11- 2	8.9830	9.000	# 6 at	6.875	10-# 5	6-# 5
11- 3	9.0159	9.125	# 6 at	6.875	10-# 5	6-# 5
11- 4	9.0417	9.125	# 6 at	6.875	10-# 5	6-# 5
11- 5	9.0675	9.125	# 6 at	6.750	10-# 5	6-# 5
11- 6	9.0932	9.125	# 6 at	6.750	10-# 5	6-# 5
11- 7	9.1189	9.125	# 6 at	6.750	10-# 5	6-# 5
11- 8	9.1522	9.250	# 6 at	6.750	10-# 5	6-# 5
11- 9	9.1779	9.250	# 6 at	6.750	10-# 5	6-# 5
11-10	9.2036	9.250	# 6 at	6.625	10-# 5	6-# 5
11-11	9.2293	9.250	# 6 at	6.625	10-# 5	6-# 5
12- 0	9.2628	9.375	# 6 at	6.625	10-# 5	6-# 5

SERVICE LOAD DESIGN OF BRIDGE SLAB
 Minimum slab thickness is 7"
 Maximum main reinforcement spacing is 9"

Georgia Department of Transportation 19-OCT-07
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=====
WHEEL          SLAB      FUTURE      CONTINUITY
LOAD           fc         fs          n    COVER    PAVING     FACTOR
(Kips)        (ksi)     (ksi)
16.00         1.400    24.000    9    2.500    0.030     0.8
=====
    
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=====
EFFECTIVE      SIZE AND      DISTRIBUTION
SPAN           SLAB THICKNESS SPACING OF MAIN REINFORCEMENT
LENGTH        MINIMUM ACTUAL REINFORCEMENT MIDDLE OUTER
(ft-in)      (in)         (in)           (in)         HALF  QUARTERS

3- 6         6.5650    7.000    # 5 at 9.000    3-# 4    2-# 4
3- 7         6.5963    7.000    # 5 at 9.000    3-# 4    2-# 4
3- 8         6.6274    7.000    # 5 at 8.875    3-# 4    2-# 4
3- 9         6.6583    7.000    # 5 at 8.625    3-# 4    2-# 4
3-10        6.6891    7.000    # 5 at 8.500    3-# 4    2-# 4
3-11        6.7198    7.000    # 5 at 8.375    3-# 4    2-# 4
4- 0         6.7503    7.000    # 5 at 8.250    3-# 4    2-# 4
4- 1         6.7807    7.000    # 5 at 8.125    4-# 4    2-# 4
4- 2         6.8110    7.000    # 5 at 8.000    4-# 4    2-# 4
4- 3         6.8411    7.000    # 5 at 7.875    4-# 4    2-# 4
4- 4         6.8711    7.000    # 5 at 7.750    4-# 4    2-# 4
4- 5         6.9009    7.000    # 5 at 7.625    4-# 4    2-# 4
4- 6         6.9307    7.000    # 5 at 7.500    4-# 4    2-# 4
4- 7         6.9603    7.000    # 5 at 7.500    4-# 4    2-# 4
4- 8         6.9898    7.000    # 5 at 7.375    4-# 4    2-# 4
4- 9         7.0211    7.125    # 5 at 7.500    4-# 4    2-# 4
4-10        7.0505    7.125    # 5 at 7.375    5-# 4    4-# 4
4-11        7.0797    7.125    # 5 at 7.250    5-# 4    4-# 4
5- 0         7.1088    7.125    # 5 at 7.125    5-# 4    4-# 4
5- 1         7.1400    7.250    # 5 at 7.250    5-# 4    4-# 4
5- 2         7.1689    7.250    # 5 at 7.125    5-# 4    4-# 4
5- 3         7.1978    7.250    # 5 at 7.000    5-# 4    4-# 4
5- 4         7.2265    7.250    # 5 at 7.000    5-# 4    4-# 4
5- 5         7.2576    7.375    # 5 at 7.125    5-# 4    4-# 4
5- 6         7.2862    7.375    # 5 at 7.000    5-# 4    4-# 4
5- 7         7.3147    7.375    # 5 at 6.875    5-# 4    4-# 4
5- 8         7.3432    7.375    # 5 at 6.750    6-# 4    4-# 4
5- 9         7.3715    7.375    # 5 at 6.750    6-# 4    4-# 4
5-10        7.4025    7.500    # 5 at 6.750    6-# 4    4-# 4
5-11        7.4307    7.500    # 5 at 6.750    6-# 4    4-# 4
6- 0         7.4589    7.500    # 5 at 6.625    6-# 4    4-# 4
6- 1         7.4869    7.500    # 5 at 6.500    6-# 4    4-# 4
6- 2         7.5179    7.625    # 5 at 6.625    6-# 4    4-# 4
6- 3         7.5458    7.625    # 5 at 6.625    6-# 4    4-# 4
6- 4         7.5737    7.625    # 5 at 6.500    7-# 4    4-# 4
6- 5         7.6015    7.625    # 5 at 6.375    7-# 4    4-# 4
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SERVICE LOAD DESIGN OF BRIDGE SLAB
 Minimum slab thickness is 7"
 Maximum main reinforcement spacing is 9"

Georgia Department of Transportation 19-OCT-07
 Office of Bridge and Structural Design 16:53:08
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=====
WHEEL          SLAB    FUTURE    CONTINUITY
LOAD           COVER   PAVING    FACTOR
(Kips)         (in)   (kips/ft^2)
16.00         2.500  0.030    0.8
=====
    
```

EFFECTIVE SPAN LENGTH (ft-in)	SLAB THICKNESS		SIZE AND SPACING OF MAIN REINFORCEMENT (in)	DISTRIBUTION REINFORCEMENT	
	MINIMUM (in)	ACTUAL (in)		MIDDLE HALF	OUTER QUARTERS
6- 6	7.6324	7.750	# 5 at 6.500	7-# 4	4-# 4
6- 7	7.6602	7.750	# 5 at 6.375	7-# 4	4-# 4
6- 8	7.6878	7.750	# 5 at 6.375	7-# 4	4-# 4
6- 9	7.7154	7.750	# 5 at 6.250	7-# 4	4-# 4
6-10	7.7429	7.750	# 5 at 6.250	7-# 4	4-# 4
6-11	7.7739	7.875	# 5 at 6.250	7-# 4	4-# 4
7- 0	7.8013	7.875	# 5 at 6.250	7-# 4	4-# 4
7- 1	7.8286	7.875	# 5 at 6.125	8-# 4	4-# 4
7- 2	7.8559	7.875	# 5 at 6.125	8-# 4	4-# 4
7- 3	7.8870	8.000	# 5 at 6.125	8-# 4	4-# 4
7- 4	7.9142	8.000	# 5 at 6.125	8-# 4	4-# 4
7- 5	7.9414	8.000	# 5 at 6.000	8-# 4	4-# 4
7- 6	7.9685	8.000	# 5 at 6.000	8-# 4	4-# 4
7- 7	7.9956	8.000	# 5 at 5.875	8-# 4	4-# 4
7- 8	8.0267	8.125	# 5 at 6.000	8-# 4	4-# 4
7- 9	8.0537	8.125	# 5 at 5.875	9-# 4	6-# 4
7-10	8.0806	8.125	# 5 at 5.875	9-# 4	6-# 4
7-11	8.1075	8.125	# 5 at 5.750	9-# 4	6-# 4
8- 0	8.1388	8.250	# 5 at 5.875	9-# 4	6-# 4
8- 1	8.1656	8.250	# 5 at 5.750	9-# 4	6-# 4
8- 2	8.1924	8.250	# 5 at 5.750	9-# 4	6-# 4
8- 3	8.2192	8.250	# 5 at 5.625	9-# 4	6-# 4
8- 4	8.2459	8.250	# 5 at 5.625	10-# 4	6-# 4
8- 5	8.2773	8.375	# 5 at 5.750	10-# 4	6-# 4
8- 6	8.3039	8.375	# 5 at 5.625	10-# 4	6-# 4
8- 7	8.3305	8.375	# 5 at 5.625	10-# 4	6-# 4
8- 8	8.3571	8.375	# 5 at 5.500	10-# 4	6-# 4
8- 9	8.3887	8.500	# 5 at 5.625	10-# 4	6-# 4
8-10	8.4152	8.500	# 5 at 5.500	10-# 4	6-# 4
8-11	8.4417	8.500	# 5 at 5.500	11-# 4	6-# 4
9- 0	8.4681	8.500	# 5 at 5.375	11-# 4	6-# 4
9- 1	8.4945	8.500	# 5 at 5.375	11-# 4	6-# 4
9- 2	8.5263	8.625	# 5 at 5.375	11-# 4	6-# 4
9- 3	8.5527	8.625	# 5 at 5.375	11-# 4	6-# 4
9- 4	8.5790	8.625	# 5 at 5.375	11-# 4	6-# 4
9- 5	8.6053	8.625	# 5 at 5.250	11-# 4	6-# 4

SERVICE LOAD DESIGN OF BRIDGE SLAB
 Minimum slab thickness is 7"
 Maximum main reinforcement spacing is 9"

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WHEEL LOAD (Kips)	fc (ksi)	fs (ksi)	n	SLAB COVER (in)	FUTURE PAVING (kips/ft ²)	CONTINUITY FACTOR
16.00	1.400	24.000	9	2.500	0.030	0.8

EFFECTIVE SPAN LENGTH (ft-in)	SLAB THICKNESS		SIZE AND SPACING OF MAIN REINFORCEMENT (in)		DISTRIBUTION REINFORCEMENT	
	MINIMUM (in)	ACTUAL (in)			MIDDLE HALF	OUTER QUARTERS
9- 6	8.6373	8.750	# 5 at	5.375	11-# 4	6-# 4
9- 7	8.6636	8.750	# 5 at	5.250	12-# 4	6-# 4
9- 8	8.6898	8.750	# 5 at	5.250	12-# 4	6-# 4
9- 9	8.7160	8.750	# 5 at	5.250	12-# 4	6-# 4
9-10	8.7422	8.750	# 5 at	5.125	12-# 4	6-# 4
9-11	8.7744	8.875	# 5 at	5.250	12-# 4	6-# 4
10- 0	8.8006	8.875	# 5 at	5.125	12-# 4	6-# 4
10- 1	8.8267	8.875	# 5 at	5.125	13-# 4	8-# 4
10- 2	8.8528	8.875	# 5 at	5.125	13-# 4	8-# 4
10- 3	8.8852	9.000	# 5 at	5.125	13-# 4	8-# 4
10- 4	8.9113	9.000	# 5 at	5.125	13-# 4	8-# 4
10- 5	8.9374	9.000	# 5 at	5.000	13-# 4	8-# 4
10- 6	8.9634	9.000	# 5 at	5.000	13-# 4	8-# 4
10- 7	8.9894	9.000	# 5 at	5.000	14-# 4	8-# 4
10- 8	9.0221	9.125	# 5 at	5.000	14-# 4	8-# 4
10- 9	9.0481	9.125	# 5 at	5.000	14-# 4	8-# 4
10-10	9.1434	9.250	# 6 at	7.000	9-# 5	6-# 5
10-11	9.1694	9.250	# 6 at	7.000	9-# 5	6-# 5
11- 0	9.1954	9.250	# 6 at	6.875	9-# 5	6-# 5
11- 1	9.2214	9.250	# 6 at	6.875	9-# 5	6-# 5
11- 2	9.2473	9.250	# 6 at	6.875	10-# 5	6-# 5
11- 3	9.2804	9.375	# 6 at	6.875	10-# 5	6-# 5
11- 4	9.3064	9.375	# 6 at	6.875	10-# 5	6-# 5
11- 5	9.3323	9.375	# 6 at	6.750	10-# 5	6-# 5
11- 6	9.3582	9.375	# 6 at	6.750	10-# 5	6-# 5
11- 7	9.3916	9.500	# 6 at	6.750	10-# 5	6-# 5
11- 8	9.4175	9.500	# 6 at	6.750	10-# 5	6-# 5
11- 9	9.4433	9.500	# 6 at	6.625	10-# 5	6-# 5
11-10	9.4692	9.500	# 6 at	6.625	10-# 5	6-# 5
11-11	9.4950	9.500	# 6 at	6.500	10-# 5	6-# 5
12- 0	9.5287	9.625	# 6 at	6.625	10-# 5	6-# 5

SERVICE LOAD DESIGN OF BRIDGE SLAB
 Minimum slab thickness is 7"
 Maximum main reinforcement spacing is 9"

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WHEEL          SLAB      FUTURE      CONTINUITY
LOAD           fc         fs          n    COVER    PAVING      FACTOR
(Kips)        (ksi)     (ksi)
16.00        1.400    24.000    9    2.750    0.030      0.8
=====
    
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=====
EFFECTIVE      SIZE AND      DISTRIBUTION
SPAN           SLAB THICKNESS SPACING OF MAIN REINFORCEMENT
