DIVISION OF HIGHWAYS
NCDOT
SUB REGIONAL TIER DESIGN GUIDELINES FOR BRIDGE PROJECTS

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NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

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PURPOSE

The Sub Regional Tier Design Guidelines for Bridge Projects establishes the controlling design elements for new and reconstructed bridges on the North Carolina Highway System designated as minor collectors, local and/or secondary roads. Engineering judgment must be applied during project development, while considering the site-specific conditions, to achieve desirable levels of service and assure safety of the traveling public. Each bridge project shall provide a safe and economical design, while maintaining or improving the operating conditions at the site.

If a bridge project is designed to the standards set forth in these guidelines, no formal design exception approval is required.

If a bridge project is designed to the standards set forth in these guidelines and does not match the current planning document, a memorandum to the project file shall be written to acknowledge that the Sub Regional Tier Guidelines for Bridge Projects was used. No formal design exception approval is required.

Formal design exception approval is required when standards set forth in these guidelines are not met. Project files shall fully justify and document the need for a design exception to the standards. Any anticipated design exception required for a project shall be listed in the environmental document.

BACKGROUND

These guidelines establish broad limits by presenting minimum values for design and allowing engineering judgment to be applied to achieve desirable levels of traffic service and safety appropriate to the social, economical and environmental controls applicable to the specific project. The North Carolina bridge inventory is aging at a rate, which exceeds the current bridge replacement program. In an effort to minimize the amount of approach work and to maximize the limited funds available for the bridge program, representatives from the Bridge Maintenance Unit, Construction, Operations, Planning, and Highway Design Branch Units evaluated the Department's bridge replacement program and established bridge replacement design criteria that maintains current operating conditions without compromising safety. These guidelines allow planners and designers to minimize changes in the vertical grade, structure length and width, approach roadway limits and right of way for each site.

PROCEDURE

The Project Development and Environmental Analysis Branch (PDEA) will prepare a planning document that includes appropriate consideration of the safety, social, economic and environmental impacts. On-site field reviews and scoping meetings must be held during the planning and design process. At a minimum, representatives from PDEA, Highway Design and the Division should be in attendance at these meetings.

PLANNING

PDEA's Bridge Project Development Unit will coordinate with Highway Design, Division and Traffic Engineering staff to provide, in the environmental document, decisions reached regarding applicable design criteria such as bridge approach travel speed, design speed, bridge width and lane and shoulder widths. These decisions will be based on traffic forecast and crash and severity rates when compared to the statewide average (provided by the Traffic Engineering and Safety Systems Branch) and whether the location is identified by North Carolina's Highway Safety Improvement Program.

The Bridge Project Development Unit will also coordinate with the Division and the Bridge Maintenance Unit on the possibility of removal of redundant bridges and options for rehabilitation instead of replacement where appropriate. Consideration shall be given to the use of accelerated construction techniques.

ROADWAY DESIGN (GEOMETRIC DESIGN CRITERIA)

The following geometric design criteria will be used based on the traffic forecast and whenever the crash and severity rates are below the statewide average (provided by the Traffic Engineering and Safety Systems Branch). Also, the project site shall not be at a location identified by North Carolina's Highway Safety Improvement Program.

Design Speed: The design speed shall be established after considering the topography, anticipated operating speed, the adjacent land use and the functional classification of the highway. The design speed selected for the project shall be identified and recorded in the environmental document. Once the design speed is selected, all of the pertinent highway features should be related to this speed to obtain a balanced design. All references to speed in this document are the design speed unless otherwise noted.

Lane and Shoulder Widths: R-R-R Guide, Table 2, Page 14.

Bridge Width:
20 year Design Volume Less than 4000 vehicle/day
Design speed of 45 mph and under: Bridge Deck Width (Minimum) = 24 feet
Design speed above 45 mph: Bridge Deck Width (Minimum) = 26 feet

20 year Design Volume Over 4000 vehicle/day
For all design speeds: Bridge Deck Width (Minimum) = 28 feet*
(* For current ADT over 3000 vehicle/day: use 30 feet)

In no case shall the bridge width be less than that of the approach roadway width (including paved shoulders).

Horizontal Clearance: Bridge Policy, Page 26. (Horizontal Clearances for Local System)

Vertical Clearance: Bridge Policy, Page 9. (Vertical Clearances)

Horizontal Alignment: An existing horizontal curve may be retained as is without further evaluation if the existing curve design, assuming correct superelevation is provided, corresponds to a speed that is within 10 mph of the design speed.

Vertical Alignment: An existing vertical curve may be retained if the curve's design speed is within 20 mph of the project's design speed and the design volumes are less than 1500 vehicles/day.

