

VIRGINIA DEPARTMENT OF TRANSPORTATION

# LOCATION AND DESIGN DIVISION

## INSTRUCTIONAL AND INFORMATIONAL MEMORANDUM

GENERAL SUBJECT: OPERATING SPEED, POSTED SPEED LIMIT, DESIGN SPEED	NUMBER: IIM-LD-117.7
SPECIFIC SUBJECT:  METHOD OF DETERMINING AND INDICATING DESIGN SPEED ON PLANS	DATE: JULY 27, 2012
	SUPERSEDES: IIM-LD-117.6
APPROVED:	Mohammad Mirshahi, P.E. Deputy Chief Engineer / State Location & Design Engineer Approved July 27, 2012

Changes are shaded.

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### CURRENT REVISION

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- This memorandum has been revised to reference the 2011 AASHTO Green Book and VDOT Road and Bridge Standard TC-5.11.
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### EFFECTIVE DATE

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- Effective July 16, 2012, VDOT adopted the 2011 AASHTO Green Book.
  - VDOT Road and Bridge Standard TC-5.11 is effective on all projects with an advertisement date of August 13, 2013 and later.
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### OPERATING SPEED

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- Operating Speed is the speed at which drivers are observed operating their vehicles during free-flow conditions. The 85<sup>th</sup> percentile of the distribution of observed speeds is the most frequently used measure of the operating speed associated with a particular location or geometric feature of a highway, or highway segment.

## POSTED SPEED

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- The Posted Speed for existing, new or reconstructed roadways should be determined by factors outlined in the MUTCD, Section 2B.13. The MUTCD requires that an engineering study be conducted in accordance with established engineering practice. VDOT has a standard study template for developing speed limit recommendations which incorporates the MUTCD, Section 2B.13 as well as other considerations pertaining to VDOT's decision-making process for speed limit approvals, including enforcement consensus.
- After a project is constructed, the Regional Traffic Engineer will re-establish the speed limit based on established traffic engineering policies. An engineering study will be performed as needed in accordance with documented traffic engineering practices.
- It is important to note that the Design Speed shown on the project title sheet may not be the same as the Design Speed of the individual geometric elements. Each curve on the project (horizontal and vertical) should show a Design Speed for that particular feature. Although these curves may present isolated instances where the physical roadway dictates the speed of vehicles, they shall not be the sole basis for determining the posted speed limit. It is more appropriate to address these locations by warning signs. It is only where the physical roadway features dictate the speed of the vehicles on extended sections, for a major portion of the roadway that they should be considered as a limiting factor in setting the speed limit. Such limitations in speed due to physical features will become apparent in the speed analysis conducted as part of the engineering study.
- For design criteria and instructions on signing roadways with a design speed < 25 mph, see the VDOT Road Design Manual, Appendix B(1), Tables 1 through 3 and AASHTO's "Guidelines for Geometric Design of Very Low-Volume Local Roads (ADT  $\leq$  400).

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## DESIGN SPEED (V)

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- Design Speed is a selected speed used to determine the various geometric design features of the roadway. The assumed Design Speed should be a logical one with respect to the topography, anticipated Operating Speed, the adjacent land use, and the Functional Classification of the highway.
- Except for local streets where speed controls are frequently included intentionally, every effort should be made to use as high a Design Speed as practical to attain a desired degree of safety, mobility, and efficiency within the constraints of environmental quality, economics, aesthetics, and social or political impacts. (See 2011 AASHTO Green Book, Chapter 2).

- The minimum Design Speed shall be based on the following criteria:
  - 1) For roadways with a Posted Speed:
    - a) For high-speed designs (50 mph and greater) Design Speed shall be a minimum of 5 mph greater than the Posted Speed.
      - Example - Design Speed 60 mph – Posted Speed 55 mph
    - b) For low-speed designs (45 mph and less) Design Speed shall be equal to or greater than Posted Speed.
      - Example - Design Speed 40 mph – Posted Speed 40 mph
  - 2) For unposted roadways: Design Speed shall be equal to Statutory Speed or 85% percentile speed (based on speed analysis, rounded up to nearest 5 mph increment).
  - 3) Roadways with ADT < 400, see the VDOT Road Design Manual, Appendix B(1), Tables 1 through 3 and AASHTO's "Guidelines for Geometric Design of Very Low-Volume Local Roads (ADT ≤ 400)".

Whenever VDOT criteria (provided above in cases 1-3) are not met, a design waiver is required to document the design speed.