LENGTH        MINIMUM ACTUAL REINFORCEMENT MIDDLE OUTER
(ft-in)       (in)         (in)           (in)         HALF  QUARTERS

3- 6          6.8150  7.000    # 5 at 8.625    3-# 4    2-# 4
3- 7          6.8463  7.000    # 5 at 8.375    3-# 4    2-# 4
3- 8          6.8774  7.000    # 5 at 8.250    3-# 4    2-# 4
3- 9          6.9083  7.000    # 5 at 8.125    3-# 4    2-# 4
3-10         6.9391  7.000    # 5 at 8.000    3-# 4    2-# 4
3-11         6.9698  7.000    # 5 at 7.875    4-# 4    2-# 4
4- 0          7.0018  7.125    # 5 at 8.000    4-# 4    2-# 4
4- 1          7.0323  7.125    # 5 at 7.875    4-# 4    2-# 4
4- 2          7.0626  7.125    # 5 at 7.750    4-# 4    2-# 4
4- 3          7.0927  7.125    # 5 at 7.625    4-# 4    2-# 4
4- 4          7.1228  7.125    # 5 at 7.500    4-# 4    2-# 4
4- 5          7.1544  7.250    # 5 at 7.625    4-# 4    2-# 4
4- 6          7.1843  7.250    # 5 at 7.500    4-# 4    2-# 4
4- 7          7.2140  7.250    # 5 at 7.500    4-# 4    2-# 4
4- 8          7.2436  7.250    # 5 at 7.375    4-# 4    2-# 4
4- 9          7.2751  7.375    # 5 at 7.500    4-# 4    2-# 4
4-10         7.3045  7.375    # 5 at 7.375    5-# 4    4-# 4
4-11         7.3338  7.375    # 5 at 7.250    5-# 4    4-# 4
5- 0          7.3630  7.375    # 5 at 7.125    5-# 4    4-# 4
5- 1          7.3943  7.500    # 5 at 7.250    5-# 4    4-# 4
5- 2          7.4234  7.500    # 5 at 7.125    5-# 4    4-# 4
5- 3          7.4524  7.500    # 5 at 7.000    5-# 4    4-# 4
5- 4          7.4812  7.500    # 5 at 7.000    5-# 4    4-# 4
5- 5          7.5124  7.625    # 5 at 7.000    5-# 4    4-# 4
5- 6          7.5412  7.625    # 5 at 7.000    5-# 4    4-# 4
5- 7          7.5698  7.625    # 5 at 6.875    6-# 4    4-# 4
5- 8          7.5984  7.625    # 5 at 6.750    6-# 4    4-# 4
5- 9          7.6295  7.750    # 5 at 6.875    6-# 4    4-# 4
5-10         7.6579  7.750    # 5 at 6.750    6-# 4    4-# 4
5-11         7.6863  7.750    # 5 at 6.750    6-# 4    4-# 4
6- 0          7.7145  7.750    # 5 at 6.625    6-# 4    4-# 4
6- 1          7.7427  7.750    # 5 at 6.500    6-# 4    4-# 4
6- 2          7.7738  7.875    # 5 at 6.625    6-# 4    4-# 4
6- 3          7.8019  7.875    # 5 at 6.500    6-# 4    4-# 4
6- 4          7.8299  7.875    # 5 at 6.500    7-# 4    4-# 4
6- 5          7.8578  7.875    # 5 at 6.375    7-# 4    4-# 4
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SERVICE LOAD DESIGN OF BRIDGE SLAB
 Minimum slab thickness is 7"
 Maximum main reinforcement spacing is 9"

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WHEEL LOAD (Kips)	fc (ksi)	fs (ksi)	n	SLAB COVER (in)	FUTURE PAVING (kips/ft ²)	CONTINUITY FACTOR
16.00	1.400	24.000	9	2.750	0.030	0.8

EFFECTIVE SPAN LENGTH (ft-in)	SLAB THICKNESS (in)		SIZE AND SPACING OF MAIN REINFORCEMENT (in)	DISTRIBUTION REINFORCEMENT	
	MINIMUM (in)	ACTUAL (in)		MIDDLE HALF	OUTER QUARTERS
6- 6	7.8889	8.000	# 5 at 6.500	7-# 4	4-# 4
6- 7	7.9167	8.000	# 5 at 6.375	7-# 4	4-# 4
6- 8	7.9445	8.000	# 5 at 6.375	7-# 4	4-# 4
6- 9	7.9722	8.000	# 5 at 6.250	7-# 4	4-# 4
6-10	7.9998	8.000	# 5 at 6.250	7-# 4	4-# 4
6-11	8.0309	8.125	# 5 at 6.250	7-# 4	4-# 4
7- 0	8.0585	8.125	# 5 at 6.250	7-# 4	4-# 4
7- 1	8.0860	8.125	# 5 at 6.125	8-# 4	4-# 4
7- 2	8.1134	8.125	# 5 at 6.125	8-# 4	4-# 4
7- 3	8.1446	8.250	# 5 at 6.125	8-# 4	4-# 4
7- 4	8.1719	8.250	# 5 at 6.125	8-# 4	4-# 4
7- 5	8.1992	8.250	# 5 at 6.000	8-# 4	4-# 4
7- 6	8.2265	8.250	# 5 at 6.000	8-# 4	4-# 4
7- 7	8.2577	8.375	# 5 at 6.000	8-# 4	4-# 4
7- 8	8.2849	8.375	# 5 at 6.000	8-# 4	4-# 4
7- 9	8.3121	8.375	# 5 at 5.875	9-# 4	6-# 4
7-10	8.3392	8.375	# 5 at 5.875	9-# 4	6-# 4
7-11	8.3662	8.375	# 5 at 5.750	9-# 4	6-# 4
8- 0	8.3976	8.500	# 5 at 5.875	9-# 4	6-# 4
8- 1	8.4246	8.500	# 5 at 5.750	9-# 4	6-# 4
8- 2	8.4515	8.500	# 5 at 5.750	9-# 4	6-# 4
8- 3	8.4784	8.500	# 5 at 5.625	9-# 4	6-# 4
8- 4	8.5099	8.625	# 5 at 5.750	9-# 4	6-# 4
8- 5	8.5367	8.625	# 5 at 5.625	10-# 4	6-# 4
8- 6	8.5636	8.625	# 5 at 5.625	10-# 4	6-# 4
8- 7	8.5903	8.625	# 5 at 5.500	10-# 4	6-# 4
8- 8	8.6170	8.625	# 5 at 5.500	10-# 4	6-# 4
8- 9	8.6487	8.750	# 5 at 5.625	10-# 4	6-# 4
8-10	8.6754	8.750	# 5 at 5.500	10-# 4	6-# 4
8-11	8.7020	8.750	# 5 at 5.500	11-# 4	6-# 4
9- 0	8.7286	8.750	# 5 at 5.375	11-# 4	6-# 4
9- 1	8.7605	8.875	# 5 at 5.500	11-# 4	6-# 4
9- 2	8.7871	8.875	# 5 at 5.375	11-# 4	6-# 4
9- 3	8.8136	8.875	# 5 at 5.375	11-# 4	6-# 4
9- 4	8.8401	8.875	# 5 at 5.375	11-# 4	6-# 4
9- 5	8.8665	8.875	# 5 at 5.250	12-# 4	6-# 4

SERVICE LOAD DESIGN OF BRIDGE SLAB
 Minimum slab thickness is 7"
 Maximum main reinforcement spacing is 9"

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WHEEL LOAD (Kips)	fc (ksi)	fs (ksi)	n	SLAB COVER (in)	FUTURE PAVING (kips/ft^2)	CONTINUITY FACTOR
16.00	1.400	24.000	9	2.750	0.030	0.8

EFFECTIVE SPAN LENGTH (ft-in)	SLAB THICKNESS		SIZE AND SPACING OF MAIN REINFORCEMENT (in)		DISTRIBUTION REINFORCEMENT	
	MINIMUM (in)	ACTUAL (in)			MIDDLE HALF	OUTER QUARTERS
9- 6	8.8986	9.000	# 5 at	5.375	11-# 4	6-# 4
9- 7	8.9251	9.000	# 5 at	5.250	12-# 4	6-# 4
9- 8	8.9515	9.000	# 5 at	5.250	12-# 4	6-# 4
9- 9	8.9778	9.000	# 5 at	5.125	12-# 4	6-# 4
9-10	9.0101	9.125	# 5 at	5.250	12-# 4	6-# 4
9-11	9.0365	9.125	# 5 at	5.125	12-# 4	6-# 4
10- 0	9.0628	9.125	# 5 at	5.125	12-# 4	6-# 4
10- 1	9.0891	9.125	# 5 at	5.125	13-# 4	8-# 4
10- 2	9.1153	9.125	# 5 at	5.000	13-# 4	8-# 4
10- 3	9.1479	9.250	# 5 at	5.125	13-# 4	8-# 4
10- 4	9.1741	9.250	# 5 at	5.000	13-# 4	8-# 4
10- 5	9.2003	9.250	# 5 at	5.000	13-# 4	8-# 4
10- 6	9.2265	9.250	# 5 at	5.000	14-# 4	8-# 4
10- 7	9.2593	9.375	# 5 at	5.000	13-# 4	8-# 4
10- 8	9.2855	9.375	# 5 at	5.000	14-# 4	8-# 4
10- 9	9.3742	9.375	# 6 at	7.000	9-# 5	6-# 5
10-10	9.4071	9.500	# 6 at	7.000	9-# 5	6-# 5
10-11	9.4333	9.500	# 6 at	7.000	9-# 5	6-# 5
11- 0	9.4594	9.500	# 6 at	6.875	9-# 5	6-# 5
11- 1	9.4855	9.500	# 6 at	6.875	10-# 5	6-# 5
11- 2	9.5188	9.625	# 6 at	6.875	9-# 5	6-# 5
11- 3	9.5449	9.625	# 6 at	6.875	10-# 5	6-# 5
11- 4	9.5710	9.625	# 6 at	6.750	10-# 5	6-# 5
11- 5	9.5971	9.625	# 6 at	6.750	10-# 5	6-# 5
11- 6	9.6231	9.625	# 6 at	6.625	10-# 5	6-# 5
11- 7	9.6566	9.750	# 6 at	6.750	10-# 5	6-# 5
11- 8	9.6827	9.750	# 6 at	6.750	10-# 5	6-# 5
11- 9	9.7087	9.750	# 6 at	6.625	10-# 5	6-# 5
11-10	9.7347	9.750	# 6 at	6.625	10-# 5	6-# 5
11-11	9.7685	9.875	# 6 at	6.625	10-# 5	6-# 5
12- 0	9.7945	9.875	# 6 at	6.625	10-# 5	6-# 5

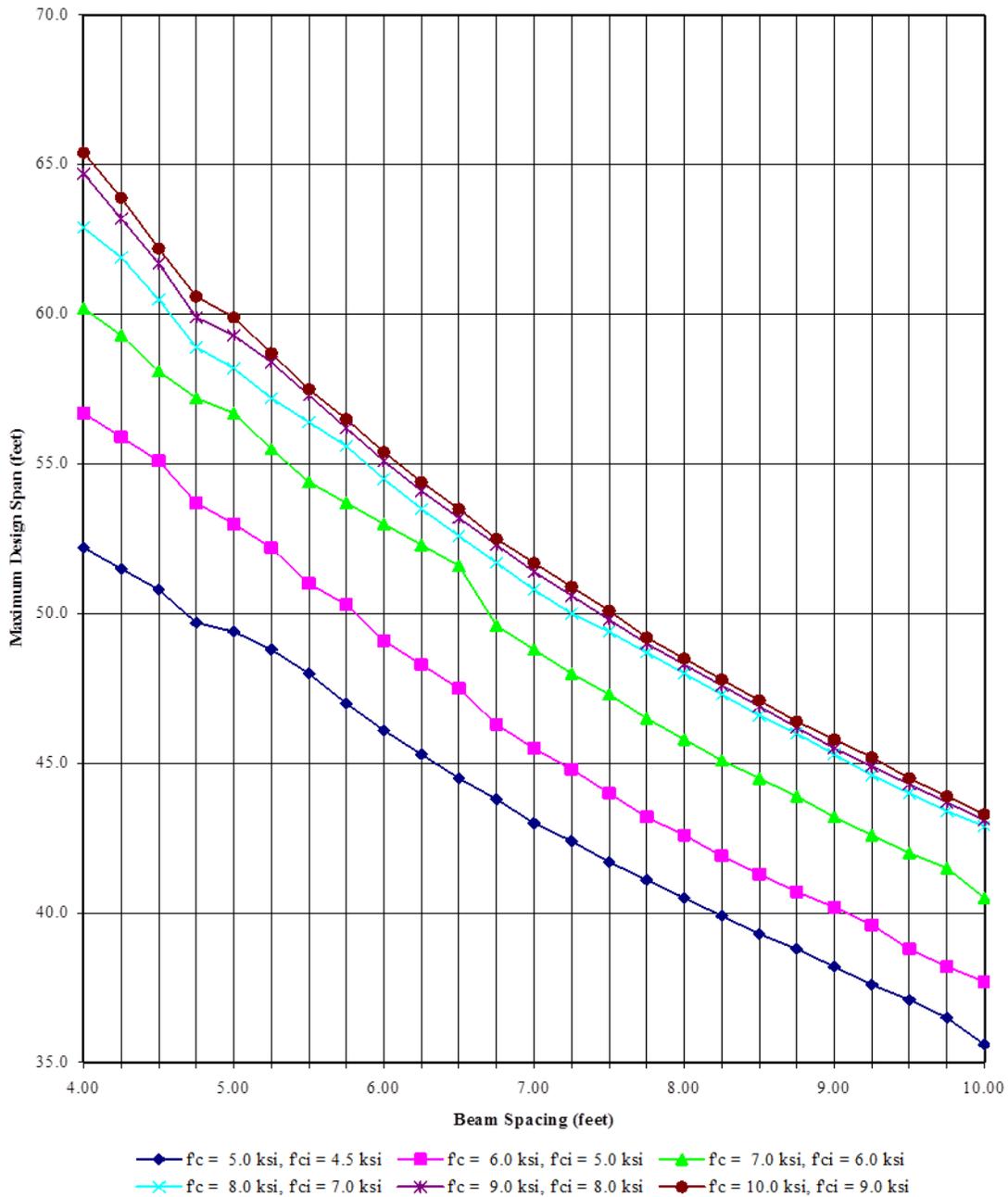
Appendix 3D – Standard Specification Beam Charts

Beam Spacing (X-Axis) versus Maximum Design Span (Y-Axis)

Assumptions

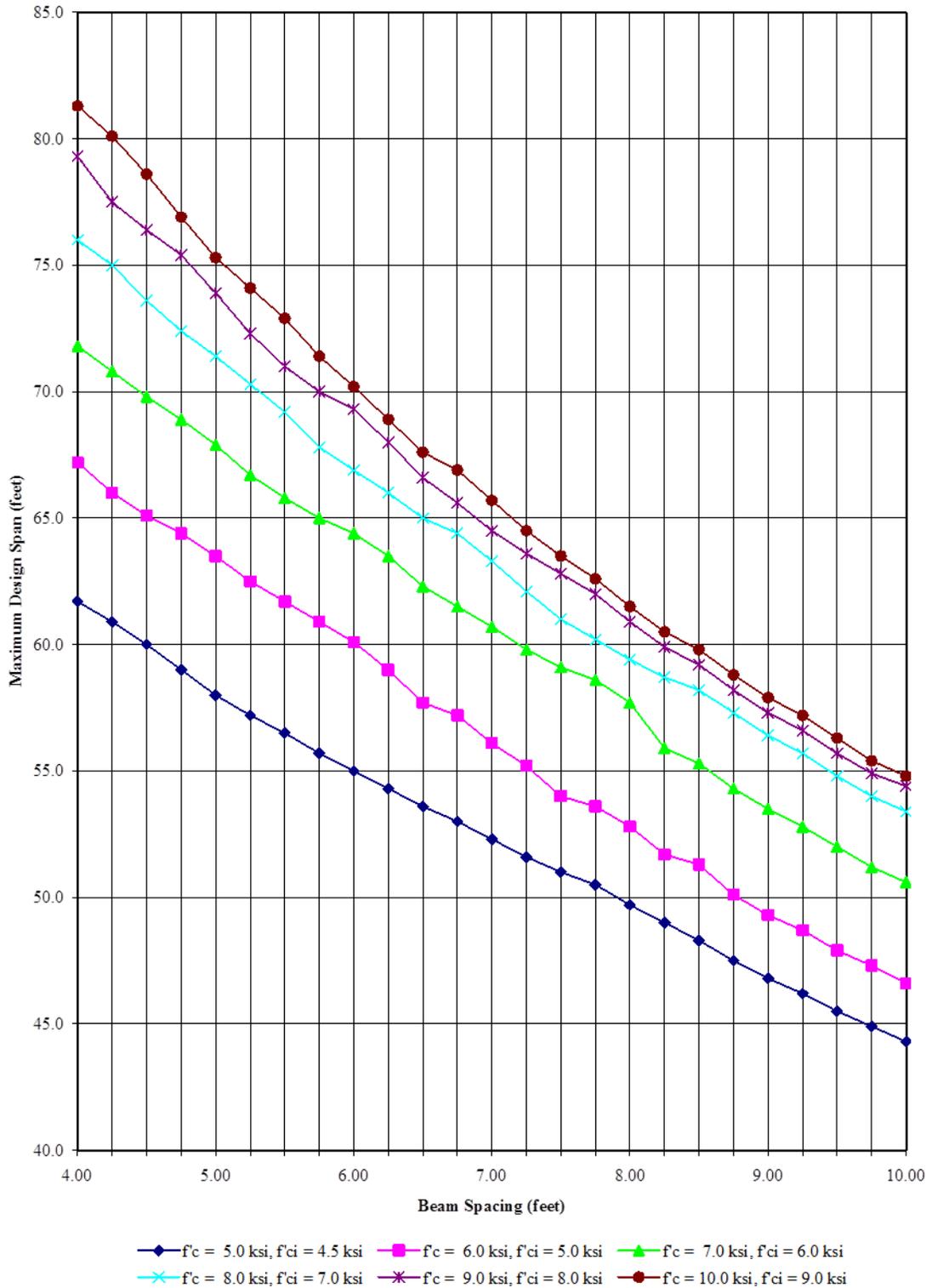
1. Beam Spacing – 4.0' to 10.0' in .25' increments
2. Number of Lanes = 3, constant
3. Number of Beams = 6, constant
4. Slab was design using BRSLAB99 with 2½" cover
5. Maximum Design Span was determined using BRPSBM1
 - a. Live Load: HS20 with Impact
 - b. Concrete Properties
 - i. $E_c = [(145)1.5](33)[(f'c).5]$
 - ii. Dead Load = 150 pcf
 - iii. Initial Tension in the Beam (SIT) = $6(f'c).5$
 - iv. Final Tension in the Beam (SIF) = $6(f'c).5$
 - c. Distribution Factor for Deflection = 1.000
 - d. Composite Slab Properties – Depth of Coping (DF)
 - i. 0.000, Type I MOD through Type IV PSC Beams
 - ii. 1.000, Bulb Tees
 - e. Non-composite Dead Loads (NCDL) – Coping
 - i. $[(1.5)(\text{Top Flange Width})/144](.150)$, Type I through Type IV PSC Beams
 - ii. $[(3)(\text{Top Flange Width})/144](.150)$, Bulb Tees
 - f. One Diaphragm at Midpoint for all spans greater than 40'-0"

Type I MOD PSC Beam (Standard Spec)



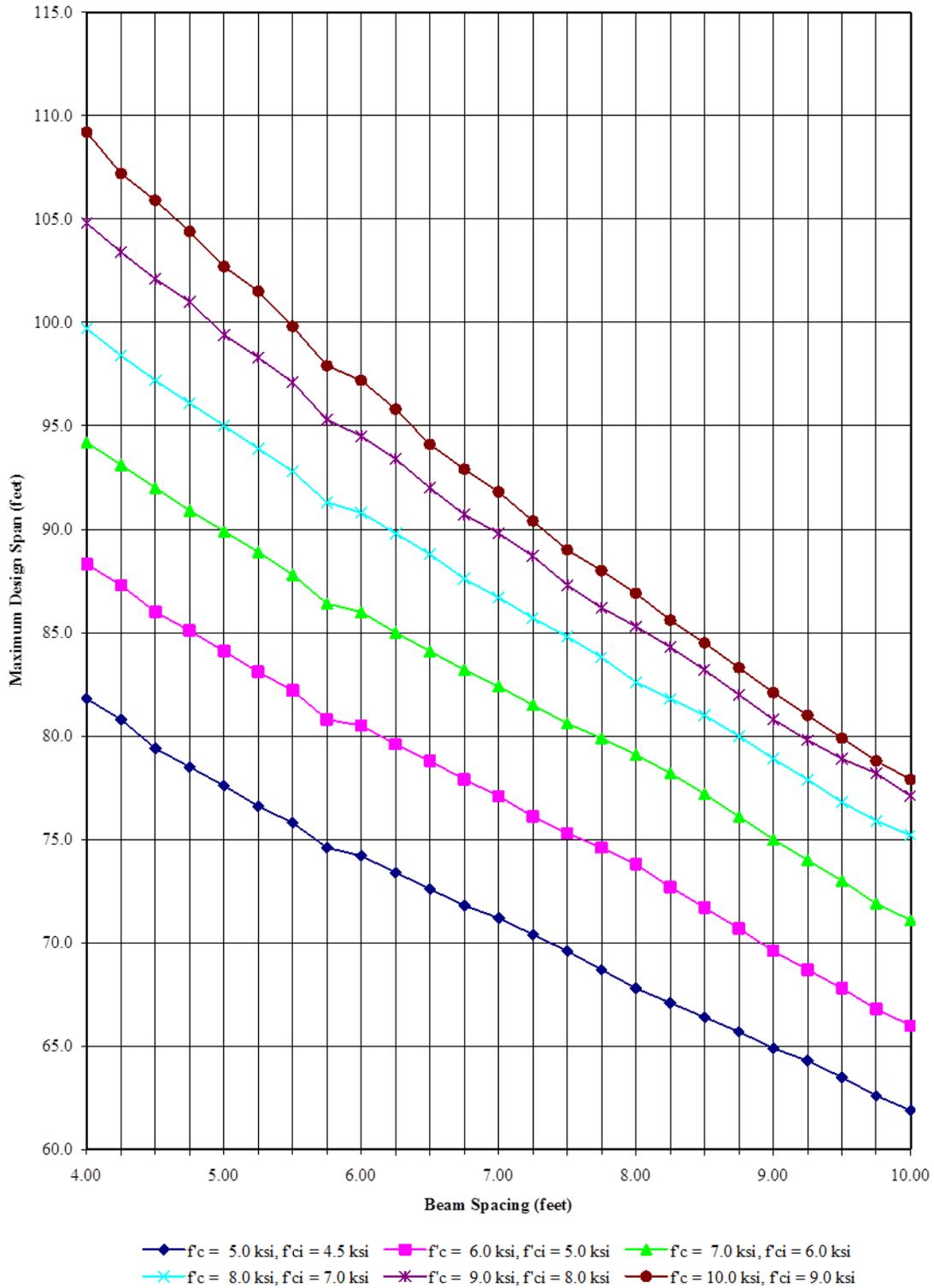
All strands are 1/2" diameter low relaxation strands each stressed to 33,818 pounds.

Type II PSC Beam (Standard Spec)



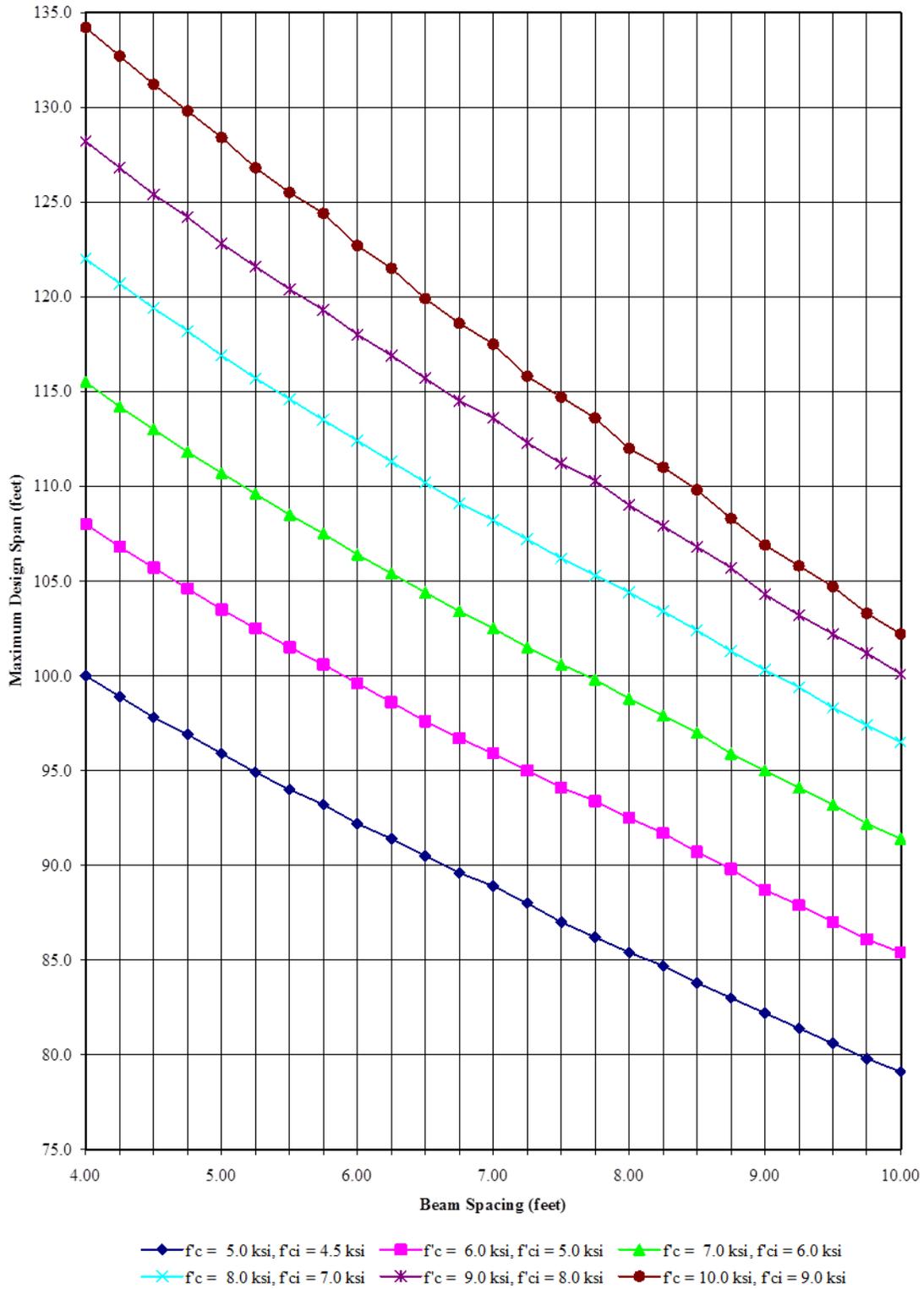
All strands are 1/2" diameter low relaxation strands each stressed to 33,818 pounds.

Type III PSC Beam (Standard Spec)



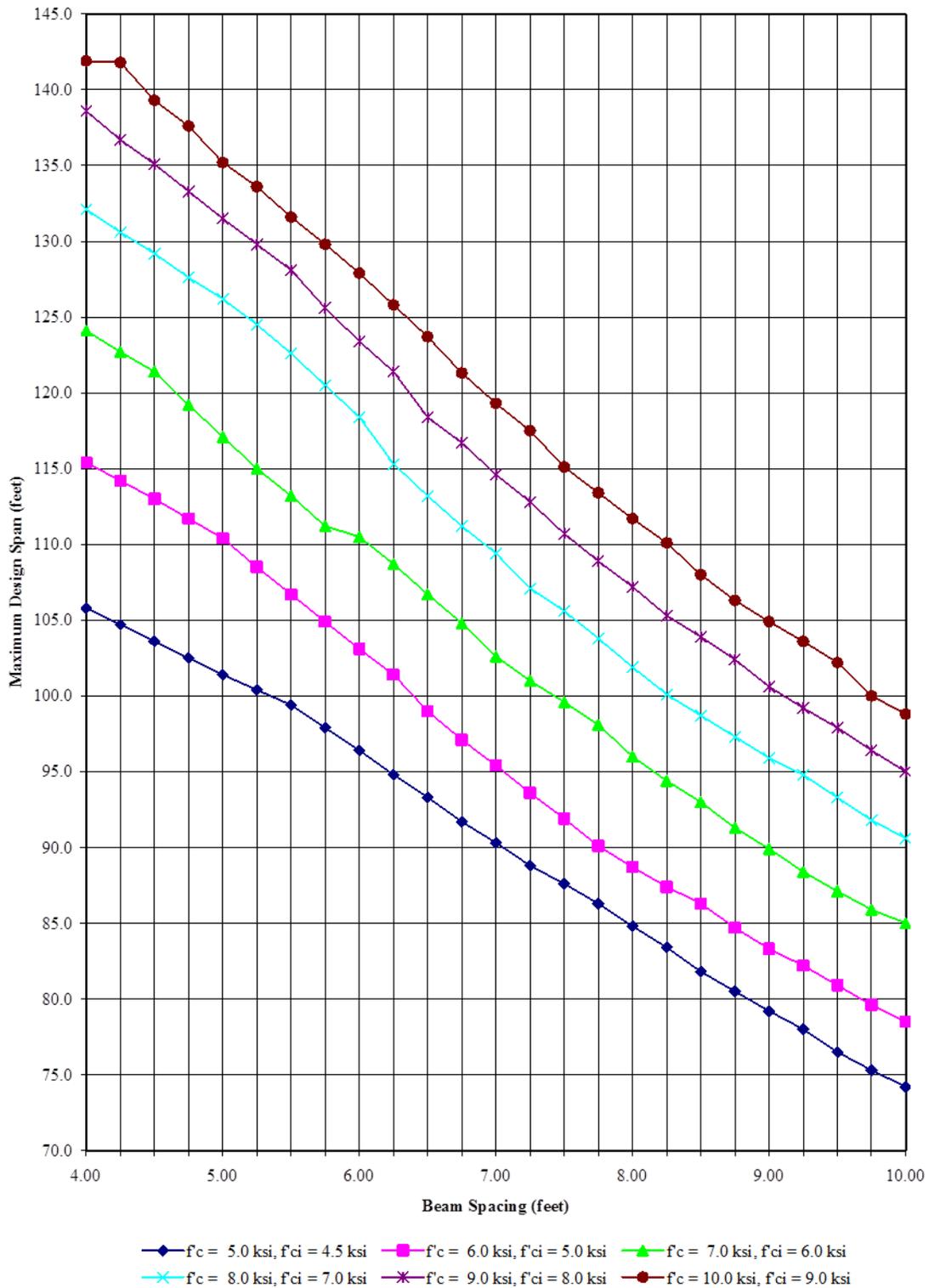
All strands are 1/2" diameter low relaxation strands each stressed to 33,818 pounds.

Type IV PSC Beam (Standard Spec)



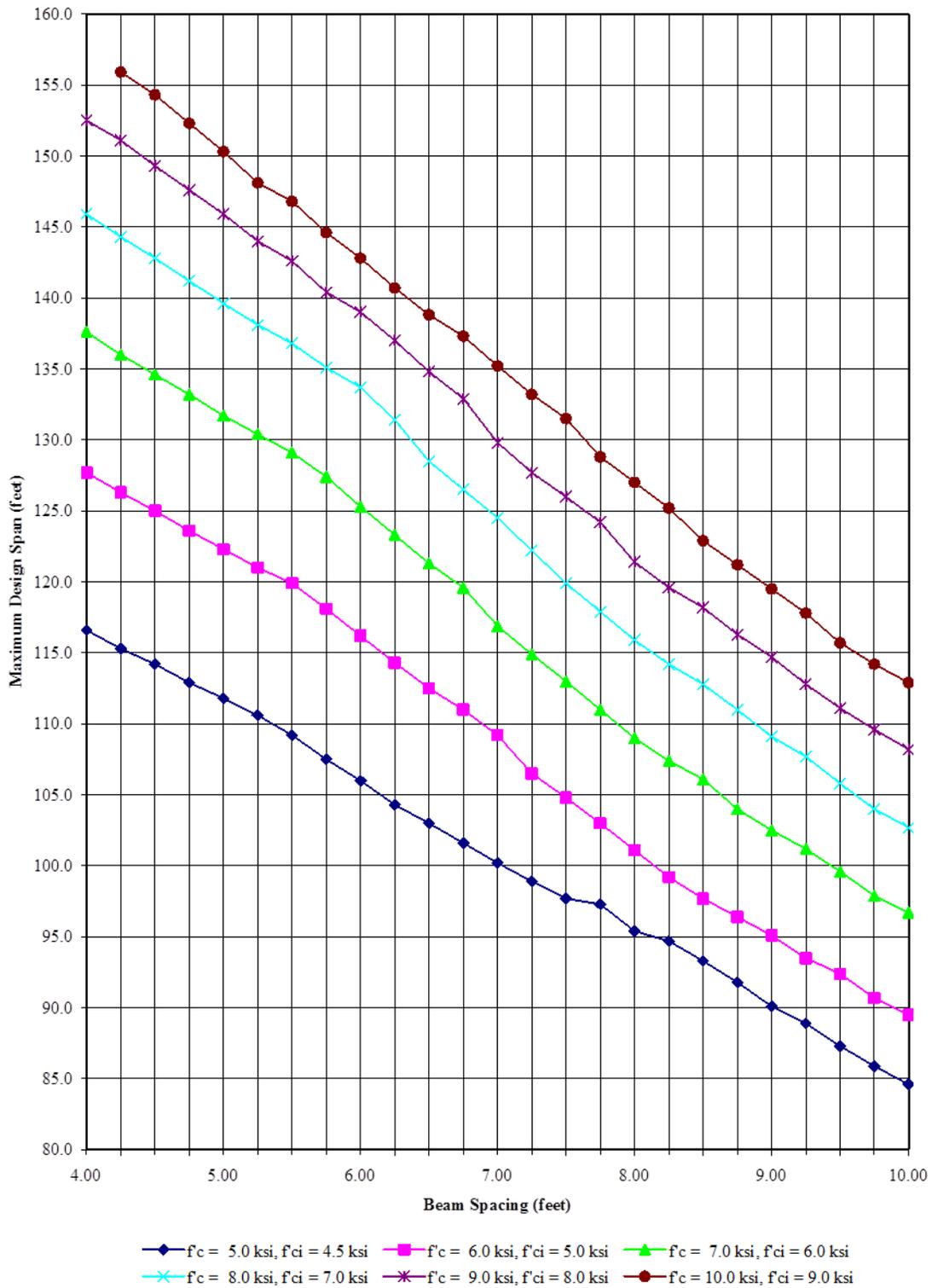
All strands are 1/2" diameter low relaxation strands each stressed to 33,818 pounds.

