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National Solutions Worldwide Impact

Updates for the 7th Edition of the AASHTO Green Book

Presentation to
Alabama Pre-Construction Conference
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April 2018

Transportation Research Center

Defense Energy Health

Status of Green Book Update

- Revisions to the 6th Edition of the Green Book (2011) began in 2016
- AASHTO balloting for the revised 7th Edition is now compete
- The 7th Edition should be published later in 2018

Scope of Green Book Updates

- New Chapter 1 to implement the resolution on design flexibility from the AASHTO Standing Committee on Highways
- Evolutionary changes to Green Book Chapters 2 through 10
- Full implementation of the new framework for geometric design throughout the Green Book will be addressed in the future 8th Edition

Resolution of the AASHTO Standing Committee on Highways – Spring 2016

- Green Book should remain research based and peer reviewed
- AASHTO should provide guidance to state DOTs and other Green Book users regarding flexibility in design
- Guidance should be provided in the next Green Book edition and in the longer term
- Guidance should address designing in and for a multimodal transportation system
- SCOD should coordinate with and possibly include other AASHTO publications in flexible design standards
- SCOD should identify gaps in necessary research and develop a plan to fill those gaps

New Resources Available

- NCHRP Report 876, *Guidelines for Integrating Safety and Cost-Effectiveness Into 3R Projects*
- NCHRP Report 855, *An Expanded Functional Classification System for Highways*
- NCHRP Report 839, *An Performance-Based Highway Geometric Design Process*
- NCHRP Report 785, *Performance-Based Analysis of Geometric Design of Highways and Streets*

Green Book Chapter 1—New Framework for Geometric Design

- Replacement for Chapter 1 presents a new framework for geometric design that addresses:
  - explicit statement of project purpose and need
  - existing functional classification system
  - new context classification system
  - multimodal considerations
  - revised design process for specific project types
  - design flexibility
  - performance-based design

Project Purpose and Need

- Purpose and need should be explicitly stated for every project
- Purpose and need can be presented as:
  - purpose and need statement required by the NEPA process
  - project objectives statement
  - both types of statements
- Purpose and need statement is the method for agency management to tell planners and designers what will and what will not be included in the project scope
- Purpose and need/project scope should be defined considering:
  - past performance
  - anticipated future performance if no project is implemented

Examples of Performance Issues That May Need to be Addressed in Particular Projects

- Existing and expected future traffic operational efficiency
- Existing and expected future crash frequency and severity
- Service and ease of use for each transportation mode
- Accessibility for persons with disabilities
- Impacts of existing and potential future development
- Operational flexibility during future incidents and maintenance activities
- Impacts on the natural environment:
  - air quality
  - noise
  - wetland preservation
  - wildlife and endangered species

Project Purpose and Need

- Purpose and need addresses performance issues that have a documented need for improvement
- Noncompliance with geometric design criteria is not, by itself, a performance issue and should not appear in a project purpose and need statement
- Noncompliance with geometric design criteria only becomes a performance issue if:
  - past (or anticipated future) performance is an issue
  - poor performance can be corrected by a geometric design improvement
- This approach is intended to avoid expenditures that have no impact on performance

Functional Classification System

- Traditional presentation of functional classification system
- Retains current four functional classes
  - local roads and streets
  - collector roads and streets
  - arterial roads and streets
  - freeways
- Text emphasizes that these functional classes characterized how a specific roadway is intended to serve motor vehicles

Context Classification System

- Traditional geometric design has addressed two roadway contexts: rural and urban
- New approach addresses five roadway contexts:
  - rural
  - rural town
  - suburban
  - urban
  - urban core

Context Classification System

- Contexts are defined based on:
  - development of density (existence of structure and structure types)
  - land uses (primarily residential, commercial, industrial, and/or agricultural)
  - building setbacks (distance from structures to adjacent roadways)
- Context classification system uses easy to assess measures:
  - can utilize review of aerial photographs