An existing vertical curve may be retained if the curve's design speed is within 10 mph of the project's design speed.

Stopping Sight Distance: Minimum stopping sight distance should be provided for the horizontal and vertical curve conditions as stated above (Horizontal and Vertical Alignment). Values are shown in Exhibit 5-2, page 381. [AASHTO, A Policy on Geometric Design of Highways and Streets (2004)].

Cross Slope: Pavement cross slope should be adequate to provide proper drainage. Normally, cross slopes range from 1.5 to 2 percent for asphalt pavements.

Superelevation: It is desirable to superelevate curves in accordance with AASHTO Guidelines. The curve should be signed and marked for the appropriate speed in accordance with the provisions of the "Manual On Uniform Traffic Control Devices For Streets And Highways" (MUTCD) if minimum superelevation rates can not be achieved.

Grades: The existing roadway grade may be retained. An appropriate minimum grade is typically 0.3%.

Guardrail: Transition guardrails to bridge rails should be provided on all four corners of an undivided two-way, two-lane bridge.

Design speed of 45 mph and under: The minimum length of guardrail required at the bridge approach is 50 feet (including the guardrail anchor units). This design utilizes a Test Level 2 (TL-2) Guardrail Anchor Unit Type 350.

Design speed above 45 mph: The minimum length of guardrail required at the bridge approach is 75 feet (including the guardrail anchor units). This design utilizes a Test Level 3 (TL-3) Guardrail Anchor Unit Type 350.

Engineering judgment must be applied during all stages of project development to achieve desirable levels of traffic service and safety, while considering site-specific conditions. At a minimum, current operating conditions shall be maintained and safety improved at documented and potentially hazardous locations.

For very low-volume local roads the Guidelines for Geometric Design for Very Low-Volume Local Roads (ADT 400 vehicles and less), AASHTO 2001 may be used in lieu of the Sub Regional Tier Design Guidelines for Bridges. "A very low-volume local road is a road that is functionally classified as a local road and has a design average daily traffic volume of 400 vehicles per day or less."

HYDRAULIC DESIGN

FEMA: Identify project site locations that require FEMA Detailed Study or Limited Detail Study and design for compliance.

Non FEMA: Consult with the Division Office to establish Level of Service needs if the existing roadway is overtopped by the 25-year frequency storm or an event with a lower return period.

The minimum return period for design shall maintain the existing level of service.

The maximum return period for design is the 25-year frequency storm.

Where design frequency is less than the 25-year storm, the engineer will assess the property upstream and downstream of the highway rights of way for impacts to private property.

Hydraulics: The recommended structure type shall be considered in the following priority order: a) Pipe Culvert (circular or arch pipe), b) Box Culvert, c) Bottomless Culvert Structure founded in non-scourable rock (concrete or metal), d) Bridge.

Deck Drainage: There shall be no direct discharge of deck runoff into open waters with classification of WS-I or Outstanding Resource Water.

There shall be no direct discharge into open waters within one half (0.5) mile of Critical Area of WSII, WSIII, and WSIV.

There shall be no direct discharge in all other water classifications where storm water runoff gutter spread is not at risk for safety of the traveling public.

Gutter Spread: Avoid spread into travel lane for a 4 inches/hour rainfall intensity. Investigate steeper gutter slope, increase deck cross slope, eliminate super elevation, coordinate rail and deck drain details with Structure Design Engineer, etc. to reduce gutter spread when necessary.

Bridge Scour: The Hydraulics Engineer shall analyze scour for the 100-year or overtopping flood. Cone of influence for total scour to be shown as 1.4H: 1V on the bridge profile drawing.

Debris Assessment: Identify debris transport potential at the site. Where debris transport potential is low, the use of battered piles may be appropriate and should be noted under "Additional Information" on the Bridge Survey Report.

General Comments: Consider span arrangements that accommodate the use of cored slabs or box beams to facilitate top down construction, even if an interior bent is in the water.

GEOTECHNICAL DESIGN

AASHTO Load and Resistance Factor Design (LRFD) Specifications: Use higher resistance factors when subsurface conditions are appropriate. Use Importance Factor, η=0.95, for load factor.

Scour: Design to allow approach fill wash outs rather than constructing abutment walls, with foundations to remain standing. Scour Critical Elevations will be required at these end bents.

Utilize designed scour countermeasures in lieu of more costly foundation solutions.

Reinforced Approach Fills: Use reinforced bridge approach fills in all coastal plain areas. In all other areas, utilize alternate standard detail to ensure backfill material is retained in areas of end bent excavation.

Interior Bents: Use drilled-in piles with a Pile Driving Analyzer (PDA) in lieu of drilled pier foundations.