54" Bulb Tee Beam (Standard Spec)



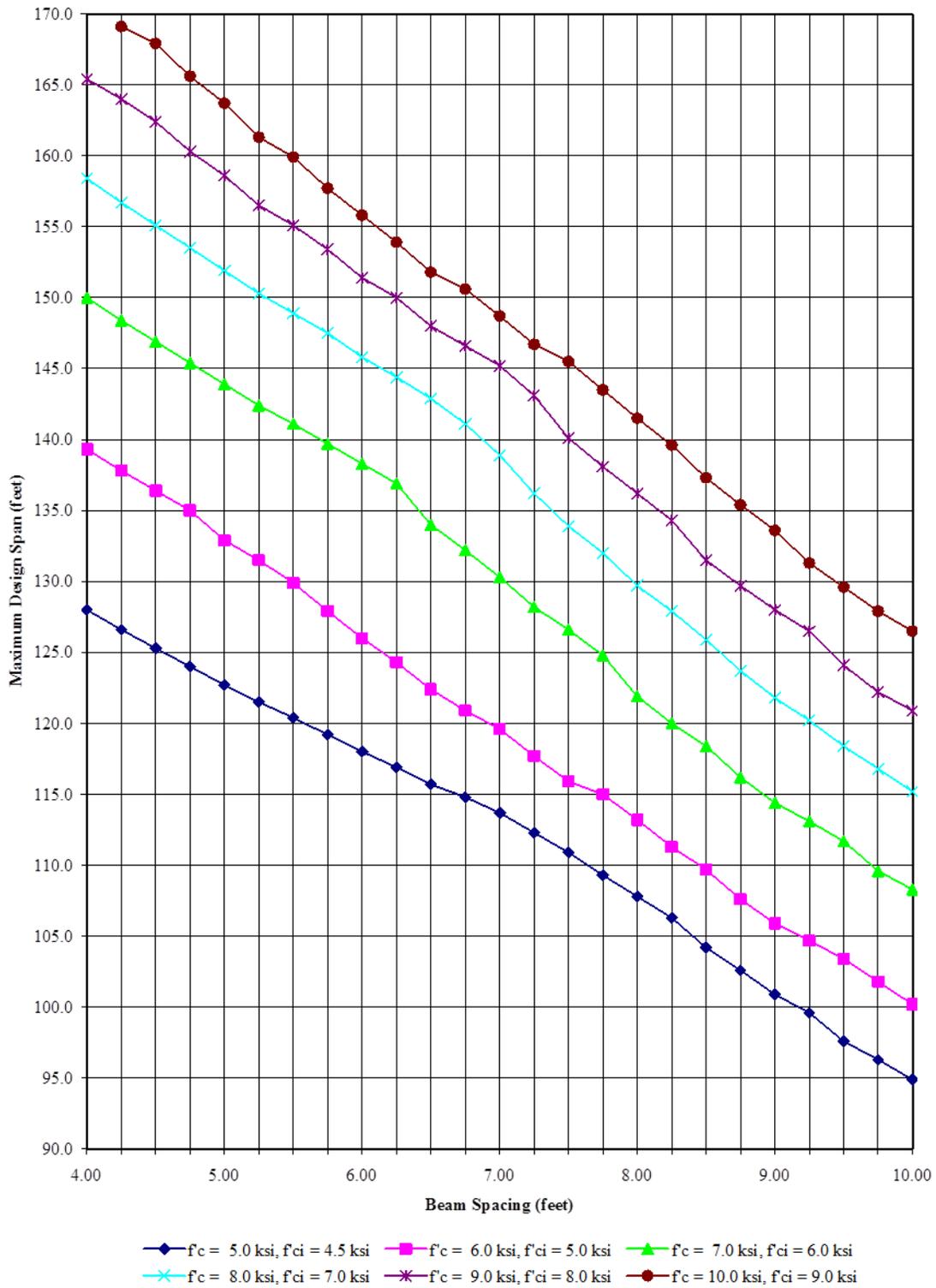
All strands are .6" diameter low relaxation strands. The 4 top flange strands are stressed to 10,000 pounds each and all remaining strands are stressed to 43,943 pounds each.

63" Bulb Tee Beam (Standard Spec)



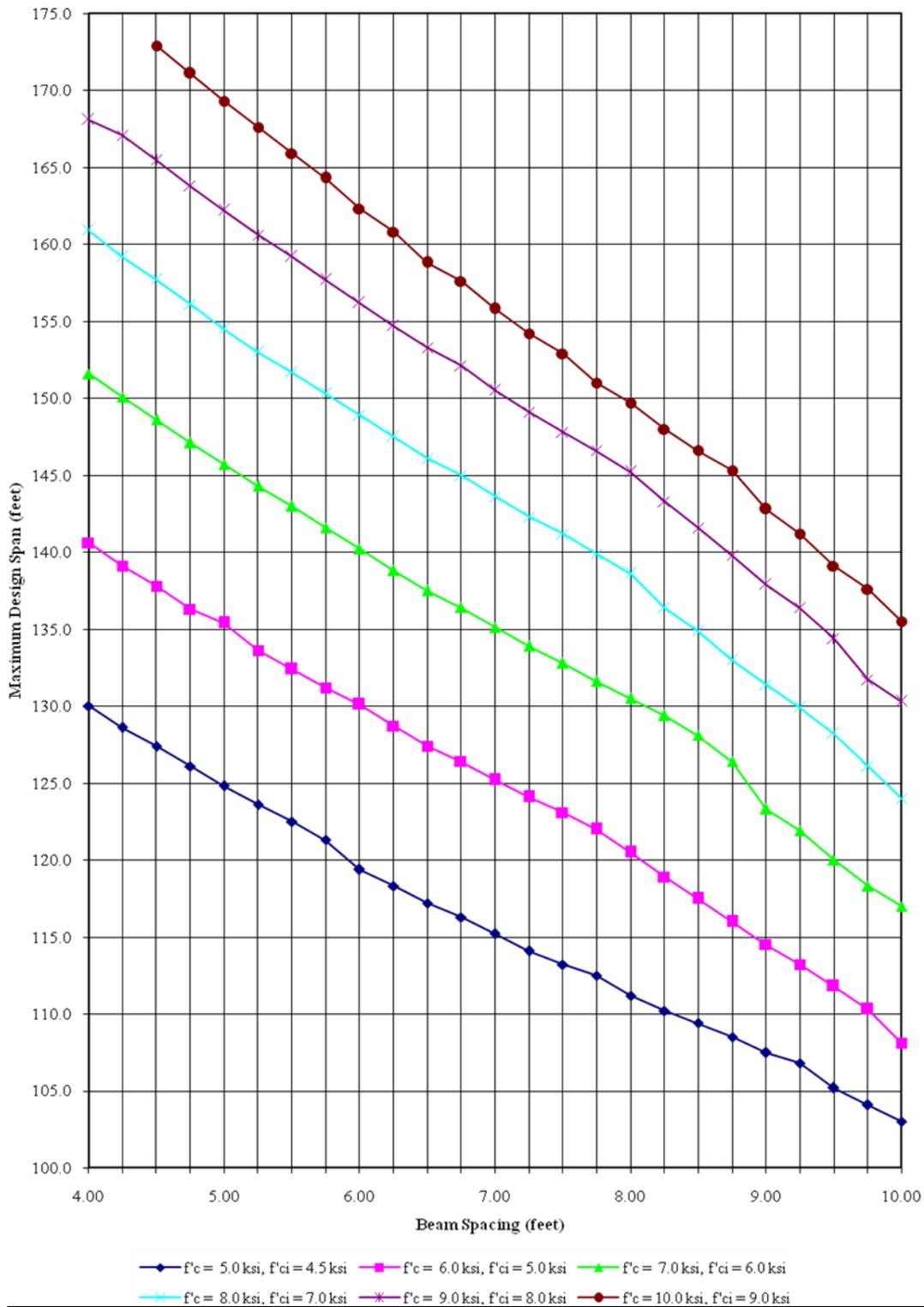
All strands are .6" diameter low relaxation strands. The 4 top flange strands are stressed to 10,000 pounds each and all remaining strands are stressed to 43,943 pounds each.

72" Bulb Tee Beam (Standard Spec)



All strands are .6" diameter low relaxation strands. The 4 top flange strands are stressed to 10,000 pounds each and all remaining strands are stressed to 43,943 pounds each.

74" Bulb Tee Beam (Standard Spec)



All strands are .6" diameter low relaxation strands. The 4 top flange strands are stressed to 10,000 pounds each and all remaining strands are stressed to 43,943 pounds each.

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Chapter 4. Substructure

4.1 Concrete and Reinforcement for Substructure

General requirements for reinforced concrete are as follows:

- a) Use Grade 60 steel for reinforcement.
- b) The length of detailed reinforcing bars should not exceed 60 feet.
- c) Use 3.5 ksi concrete for all substructure elements when the bridge is supported by one or more concrete column piers.
- d) Use 3.0 ksi concrete for all substructure elements if there are no concrete column piers supporting the bridge.
- e) For LRFD projects, use Class 2 exposure condition in accordance with LRFD 5.7.3.4 for any bridges over waterways located fully or partially in the following coastal counties: Chatham, Bryan, Liberty, McIntosh, Glynn, and Camden. Use Class 1 exposure condition for all other bridges.
- f) Use 3.0 inch cover in accordance with LRFD 5.12.3 for any bridges over waterways located fully or partially in the coastal counties listed above. This requirement applies to Standard Specification bridges as well.
- g) When the least dimension of a concrete bridge component is greater than 5'-0" or the diameter of a drilled shaft is greater than 6'-0", Special Provision 500 – Concrete Structures for mass concrete will be required. Include the following note on the General Notes sheet:

“MASS CONCRETE – BRIDGE CONTAINS COMPONENTS SUBJECT TO MASS CONCRETE REQUIREMENTS, SEE SPECIAL PROVISION SECTION 500 – CONCRETE STRUCTURES. NO SEPARATE MEASUREMENT AND PAYMENT WILL BE MADE FOR MASS CONCRETE. INCLUDE ALL COSTS, INCLUDING INCIDENTALS, IN THE PRICE BID SUBMITTED FOR _____ CONCRETE.”

4.2 Foundations

4.2.1 General

Foundations for bridges shall be designed based on the Bridge Foundation Investigation (BFI) report approved by the Office of Materials.

All loads and resistances presented on the plans shall be in kips, kips per linear foot (klf) or kips per square foot (ksf).

4.2.1.1 500-Year Scour for Stream Crossings

Foundation depths shall be determined based on the 500-year storm event and the associated 500-year scour line. This scour line shall be shown on the Preliminary Layout but may be adjusted in the BFI based on detailed geotechnical exploration.

When piles are used, they should penetrate a minimum of 10 feet below the 500-year scour line. Spread footings should be keyed in below the 500-year scour line. Deep foundations shall be examined for the 500 year storm event.

For Standard Specification projects, deep foundations shall be designed for a Safety Factor = 1.0 for the 500 year storm event.

Scour information shall not be included in the final bridge plans.

4.2.1.2 Foundation Types

Foundations shall be designed for existing conditions. The foundations for highway bridges consist of the following types necessary to support the superstructure:

- Driven piles for pile bents
- Caissons (drilled shafts)
- Spread footings
- Pile footings

For general guidelines for foundation types in Georgia, see Appendix 4A.

4.2.2 Driven Piles

4.2.2.1 Pile Type and Size Selection

GDOT uses the following pile types:

- Steel H piles
- Prestressed concrete (PSC) piles
- Metal shell piles

Driven piles shall be designed in accordance with LRFD 10.7 or Standard Specification 4.5, as appropriate.

4.2.2.2 General

For future reference of pile design loads and for verification of loads used in preparing the LRFD BFI, include the following note on all sheets for substructures that utilize driven piles:

“Piles are designed for a maximum factored axial load of ____ kips.”

The LRFD BFI will specify the method to measure driving resistance in the field. The two methods commonly used by GDOT are Dynamic Testing and FHWA-Modified Gates Formula. If Dynamic Testing is required, place the following General Note in the plans:

“Driving resistance - determine pile driving resistance using dynamic pile testing in accordance with special provision 520. Dynamic pile testing shall be required for one pile at each of bents **, ** and **.”

When Special Provision 523 specifies Pile Driving Analyzer (PDA) test to be performed by GDOT personnel, include the following General Note in the plans:

“Dynamic pile testing - Pile Driving Analyzer (PDA) will be utilized by the Georgia DOT during the pile driving operation in accordance with special provision 523. Notify the Geotechnical Bureau of the Georgia DOT office of materials and testing at 404-608-4720 two weeks prior to driving piles.”

When Special Provision 523 indicates PDA test to be performed by the Contractor, include the following General Note in the plans:

“Dynamic pile testing - perform pile testing using the Pile Driving Analyzer (PDA) in accordance with special provision section 523. Notify the Geotechnical Bureau of the Georgia DOT office of materials and testing at 404-608-4720 two weeks prior to driving piles.”

Include the following pay item when Dynamic Testing is specified. The number of tests is indicated in the LRFD BFI by designating test locations.

523-1100 ** EA dynamic pile test**

If FHWA-Modified Gates Formula is specified, place the following General Note in the plans:

“Driving resistance - determine driving resistance for piles using FHWA-modified gates formula in accordance with special provision 520.”

For all LRFD projects, WAVE equation analysis should be performed by the contractor and submitted to the Geotechnical Bureau for review and approval. Place the following General Note in the plans for all LRFD projects (except for Design-Build projects):

“Wave equation - Perform Wave Equation Analysis (WEAP) in accordance with special provision 520. Provide results of the WEAP to the Geotechnical Bureau of the Georgia DOT office of materials and testing for review and approval two weeks prior to driving piles.”

Once the LRFD BFI report has been completed and accepted, a variation of up to 5% between the final calculated pile load and the value in the LRFD BFI report does not require a revision of the LRFD BFI report or driving resistance. Use the driving resistance from the LRFD BFI report and the final calculated maximum factored axial load on the plans.

Batter piles, where required, are typically battered at a rate of 1½ inches horizontal on 12 inches vertical. The batter shall not exceed 4:12.

The designer shall include driving data piles on bridges at the rate of about one for every four bents. Driving data pile locations shall be designated on the General Notes sheet using the Driving Data Piles note from the BridgeNotes program. On bridges with PSC piles, the test piles can be counted as driving data piles.

Total pay quantity for piling is rounded off to the nearest 10 feet. Length of each pile can be calculated as the difference between top of pile elevation and the estimated tip elevation (or average estimated tip if a range is given) from the BFI. The designer shall include the additional length of piles caused by batter piling.

The designer shall always include a pay item for a load test for each different pile (type and size) used on the project.

4.2.2.3 Steel H Piles

Steel H piles specified for use in the Bridge Foundation Investigation (BFI) report will be one or several of the following sizes:

- HP 10x42
- HP 12x53
- HP 14x73
- HP 14x89
- HP 14x102
- HP 14x117

One large pile may require a higher capacity pile hammer but this may still be more economical than driving two smaller piles per beam in an end bent.

When H-pile intermediate bents are recommended in the Foundation Recommendation Letter, 36 ksi H-piles should be used for all H-piles at the bridge site. Use 50 ksi H-piles only when all the H-piles are fully embedded for the entire bridge. Do not use 36 ksi and 50 ksi piles for the same bridge.

If 50 ksi piles are used, indicate this in the Design Data section of the General Notes sheet and include the following note on the General Notes sheet:

“STEEL H-PILES - use steel for H-piles that meets the requirements of ASTM a 709 gr 50.”

The following stresses and maximum factored structural resistance values for steel H-Piles should be used in preparation of all LRFD BFI reports and is incorporated in the GDOT LRFD BFI report template. The piles are assumed to be continuously supported during driving operations. A resistance factor of 0.5 from LRFD 6.5.4.2 was used assuming piles subject to damage with axial loading only.

Table 4.2.2.3-1 Properties for Grade 36 Steel H-Piles (LRFD)

Pile Size	Stress Limits		Max. Factored Structural Resistance, P _R (kips)
	Compression (ksi)	Tension (ksi)	
HP 10x42	32.4	32.4	223
HP 12x53	32.4	32.4	279
HP 14x73	32.4	32.4	385
HP 14x89	32.4	32.4	470
HP 14x102	32.4	32.4	540
HP 14x117	32.4	32.4	619

Table 4.2.2.3-2 Properties for Grade 50 Steel H-Piles (LRFD)

Pile Size	Stress Limits		Max. Factored Structural Resistance, P_R (kips)
	Compression (ksi)	Tension (ksi)	
HP 10x42	45.0	45.0	310
HP 12x53	45.0	45.0	384*
HP 14x73	45.0	45.0	520*
HP 14x89	45.0	45.0	653
HP 14x102	45.0	45.0	750
HP 14x117	45.0	45.0	860

* 12x53 and 14x73 H-pile sections are slender elements for Grade 50 steel and a reduction has been applied in accordance with LRFD 6.9.4.2.

For LRFD projects, when steel H-piles are driven to hard rock, verify the maximum factored structural resistance from the above tables is greater than the driving resistance for the respective pile to mitigate potential damage to the pile.

4.2.2.4 Prestressed Concrete (PSC) Piles

Prestressed concrete (PSC) piles specified for use in the Bridge Foundation Investigation (BFI) report will be one or several of the following sizes:

- 14" x 14"
- 16" x 16"
- 18" x 18"
- 20" x 20"
- 24" x 24"
- 30" x 30"
- 36" x 36"

The details of the PSC piles listed above are specified in the GDOT Standard 3215. The designer shall receive approval from the Bridge Office prior to using a PSC pile size greater than 20".

The following stresses and maximum factored structural resistance values for PSC piles should be used in preparation of all LRFD BFI reports and is incorporated in the GDOT LRFD BFI report template. The piles are assumed to be continuously supported during driving operations. A resistance factor of 0.75 from LRFD 5.5.4.2 was used for compression controlled sections. The 28-day concrete strength is 5.0 ksi and pile detailing is in accordance with Georgia Standard 3215.

Table 4.2.2.4-1 Properties for PSC piles (LRFD)

Pile Size	Stress Limits			Max. Factored Structural Resistance, P _R (kips)
	Compression (ksi)	Tension (ksi)		
		Normal	Severe	
14" SQ PSC	3.214	1.248	1.036	473
16" SQ PSC	3.457	1.005	0.793	636
18" SQ PSC	3.623	0.839	0.627	820
20" SQ PSC	3.573	0.889	0.677	1006
24" SQ PSC, VOID	3.519	0.943	0.731	1158
24" SQ PSC	3.662	0.800	0.588	1464
30" SQ PSC, VOID	3.553	0.909	0.697	1706
30' SQ PSC	3.561	0.901	0.689	2224

The following reference shall be included on the General Notes sheet under Bridge consists of:

“SQUARE PRESTRESSED CONCRETE PILES ----- GA. STD. 3215 (2-22-84)”

When the BFI recommends PSC piles, it will also call for test piles with locations. The contractor uses test piles, longer than estimated pile lengths, to determine final order lengths of the remaining piles. The length of test pile shall be 5 feet plus the top of pile elevation minus the estimated tip elevation. Round test pile lengths up to the nearest foot. Because test piles are part of permanent construction, the engineer must deduct the calculated in-place length, not the test pile length, from the total piling quantity.

If severe corrosion or other unusual problems make Type II cement or HPC (High Performance Concrete) necessary as recommended by the Office of Materials, the designer shall include the High Performance Concrete (HPC) Piles note on the General Notes sheet using the BridgeNotes program.

Freeze bearing for piles may be required in the BFI for certain conditions. In this case, the pile driving notes shall be included in the General Notes sheet as follows:

- a) When freeze bearing is required if the piles fail to attain driving resistance after achieving the minimum tip elevation, include the Pile Driving note using the BridgeNotes program.
- b) When freeze bearing is required if the piles fail to attain driving resistance after achieving the estimated tip elevation, include the Pile Driving (Table) note using the BridgeNotes program.

Do not use the words "estimated tip" in the plans since these words are a reflection of the BFI, which is not a part of the contract.

4.2.2.5 Metal Shell (MS) Piles

Metal shell (MS) piles specified for use in the Bridge Foundation Investigation (BFI) report will be one or several of the following sizes:

- 12 ¾” O.D.
- 14” O.D.
- 16” O.D.
- 18” O.D.
- 20” O.D.
- 24” O.D.

MS piles shall be driven and then filled with concrete at all locations as specified in the GDOT Standard Specifications. MS piles at intermediate pile bents also include reinforcement as detailed in the GDOT Bridge Cell Library. It is assumed that the metal shell does not contribute to the total capacity of the pile.

The following stresses and maximum factored structural resistance values for Metal Shell piles should be used in preparation of all BFI reports and is incorporated in the GDOT BFI report template. The piles are assumed to be continuously supported during driving operations. Grade 3 steel as specified in ASTM A252 (steel yield strength = 45 ksi) is used for the calculations. No factored axial structural resistances were provided since the load will be controlled by the drivability limits of the metal shell.

Table 4.2.2.5-1 Properties for Metal Shell Piles

Pile Size	Shell Thickness (in)	Stress Limits	
		Compression (ksi)	Tension (ksi)
14” Diameter	0.2500	40.5	40.5
14” Diameter	0.3125	40.5	40.5
16” Diameter	0.2500	40.5	40.5
16” Diameter	0.3125	40.5	40.5
18” Diameter	0.3125	40.5	40.5
20” Diameter	0.3125	40.5	40.5
24” Diameter	0.5000	40.5	40.5

Metal shell thickness shall be modified based on the outer diameter by including the Metal Shell Pile note on the General Notes sheet using the BridgeNotes program.

GDOT Standard Specification 520 includes two detailing options (Option 1 and Option 2) for metal shell pile closure plates. Option 1 is specified as the default option; however, if the BFI recommends Option 2, the following note shall be added to the General Notes sheet:

“PILE CLOSURE PLATE DETAIL - USE CLOSURE PLATE OPTION 2 AT THIS SITE IN ACCORDANCE WITH SUB-SECTION 520.3.05.M OF THE GEORGIA DOT SPECIFICATIONS.”

4.2.2.6 Timber Piles

Timber piles shall not be used on any GDOT bridge project. They are sometimes used to support culverts in poor soils.

4.2.2.7 Pile Driving Aids

4.2.2.7.1 Jetting and Spudding

The BFI often recommends jetting and/or spudding to assist penetration for PSC or MS piles. Jetting consists of using water at the tip of the pile to loosen the soil and aid driving. Spudding consists of using a "spud" (usually a heavy H-pile) to break up hard layers before driving the permanent pile. The designer shall include the Piling (Jetting and Spudding) note from the BridgeNotes program on the General Notes sheet when jetting and/or spudding are recommended in the BFI. No pay item is required for jetting and/or spudding.