Framework for Geometric Design

Functional Class	Context Class				
	Rural	Rural Town	Suburban	Urban	Urban Core
Local Road or Street					
Collector Road or Street					
Arterial Road or Street					
Freeway					

Photos of Context Classes

Rural Context

Rural Town Context

Photos of Context Classes

Suburban Context

Urban Context

Urban Core Context

Multimodal Considerations

- Consider needs of all transportation modes in every project
  - automobiles
  - bicyclists
  - pedestrians
  - transit
  - trucks
- Consideration does not necessarily mean that dedicated facilities are provided for every mode in every project
- Appropriate balance among transportation modes may vary widely between specific roads and streets
- Balance among transportation modes should be a conscious decision considering:
  - needs of and travel demands for each mode
  - local and regional transportation agency master plans
  - community needs

Multimodal Considerations

- Purpose and need for project provides a perspective on the appropriate balance among transportation modes
- Additional considerations:
  - demand volumes
  - community and stakeholder input

Revised Design Process for Specific Project Types

- Three project types are addressed in design procedures:
  - new construction projects
  - reconstruction projects
  - projects on existing roads

Revised Design Process for Specific Project Types

NEW CONSTRUCTION PROJECTS

- New alignment where no existing roadway is present
  - could be an undeveloped site or site with existing development
- Design guidance in Chapters 2 through 10 is primarily intended for new construction projects
  - new construction projects often have fewer constraints than projects on existing roads
- Projects are designed within the framework defined by functional and context classes and should consider needs of all transportation modes
- Performance of an existing road is not a factor in design, but forecast performance of design alternatives in future years may strongly influence design decisions

Revised Design Process for Specific Project Types

RECONSTRUCTION PROJECTS

- Projects that utilize an existing roadway alignment (or make only a minor change in alignment), but involve a change in the basic roadway type
- Changes in basic roadway type include the following where these cannot be accomplished within the existing roadway width (including shoulders):
  - widening to provide additional through lanes
  - adding a raised or depressed median where none currently exists
- Projects on existing alignment that do not change the basic roadway type but replace the existing pavement structure down to the subgrade are no longer classified as reconstruction

Revised Design Process for Specific Project Types

RECONSTRUCTION PROJECTS

- Design decisions in reconstruction projects are often difficult to adapt new facility type to the existing alignment and fit is within the community context
- Like all projects, reconstruction projects are designed within the framework defined by functional and context classes and should consider needs of all transportation modes
- Design guidance in Chapters 2 through 10 is desirable, but may be impractical due to project constraints and may not be relevant to project purpose and need
- Design decisions should be made using a flexible, performance-based approach

Revised Design Process for Specific Project Types

PROJECTS ON EXISTING ROADS

- Projects that utilize an existing roadway alignment (or make only a minor change in alignment) and do not involve a change in the basic roadway type
- Projects on existing roads are classified by the primary reason the project is being undertaken:
  - repair infrastructure condition
  - reduce current or anticipated traffic operational congestion
  - reduce current or anticipated crash patterns
- Like all projects, projects on existing roads are designed within the framework defined by functional and context classes and should consider needs of all transportation modes
- A flexible, performance-based approach is utilized

Revised Design Process for Specific Project Types

PROJECTS ON EXISTING ROADS

- Projects undertaken to improve infrastructure condition should follow guidelines presented in NCHRP Report 876
- Projects undertaken because of traffic operational congestion should be designed based on the HCM or applicable models
- Projects undertaken because of crash patterns should be designed based on the HSM or applicable models
- Make geometric design changes only to address identified needs

Design Flexibility

- Design flexibility is of critical importance because each project:
  - has a specific purpose and need
  - has specific context and constraints
  - serves a unique set of users
  - fills a distinct position in the transportation network
- No single set of geometric design criteria meets the needs of all, or even most, projects
- Designers are responsible for considering a range of factors when applying design criteria, making tradeoffs among possible design options to best serve the traveling public and the community at large
- Design flexibility removes an unnecessary layer of constraints to achieving the most appropriate design