STRUCTURE DESIGN

AASHTO Load and Resistance Factor Design (LRFD) Specifications: Use Importance Factor, η=0.95, for load factor. Use empirical deck design method for cast in place decks of girder bridges.

Bridge Rail: Utilize Standard Flat Face rail to facilitate deck drain functionality and minimize bridge width. (Show plan details for an epoxy protective coating for exterior cored slab or box beam surfaces adjacent to deck drains.)

Use Standard 1-Bar Metal Rail or approved precast New Jersey shaped barrier rail as appropriate for posted or design speed of 45 mph or less.

For designated bicycle routes or on roadways where the need to accommodate bicycle safety has been identified in the environmental planning document, use of a 42" rail height is acceptable; however, the Standard 2-Bar Metal Rail (54" rail height) shall be utilized for bridges spanning waterways of 100 feet or more in width.

Design Lanes: Use the actual number of travel lanes on the structure for design of superstructure and substructure elements, in lieu of the number of lanes that can be accommodated by the clear roadway.

Approach Slabs: Detail 12 foot long approach slabs, with ends parallel to the skew.

Overlays: Except for low water bridges, show plan details for an asphalt overlay on cored slab and box beam superstructures.

Substructure: Limit cap, column and drilled shaft sizes to those required for load carrying capacity, while maintaining constructability.

Appendix

Table 2

Minimum Width Revisions Based on

(NCHRP Report 486, Table 4)

Minimum Lane and Shoulder Widths for R-R-R Projects

Design Speed	Current ADT	Arterial		Collector		Local	
		Lane Width	Shoulder	Lane Width	Shoulder	Lane Width	Shoulder
Under 50 mph (Level and Rolling Terrain)	0 - 1000	11	4	10	3	10	3
	1000-2000	11	4	10	3	10	3
	over 2000	12	6	11	6	11	6
50 mph and over (Level and Rolling Terrain)	0 - 1000	11	4	11	3	10	3
	1000-2000	12	6	11	4	11	3
	over 2000	12	6	11	6	11	6
Under 50 mph (Mountainous Terrain)	0 - 1000	10	3	10	3	10	3
	1000-2000	11	3	10	3	10	3
	over 2000	12	6	11	6	11	4
50 mph and over (Mountainous Terrain)	0 - 1000	11	3	11	3	10	3
	1000-2000	11	3	11	3	10	3
	over 2000	12	6	11	6	11	4

NOTES:

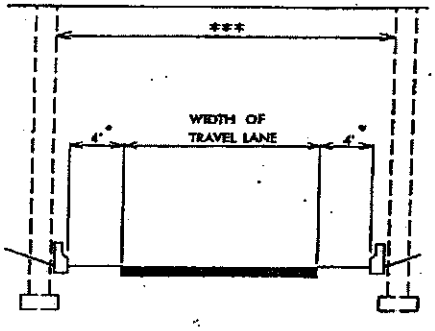
1. Shoulder dimensions indicate graded widths and include paved shoulder widths.
2. Where guardrail is to be installed, graded shoulder width must be increased by 3 feet.
3. Where truck traffic (TTST and Duals) volume exceeds 10% of current ADT, lane widths should be increased by 1' to a maximum of 12'. 12' lane width should be used on routes designated as part of the National Truck Network.
4. For current ADT less than 1000, paved shoulder should be considered. For current ADT between 1000 - 3000, 2' paved shoulders are recommended. For current ADT over 3000, 4' paved shoulders should be used.