4.2.2.7.2 Predrilling

The BFI may recommend predrilling be allowed at the contractor's option in lieu of jetting or spudding. Predrilling consists of loosening the soil with an auger to aid driving. The BFI will include an elevation for the limit of predrilling, which will usually be referenced to the estimated or minimum pile tip. When the BFI mentions predrilling, the designer shall include the Piling (Predrilling in lieu of Jetting and Spudding) note from the BridgeNotes program on the General Notes sheet instead of the jetting and spudding note. No pay item is required for predrilling.

4.2.2.7.3 Pilot Holes

The BFI sometimes recommends pilot holes for piles in order to assure adequate penetration below the scour line. Pilot holes are created by using an auger to remove the soil. This process is more costly than predrilling. The designer shall include the Pilot Hole note from the BridgeNotes program on the General Notes sheet and specify the required diameter and bottom elevation of the pilot hole in the note. Pay item 520-5000 PILOT HOLES shall be in the plans to cover the required quantity of pilot holes.

4.2.2.7.4 Pile Points

When the BFI calls for pile points to ensure adequate penetration into weathered rock, the designer shall include the Pile Points note on the General Notes sheet using the BridgeNotes program.

In special cases where it is anticipated piles will have to be driven through boulders, rock layers, or hard buried objects, such as concrete, extremely hard stumps or wooden piles, the BFI may recommend the use of special driving points, other than those called for in the GDOT Standard Specifications. In this case, the designer shall include the following note on the General Notes sheet:

“PILE POINTS – REINFORCE ALL PILE TIPS AT BENTS ** WITH PRUYN POINT NO. 75750 OR APPROVED EQUAL.”

4.2.3 Caissons

4.2.3.1 General

When caissons are recommended in the BFI, foundation bearing strength and bottom elevations for caissons will be included. Details and requirements for caisson construction are covered under Special Provision 524 which is usually included with the BFI. Special provision 524 also includes important information such as whether the hole is dry or wet (uses slurry) and whether a demonstration shaft is required.

4.2.3.2 Dimensions

The diameter of a caisson shall be designed in 6" increments. A minimum caisson diameter of 48 inches is required for dry caissons to allow access by inspectors. All caissons shall have a minimum concrete cover of 6".

4.2.3.3 Elevations

Caisson tip elevations should be given to one decimal place and a plus/minus sign to indicate possible variations.

For caissons in the water, detail the top of the caisson 1 foot above the normal pool elevation for quantity calculations. The assumed normal pool elevation shall be included in a note on the plans. Include a note directing the contractor to set the top of caisson 1 foot above the water surface at the time of construction. For caissons in the ground, the top shall be 1 foot below final ground elevation.

4.2.3.4 Reinforcement

Reinforcement in the caisson is specified by size only (#11 instead of 1110) because payment for it is included in linear feet of caisson. However when using a transition bar that laps with the steel in the caisson and the steel in the column, that steel can be detailed and included in the bar schedule. Do not use hooked bars in the top of a caisson.

Use hoop stirrups for caissons. Spiral reinforcement is not allowed in caissons. Stirrups shall not be larger than #6 bars. The clear spacing between caisson stirrups shall be limited to a minimum of 5" to allow for effective movement of concrete. Similarly, vertical caisson reinforcement should have a minimum of 5" clear spacing.

No seismic detailing for a plastic hinge is required near the theoretical fixity location.

4.2.4 Spread Footings

4.2.4.1 Dimensions and Elevations

Use a square spread footing whenever possible. Plan footing dimensions shall be detailed in 3 inch increments in each direction. Spread footings shall be a minimum of 2'-3" thick to allow for the development of the hooks of No. 11 bars from the column.

Bottom of spread footing elevation should be given to one decimal place and a plus/minus sign to indicate possible variations. Bottom of footing elevations should be set to provide a 2 foot minimum soil cover over the footing.

4.2.4.2 Reinforcement

When using a square footing, use the same reinforcement in both the transverse and longitudinal directions to avoid incorrect installations in the field.

In addition to the mat of reinforcement at the bottom of the footing for design, detail a mat of reinforcement at the top of the footing comprised of #4 bars spaced at a maximum of 12" in each direction.

4.2.4.3 Design and Additional Considerations

To allow for field variations in rock elevation, intermediate bents shall be designed for the case where the bottom of footing elevation is 3 feet lower than that indicated in the BFI. The designer shall include the Footing Elevations note from the BridgeNotes program on the General Notes sheet.

When recommended in the BFI, spread footings and the seals beneath spread footings should be keyed into the underlying material. A note shall be placed on the plans requiring the entire footing or seal be keyed in, not just the area under the column as indicated in the GDOT Standard Specifications.

Spread footings should not be used on rock embankment because of the potential for excessive settlement.

4.2.5 Pile Footings

4.2.5.1 Footing Dimensions and Elevations

Use a square pile footing whenever possible. Plan footing dimensions shall be detailed in 1" increments in each direction. Pile footings shall be a minimum of 3'-3" thick when steel H-piles are used and 3'-6" when PSC piles or metal shell piles are used to allow for the development of the hooks of No. 11 bars from the column.

Bottom of pile footing elevations should be detailed to two decimal places.

4.2.5.2 Footing Reinforcement

Detail 180 degree hooks for the bottom reinforcement mat in pile footings. The bottom reinforcement mat can be placed directly on top of H-Piles. However, the designer shall detail 3 inches of clearance on top of metal shell and PSC piles to allow the footing concrete to properly bond with the footing reinforcement. When using a square footing, use the same reinforcement in both the transverse and longitudinal directions to avoid incorrect installations in the field.

When seismic detailing is required for the bridge, detail a mat of reinforcement at the top of the footing comprised of #4 bars spaced at a maximum of 12" in each direction.

4.2.5.3 Pile Layouts

Use one of the GDOT pile layouts that are presented in Appendix 4B to design pile footings.

Minimum pile spacing and edge distances shall be determined in accordance with LRFD 10.7.1.2 and detailed in 1 inch increments.

4.2.5.4 Design and Additional Considerations

Pile footings shall be designed for zero tension (no uplift) in the piling.

The top of the pile footings should be a minimum of 2 feet below ground, with the following exceptions for the bridges over the streams:

- a) If the bridge is located in one of the coastal counties and the waterway has very low flow velocity and low debris potential (such as in a coastal swamp), then the bottom of the footing will be located 1 foot above mean water level. This is known as a “pedestal bent”.
- b) If the bridge requires a large number of cofferdams for pile footing construction, pedestal bents could be used to eliminate the high cost cofferdams. However, use of this option must be approved by the Bridge Office.

When the BFI or the Office of Construction recommends setting up Type II backfill material under a footing, do not increase the bridge excavation quantity for this material since the GDOT Standard Specification covers additional excavation up to three feet below the plan elevation of the bottom of footing.

4.2.6 Cofferdams and Seals

4.2.6.1 General

When a bridge with concrete footings crosses a stream or its footings are located close to the water table, cofferdams and/or seal concrete may be necessary for intermediate bent construction. Since the need for cofferdams and/or seals is determined by the Office of Construction, the designer shall send a transmittal to the State Bridge Construction Engineer requesting a recommendation in accordance with Section 1.6.9.2.1.

Seals should not be used except as recommended by the Office of Construction due to the possibility of future voids under the seal. Contractors should not be allowed to substitute a concrete seal in lieu of dewatering cofferdams.

4.2.6.2 Dimensions and Elevations

Seals are typically 1'-6" wider on each side than the footprint of the footing. Use the following seal concrete thickness and strength that have been determined to resist the buoyant force from the hydraulic head (H) on the other side of the cofferdam:

- Seal concrete thickness for pile footings = $0.25 \times H \geq 2$ feet
- Seal concrete thickness for spread footings = $0.4 \times H \geq 2$ feet
- Seal concrete strength = 2.0 ksi

The Plan and Elevation sheet should show the elevation of the bottom of the seal for spread footings, but the bottom of the footing for pile footings. The water elevation used to determine the footing height should be shown on the intermediate bent sheet.

4.2.6.3 Seal Concrete Payment

If the plans do not include seal concrete but field conditions require it, the seal concrete price is based on the cost of Class A concrete according to the GDOT Standard Specifications. When

the plans include cofferdams but do not include either seal concrete or Class A concrete, a special provision is required to address payment for seal concrete.

4.3 End Bents

4.3.1 General

The following note shall be added to all end bent sheets that references Georgia Standard 9037 for drainage details required at end bents:

“SEE GA. STD. 9037 FOR DRAINAGE DETAILS AT END BENTS.”

The GDOT Standard Specifications state that no separate measurement will be made under the item of Bridge Excavation for any excavation necessary for end bent construction. Unusual situations, such as spread footing abutments, may require the following note on the General Note sheet for clarity:

“END BENT EXCAVATION – ALL COSTS FOR END BENT EXCAVATION SHALL BE INCLUDED IN THE OVERALL BID SUBMITTED”

4.3.2 End Bent Caps

Typically, a pile is placed under each beam, so the bent cap is subjected to minimal shears and moments. Use a 3' wide by 2' deep cap with typical reinforcement that can be found in the GDOT Bridge Cell Library. A 2-foot 6-inch wide cap can be used for unskewed RCDG bridges. When the skew angle causes the clearance from the bearing pad to the edge of cap to be less than 2 inches, the cap should be widened in 3-inch increments.

Cap step lengths do not need to match the calculated skewed beam distance so detail the cap steps to the nearest 1".

Detail a 3-inch diameter by 12-inch deep hole at each dowel bar or anchor bolt location. A deeper hole may be required for steel spans longer than 100 feet. For RCDGs, detail a No. 10 dowel bar to be cast in place.

If the elevation difference between adjacent cap steps is less than 1/2 inch, detail both steps to the lower elevation. No change to the D-dimension is necessary for this adjustment.

When different beam sizes or severe cross-slopes cause the top of cap step to be more than 6" above the main reinforcing, additional reinforcement will be required for that step. In this case, detail two No. 4 bars in the same direction of the main reinforcement at the top of the cap step with 2-inch clearance. Detail stirrups with approximately 1-foot spacing and with the legs extended down into the main cage a minimum of one foot.

The provisions for temperature and shrinkage reinforcement in LRFD 5.10.8 can be waived for side faces of bent caps with a minimum height of 2 feet or less. LRFD 5.10.8 can also be waived for the bottom of the pile cap for bents 3.5 feet wide or less.

For a skew of 50 degrees or sharper, it should be noted that the movement of an expansion endwall may be restricted by the sides of the cap steps. The designer should consider skewing the cap steps parallel to the beams to prevent this restriction of movement, particularly for fascia beams.

When the cap steps are less than 2 inches high, an extra thickness of expansion material adjacent to cap steps can be used in lieu of skewing the cap steps.

4.3.3 End Bent Piling

End bent piles should support all loads including loads from the approach slab. A typical 30-foot GDOT standard approach slab is designed based on the assumption that up to 10 feet of the subgrade could be lost, transferring the load to the paving rest and remaining soil. Therefore, it is assumed that the paving rest supports one end of the approach slab, which is modeled as a 10-foot simple beam, and transfers the dead and live loads to the piles.

If the end bent fill height is greater than 20 feet, add battered piles between beams at a rate of 1 per 4 or 5 vertical piles. If the pile spacing is very close, some of the load-bearing vertical piles can be battered instead of adding piles.

4.3.4 Wingwalls

The end of wingwall is determined by projecting the slope of the end roll up until it meets the shoulder grade at the inside face of the wing, as shown in Figure 4.3.4-1. The length of the wingwall is the distance from this end to the front face of cap, accounting for the effect of the skew.

Generally, use the same length for both wingwalls at an end bent. When the wingwall length becomes longer than 16.5 feet due to bent skew effects, the designer should keep the length of the side unaffected by the skew at 16.5 feet.

Wingwall length shall be detailed to the nearest 6 inches.

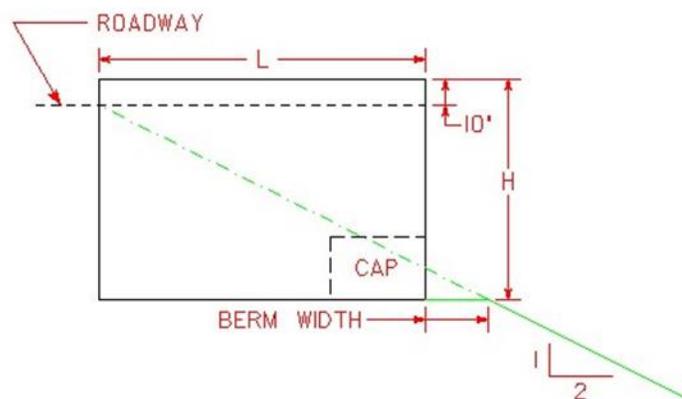


Figure 4.3.4-1 Wingwall Dimensions

The top of wingwall is determined by adding 4 to 10 inches to the shoulder grade at the beginning and end of the wingwall. The top of the wingwall should be leveled to the higher elevation if the difference is less than 6 inches. Use 6 inches as a minimum to match the transition curb of the approach slab when present. The bottom of the wingwall should be level.

On curved alignments, do not curve wingwalls. Skew the wingwall to prevent its encroachment on the shoulder.

Use of piling under wingwalls is governed by wingwall length (L) as follows:

- a) When $L \leq 12$ ft., no piles are needed.
- b) When $12 \text{ ft.} \leq L \leq 16.5$ ft., add one pile at the end.
- c) When $16.5 \text{ ft.} < L \leq 20$ ft., add one pile each at the mid-point and at the end
- d) When $L \geq 20$ ft., add one pile each at the end and at third points along the wingwall length.

A 2'-6" square pile box should be placed at each pile location in the wingwall. Increase the size of the box to 3'-0" square when using 18-inch or larger piles to maintain minimum clearance.

4.3.5 Rip Rap

At stream crossings, indicate rip rap on the endrolls as specified on the preliminary layout and in the hydraulic study. Extend the rip rap limit 20 feet beyond the end of the wingwall. The calculated rip rap quantity should also be used for the quantity of filter fabric.

If the BFI report recommends a different type and/or depth of rip rap, the designer shall consult with the hydraulic engineer and the geotechnical engineer to determine the appropriate rip rap requirements.

When the Hydraulic Data indicates abnormal flows, the elevation for the top of rip rap shall be 2 feet above the abnormal 100-year flood elevation.

4.3.6 Slope Paving

Slope paving shall be used on all grade separation and railroad crossing bridges. The footprint of the slope paving extends beyond the edge of the deck by 2 feet on each side of the bridge. For skewed bridges, the slope paving parallels the edge of the bridge on one side and is normal to the bottom of the slope on the other side, so that runoff water from bridge stay on paved slope all the way to the bottom (see Figure 4.3.6-1). However, on railroads in cut sections limit the slope paving to 2 feet outside the edge of deck on both sides to minimize additional cut in the endroll (see Figure 4.3.6-2).

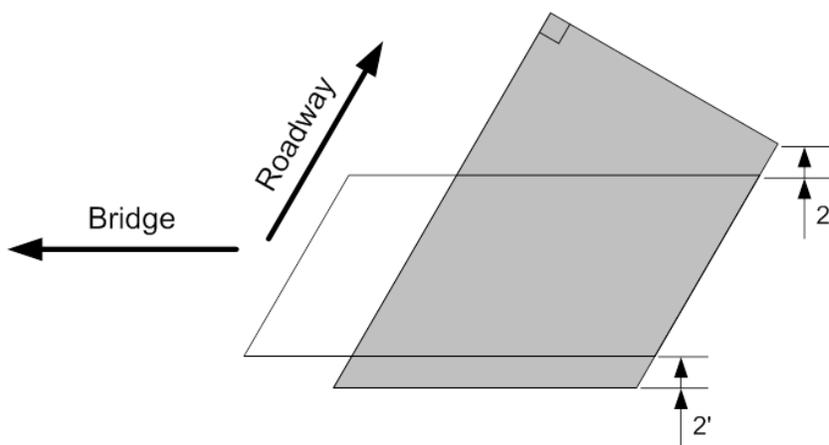


Figure 4.3.6-1 Typical Slope Paving at End of Bridge

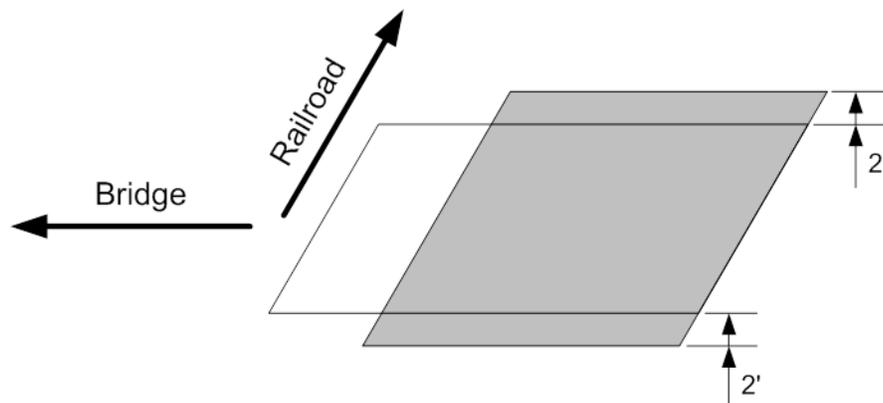


Figure 4.3.6-2 Slope Paving at Railroad Cut Section

4.4 Intermediate Bents

4.4.1 Concrete Column Bents

4.4.1.1 Preliminary Design Considerations

Use a 2-column bent when the cap length is 50 feet long or less. The columns should be arranged to balance the dead load moments on either side of the column to avoid long-term bowing due to creep. Experience has shown that setting the cantilever lengths at approximately 20% of the cap length can accomplish this. For cap lengths greater than 50 feet, use a 3-column bent or divide into two 2-column bents.

When possible, use one column size for the entire bridge. For 90-degree bridges, set the column width equal to the cap width. However, it is acceptable and generally preferred to use a smaller column in skewed bridges that have wider caps to accommodate the bearings. The minimum column width should be 75% of the cap width.

Short column bents may have an issue with accommodating the forces generated by the shrinkage of the cap. These forces may be reduced by detailing a construction joint in the cap or by the use of a wall pier with a strip footing. The minimum width of a wall pier is 2 feet. Use of a wall pier shall be approved by the Bridge Office.

4.4.1.2 Concrete Column Bent Caps

4.4.1.2.1 Cap Dimensions

The width of an intermediate bent cap should be a minimum of 3 feet and increased in 3-inch increments to account for skew, bearing size and edge distances. The depth and length of a cap should be detailed in 3-inch increments. For bent caps at grade separations, use a minimum depth to width ratio of 0.75, with a ratio of 1.0 preferred at road underpasses, in order to provide a more aesthetic appearance. The cap should be long enough so the bottom of beam does not cross the end of the cap.

Size the pier cap to provide a minimum of 3-inch clearance from the edge of bearing pad to the edge of cap or riser. On skews sharper than 75 degrees, this clearance can be reduced to 2 inches since only the corner of the bearing pad would be too close to an edge and most of the pad would still be beyond the 3 inch limit.

4.4.1.2.2 Cap Risers and Steps

When the back and ahead beams have different depths, a riser will be required on the cap to compensate for the difference. When the height of the riser is more than 4 inches, two continuous No. 5 bars should be detailed in the top of the riser in the direction of the main reinforcement. If the riser height is more than 18 inches, additional No. 4 bars should be distributed along each face of the riser to control cracking. Detail stirrups with approximately 1-foot spacing and with the legs extended down into the main cage a minimum of one foot. Do not attempt to control cracking by putting a joint in the riser between steps. This detail concentrates stresses at that point and can cause cracking in the main body of the cap.

When a cross-slope or fascia beam causes the top of cap step to be more than 6" above the main or riser reinforcing, additional reinforcement will be required for that step. In this case, detail two No. 5 bars in the same direction of the main reinforcement at the top of the cap step with 2-inch clearance. Detail stirrups with approximately 1-foot spacing and with the legs extended down into the main cage a minimum of one foot.

4.4.1.2.3 Maximum Cap Moment and Shear at the Columns

When designing the negative moment reinforcement over the columns, the designer should consider the moment at the quarter point as maximum. The shear at the face of column should be considered as maximum in the design for stirrups.

4.4.1.2.4 Detailing

A minimum concrete cover of 2 inches is required in the cap.

Minimum spacing for stirrups in the cap shall be 5 inches. Use double stirrups in high shear areas as necessary. Using 'open top' stirrups to miss anchor bolt hole block outs is permitted but usually not necessary. The contractor is able to shift stirrups in order to miss block outs for the anchor bolt holes.

Cap step lengths do not need to match the calculated skewed beam distance so detail the cap steps to the nearest 1".

4.4.1.3 Columns

All columns that have less than 30'-0" horizontal clearance from the edge of roadway shall be designed for the vehicular collision force in accordance with LRFD 3.6.5. Protection by barrier or embankment will not negate this requirement.

Columns should be dimensioned in 6-inch increments beginning at 3 feet. Columns narrower than 3 feet should not be used unless it is necessary to match the existing column size and to maintain horizontal clearance. In general, columns should be square with a square reinforcing pattern consisting of the same number of bars in each face. Round columns should be used on drilled shaft foundation.

Use Table 4.4.1.3-1 to determine the number and location of required construction joints in columns. Column height, x , is measured from top of footing to bottom of cap.

Table 4.4.1.3-1 Construction joints in columns

Column Height, x	Construction Joints
$X \leq 30$ ft.	No construction joint
30 ft. < $x \leq 40$ ft.	1 construction joint at mid-height
40 ft. < $x \leq 60$ ft.	2 construction joints at one-third points
$X > 60$ ft.	Construction joints at 20 ft. max. spacing

Reinforcement should be detailed to take the construction joint into account.

For drilled caissons, it is recommended to use a column that is 6 inches smaller in diameter than the caisson to line up the reinforcements and meet the different requirements in concrete cover.

Use a minimum concrete cover of 2 inches in the column. However, if the cap has the same width as the column, then the main column bars have to be shifted in to miss the main cap bars. This adds to the minimum concrete cover required.

Do not hook column bars in the top of the cap.

Column cross-ties shall be arranged to accommodate at least a 6-inch tremie to facilitate concrete placement.

Detail column reinforcement to provide at least a 6" center-to-center spacing between stirrups.

4.4.1.4 Footings

See Sections 4.2.4 and 4.2.5 for information about spread footings and pile footings.

4.4.2 Pile Bents

Pile bent consists of a concrete cap formed directly on top of piles. Typically, a pile is placed under each beam. Exterior piles are generally battered outwards at a 1.5:12 ratio for lateral stability.

A tower bent is a pile bent with two piles under each beam battered at a 1.5:12 ratio in the longitudinal direction for additional stability. Tower bents should be considered at fixed bent locations when the bridge length requires an intermediate expansion joint. The preliminary layout sometimes precludes tower bents at certain locations.

Unless a refined analysis is performed pile fixity should be assumed at a depth 10ft below the ground line.

4.4.2.1 Pile Bent Caps

When each beam has a pile directly under it, the pile bent cap is subjected to minimal shears and moments. Use a minimum of 3' wide by 2' deep cap with typical reinforcement that can be found in the GDOT Bridge Cell Library, unless pile and beam configurations require more detailed flexural and shear design. Cap step lengths do not need to match the calculated skewed beam distance so detail the cap steps to the nearest 1".

The provisions for temperature and shrinkage reinforcement in LRFD 5.10.8 can be waived for side faces of bent caps with a minimum height of 2 feet or less. LRFD 5.10.8 can also be waived for the bottom of the pile cap for bents 3.5 feet wide or less.