Design Flexibility

- There is substantial flexibility in Green Book Chapters 2 through 10
- Performance-based analysis can help exercise that flexibility and identify when alternative design criteria should be used
- Design flexibility does not mean that designers can use arbitrary discretion in the design of projects. Flexibility should be exercised to better meet specific project goals or to work within defined constraints
- Designers are expected to balance competing needs
- Documentation of how flexibility was exercised to meet competing needs is needed to show:
  - why proposed design is an appropriate solution
  - how it meets the needs of each transportation mode
  - how it is expected to perform in the future
  - how it fits within available funding

Performance-Based Design

- Performance measures demonstrate how a project meets its purpose and need
- Performance measures can be used to select among design alternatives
- Performance measures can be used in economic analysis
- Both quantitative and qualitative performance measures can be used:
  - not every potential project effect can be quantified

Performance-Based Design

- Alternative approaches to performance-based design:
  - set performance goals for a project by establishing quantitative targets for improvement in specific measures of future performance relative to the no-build condition
  - set performance goals that specify performance measures that will be improved from the no-build condition (without necessarily saying how much) and other performance measures that will, at least, remain unchanged in comparison to the no-build condition
- Guidance and performance analysis tools:
  - NCHRP Report 785, *Performance-Based Analysis of Geometric Design of Highways and Streets*
  - TRB *Highway Capacity Manual* and other operation models
  - AASHTO *Highway Safety Manual* and other crash prediction methods

General Changes to Green Book Chapters 2 through 10

- Flipped units of measurement (US Customary first; metric second)
- Generally increased the top end of the design speed range
  - 80 mph [130 km/h] in some cases; 85 mph [140 km/h] in others
- Increased emphasis on multimodal design
  - Incorporates latest ADA/Section 404 requirements

Chapter 2 – Design Controls and Criteria

- Greater emphasis on transportation of people (as opposed to design for vehicles)
  - Multimodal LOS
  - Greater emphasis on lower speed, walkable, urban zones
- Update to pedestrian walking speed
- Emphasizes the AASHTO *Highway Safety Manual* and encourages its use

Chapter 3—Elements of Design

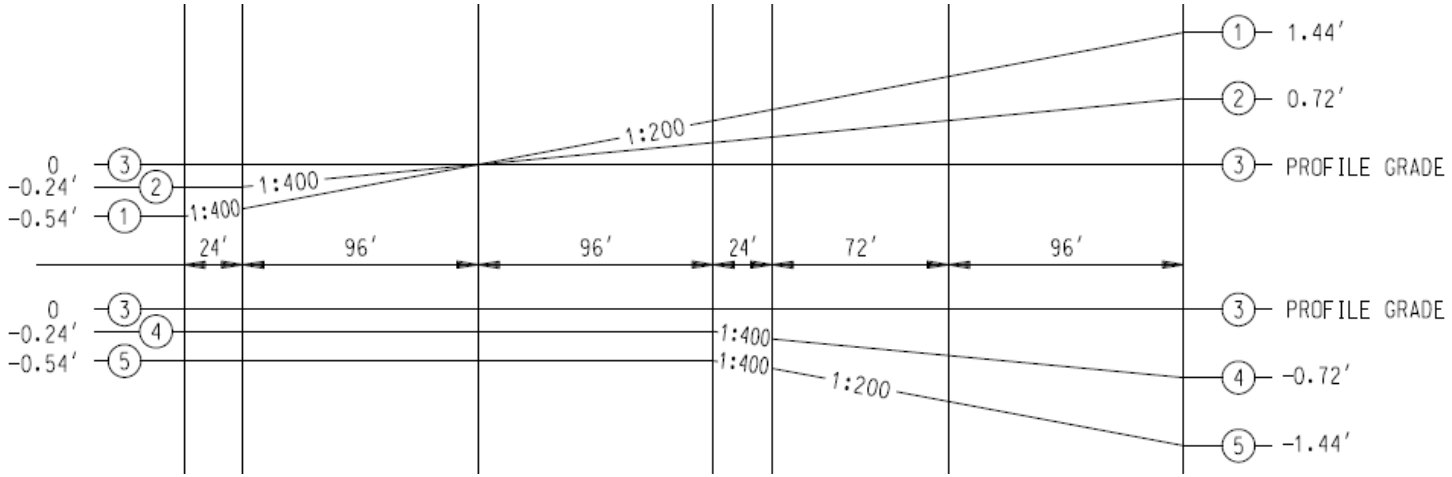
- Added 85 mph [140 km/h] to SSD tables
- Explanation added for how to compute e and minimum R for horizontal curves with design speeds greater than 80 mph [130 km/h]