LOCAL AND COLLECTOR SYSTEM

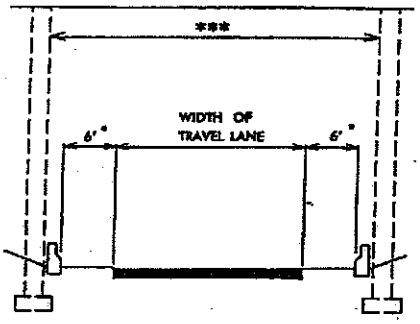
HORIZONTAL CLEARANCES

DESIGN YEAR ADT

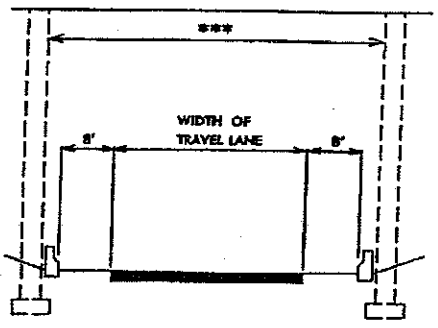
UNDER 400



400 – 2000



OVER 2000



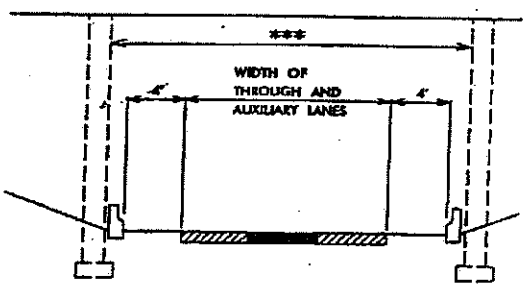
SHOULDER APPROACH

* THE OFFSET FOR BRIDGES WITHIN THE URBAN AREA BOUNDARY MAY BE INCREASED TO A MIN. OF 7'–6" TO ACCOMMODATE FUTURE SIDEWALKS. ENGINEER SHOULD CHECK WITH HYDRAULICS TO DETERMINE IF ADDITIONAL OFFSET IS NEEDED TO ACCOMMODATE FOR DRAINAGE.

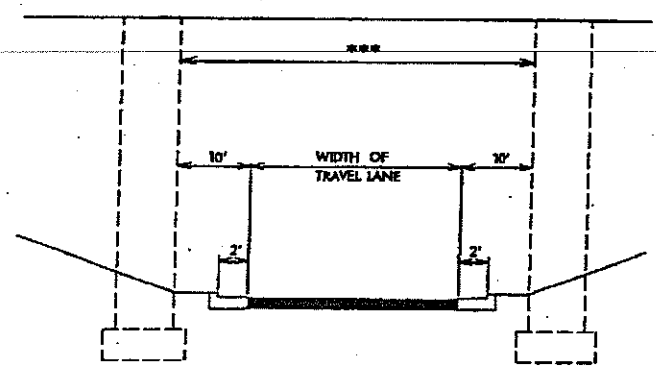
*** SEE EXCEPTIONS TO POLICY ON PAGE 3 OF THIS MANUAL FOR ADDITIONAL INFORMATION.

NOTE:

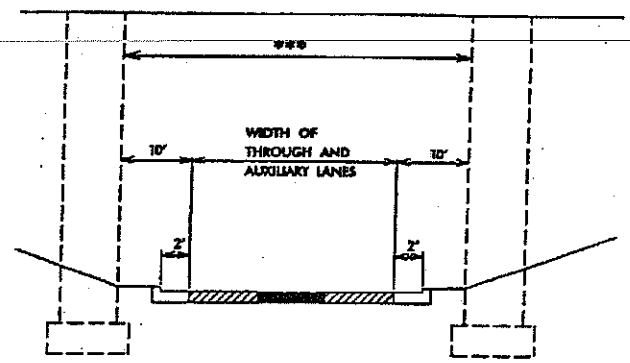
PIER NECESSITY AND LOCATION ARE TO BE DETERMINED BY THE STRUCTURE DESIGN UNIT. SEE THE ROADWAY DESIGN MANUAL, CHAPTER 6–10 FOR ENDBENT SLOPE BREAK POINT.



SHOULDER APPROACH WITH AUXILIARY LANES



CURB AND GUTTER APPROACH



CURB AND GUTTER APPROACH WITH AUXILIARY LANES

LEGEND

THROUGH TRAVEL LANES

AUXILIARY LANES

VERTICAL CLEARANCES

Vertical clearances for new structures shall be designed above all sections of pavement including the useable shoulder. Future widening and pavement cross slope will be considered in design clearance.

Vertical clearances shall be as shown below. These clearances include a 6" allowance for future resurfacing. An additional 6" range is shown to allow for the flexibility necessary in the coordination of roadway grades with final superstructure depths.

Vertical clearances above these limits must be justified by economics or some vertical control.

1. Over Interstates and Freeways and Arterials
   Vertical Clearances – 16'-6" to 17'-0"

   Note: "17'-0" to 17'-6" vertical clearance is desirable for structures located over Interstates, Freeways, or Arterials constructed with portland cement concrete pavement. If the pavement type is not known during the preliminary design phase, then the desirable clearance range should apply to structures located over these facilities having design year average daily truck traffic of 5000 or greater."

2. Over Local and Collector Roads and Streets
   Vertical Clearance – 15'-0" to 15'-6"

3. Over all Railroads
   Vertical Clearance – 23'-0" to 23'-6" or less if approved by Railroads

4. Navigable Waters
   The U.S. Coast Guard permit determines the minimum clearances for navigable waters. Clearances over waters not regulated by the U.S. Coast Guard will be determined by negotiations and agreement with the appropriate interests.

5. Normal minimum clearance above design high water should be 2'-0" for all Interstates, Freeways, Arterials, and Secondary Crossings of Major Rivers, 1'-0" for all other roads. Where conditions warrant, less than the above may be permitted.

6. Pedestrian overpasses and sign structures vertical clearance – 17'-0" to 17'-6"