4.4.2.2 Sway Bracing

Sway bracing is only used for H-Pile bents where the unbraced length of piles exceeds 12 feet. Sway bracing is normally comprised of L4x4x3/8 angles arranged in an "X" fashion. Sway bracing shall be detailed to extend 4 inches outside the edge of the exterior piles. The top of the angles shall be placed 4 inches below the bottom of the cap. The bottom of the angles shall be placed 12 inches above the higher of the ground line or the normal pool elevation.

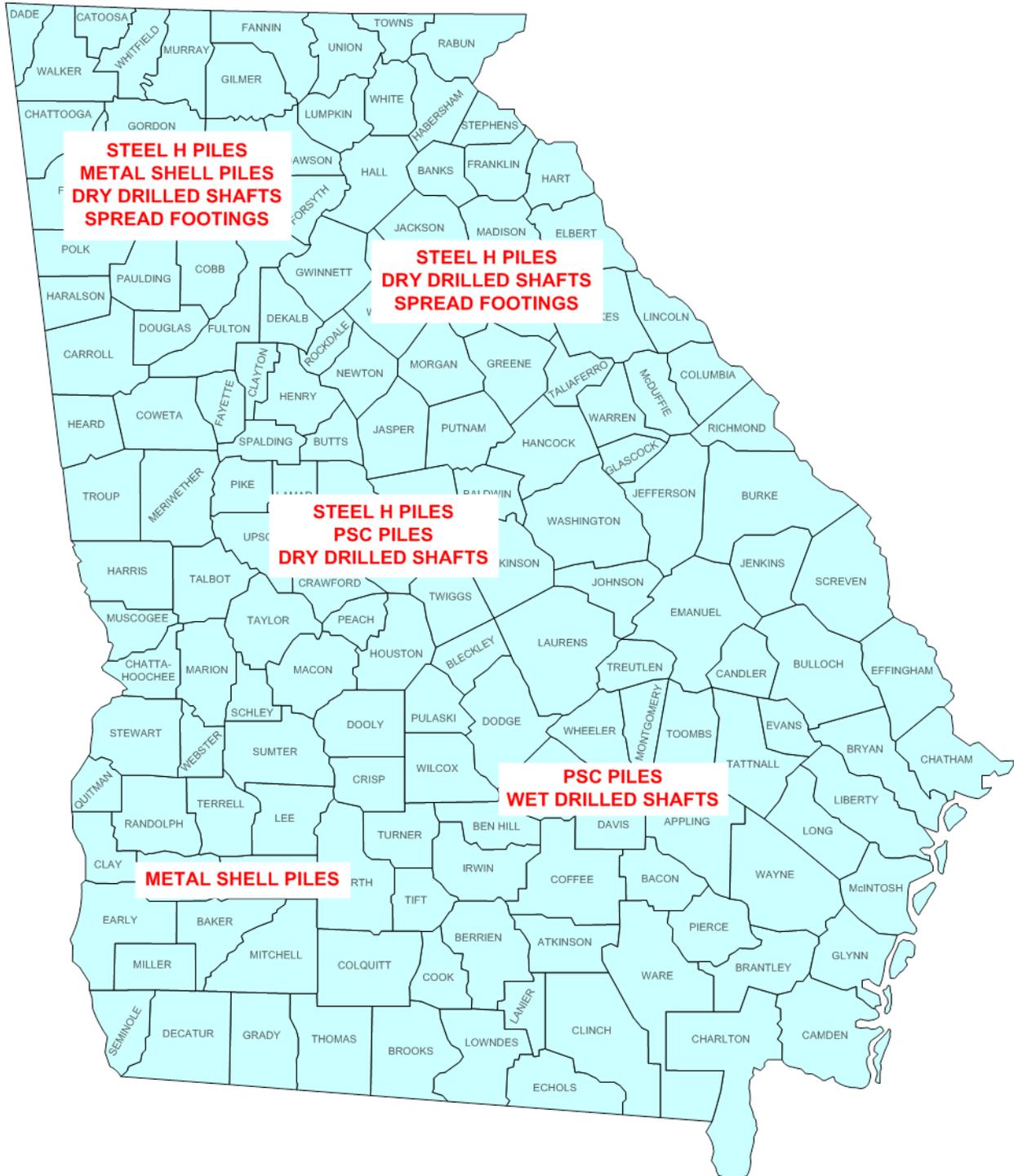
4.4.2.3 Pile Protection

H-Piles at stream crossings shall be protected with concrete encasement as follows:

- a) In the stream, use encasement from 2 feet below ground to 2 feet above normal pool.
- b) On banks and flood plains, use encasement from 2 feet below ground to the higher of 2 feet above ground or 2 feet above normal pool.
- c) If the elevation of "normal pool" is not clear, extend the encasement to the 2-year flood height which is usually available in the hydraulic study under the 50-year storm summary table.

All exposed H-piles shall be painted using 2P coating as specified in GDOT Standard Specification 870.2.05. Include the Special Protective Coating for Piles note on the General Notes sheet using the BridgeNotes program.

Appendix 4A - General Guide Map for Foundation Types



Appendix 4B - Preset Pile Layouts

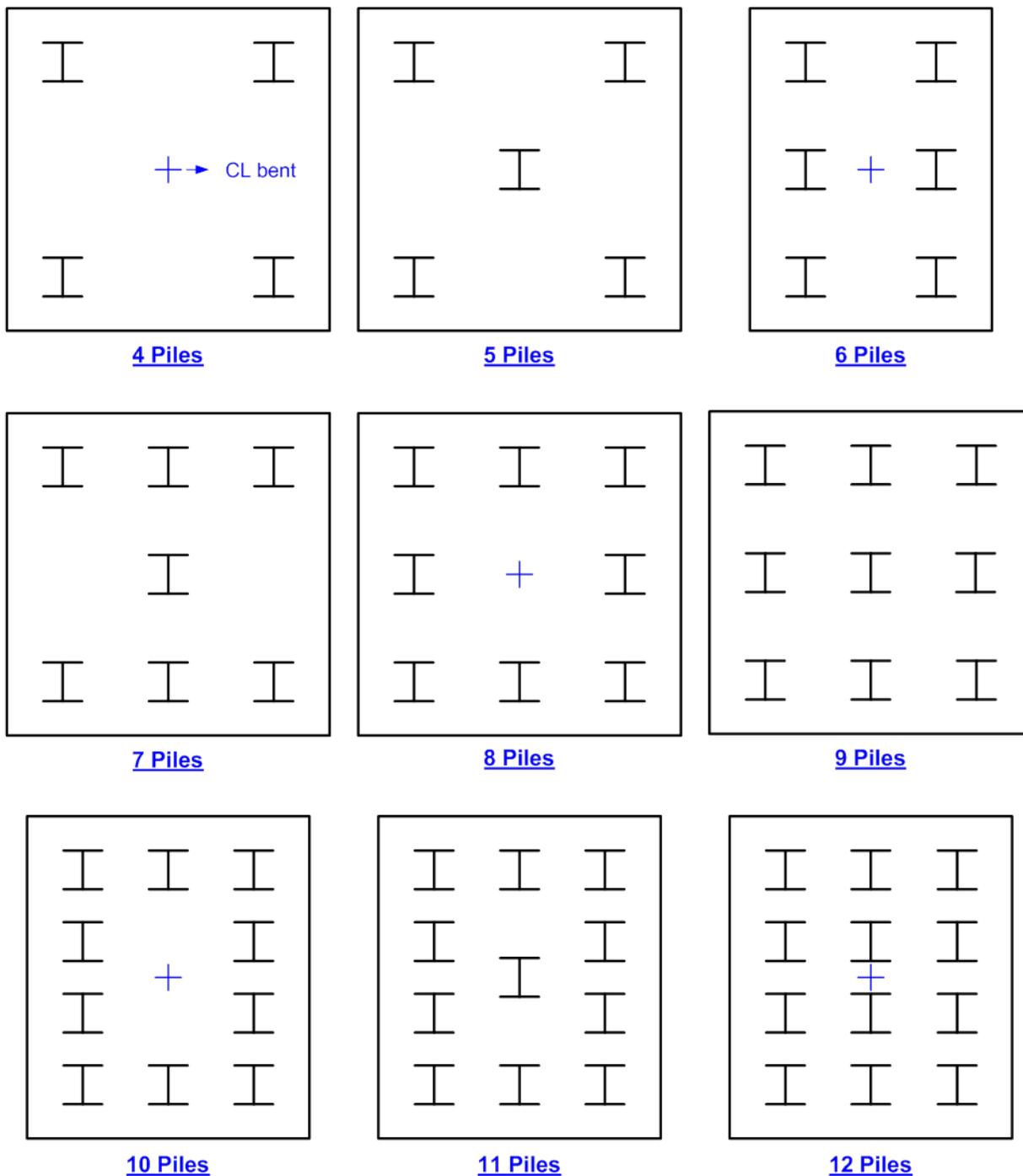


Figure 4B-1 GDOT Pile Layout (4 to 12 Piles)

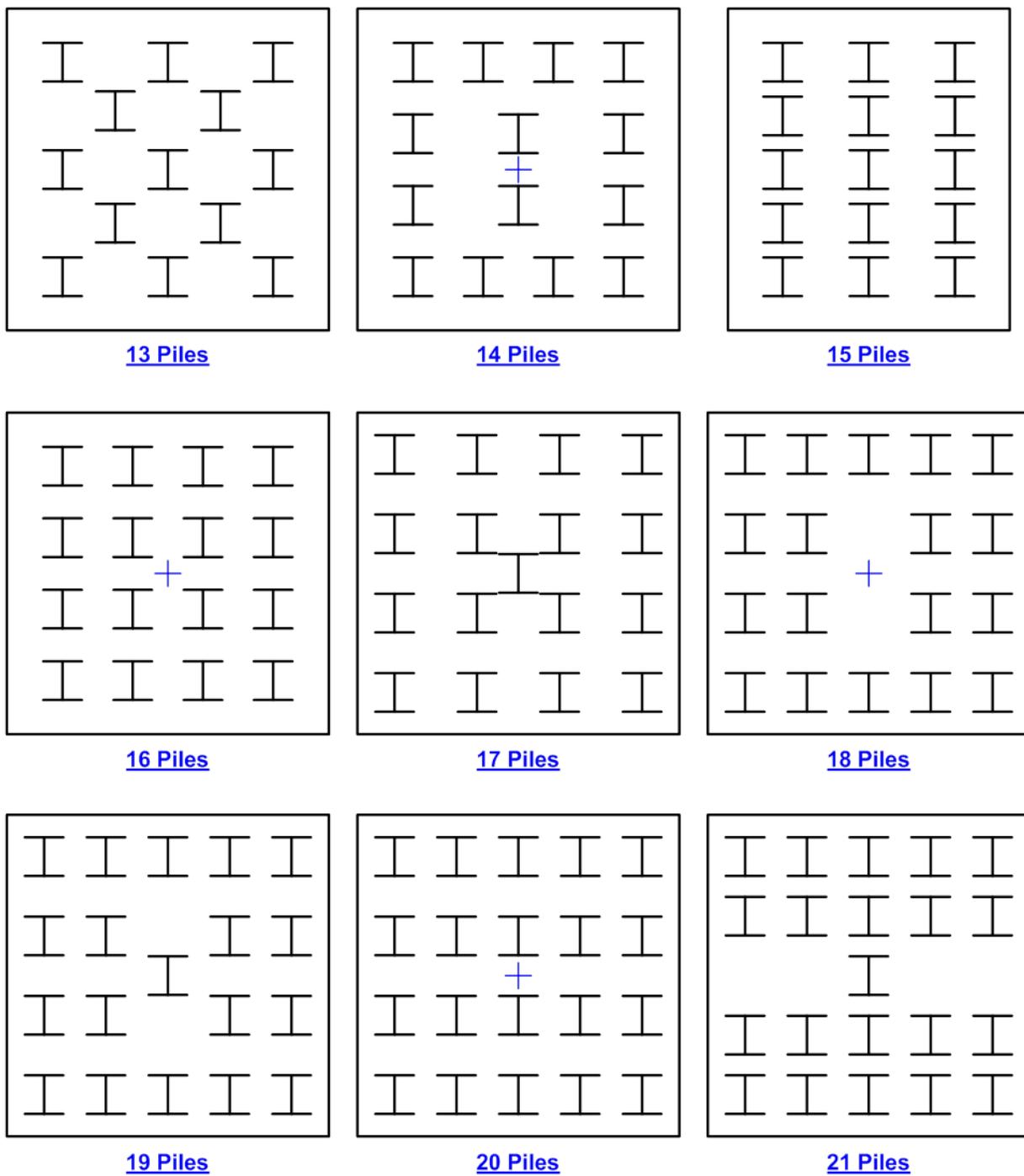


Figure 4B-2 GDOT Pile Layout (13 to 21 Piles)

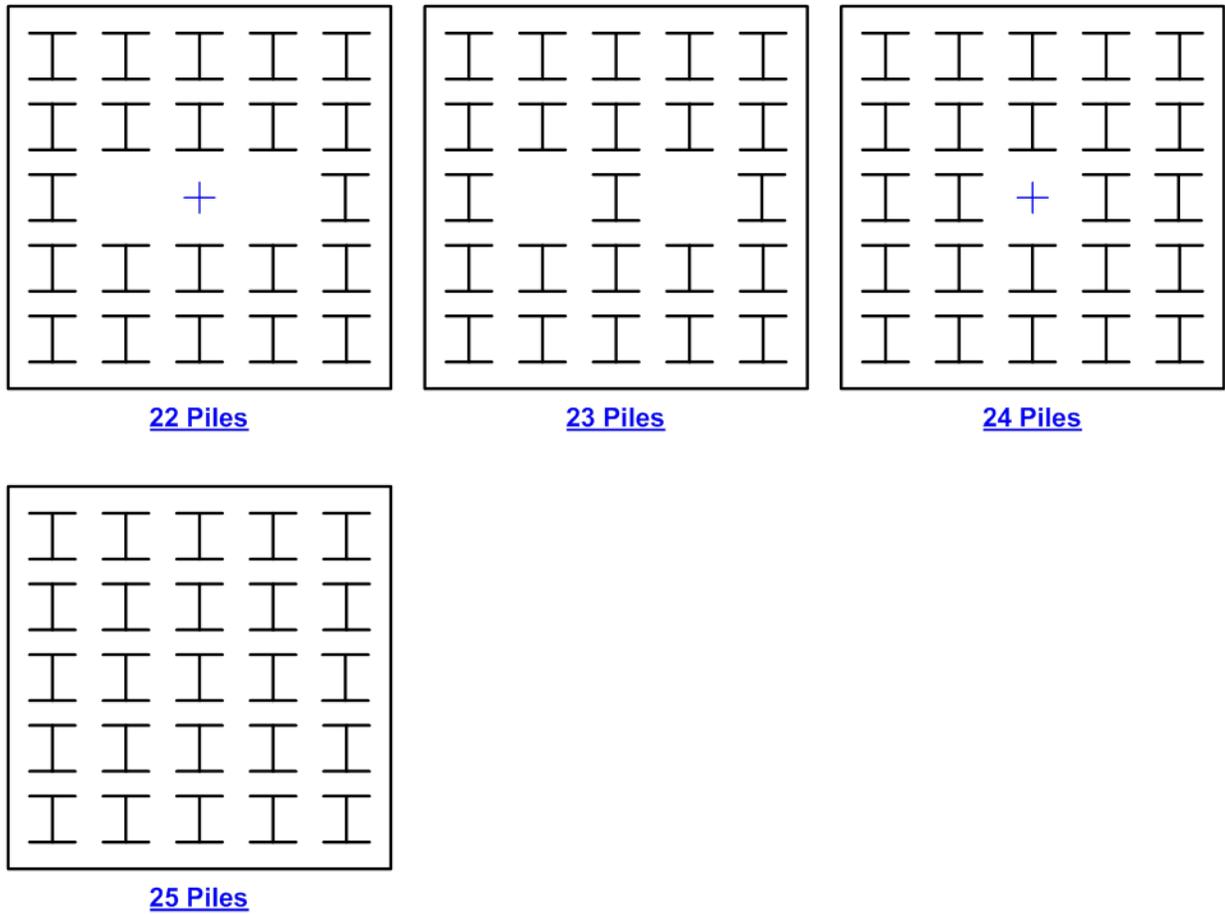


Figure 4B-3 GDOT Pile Layout (22 to 25 Piles).

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Chapter 5. Retaining Walls

5.1 General

All retaining walls shall be designed in accordance with Chapter 11 of the AASHTO LRFD Specifications and as noted in this section.

5.1.1 Wall Types

The type of wall should be determined based on economy, constructability and geotechnical conditions. Coordination between the roadway designer and Bridge Office shall take place during the preliminary design phase, before Right-of-Way plans are finalized. Typical wall types utilized on GDOT projects are presented in Table 5.1.1-1 with their corresponding design options.

Table 5.1.1-1 Current GDOT Wall Types and Design Options

Wall Type	Design Option
Gravity Wall	GDOT Standards
Reinforced Concrete Cantilever	GDOT Standards or In-House Design
MSE Wall	Contractor Design
Prefabricated Modular Wall	Contractor Design
Modular Block Wall	Contractor Design
Soldier Pile	In-House Design
Tie-Back	Contractor Design
Soil Nail	Contractor Design

5.1.2 Wall Design Options

5.1.2.1 GDOT Standard Design

Whenever possible, the roadway designer should use a pre-designed concrete wall found in the GDOT Standards or Construction Details, as listed in Table 5.1.2.1-1. In this case, the roadway designer will include the appropriate standard in the contract plans and a retaining wall envelope for the structure under section 31 of the contract plans.

Table 5.1.2.1-1 GDOT Standard Retaining Walls

Standard/Detail Number	Title	Application
4948B	Concrete Side Barrier Types 2, 2-A, 2-B, and 2-C	RC cantilever fill wall adjacent to roadway
4948C	Concrete Side Barrier Types 6, 6-A, 6-B, and 6-C	RC cantilever cut wall adjacent to roadway
9031L	Retaining Wall Typical Sections, Raising Headwall, And Typical Pipe Plug	Gravity wall with or without barrier face
PW-1	Parapet Retaining Wall, Type P1, P2 and	RC cantilever fill wall

	P3	adjacent to sidewalk
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5.1.2.2 In-House Design

When the GDOT Standards or Construction Details are not applicable, the roadway designer will submit a request to the Bridge Office for a special designed retaining wall. If the wall is to be designed by the Bridge Office or a consultant, a complete set of final wall plans, including all geometry and structural details, will be produced and submitted to the roadway designer for inclusion in section 32 of the contract plans.

5.1.2.3 Contractor Design

In cases where a special design wall is requested by the roadway designer, the contractor may be tasked with completing the final wall design due to the proprietary and technical nature of some wall types such as MSE, Soil Nail, Tie Back, Modular and Modular Block. The Bridge Office or consultant will provide a P&E sheet, a typical section, design criteria and quantities for inclusion in section 32 of the contract plans. The contractor shall provide the final design to the Bridge Office for review as shop drawings.

5.2 Preliminary Wall Design

5.2.1 Initial Design Request from Roadway Designer

When a special design retaining wall is required on a project, the roadway designer shall submit the following information to the Bridge Office:

- a) An elevation view (profile) of the wall showing the following:
 - o Beginning and ending wall stations
 - o Elevations on top of the wall at the beginning, end, and at profile break points
 - o The original ground profile
 - o The proposed ground profile
- b) Roadway cross-sections in the vicinity of the wall that show the existing and final slope behind the wall
- c) Project Cover Sheet
- d) Project typical sections associated with the wall
- e) Project plan-and-profile sheets showing the following:
 - o Limits of right-of-way
 - o Superelevation data
 - o Horizontal and vertical alignment data
 - o Horizontal offsets to the face of the wall, gutterline at barrier or face of parapet on the wall as applicable
 - o Location and height of any sound barriers on the wall
 - o Location of any overhead signs near the wall

- Location of any roadway lighting near the wall
- Location of any drainage structures that will affect the wall
- f) Any construction sequence requirements for the wall construction
- g) Any architectural treatment required for the wall

5.2.2 Items to Coordinate with the Roadway Designer

Once the initial request for a special design wall has been received, the following items should be considered during coordination between the Bridge Office and roadway designer:

- a) Right-of-Way: Right-of-Way and easement limits may be affected by the selected wall type.
- b) Existing Structures: Surcharges from existing adjacent structures should be considered as well as the impact of the wall on those structures.
- c) Wall Termination Points: Termini for the wall should be selected to avoid construction and right-of-way issues. A situation to consider is when there is an elevation difference between the proposed top of wall and ground line at an end of the wall. In this case, the subsequent slope wrapping around the front face of the wall may interfere with obstacles or boundaries.
- d) Top of Wall Profile: The top of wall should be designed to present a smooth profile with no sharp breaks, peaks or valleys.
- e) Drainage: Run-off water from behind the wall is typically collected in a paved ditch at the top of the wall. An appropriate top of wall slope and ditch should be provided to allow the water to drain to the ends of the wall. Consideration should also be given to where the water outfalls and the volume of water that will be present.
- f) Utilities: All utility locations near the proposed wall should be verified as both buried and overhead utilities may conflict with wall construction. The wall footing should be set so that it will not be influenced by any adjacent water line that may fail in the future.

5.2.3 Preliminary Wall Plans and Wall Foundation Investigation

The Bridge Office or consultant will use the information outlined in Section 5.2.1 to select the wall type and prepare preliminary wall plans that consist of a plan view, elevation view and a typical section. After the preliminary wall plans are approved by the Bridge Office, the Wall Foundation Investigation (WFI) shall be requested.

5.3 Final Wall Plans

Final wall plans shall be developed based upon the recommendations previously approved and the Wall Foundation Investigation. If the WFI reveals unexpected geotechnical conditions, the designer shall submit a second wall recommendation, as necessary, to the Bridge Office for concurrence prior to proceeding with final wall plans.

Based on the design option selected, the final wall plans shall be developed as described in the following subsections.

5.3.1 Final Plans for In-House Design

The final wall plans developed using the in-house design option shall include the following:

- Plan view including all relevant geometric data
- Elevation view
- General notes
- A list of pay items and quantities
- Section view
- Weep hole/drain details for the relief of water pressure behind the wall
- Drainage details for adequate treatment of surface water behind the wall
- Waterproofing details
- Barrier details on top of wall and at face of wall
- Lighting details
- Overhead sign details
- Reinforcement schedule

5.3.2 Final Plans for Contractor Design

Final plans to be provided to the Contractor under the contractor design option shall include the following:

- Wall envelopes
- Location of vertical construction joints
- Typical sections
- Geotechnical design criteria including wall design parameters
- Barrier requirements
- Special loading, such as vertical loads from foundations adjacent to the walls
- Requirements for lighting, overhead sign structures and drainage structures.
- A list of pay items and quantities, as applicable

5.4 Staking for Retaining Walls on Construction

GDOT Standard Specification 149.3.03.D addresses the construction requirements in regards to staking for retaining walls. Prior to approving the calculations and plans for contractor designed walls, the reviewer shall have a letter from the contractor stating that the wall has been staked out and that the field conditions match design assumptions.

5.5 Special Considerations for Individual Wall Types

5.5.1 Gravity Wall

GDOT Standard 9031L outlines the use of a gravity wall under various front face and retained slope conditions. The maximum height of a gravity wall in any case is limited to 10 feet.

It is not recommended to use a gravity wall adjacent to roadways or parking lots where it creates a potential vertical drop for a vehicle. In this case, use a Type 2 side barrier wall as specified in GDOT Standard 4948B or a parapet wall as specified in Construction Detail PW-1.