Chapter 3—Elements of Design

- Added speed-distance curves for 140 lb/hp heavy trucks on grades
  - retained 200 lb/hp curves as well

Chapter 3—Elements of Design

- Superelevation transitions
  - more flexibility with distribution and rate of rotation
  - increased awareness of oversupply through transitions (introduced equation from NCHRP Report 774 to check for this condition)



Chapter 4—Cross Section Elements

- Expanded discussion of driveway width from NCHRP Report 659
- Discussion of median geometry to reduce cross-median crashes (from NCHRP Report 790)
- Updated noise abatement discussion per latest FHWA guidance
- Update to pedestrian walking speed

Chapters 5 through 7—Local, Collector, and Arterial Roads and Streets

- Revised lane width discussion in Chapters 5 and 6 to align with Chapter 7 – i.e., right sizing
- Revised rural traveled way and shoulder widths to more right-sized values
  - based on *Highway Safety Manual* data
- Added material presenting design speed ranges for different contexts
- Deleted section on bridges to remain in place
  - No longer addressed in AASHTO bridge specifications
- Added sections in Chapters 6 and 7 on high- to low-speed transition zones (based on NCHRP Report 737)

Chapter 5—Local Roads and Streets

- New section on driveways in rural areas
- Recreational and special purpose roads reorganized into separate sections
- Updated minimum curve radii for unpaved roads
  - based on U.S. Forest Service guidance

Chapter 7—Arterial Roads and Streets

- Title changed from “Rural and Urban Arterials” to “Arterial Roads and Streets”
  - consistency with Chapters 5 and 6
  - reduces potential confusion created by new context categories
- New section and other material on design in the rural town context

Chapter 7—Arterial Roads and Streets

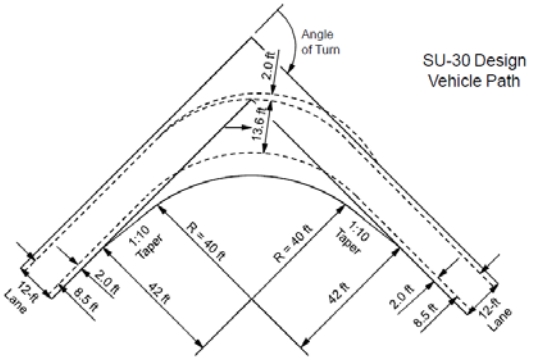
- Urban area design
  - removed material on operational and control measures
    - did not pertain to geometric design
  - added a section on speed management in design

Chapter 8--Freeways

- Revised design speed guidance to encourage right-sized and context sensitive designs in urban and suburban settings
  - moved away from “the higher the better”
- Removed material targeting specific levels of service

Chapter 9--Intersections

- Cleaned house a bit
  - Removed material on:
    - edge of traveled way designs
    - median design layout
    - intersection sight distance charts