- A Design Exception is required if AASHTO minimum design speeds for individual geometric elements are not met.
- For the appropriate minimum Design Speed with regard to functional classification and terrain, refer to VDOT's Road Design Manual, Appendix A. Additional information is available in NCHRP Report 504 "Design Speed, Operating Speed and Posted Speed Practices", at: [http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp\\_rpt\\_504.pdf](http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_504.pdf) .
- For the determination of the roadway posted speed limits, the plans are to indicate the Design Speed (V) of each horizontal and vertical (crest and sag) curve along with the horizontal and vertical curve data.
- The Design Speeds (V) are to be determined as follows:
  - Crest Vertical Curves
    - See "Sight Distance on Crest Vertical Curves" (VDOT's Road & Bridge Standards, Section 600) to determine sight distance parameters.
    - See 2011 AASHTO Green Book "Crest Vertical Curve" criteria, pages 3-151 through 3-157 to determine the Design Controls.
  - Sag Vertical Curves
    - See 2011 AASHTO Green Book "Sag Vertical Curve" criteria, pages 3-157 through 3-161 to determine the Design Controls.

## Horizontal Curves

- The appropriate Transition Curve Standard (TC-5.01R, TC-5.01U, or TC-5.04ULS, TC-5.11R, TC-5.11U, or TC-5.11ULS) from VDOT'S Road and Bridge Standards, Section 800, provides the Design Speed (V) for horizontal curves (based on the radius of curvature (R) and the superelevation rate (E) provided by GeoPak.

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## SHOWING DESIGN SPEED (V) FOR HORIZONTAL CURVES ON PLANS

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- The Design Speed shown on the plans for each horizontal curve is not necessarily the Minimum Design Speed shown on the Title Sheet.
- GEOPAK supplies the superelevation dependent upon the input (urban/rural, radius, etc.) for each curve but does not provide the design velocity.
- Designers shall determine the Design Speed (V) for each curve. This data is to be shown on the plans in the horizontal curve data for each curve.

### Example:

#### Title Sheet:

Urban Principal Arterial (TC-5.11U - 2011 AASHTO Green Book)  
45 mph Minimum Design Speed

#### Horizontal Curve on plans:

Radius = 1533'  
Superelevation = 3.3% (provided by GEOPAK)  
V = ?

1. To verify the velocity of the horizontal curve compare project radius and superelevation with Design Factors Charts in Section 800 of the Road and Bridge Standards.
2. Start with Section 802.30 TC-5.11U for given Design Speed shown above (45 mph).
  - ⇒ Chart shows that a curve with 3.3% superelevation and radius of 1446' will support a velocity of 45 mph. The radius on the plans is greater than 1477' (1533').
3. Go to Section 802.31 (50 mph Design Speed).
  - ⇒ Chart shows that a curve with 3.3% superelevation and radius of 1857' will support a velocity of 50 mph, but the radius on the plans is less than 1857' (1533').

4. Therefore, the project radius and superelevation will not support a 50 mph design velocity. The more conservative  $V = 45$  mph shall be shown on the plans as the velocity of the curve.

A Design Exception is required whenever the curve radius and superelevation do not support the minimum design speed. (See IIM-LD-227 for information on Design Exceptions.)

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## ADDITIONAL RESOURCES

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- Transportation Research Board, NCHRP Report 504, Design Speed, Operating Speed, and Posted Speed Practices, available at: [http://trb.org/publications/nchrp/nchrp\\_rpt\\_504.pdf](http://trb.org/publications/nchrp/nchrp_rpt_504.pdf) .
- 2004 AASHTO Green Book, "Speed", Chapter 2.
- NS 23 CFR 625 available at: <http://www.fhwa.dot.gov/legsregs/directives/fapg/0625sup.htm>
- The Federal Aide Policy Guide (FAPG)
- "Compatibility of Design Speed, Operating Speed and Posted Speed" (1995 - By FHWA and TXDOT)
- ITE's "Speed: Understanding Design, Operating and Posted Speed" (1997 - By Ray Krammes (FHWA) and Kay Fitzpatrick (TTI))
- Manual on Uniform Traffic Control Devices (MUTCD, 2009 Edition)
- Note that the statutory speed limit is 55 mph for cars and 45 mph for trucks with the following exceptions: 25 mph in residence and business districts; 35 mph in cities and towns; 35 mph on Rural Rustic Roadways; 55 mph or 35 mph on non-surface treated roadways (depending on jurisdiction). See §§ [46.2-873](#) through [46.2-875](#) of the Code of Virginia.

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## SHOWING DESIGN SPEED ON TITLE SHEET

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- See the current version of Instructional and Informational Memorandum IIM-LD-204 for the method of showing design speed data on the plans.
- An asterisk is to be shown adjacent to the Design Speed (Example - \* 60 MPH) on the title sheet and the following note shown:

\* See Plan and Profile Sheets for the horizontal and vertical curve design speeds.