5.5.2 RC Cantilever Wall

Standards 4948B and 4948C, as well as Construction Detail PW-1 present three types of RC cantilever walls that can be applied appropriately without design or review by the Bridge Office. The maximum heights for these walls are presented in Table 5.5.2-1.

Table 5.5.2-1 Standard RC Cantilever Walls and Height Limits

Wall Type	Maximum Height
Type 2 Side Barrier	12'-10"
Type 6 Side Barrier	10'-6"
Parapet Retaining Wall	14'-0"

When the in-house design option is used for an RC cantilever wall, it shall be designed and detailed in accordance with AASHTO LRFD Specifications. The basic soil properties for design, such as unit weight, angle of internal friction, coefficient of friction and bearing capacity should be provided in the WFI report. The GDOT Bridge Cell Library may be used for final detailing.

Use of counter forts is allowed when it results in the most cost-effective design. RC cantilever wall footings shall be embedded a minimum of 2 feet below the proposed ground line. In calculating the passive resistance force at the face of the wall, this 2-foot soil layer shall be neglected to account for potential disturbance in the future.

For Standard Specification projects, the Bridge Design Basic Drawings web page includes some "Special Design Retaining Walls." When these drawings are used, the plans must be reviewed by the Bridge Office and require a Wall Foundation Investigation (WFI) to determine allowable bearing pressure. These basic drawings include reinforcement details for different wall heights, but a summary of quantities is still required along with a plan and elevation view, general notes, sections and details, rebar tables, WFI information, etc.

5.5.3 MSE Walls

Contractor-designed MSE walls are governed by Section 627 of the GDOT Standard Specifications. This specification covers the design and construction of MSE walls, and refers to Section 626 for additional construction requirements.

5.5.3.1 Design Criteria

All MSE walls shall be designed and constructed in accordance with the following requirements:

- a) The minimum cover from the proposed ground line to the bottom of the wall (top of leveling pad) shall be two feet. Increase the cover when required as follows:
 - o The top of leveling pad elevation shall be at least 2' below the bottom of adjacent ditch.
 - o Where the proposed ground line slopes downward from the front face of the wall, the top of leveling pad elevation shall be set to maintain a minimum 10' berm in front of the wall (see Figure 5.5.3.1-1).
 - o The top of leveling pad elevation shall be set at or below the level of adjacent utilities such as water lines that may fail and scour the foundation in the future.
- b) The maximum slope behind the wall shall be 2 horizontal to 1 vertical.
- c) The top elevation of all walls which retain sloping backfills shall be set to accommodate a drainage ditch, such as the one presented in Construction Detail D-49 or a larger ditch as drainage area requires. The V-shaped ditch intended for gravity walls shall not be used. Ditch paving behind the wall is a roadway item, so it should be confirmed with the roadway designer that this quantity is included on the roadway plans.
- d) At abutment walls, shoulder points at the top of the wall shall be located 10' beyond the wingwalls, measured perpendicular to the centerline of the bridge (see Figure 5.5.3.1-2).
- e) For MSE walls used as the front face of an end bent (abutment), the minimum distance from the Back Face of Paving Rest to the front face of the wall shall be 6'-0", measured normal to the wall.
- f) At wall abutments, the backfill behind the end bent cap and end of bridge must be paid for separately as cubic yards of "Additional MSE Backfill". Meanwhile, backfill behind the wall panels is included in the square foot price of wall on contractor designed walls. The limits of "Additional MSE Backfill" shall be extended back further to accommodate the same length of straps used in the associated wall section (see Figure 5.5.3.1-3).
- g) There are 4 types of MSE wall copings available as follows:
 - o Coping A: Basic coping without barrier
 - o Coping B: Coping with parapet and moment slab to be used adjacent to sidewalk
 - o Traffic Barrier H: Coping with GDOT "New Jersey" or S-Type barrier and moment slab to be used adjacent to traffic
 - o Traffic Barrier V: Coping with GDOT "New Jersey" or S-Type barrier without a moment slab
- h) See GDOT Coping Detail Sheets for Georgia Stabilized Embankment (GSE) walls for general coping details.
- i) For MSE walls supporting traffic, use Type H traffic barrier as coping rather than Type V. Type H barrier consists of the GDOT "New Jersey" or S-Type barrier with a moment slab. If a sidewalk is present along the top of the wall, use a 2'-3" high Type B coping with aluminum handrail or match the adjacent railing system.

- j) Before using MSE walls on urban streets, the designer shall investigate to see if underground utilities will interfere with the wall system and its modules or straps. In general, MSE walls shall not be used in situations in which maintenance crews of the underground utilities will dig into the straps, mesh or modules. RC cantilever walls shall be used in these instances.
- k) Overhead sign foundations shall not be placed on the reinforced backfill of MSE walls.
- l) The General Notes should specify a plain finish on the panels unless the Project Manager requires an architectural finish. If the wall is visible to the public, a graffiti proof coating should be specified. It is important to verify this finish in the contractor’s wall plans, since they generally use a textured finish by default.
- m) Bridge replacements with wall abutments are often stage constructed. A vertical joint is required between the stages to allow for differential settlement.

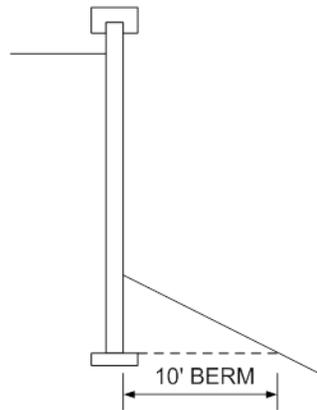


Figure 5.5.3.1-1 Berm in Front of Wall

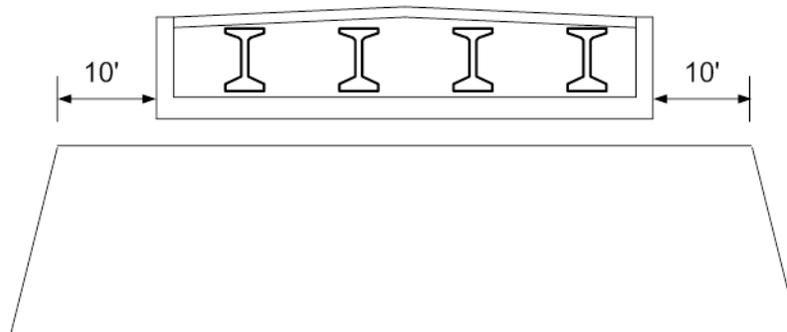


Figure 5.5.3.1-2 Shoulder Points of MSE Wall at Abutments

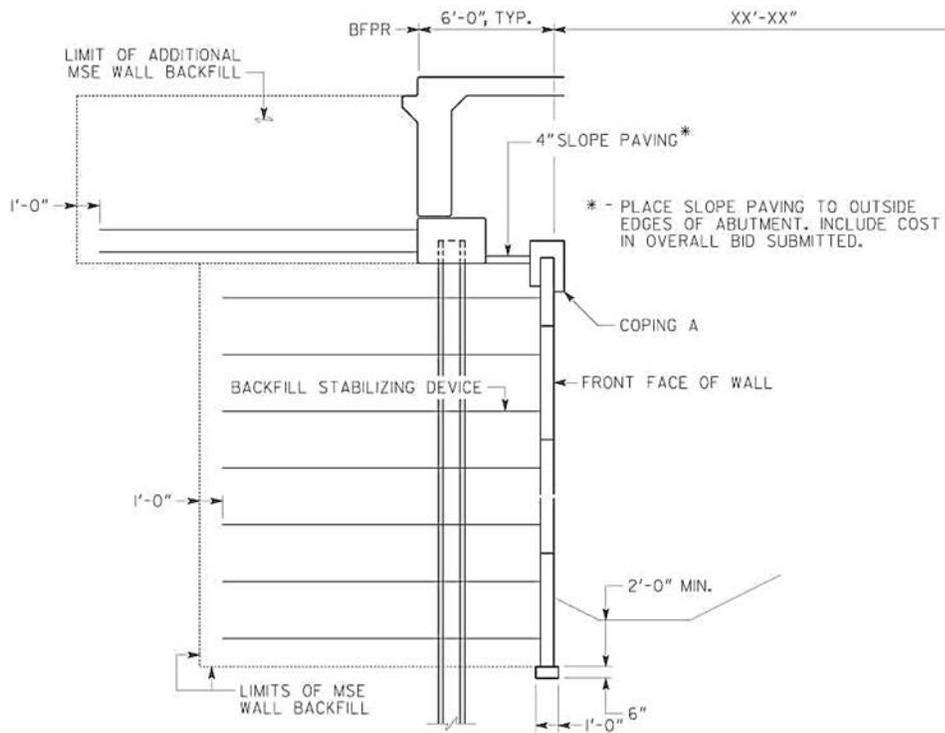


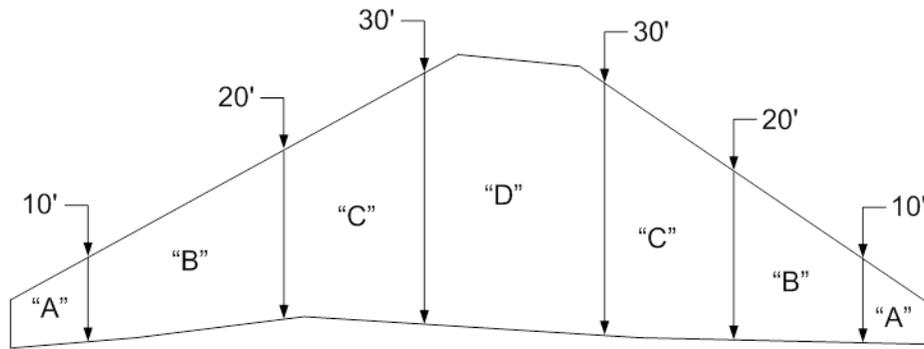
Figure 5.5.3.1-3 Typical Wall Abutment Detail

5.5.3.2 Erosion Protection for End Bents

When an MSE wall is used at the abutment, the area between the front face of the end bent cap and the back face of the wall shall be detailed with 4-inch concrete slope paving. This detail is used to prevent erosion or loss of fines due to concentrated water flowing in this area. The plans should note that costs for this slope paving should be included in overall bid submitted for the contract.

5.5.3.3 Calculation of Quantities

Walls constructed according to GDOT Standard Specification 627 are paid for per square foot of wall face area. Wall face area shall be measured in vertical bands and paid for according to the height range of that band, as shown in Figure 5.5.3.3-1. The height shall be measured from the top of the leveling pad to the top of coping, gutter line, or top of side walk, depending on application. Additional payment for location of steps in the leveling pad is not allowed. Instead, payment is restricted to the wall envelope area in the contract plans unless the envelope changes due to field conditions.



<u>PAY ITEM NUMBER</u>	<u>QUANTITY</u>	<u>UNIT</u>	<u>PAY ITEM</u>
627-1000	"A"	SF	MSE WALL FACE, 0-10FT HT, WALL NO-1
627-1010	"B"	SF	MSE WALL FACE, 10-20FT HT, WALL NO-1
627-1020	"C"	SF	MSE WALL FACE, 20-30FT HT, WALL NO-1
627-1030	"D"	SF	MSE WALL FACE, GTR THAN 30FT HT, WALL NO-1

Figure 5.5.3.3-1 Calculation of Wall Face Pay Item Quantities

5.5.4 Prefabricated Modular Wall

Prefabricated modular walls, such as Doublewal™ shall be procured using the contractor design option as described in 5.1.2.3. GDOT Standard Specification 602 covers the use of Doublewal™, meanwhile a Special Provision shall be required in the contract documents for other suppliers.

5.5.5 Modular Block Wall

Modular block walls, such as Keystone™ shall be procured using the contractor design option as described in 5.3.2, and will require Special Provision 630 to be included with the contract documents. Modular block walls should not be used to support roadway or in other situations requiring a barrier at the top of the wall.

Modular block wall design height shall be limited to a maximum of 20 feet.

5.5.6 Soldier Pile Wall

Soldier pile walls up to 15 feet in height may be used when temporary shoring is undesirable due to cost or right of way restrictions. These walls can be built from the top and wood lagging acts as the necessary shoring prior to the installation of a concrete facing.

Soldier Pile walls shall be designed using the Coulomb’s method to determine active earth pressure. A minimum of 2 feet of soil in front of the wall shall be neglected in the calculation of passive resistance against the discrete support elements. This depth may need to be increased if the ground line in front of the wall slopes down from the face.

Discrete support elements consist of rolled steel W or HP sections embedded in pilot holes filled with concrete. Pilot hole section to be embedded under the proposed ground line (from the bottom of the hole to the bottom of the facing) shall be filled with class A concrete and reinforced with 8-#6 longitudinal bars confined by #4 stirrups spaced at 12”. The remainder of the pilot hole (from the bottom of facing to the existing ground line) shall be filled with flowable fill without reinforcement.

A 12 inch thick cast in place concrete facing shall be attached to the rolled steel sections with shear studs. The amount of front and back face reinforcement in the facing shall be determined neglecting any support resistance provided by the temporary wood lagging. Wall facing shall extend 2 feet below the proposed ground line at the face of the wall.

If a soldier pile wall is used as temporary shoring, the contractor is responsible for the design and detailing.

5.5.7 Tie-Back Wall

Tie-back walls shall be procured using the contractor design option as described in 5.1.2.3. GDOT Standard Specification 617 covers the use of tie-back walls. Permanent facing for tie-back walls shall be cast-in-place concrete. Pneumatically applied concrete (shotcrete) will not be permitted.

5.5.8 Soil Nail Walls

Soil nail walls shall be procured using the contractor design option as described in 5.1.2.3 and will require Special Provision 628 to be included in the contract documents.

Soil nail walls are subject to settlement, so they should not be used to support pavements or structures. The shotcrete that is used to stabilize the soil face during the construction of a soil nail wall is not an acceptable final finish for a permanent installation. An additional surface treatment shall be specified on the final plans.

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Chapter 6. Retaining Walls

6.1 General

Culverts for GDOT projects are normally sized by roadway/hydraulic designers and selected from the GDOT Roadway Standards, so they are considered roadway items. When unusual circumstances preclude the use of a standard culvert as listed in Section 6.3, a culvert shall be designed in accordance with LRFD 12.11 or Standard Specification Section 6.

6.2 Culvert Sizing

Culvert sizes shall be determined following the methods as specified in the GDOT Drainage Manual.

6.3 Standard Culvert Design

Whenever possible, the designer should use the pre-designed concrete culvert sections found in the GDOT Roadway Standards, as listed in Table 6.3-1.

Table 6.3-1 GDOT Standard Culverts

Standard Number	Description
2312	Details For Extending Culverts (Raising Parapets or Lengthening Culverts 2' or less)
2317	Details for Extending Concrete Box Culverts
2318	Details for Extending Concrete Box Culverts With Skews below 75
2319A	Reinforced Concrete Box Culverts Quadruple 10' x 10' for Depths of Fill Up to 50 Feet
2319B	Reinforced Concrete Box Culverts Quadruple 10' x 10' for Depths of Fill Up to 50 Feet
2320A	Reinforced Concrete Box Culverts Double 10' x 8', 10' x 9', and 10' x 10' for Depths of Fill Up to 50 Feet.
2320B	Reinforced Concrete Box Culverts Double 10' x 8', 10' x 9', and 10' x 10' for Depths of Fill Up to 50 Feet.
2320C	Reinforced Concrete Box Culverts Double 10' x 8', 10' x 9', 10' x 10' for 45, 60 and 75 Deg Skews
2320D	Reinforced Concrete Box Culverts Double 10' x 8', 10' x 9', 10' x 10' for 45, 60 and 75 Deg Skews
2321	Standard Reinforced Concrete Box Culvert Single 3FT x 2FT to Single 6FT x 6FT For Depths of Fill Up To 20 FT
2321	Standard Reinforced Concrete Box Culvert Single 3FT x 2FT to Single 6FT x 6FT For Depths of Fill Up To 20 FT (Sheet 2)
2322	Reinforced Concrete Box Culverts Single 4' x 6', Single 5' x 6' for Depths of Fill Up to 20 Feet.
2323	Reinforced Concrete Box Culverts Single 7' x 4' To Single 9' x 10' for Depths of

	Fill Up to 20 Feet. (2 sheets)
2324	Reinforced Concrete Box Culverts Single 10' x 4' Thru Single 10' x 12' for Depths of Fill Up to 20 Feet. (2 sheets)
2325	Reinforced Concrete Box Culverts Double 3'x 2'6" To Triple 6' x 6' for Depths of Fill Up to 20 Feet. (2 sheets)
2326	Reinforced Concrete Box Culverts Double 7' x 4' To Triple 9' x 10' for Depths of Fill Up to 20 Feet. (2 sheets)
2327	Reinforced Concrete Box Culverts Double 10' x 4' To Triple 10' x 12' for Depths of Fill Up to 20 Feet. (2 sheets)
2328	Reinforced Concrete Box Culverts Single 3' x 2' To Triple 6' x 6' for 75, 60 and 45 Skews (3 sheets)
2329	Reinforced Concrete Box Culverts Single 7' x 4' To Triple 9' x 10' For 75, 60, and 45 Skews (4 sheets)
2330	Reinforced Concrete Box Culverts Single 10' x 4' To Triple 10' x 12' for 75, 60, and 45 Skews (4 sheets)
2331	Reinforced Concrete Box Culvert Wingwalls and Parapets Quantities Single 3' x 2' To Triple 10' x 12' For 75, 60, and 45 Skews
2332	Concrete Box Culvert Aprons, Baffles and Inlet Beveling Detail and Adjacent Box Culvert Joint Detail (2 sheets)
2530P	Precast Box Culvert Barrels 4 x 3 Thru 10 x 10 Single and Multiple Lines
2535P	Precast Box Culvert Ends - Wingwalls, Parapets Toewalls and Aprons

6.4 Required Notes for Culvert Plans

The notes presented below shall be included in all project plans containing culverts in order to minimize concrete cracking that tends to occur when culverts settle. The minimum earth cover and location of construction joints presented in these notes are not specified uniformly in the GDOT Standard Specifications or pre-designed concrete culvert sections found in the GDOT Roadway Standards.

With concurrence between the Office of Construction and the Bridge Office, these notes should be placed in a prominent position on plan sheets containing box culvert details. The recommended location for the following notes is on each drainage cross section sheet where a box culvert is included:

BOX CULVERT REQUIREMENTS:

MINIMUM FILL HEIGHT FROM TOP OF CULVERT TO BOTTOM OF BASE WITHIN TRAVELWAY SHALL BE 12 INCHES.

MAXIMUM POUR LENGTH SHALL NOT EXCEED 30 FEET ALONG THE LENGTH OF THE CULVERT.

TRANSVERSE CONSTRUCTION JOINTS SHALL BE PLACED IN THE BARREL, NORMAL TO THE CENTERLINE OF CULVERT, AT THE OUTSIDE SHOULDER BREAK POINTS. LONGITUDINAL BARREL REINFORCING STEEL SHALL NOT BE CONTINUOUS

THROUGH THESE JOINTS, PROVIDED THAT THE JOINTS ARE MORE THAN 15 FEET FROM THE BARREL ENDS.

WHEN TRANSVERSE CONSTRUCTION JOINTS OCCUR WITHIN 15 FEET OF THE BARREL ENDS OR WITHIN THE LIMITS OF THE PAVEMENT, THE LONGITUDINAL BARREL REINFORCING SHALL THEN BE CONTINUOUS THROUGH SUCH JOINTS. THE MINIMUM LENGTH OF LAP SPLICE FOR LONGITUDINAL REINFORCING SHALL BE 24 INCHES.

TRANSVERSE CONSTRUCTION JOINTS PLACED AT ANY OTHER LOCATION NOT SPECIFIED ABOVE SHALL BE FORMED WITH NO LONGITUDINAL REINFORCING STEEL PASSING THROUGH THE JOINTS.

6.5 Three-Sided or Bottomless Culverts

A bottomless culvert is allowed only when no other practical solution, such as a bridge or standard box, will satisfy the project requirements. This may occur when the only way to obtain an environmental clearance is through the use of a bottomless culvert. In this case, the detailed plans for the bottomless culvert must be included in the contract documents. The provisions for the sizing of bottomless culverts are outlined in the GDOT drainage manual.

The foundation design for the bottomless culvert must be included in culvert details and stamped by a registered Georgia Professional Engineer. In addition, the foundation design must detail how the bottomless culvert foundation will be protected from scour. Rip-rap is not considered satisfactory for protecting a spread footing from scour. Footings must be keyed into solid rock or founded on piling embedded well below the scour line.

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Chapter 7. Miscellaneous Structures

7.1 Temporary Detour Bridges

Temporary detour bridges are used to facilitate the construction of a project and are intended to be removed upon either completion of the entire project or at a particular project stage. Temporary detour bridges are generally used for stream crossings, but they might be utilized for grade separations or railroad crossings. GDOT Standard Specification 541 addresses the materials, design, construction, maintenance, removal and payment for detour bridges.

Site specific hydraulic studies play an important role in design of detour bridges at stream crossings. See GDOT Drainage Manual Chapter 14 for design criteria governing detour bridges.

7.1.1 Temporary Detour Bridge Length

- 1) Compare the stream velocities between the natural (unconstricted) stream and the existing bridge opening. If the existing bridge velocities are less than approximately 2.0 times the natural (unconstricted) velocities and there are no visible signs of scour at the existing bridge, then consideration can be given to having a temporary detour bridge length less than the existing bridge. The detour bridge length should be minimized. A temporary detour bridge length approximately $\frac{2}{3}$ the length of the existing bridge length (typically a good first iteration) should be considered – though this must be analyzed, verified and refined if necessary. A temporary detour bridge length less than the existing bridge will act as a constriction and will tend to increase backwater upstream of the bridge. The temporary detour bridge length should remain large enough so that it will not induce:
 - a) Design-year velocities through the temporary detour bridge opening which are more than approximately 2.0 times the natural (unconstricted) stream velocities unless:
 - i. The temporary detour bridge length matches the existing bridge length, or
 - ii. The streambed is comprised of a scour-resistant material
 - b) An increase in the design-year backwater more than 1.0 ft. above the existing bridge conditions
- 2) If the existing bridge velocities are greater than approximately 2.0 times the natural (unconstricted) stream velocities or there are visible signs of contraction or local scour at the existing bridge, then the temporary detour bridge shall be the same length* as the existing bridge. *See note 5 below.
- 3) The length of the temporary detour bridge shall be long enough to ensure that the toe of slopes of the bridge be a minimum 10.0 ft. from the top of banks of the main channel. This buffer zone is needed for erosion control measures.
- 4) Temporary bridges should be studied in incremental lengths divisible evenly by 20.0 ft.
- 5) While unlikely, it is possible that a temporary detour bridge can be longer than the existing bridge. This scenario could arise as a result of extreme or unusual hydraulic circumstances. The designer and the Department should be in agreement before specifying a detour bridge longer than the existing bridge.

7.1.2 Temporary Detour Bridge Elevations

- 1) If the temporary detour bridge length is to be the same as the existing bridge length, then the low member of the temporary detour bridge shall clear the design-year (10-year or 2-year) flood stage elevation of the existing bridge (constricted) condition by approximately 1.0 ft.
- 2) If the temporary detour bridge is to be shorter than the existing bridge, additional backwater may be generated. In this situation, there are several factors which should be considered:
 - a) The design-year (10-year or 2-year) flood stage upstream of the bridge should not be increased by more than 1.0 foot. Examine the area just upstream of the bridge. If there are homes, businesses, property, etc. which would be impacted by raising the flood stage upstream of the temporary bridge, then the temporary detour bridge length should be as long as the existing bridge.