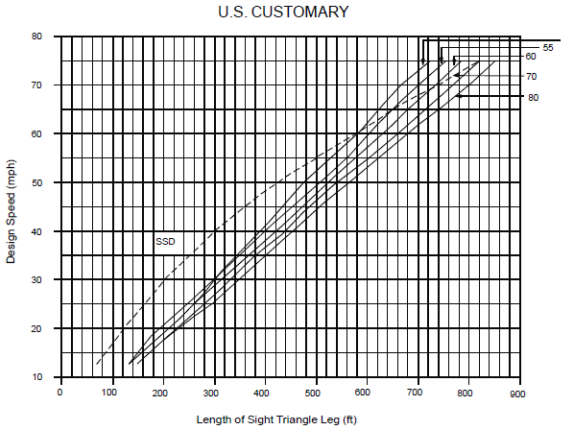


SU-30 Design Vehicle Path

Minimum Simple Curve with Taper, 40-ft Radius, Offset 2 ft

– B –

Metric						u.s. Customary					
			Simple Curve Radius with Taper						Simple Curve Radius with Taper		
Angle of Turn (°)	Design Vehicle	Simple Curve Radius (m)	Radius (m)	Offset (m)	Taper I:t	Angle of Turn (°)	Design Vehicle	Simple Curve Radius (ft)	Radius (ft)	Offset (ft)	Taper I:t
90	P	9	6	0.8	10:1	90	P	30	20	2.5	10:1
	SU-9	15	12	0.6	10:1		SU-30	50	40	2.0	10:1
	SU-12	24	14	1.2	10:1		SU-40	80	45	4.0	10:1
	WB-12	—	14	1.2	10:1		WB-40	—	45	4.0	10:1
	WB-19	—	36	1.3	30:1		WB-62	—	120	4.5	30:1
	WB-20	—	37	1.3	30:1		WB-67	—	125	4.5	30:1
	WB-28D	—	30	1.8	10:1		WB-92D	—	95	6.0	10:1
	WB-30T	—	25	0.8	15:1		WB-100T	—	85	2.5	15:1
	WB-33D	—	35	0.9	15:1		WB-109D	—	115	2.9	15:1
105	P	—	6	0.8	8:1	105	P	—	20	2.5	8:1
	SU-9	—	11	1.0	10:1		SU-30	—	35	3.0	10:1
	SU-12	—	14	1.2	10:1		SU-40	—	45	4.0	10:1
	WB-12	—	12	1.2	10:1		WB-40	—	40	4.0	10:1
	WB-19	—	35	1.0	15:1		WB-62	—	115	3.0	15:1
	WB-20	—	35	1.0	15:1		WB-67	—	115	3.0	15:1
	WB-28D	—	24	2.4	10:1		WB-92D	—	80	8.0	10:1
	WB-30T	—	22	1.0	15:1		WB-100T	—	75	3.0	15:1
	WB-33D	—	28	2.8	20:1		WB-109D	—	90	9.2	20:1
120	P	—	6	0.6	10:1	120	P	—	20	2.0	10:1
	SU-9	—	9	1.0	10:1		SU-30	—	30	3.0	10:1
	SU-12	—	11	1.8	8:1		SU-40	—	35	6.0	8:1
	WB-12	—	11	1.5	8:1		WB-40	—	35	5.0	8:1
	WB-19	—	30	1.5	15:1		WB-62	—	100	5.0	15:1
	WB-20	—	31	1.6	15:1		WB-67	—	105	5.2	15:1
	WB-28D	—	24	2.1	10:1		WB-92D	—	80	7.0	10:1
	WB-30T	—	20	1.1	15:1		WB-100T	—	65	3.5	15:1
	WB-33D	—	26	2.8	20:1		WB-109D	—	85	9.2	20:1



Chapter 9--Intersections

- New or revised drawings and/or text for:
  - Channelized right-turn lanes
  - Offset left-turn lanes
  - Bypass lanes
  - Reduced conflict intersections
    - U-turn roadways
    - Loons

Chapter 9--Intersections

- Added tables on characteristics of nonmotorized users
- Added intersection sight distance discussion for roundabouts
- Revised criteria for turn-lane length

Chapter 10—Grade Separations and Interchanges

- Added a new section on diverging diamond interchanges

Chapter 10—Grade Separations and Interchanges

- Added a new table on maximum ramp grade (replacing a paragraph of text)
- Acceleration and deceleration length tables expanded to include 80 mph [130 km/h] design speed

Questions?