 - b) If there are no properties upstream of the temporary detour bridge which could be impacted by a rise in the design year flood stage, then the superstructure (low steel) of the temporary detour bridge elevation shall be set to clear the design-year (10-year or 2-year) flood stage elevation induced by the temporary detour bridge constriction by approximately 1.0 ft. This rise should not exceed 1.0 ft. This rise should be limited so that it does not generate velocities more than approximately 2.0 times the natural (unconstricted) stream velocities unless streambed geology permits.
- 3) Streambed geology should be considered. If the streambed is comprised of a scour-resistant material, velocity increases greater than approximately 2.0 times the natural (unconstricted) conditions might be inconsequential. Therefore, in these geologic conditions, the bridge length could possibly be reduced more than with a sandy stream bed. However, the maximum 1.0 ft. increase in backwater should still be observed.
- 4) Temporary detour roadway geometrics – specifically profiles – should be considered when setting the elevation of the temporary detour bridge.

7.1.3 Temporary Detour Bridge Location

- 1) It is recommended that unless other considerations exist (environmental, right-of-way, buildings (or other structures), utilities, roadway geometry, channel geometry, etc.), the temporary detour bridge be located downstream of the existing bridge. This should ensure that, in the event that the temporary detour bridge is breached during a design flood, its failure will not result in the loss of the existing bridge or the proposed bridge.
- 2) For 2-lane bridges, the centerline to centerline distance of the temporary detour bridge to the existing bridge should be a minimum of 50 ft. This offset should ensure the constructability of the temporary and permanent bridge as well as the temporary and permanent roadway. At the engineer's discretion in spatially-constrained situations, this offset distance can be reduced to as little as 42 ft.
- 3) It should be assumed that the temporary detour bridge be centered about the stream channel and/or aligned with the existing bridge.

7.1.4 Temporary Detour Bridge Width

The detour bridge width shall accommodate the number and width of lanes shown in the roadway detour plans. The minimum lane widths for detour bridges are typically 11 feet for interstate detours and 10 feet for non-interstate detours. The minimum clearance from edge of travelway to traffic barrier is 2 feet.

7.2 Pedestrian Bridges

Pedestrian bridges are structures which primarily carry pedestrian and/or bicycle traffic. The Americans with Disabilities Act (ADA) requires that no grade be steeper than 1:12 (8.33%) for structures that carry pedestrian traffic.

For LRFD projects, the design of these structures shall be in accordance with the following:

- AASHTO LRFD Bridge Design Specification, 6th Edition, and
- LRFD Guide Specifications for Design of Pedestrian Bridges, 2nd Edition.

For Standard Specification projects, the design of these structures shall be in accordance with the following:

- AASHTO Standard Specifications for Highway Bridges, 17th Edition, and
- AASHTO Guide Specifications for Design of Pedestrian Bridges, 1997.

Projects containing pedestrian bridges may have very specific architectural requirements. Coordination with the GDOT Project Manager is necessary prior to commencing work on this structure type.

7.3 Support Structures for Signs, Signals and Lights

7.3.1 Standard Supports

Whenever possible, the roadway designer should use GDOT standard supports as listed in Table 7.3.1-1. Structures not addressed by these standards are designed by the contractor in accordance with the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals. The contractor is required to submit shop drawings for approval by the Bridge Office.

Table 7.3.1-1 GDOT Standard Supports

Standard/Detail Number	Description
4030	Details of Galvanized Metal Circular Guardrail for Protection of R.R. Signs
9023A	Railroad Grade Crossing Signs and Markings
9024A	Railroad Grade Crossing – Railroad Signing and Marking at Crossing with RR Signals and/or Gates
9041	Assembly Details on Aluminum Bolted Extruded Panels for Special Roadside Signs
9042	Aluminum Bolted Extruded Panels Assembly Component Details (For

	Special Roadside Signs)
9054A	Erection and Foundation Details for Special Roadside Signs - Breakaway Type Posts
9054B	Erection and Foundation Details for Special Roadside Signs - Breakaway Type Posts
9054C	Erection and Foundation Details for Special Roadside Signs - Breakaway Type Posts
9055	Erection and Foundation Details for Special Roadside Signs - Breakaway Type Posts (Wood) (To be used only where specified)
T03c	Details of Strain Pole Erection for Overhead Signs
T03d	Details of Timber Pole Erection for Overhead Signs
TS-04	Details of Metal Traffic Signal Support Structures
TS-05	Details of Concrete Traffic Signal Strain Poles
TS-06	Details of Strain Poles and Mast Arm Pole Foundations
TS-07	Grounding Details for Overhead Span Wire Signs and Traffic Signals

7.3.2 Strain Poles on Bridges

Overhead lane signs are sometimes needed over bridges with turn lanes. These signs are attached to tensioned wires supported by Type I, II or III strain poles, as specified in the GDOT Standard Specification 639. Whenever possible, these strain poles shall be stand-alone structures with their own foundation. However, in some urban areas there is not an appropriate place to locate a strain pole on the ground and therefore a strain pole must be mounted on the bridge. When this situation occurs, only steel strain poles shall be used and supported on the bridge substructure, not the superstructure. Both of the poles in the pair shall be located at the same bent and the cables attached to the poles shall be parallel to the bent, in order to keep all loads in the plane of the bent. Since anchor bolts for strain poles are typically 54 inches long, through-bolts are necessary on caps less than 57 inches deep.

Type IV strain poles supporting cable or mast-arm mounted traffic signals are generally not allowed on bridges.

7.4 Sound Barriers

A sound barrier is a structure erected to attenuate noise created by traffic. It consists of rolled steel section posts supporting wall panels made of various materials. The posts are embedded in a concrete shaft or mounted with bolted base plates to footings, traffic barriers or retaining walls.

Whenever possible, the roadway designer should use GDOT standard sound barriers as listed in Table 7.4-1. Structures not addressed by these standards are designed by the contractor in accordance with Chapter 15 of the AASHTO LRFD Bridge Design Specifications. Vehicular collision forces defined in LRFD 15.8.4 may be ignored. The contractor is required to submit shop drawings for approval by the Bridge Office.

Table 7.4-1 GDOT Standard Sound Barrier Details

Detail Number	Description
N-1A	Foundation and Post Details
N-1B	Foundation and Post Details
N-2	Details at Concrete Side Barrier
N-3	Spread Footing Alternate for Sound Barrier Wall
N-4	Sound Barrier, Type B, Interlocking Steel Panels
N-5	Sound Barrier, Type C, Precast Concrete Panels
N-6	Sound Barrier, Type F, Glass Reinforced Thermo Composite Panels Filled with Recycled Tire Rubber
N-7	Sound Barrier, Type G, Precast Autoclaved Aerated Concrete Panels

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Chapter 8. Final Plan Revisions, Shop Drawings, and As-Builts

8.1 Final Plan Revisions and Re-Designs

8.1.1 Revisions and Amendments

8.1.1.1 Revisions Prior To Letting

Use the following procedure when revising plans after they have been signed by the Chief Engineer:

- a) Check with the Project Manager to find out whether the plans can be revised. If they can, revise the plans and transmit them to the Project Manager.
- b) If the plans cannot be revised, the designer, in consultation with the Assistant State Bridge Engineer shall prepare an amendment listing the required changes. This amendment will be provided to the Office of Bidding Administration by the Assistant State Bridge Engineer.

Revised quantities can be changed prior to the advertisement (4 weeks prior to the letting), but after the plans are in the hands of the public, the original quantity can only be lined through with the new quantity written in adjacently.

8.1.1.2 Amendments

8.1.1.2.1 General

Once a project has been let, amendments to the contract must be posted to the plans. Amendments should not be posted until the project has been awarded or rejected.

8.1.1.2.2 For Rejected Projects

If the project is rejected, the amendments should be made as soon as possible so that they will be in the plans when the project is re-bid. The amendments should be marked as revisions, and any other revisions should be made at this time. The Group Leader should make sure that the revisions are posted before the plans are re-advertised.

8.1.1.2.3 For Awarded Projects

If the project is awarded, all changes to the plans which are included in the amendments should be made when a copy of the amendments is received from the Office of Bidding Administration. Changes should be made exactly as shown in the amendment. These changes should be marked as revisions, with the notation "Per amendment" in the Revision box. No other changes should be transmitted with these revisions. If any other changes to the plans are needed, the changes due to the amendments should be transmitted, then, at a later date, any other revisions should be processed. In the transmittal letter for the amendments, include the comment "As per amendments" and attach a copy of the corresponding amendments to the transmittal. This is to ensure that everyone understands that the changes to plans are actually already part of the contract since they were issued as an amendment.

When transmitting contract drawings, the designer should fill in the sheet number and total number of sheets located in the top right hand corner of each revised sheet.

8.1.1.3 Revisions after Letting (“Use on Construction” Revisions)

Use the following procedure when revising plans on projects let to contract:

- a) Revise quantities in the Summary of Quantities or detail sheets by lining through the previous quantity and placing the new quantity adjacent to that.
- b) Identify the revision by a symbol, typically a triangle with the revision number inside.
- c) Denote the revision date and comment in the revision box.
- d) Fill in the sheet number and total number of sheets located in the top right hand corner of each revised sheet.
- e) Revisions on projects indicated as Full Oversight or PoDI (Project of Division Interest) must be cleared by the FHWA before being finalized. It should be noted in the transmittal letter that the revision has been discussed with the FHWA.
- f) Do not change the character of the work without consulting with the Office of Construction concerning a Supplemental Agreement.
- g) The transmittal letter should contain brief statements of the changes. The transmittal should indicate any pay items for which the quantities changed.
- h) Revisions made to agree with shop drawings should be stated as such on the transmittal letter.

8.1.2 Plan Changes and Revisions during Construction

8.1.2.1 General

Once a Contract has been awarded, any bridge plan changes or revisions shall be coordinated with the Office of Construction or the GDOT field engineer in charge of the project. This policy must be carefully followed to minimize conflicts among material suppliers, contractors, GDOT personnel and other interested parties. Since the Districts are responsible for administering construction contracts, any revisions or changes affecting the contract must be coordinated with the District Construction Office.

When the Contractor’s redesign is approved, full-size prints shall be obtained. The Contractor should put a title block in the upper right corner of the plans and use sheet numbers as shown in the roadway plans, when practical. If the Plan and Elevation (P&E) sheet for the bridge was roadway sheet 64 of 135, then the redesign sheets would be 64A, 64B, etc. If only the beam design is changing, then use the sheet number of the beams. The revised sheets shall be sent to the Office of Design Policy and Support for inclusion in the record set of plans.

8.1.2.2 Contractor Redesign by Specifications

Contractor redesigns in accordance with the GDOT Standard Specifications, as described in the following sections, do not require the approval of the Office of Construction

8.1.2.2.1 Reinforced Concrete Deck Girders

When the contract plans feature RCDGs, contractors may submit a re-design utilizing either pre-stressed concrete stems or Type I Mod beams in accordance with GDOT Standard Specification 542. The GDOT engineer shall verify the structural adequacy of the re-design

and that all hydraulic requirements of the initial design are met before approving the submittal.

8.1.2.2.2 Welded Wire Fabric

GDOT Standard Specification 865 allows the substitution of welded wire fabric (WWF) for rebar in PSC beams, but does not address substitutions in other structural elements. It is the policy of the Bridge Office to allow such substitutions as long as the WWF will provide an area of steel equal to the plan value in each direction. No reduction in area will be allowed based on higher strength of WWF.

Lap and development lengths for such substitutions shall comply with AASTHO Standard Specifications 8.32.5.1 and 8.32.5.2 or LRFD 5.11.6.2, as applicable. In either case, the design yield strength of WWF should be assumed to be 60 ksi, regardless of the yield strength of the material to be substituted.

8.1.2.3 Other Contractor Redesigns

Proposals by the Contractor to revise the project for efficiency, cost savings or other considerations are subject to approval by the Office of Construction with a review performed by the Bridge Office as necessary. In all communications with the Contractor during the review process, the designer shall keep the GDOT field engineers informed and coordinate with the liaisons of the Office of Construction. All proposed changes originating with material suppliers or fabricators must be submitted by the Contractor.

8.1.2.4 Revisions for Errors and Field Conditions

When the contract plans need to be modified, the following actions shall be taken depending on the cause of the error:

- a) Construction Errors: When the Contractor makes an error during construction, the Contractor shall propose a solution to be approved by the Department. Department personnel should not offer solutions to the Contractor. Any damages or reduction in payment are negotiated by the Office of Construction.
- b) Design Errors: When there is an error on the plans, the Department will typically propose corrections.
- c) Field Conditions: When unexpected conditions are encountered that force a change to the design, the solution should be found through cooperation with all parties.

Any revisions made for the above conditions shall be coordinated with the State Bridge Construction Engineer or the GDOT field engineer in charge of the project. The revision of the plans shall be made as specified in Section 8.1.1.3. The revised sheets shall be sent to the Project Manager for distribution as a "Use On Construction" revision.

8.2 Shop Drawings

Shop drawings are required as specified in GDOT Standard Specification 105.02. Items requiring shop drawings include metal deck forms, bearing pads, PSC beams, steel beams, detour bridges, cofferdams, fencing, handrail, other types of bearings, etc. The shop drawings should be submitted by the Contractor, not directly from the fabricator. If the designer receives drawings from the

fabricator, the Contractor must be notified and a review will not commence until a letter covering the drawings is received from the Contractor.

8.2.1 Shop Drawing Review

8.2.1.1 Timeliness of Review

Because the fabricator must have the plans approved before starting fabrication, shop drawing approvals are time critical, so reviews should be prompt (typically within two weeks). The designer shall keep a shop drawing log showing the date of the submittal to the Bridge Office, date of return to the Contractor and an indication of approval or exceptions to the shop drawings.

8.2.1.2 Professional Engineer's Stamp for Design Changes

Shop drawings shall be stamped and signed by a Georgia Professional Engineer when a design change is made from the contract plans.

8.2.1.3 Shop Drawing Compatibility

In addition to evaluating the compliance of each shop drawing submittal, the designer should ensure that no conflicts occur with other shop drawings or the contract drawings. Potential areas of conflict include the following:

- beams and deck forms
- beams and diaphragm holes
- handrail post spacing on the shop drawings and the insets for post on the bridge plans

8.2.1.4 Conditional Approval

The reviewer shall not provide conditional approval for shop drawings or mark them "Approved as Noted". If changes are minor the reviewer may allow corrected sheets to be substituted so that the entire set can then be approved.

8.2.1.5 Stamping of Drawings

The reviewer shall stamp every page of each copy of approved shop drawings. When shop drawings are to be revised, the reviewer may stamp only those sheets requiring revision. Only the first sheet of design calculations needs to be stamped.

8.2.1.6 Distribution

See Section 1.6.9.2.4 for distribution of shop drawings that have been reviewed.

8.2.1.7 Shop Drawing Log

The designer shall keep a shop drawing log showing the date of the submittal to the Bridge Office, date of return to the Contractor and an indication of approval or rejection.

8.2.1.8 Record Keeping

All original shop drawing transmittal letters, both "in" and "out" shall be sent to the General Files. This should be done by including the original letter with the sets of drawings provided to the office clerk for transmittal. All other parties shall get photocopies of these letters.

8.2.1.9 Consultant Review

Shop drawings reviewed by consultants must be sent through the Bridge Office which will also stamp them after the consultant's review. Fabrication is not allowed to proceed without a Bridge Office approval stamp.

8.2.2 Metal Deck Forms

8.2.2.1 Professional Engineer's Stamp

Metal deck form shop drawings must include the stamp of the registered Georgia P.E. responsible for the design.

8.2.2.2 Key Review Items

Metal deck form shop drawings indicating intermediate supports between beams shall not be approved.

Metal deck forms shall have a minimum of 1" of bearing on the support angle at each end, as specified in GDOT Standard Specification 500.08.E.10.

The reviewer shall ensure that the gauge of steel shown on the shop drawings matches the design calculations and that the calculated deflection does not exceed the allowable limits.

For continuous steel beams, there shall be no welding between the hangers and the flange at the locations where the top flange is in tension under any loading condition. Therefore, the shop drawing shall indicate that straps connecting these hangers across the top flange are provided at these locations which should be clearly indicated on the plans.

8.2.2.3 Submittal to the Office of Materials

Approved shop drawings for metal deck forms are not required to be forwarded to the Office of Materials.

8.2.3 Bearing Pads

Bearing pads located farther than 40 feet from a fixed bent shall be redesigned when the contractor replaces RCDGs with Type I Mod PSC beams. The reviewer shall ensure the shop drawings match with the bearings in the redesigned bridge plans.

Approved shop drawings for bearing pads shall be forwarded to the Inspection Branch Chief at the Office of Materials.

8.2.4 PSC Beams

8.2.4.1 PE's Stamp on Modified Beam Drawings

PSC beam shop drawings may contain slight modifications from the contract drawings to aid in the fabrication process. As long as these modifications do not change the stress distribution in the PSC beam from the original design, the Contractor does not need to submit calculations and no PE stamp is required.

Sometimes PSC beams in shop drawings are modified from one hold-down to two to reduce the hold-down force. If there are no other changes in the beam design, the Contractor will not be

required to submit redesign calculations provided that the new hold-downs are no more than 3'-0" from the mid-point of the beam.

When the modifications change the stress distribution from the original design, the Contractor shall submit design calculations along with a set of beam drawings, stamped by a registered Georgia PE, to be included in the record set of plans.

8.2.4.2 Fabrication Length

The reviewer shall verify the fabrication lengths which may be slightly different from the plan lengths. The fabrication length accommodates elastic shortening, grade adjustments, concrete shrinkage, epoxy coating end treatments, etc.

8.2.4.3 Strands and Stirrups

The arrangement of straight and draped strands shall be verified to ensure no conflict with either diaphragm holes or dowel bar chases. The middle strands in the top flange may be shifted to be located between the stirrups.

Stirrups shall be detailed outside the strands in the web.

8.2.4.4 Embedded Elements

PSC beam shop drawings shall correspond with the metal deck form shop drawings since the clips must be located correctly on the beams in order for the deck forms to be installed. Inclusion of overhang brackets shall be verified on exterior beams.

For safety rail supports, it is acceptable to use a reinforcing bar embedded in the beam at the rail post locations. This bar should be cut off or bent into the deck steel after the safety rail is no longer needed. It is not acceptable to detail pipes in the top of a PSC beam to support safety railing posts. This is not acceptable since these pipes may hold water which freezes and causes splits in the beam.

Lifting loops shall be adequately embedded near the girder ends. The lifting loops shall extend through the girder to within 4" of the bottom so that the weight of the girder will not cause tension stresses at the junction of web and top flange. The location of the lifting loops shall comply with the contract drawings.

8.2.4.5 Minimum Release Time

PSC beam shop drawings shall specify a strand release time of no less than 18 hours to comply with the GDOT Standard Specifications.

8.2.4.6 Submittal to the Office of Materials

Approved shop drawings for PSC beams should be forwarded to the Concrete Branch Chief at the Office of Materials.

8.2.5 Detour Bridges

The detour bridge shall be designed by the Contractor and the shop drawings shall be stamped by a registered Georgia Professional Engineer. When the Contractor submits a new detour bridge design, the Bridge Office encourages that the design be in accordance with AASHTO LRFD

Specifications to ensure its long term viability. However, the current GDOT policy allows for designs in accordance with the AASHTO Standard Specifications.

The reviewer shall verify the design of the detour bridge including compliance with the plans for length, width and minimum bottom of beam elevation.

There are pre-approved detour bridge designs owned by some bridge contractors. Since the shop drawings for these bridges have been previously reviewed and accepted by the Bridge Office, the Contractor is not required to submit the shop drawings but the reviewer may request them. The reviewer shall still verify whether the overall size of the bridge matches the contract plans and if the pile types and sway bracing comply with the height requirements on the pre-approved drawings.

Approved detour bridge shop drawings are not required to be forwarded to the Office of Materials.

8.2.6 Steel Beams

When a steel beam design is modified by the Contractor from the original design, the Contractor shall submit design calculations along with a set of beam drawings, stamped by a registered Georgia Professional Engineer.

Approved shop drawings for all steel structures including plate girders, welded continuous rolled beams and pot bearings shall be forwarded to the Inspection Branch Chief at the Office of Materials and to the Office of Design Policy and Support for inclusion in the record set of plans.

8.2.7 Post Tensioned Members

Approved shop drawings for post-tensioned members shall be forwarded to the Office of Design Policy and Support for inclusion in the record set of plans. Design calculations for the post-tensioning operation shall be retained in the bridge design files.

8.2.8 Contractor-Designed Walls

Contractor-designed wall shop drawings shall be stamped by a registered Georgia Professional Engineer. The reviewer shall ensure the shop drawings comply with plan requirements including finish and graffiti proof coating. Prior to approving the calculations and plans, the reviewer shall have a letter from the contractor stating that the wall has been staked out and that it fits the site. See Section 149.3.03.D of the Standard Specifications.

Approved shop drawings shall be forwarded to the Office of Design Policy and Support for inclusion in the record set of plans. It is not necessary to forward approved wall shop drawings to the Office of Materials.

8.2.9 Contractor-Designed Sign Supports

Contractor-designed sign support shop drawings shall be stamped by a registered Georgia Professional Engineer. The reviewer shall ensure the shop drawings comply with plan requirements.

Approved shop drawings shall be forwarded to the Office of Design Policy and Support for inclusion in the record set of plans. It is required to forward approved sign support shop drawings to the Inspection Branch of the Office of Materials.

8.2.10 Miscellaneous Shop Drawings

Shop drawings for miscellaneous items such as fencing, shoring, and cofferdams are not required, but will be reviewed if submitted.

Shoring plans requiring railroad approval shall be submitted directly to the railroad once they have been approved by the Bridge Office.

8.3 As-Built Foundation Information Sheet

Each set of bridge plans shall include an As-Built Foundation Information sheet. This sheet will include spaces for field personnel to record the tip elevations of all piles, top and tip of caisson elevations, the bottom of footing elevations and the bottom of seal elevations. For pile footings, a schematic should be included, with the piles numbered left to right, then back to ahead.

As-Built Foundation Information sheets shall be completed by the GDOT Project Engineer and returned to the Bridge Office. This information shall be incorporated in the design files and a revised sheet will be transmitted as specified in Section 1.6.9.2.4. This information is important for long-term evaluation of the structure.

Information collected during data pile driving may be sent to the Bridge Office by mistake. It should be forwarded to the Geotechnical Bureau of the Office of Materials.

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Chapter 9. Seismic Design Guidelines

9.1 Standard Specification Design

Bridges shall be designed for Seismic Category A except for bridges in the portion of Georgia where the Acceleration Coefficient is greater than 0.09, where bridges shall be designed for Seismic Category B (Figure 9A-1 in Appendix 9A). A typical design for Category B bridges would use the analysis program SEISAB and then run North Carolina's version of BRPIER to consider the seismic forces.

Support length requirements for Categories A or B can be fulfilled using the cap dimensions, not just the bearing pad dimensions.

When a project calls for widening a bridge in a Category B region where the existing structure was originally designed for Category A, the widened portion shall be designed for Category B.

9.2 LRFD Specification Design

9.2.1 General

Seismic design of bridges shall be performed in accordance with the LRFD 3.10, LRFD 4.7.4 and LRFD 5.10.11. Based on the design earthquake and subsurface soil condition at the bridge site, the seismic performance zone and subsequently the design procedure shall be determined.

Seismic hazard at a bridge site could be characterized by the design response spectrum that is established using the general procedure or site-specific procedure, as specified in LRFD 3.10.2.

The seismic performance zone and the long-period acceleration coefficient, S_{D1} , shall both be indicated in the Design Data section of the General Notes sheet.

9.2.1.1 Site Class

Site class, from A to F, at the bridge location shall be determined based on the soil type and properties of the upper 100 feet of the soil profile, as specified in LRFD 3.10.3.1. It will be determined by the Geotechnical Bureau and provided on the Bridge Foundation Investigation (BFI) report.

For site class A through E, the seismic performance zone and design response spectrum can be determined using the general procedure as specified in LRFD 3.10.2.1. Site class F requires the site-specific procedure, as specified in LRFD 3.10.2.2, to determine seismic performance zone and to establish design response spectrum.

9.2.1.2 Design Earthquake Parameters

The LRFD Specifications provide the design earthquake parameters in the maps in LRFD 3.10.2.1, which will be used to determine the seismic performance zone and the design response spectrum of the bridge site. Using the geographical information of the bridge location, the following three acceleration coefficients should be read from the maps:

- Horizontal peak ground acceleration coefficient, PGA
- Horizontal response spectral acceleration coefficient at period of 0.2 second, S_s

- Horizontal response spectral acceleration coefficient at period of 1.0 second, S_1

9.2.1.3 Seismic Performance Zone

Seismic performance zone, from 1 to 4, of the bridge site shall be determined using the long-period acceleration coefficient, S_{D1} , in accordance with LRFD 3.10.6, except for the bridges in the site class F. S_{D1} shall be calculated by multiplying S_1 and the corresponding site factor for long-period spectrum range, F_v , as determined in accordance with LRFD 3.10.3.2. Seismic performance zone for the site class F shall be determined using the value of S_{D1} from the site-specific response analysis.

The state of Georgia is located in a relatively low seismic hazard zone and the general guidelines regarding the seismic performance zones in Georgia are presented as follows:

- a) If the site class is determined as class A, B or C, all bridge sites in Georgia will be classified as seismic performance zone 1.
- b) If the site class is determined as class D, the bridge sites in northern and eastern Georgia with S_1 of 0.0625 or above will be classified as seismic zone 2 and other sites will be classified as seismic zone 1.
- c) If the site class is determined as class E, only the bridge sites in southern Georgia with S_1 below 0.0429 will be classified as seismic zone 1 and other sites will be classified as seismic zone 2.
- d) If the site class is determined as class F, the seismic performance zone will be determined by a site-specific response analysis.

9.2.1.4 Design Response Spectrum

For the bridges in site class A through E, design response spectrum shall be established as specified in LRFD 3.10.4.1, using the acceleration coefficients read from the maps in LRFD 3.10.2.1 and the site factors specified in LRFD 3.10.3.2.

For the bridges in site class F, the design response spectrum shall be established from a site response analysis in accordance with LRFD 3.10.2.2 and provided in the Bridge Foundation Investigation (BFI) report. The long-period acceleration coefficient, S_{D1} , shall be determined from the site response analysis and used to determine the seismic performance zone in accordance with LRFD 3.10.6.

This spectrum should be used to determine the lateral force by the design earthquake. This lateral force will be applied to the substructure and connections as specified in Section 9.2.2.

9.2.2 Seismic Design Procedures

Seismic analysis methods to determine the design earthquake loads on the substructure shall be selected as specified in LRFD 4.7.4, unless specified otherwise by the Bridge Office. The analysis method is selected based on the seismic zone, operational class and regularity of the bridge. All bridges are designated as "Other Bridges" for the operational class as defined in LRFD 3.10.5, unless designated otherwise by the Bridge Office.

The requirement for minimum support length at expansion bearings, as specified in LRFD 4.7.4.4, shall be satisfied for all bridges.

The seismic design flowchart presented in LRFD APPENDIX A3 may be used as an aid for design of bridges in different seismic zones.

9.2.2.1 Single Span Bridges

Single span bridges do not require a seismic analysis regardless of the seismic zone, as specified in LRFD 4.7.4.2. The connection design forces in restrained directions shall be determined in accordance with LRFD 3.10.9.1.

9.2.2.2 Multi-Span Bridges in Seismic Performance Zone 1

Multi-span bridges in seismic zone 1 do not require a seismic analysis, as specified in LRFD 4.7.4.3. The connection design forces in restrained directions shall be determined in accordance with LRFD 3.10.9.2, using the load factor for live loads of 0.5.

9.2.2.3 Multi-Span Bridges in Seismic Performance Zone 2

Multi-span bridges in seismic zone 2 require a seismic analysis, as specified in LRFD 4.7.4.3. One of three elastic analysis methods, i.e., uniform load method, single-mode method, or multi-mode method, should be used for the seismic analysis.

Horizontal static earthquake loadings in longitudinal and transverse directions should be calculated from one of the analysis methods specified in LRFD 4.7.4.3.1, then combined and modified to determine the seismic design load cases as specified in LRFD 3.10.9.3. These load cases shall be combined with other loads for the Extreme Event I Limit State, as specified in LRFD 3.4.1.

For the Extreme Event I Limit State, the load factors for dead loads, γ_p , shall be 1.0 for steel pile bents in accordance with LRFD 6.5.5. For all other substructure types, the load factors for dead loads shall be in accordance with LRFD 3.4.1.

The load factor for live loads in the Extreme Event I Limit State, γ_{EQ} , shall be 0.5 for all substructure types, unless specified otherwise by the Bridge Office.

The resistance factors in the Extreme Event I Limit State shall be 1.0 for steel pile bents in accordance with LRFD 6.5.5 and 0.9 for other substructure types in accordance with LRFD 5.10.11.4.1b.

9.2.2.4 Multi-Span Bridges in Seismic Performance Zones 3 and 4

Multi-span bridges in seismic zones 3 and 4 require a seismic analysis, as specified in LRFD 4.7.4.3. An elastic method or time history method should be used for the seismic analysis. Horizontal loadings should be taken as the lesser of the modified design forces calculated in accordance with LRFD 3.10.9.4.2 or the inelastic hinging forces determined in accordance with LRFD 3.10.9.4.3. These horizontal loadings should be combined and modified to determine the seismic design load cases as specified in LRFD 3.10.9.4. These load cases shall be combined with other loads for the Extreme Event I Limit State, as specified in LRFD 3.4.1.

For the Extreme Event I Limit State, the load factors for dead loads, γ_p , shall be 1.0 for steel pile bents in accordance with LRFD 6.5.5. For all other substructure types, the load factors for dead loads shall be in accordance with LRFD 3.4.1.

The load factor for live loads in the Extreme Event I Limit State, γ_{EQ} , shall be 0.5 for all substructure types, unless specified otherwise by the Bridge Office.

The resistance factors in the Extreme Event I Limit State shall be 1.0 for steel pile bents in accordance with LRFD 6.5.5 and 0.9 for other substructure types in accordance with LRFD 5.10.11.4.1b.

9.2.3 Seismic Detailing Requirements

Bridge substructures shall be detailed as required in LRFD 5.10.11. The seismic detailing requirements for the amount and spacing of reinforcement shall always be checked after the general detailing requirements are met, and more reinforcement shall be added as necessary.

Seismic hooks of lateral reinforcement, as specified in LRFD 5.10.2.2, shall be used in the plastic hinge regions, typically located at top and bottom of columns and pile bents.

9.2.3.1 Bridges in Seismic Performance Zone 1

The bridges in seismic zone 1 with the long-period acceleration coefficient, S_{D1} , of 0.10 or greater shall meet the seismic detailing requirements, as specified in LRFD 5.10.11.2. In the plastic hinge regions of columns and pile bents, the minimum amount and the maximum spacing of transverse reinforcement shall meet the requirements specified in LRFD 5.10.11.4.1d and LRFD 5.10.11.4.1e, respectively.

9.2.3.2 Bridges in Seismic Performance Zone 2

The bridges in seismic zone 2 shall meet the seismic detailing requirements specified in LRFD 5.10.11.3. Columns/pile bents and wall-type piers shall be detailed in accordance with LRFD 5.10.11.4.1 and LRFD 5.10.11.4.2, respectively.

The amount of longitudinal reinforcement in a column shall be determined in accordance with LRFD 5.10.11.4.1a with an exception for the maximum amount being specified in LRFD 5.10.11.3. This requirement for longitudinal reinforcement shall apply to the entire height of the column.

The amount of transverse reinforcement in a column or pile shall not be less than that required in LRFD 5.10.11.4.1c or LRFD 5.10.11.4.1d. The spacing of transverse reinforcement shall not be larger than that required in 5.10.11.4.1e. These requirements for transverse reinforcement shall apply to the plastic hinge regions. The transverse reinforcement shall extend into the adjoining members in accordance with LRFD 5.10.11.4.3.

Splicing of longitudinal reinforcement shall conform to the provisions in LRFD 5.10.11.4.1f.

Longitudinal and transverse reinforcements in concrete piles shall conform to the provisions in LRFD 5.13.4.6.2.

9.2.3.3 Bridges in Seismic Performance Zones 3 and 4

The bridges in seismic zone 3 or 4 shall meet the seismic detailing requirements specified in LRFD 5.10.11.4. Columns/pile bents and wall-type piers shall be detailed in accordance with LRFD 5.10.11.4.1 and LRFD 5.10.11.4.2, respectively.

The amount of longitudinal reinforcement in a column shall be determined in accordance with LRFD 5.10.11.4.1a. This requirement for longitudinal reinforcement shall apply to the entire height of the column.

The amount of transverse reinforcement in a column or pile shall not be less than that required in LRFD 5.10.11.4.1c or LRFD 5.10.11.4.1d. The spacing of transverse reinforcement shall not be larger than that required in 5.10.11.4.1e. These requirements for transverse reinforcement shall apply to the plastic hinge regions. The transverse reinforcement shall extend into the adjoining members in accordance with LRFD 5.10.11.4.3.

Splicing of longitudinal reinforcement shall conform to the provisions in LRFD 5.10.11.4.1f.

Longitudinal and transverse reinforcements in concrete piles shall conform to the provisions in LRFD 5.13.4.6.3.

Appendix 9A – Seismic Category B for Standard Specification

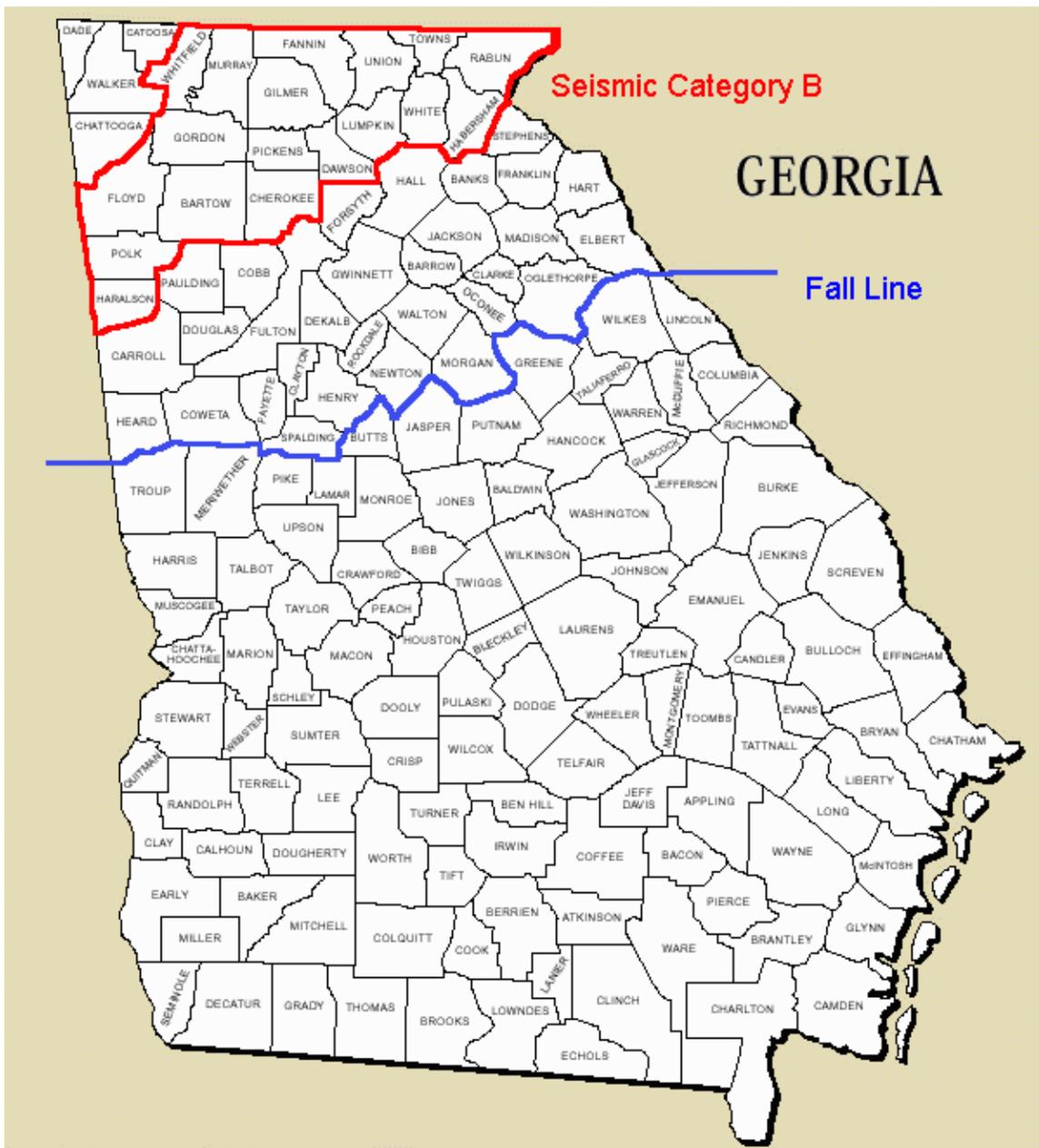


Figure 9A-1 Map of Seismic Category B Counties

Appendix 9B - Typical Seismic Detailings

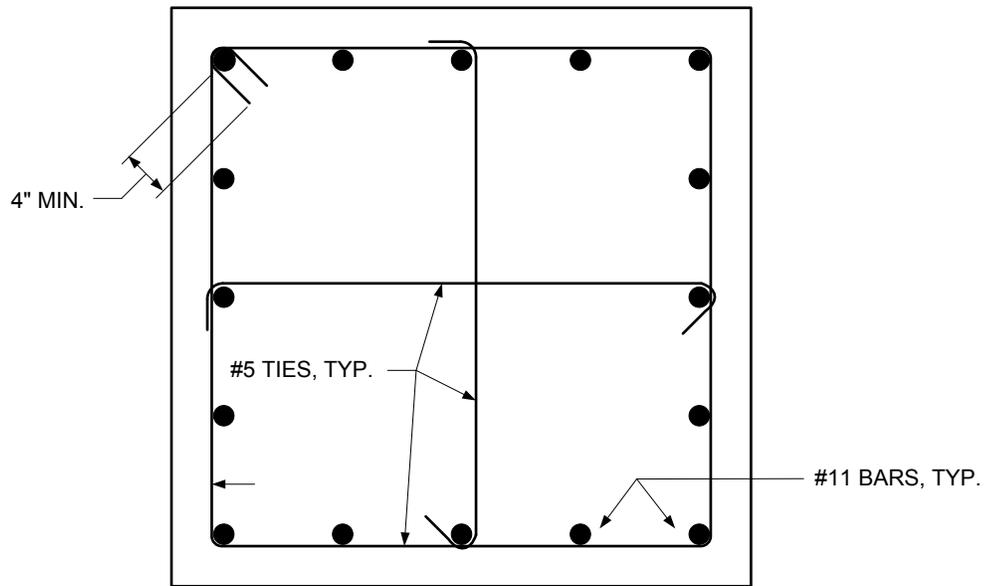


Figure 9B-1 Typical Section of Column in Plastic Hinge Regions for Seismic Zones 2, 3 and 4

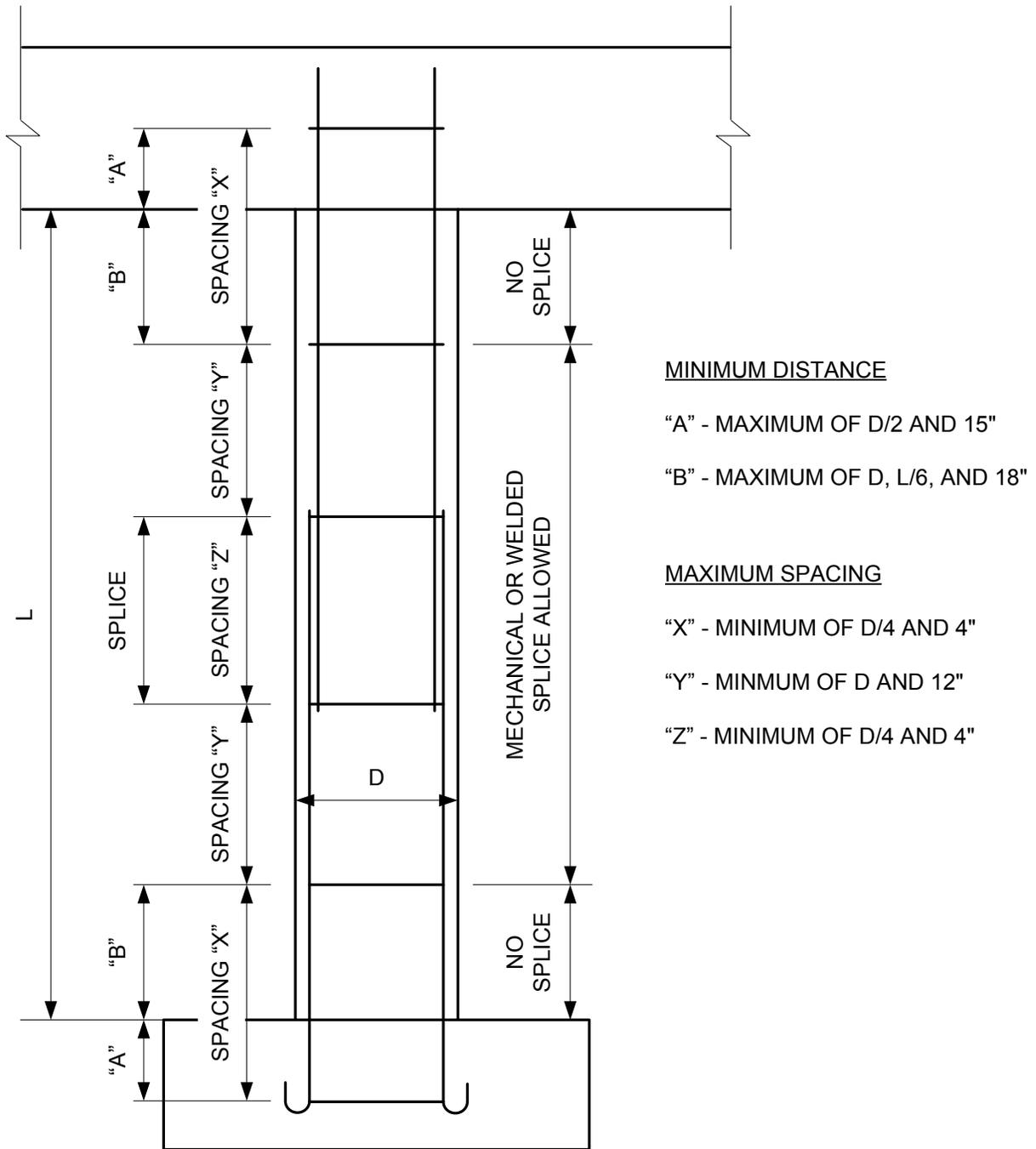
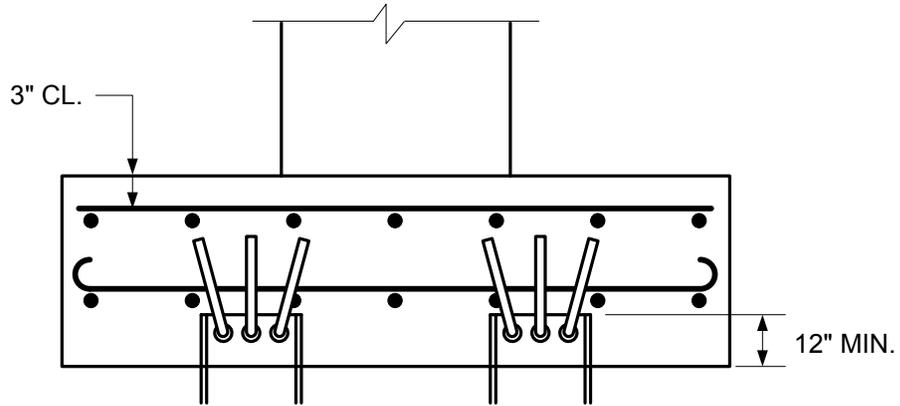
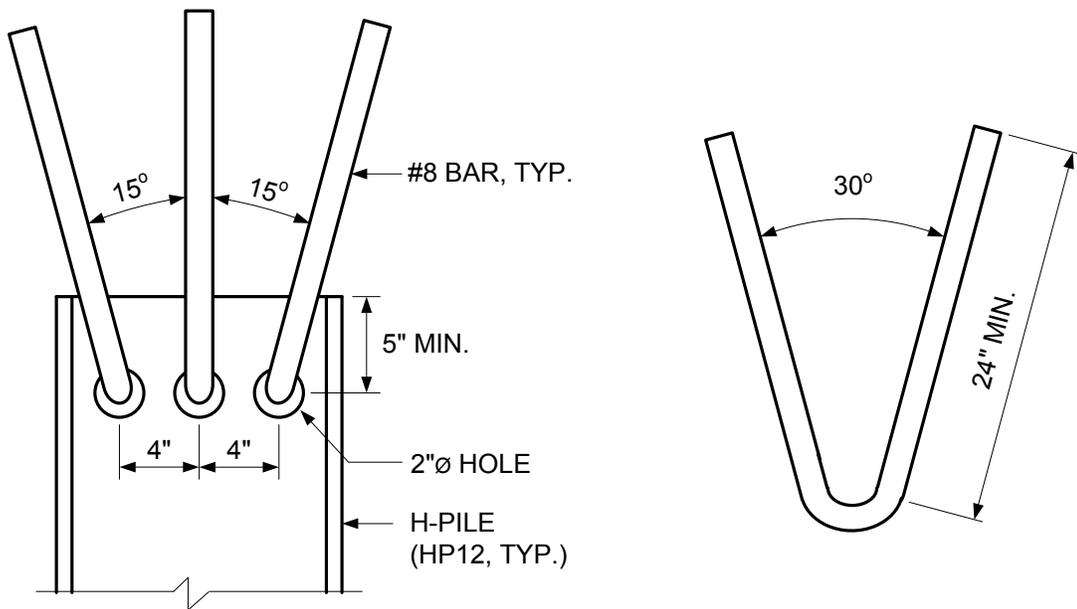


Figure 9B-2 Column Detailing Guidance for Seismic Zones 2, 3, and 4



DETAIL AT FOOTING



TOP OF PILE

#8 BAR

Figure 9B-3 H-Pile Connection Detail for Seismic Zones 2, 3, and 4

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