THE GREEN BOOK

A Policy on Geometric Design of Highways and Streets

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American Association of State Highway and Transportation Officials
AASHTO
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FOREWORD

Highway engineers, as designers, strive to meet the needs of highway users while maintaining the integrity of the environment. Unique combinations of design controls and constraints that are often conflicting call for unique design solutions. *A Policy on Geometric Design of Highways and Streets* provides guidance based on established practices that are supplemented by recent research. This document is also intended as a comprehensive reference manual to assist in administrative, planning, and educational efforts pertaining to design formulation.

Design values are presented in this document in both metric and U.S. customary units and were developed independently within each system. The relationship between the metric and U.S. customary values is neither an exact (soft) conversion nor a completely rationalized (hard) conversion; and the use of brackets around U.S. Customary values does not indicate as in some AASHTO publications that these are soft conversions. The metric values are those that would have been used had the policy been presented exclusively in metric units; the U.S. customary values are those that would have been used if the policy had been presented exclusively in U.S. customary units. Therefore, the user is advised to work entirely in one system and not attempt to convert directly between the two.

The fact that new design values are presented herein does not imply that existing streets and highways are unsafe, nor does it mandate the initiation of improvement projects. This publication is not intended as a policy for resurfacing, restoration, or rehabilitation (3R) projects. For projects of this type, where major revisions to horizontal or vertical curvature are not necessary or practical, existing design values may be retained. Specific site investigations and crash history analyses often indicate that the existing design features are performing in a satisfactory manner. The cost of full reconstruction for these facilities, particularly where major realignment is not needed, will often not be justified. Resurfacing, restoration, and rehabilitation projects enable highway agencies to improve highway safety by selectively upgrading existing highway and roadside features without the cost of full reconstruction. When designing 3R projects, the designer should refer to *TRB Special Report 214*, *Designing Safer Roads: Practices for Resurfacing, Restoration, and Rehabilitation*, and related publications for guidance.

The intent of this policy is to provide guidance to the designer by referencing a recommended range of values for critical dimensions. Good highway design involves balancing safety, mobility, and preservation of scenic, aesthetic, historic, cultural, and environmental resources. This policy is therefore not intended to be a detailed design manual that could supersede the need for the application of sound principles by the knowledgeable design professional. Sufficient flexibility is permitted to encourage independent designs tailored to particular situations. Minimum values are either given or implied by the lower value in a given range of values. The larger values within the ranges may be used where social, economic, and environmental impacts are not critical. Engineering judgment is exercised by highway agencies to select appropriate design values.

The highway, vehicle, and individual users are all integral parts of transportation safety and efficiency. While this document primarily addresses geometric design issues, a properly equipped and maintained vehicle and reasonable and prudent performance by the user are also needed for safe and efficient operation of the transportation facility.

Emphasis is placed on the joint use of transportation corridors by pedestrians, cyclists, and public transit vehicles. Designers should recognize the implications of sharing transportation corridors and are encouraged to consider not only vehicular movement, but also movement of people, distribution of goods, and provision of essential services. A more comprehensive transportation program is thereby emphasized.

Cost-effective design is also emphasized. The traditional procedure of comparing highway-user benefits with costs has been expanded to reflect the needs of non-users and the environment. Although adding complexity to the analysis, this broader approach also takes into account both the need for a given project and the relative priorities among various projects. The results of this approach may need to be modified to meet the needs-versus-funds challenges that highway administrators face. The goal of cost-effective design is not merely to give priority to the most beneficial individual projects but to provide the most benefits to the highway system of which each project is a part.

Most of the technical material that follows is detailed or descriptive design information. Design guidelines are included for freeways, arterials, collectors, and local roads, in both urban and rural locations, paralleling the functional classification used in highway planning. The book is organized into functional chapters to stress the relationship between highway design and highway function. An explanation of functional classification is included in Chapter 1.

These geometric design guidelines are intended to provide operational efficiency, comfort, safety, and convenience for the motorist. The design concepts presented herein were also developed with consideration for environmental quality. The effects of the various environmental impacts can and should be mitigated by thoughtful design processes. This principle, coupled with that of aesthetic consistency with the surrounding terrain and urban setting, is intended to produce highways that are safe and efficient for users, acceptable to non-users, and in harmony with the environment.

This publication supersedes the 2004 AASHTO publication of the same name. Because the concepts presented cannot be completely covered in this one document, references to additional literature are given at the end of each chapter. These references include works that were cited or consulted in the development of the chapter or are of interest to the discussion of the subject matter therein. Of these documents, only those balloted and published by AASHTO represent AASHTO policy.

1 Highway Functions

1.1 SYSTEMS AND CLASSIFICATIONS

The classification of highways into different operational systems, functional classes, or geometric types is needed for communication among engineers, administrators, and the general public. Various classification schemes have been applied for distinct purposes in different rural and urban regions. Classification of highways by design types based on the major geometric features (e.g., freeways, conventional streets, and highways) is the most helpful approach for highway location and design procedures. Classification by route numbering (e.g., U.S., State, and County) is the most helpful approach for traffic operations. Administrative classification (e.g., National Highway System or Non-National Highway System) is used to denote the levels of government responsible for and the method of financing highway facilities. Functional classification, the grouping of highways by the character of service they provide, was developed for transportation planning purposes. Comprehensive transportation planning, which is an integral part of total economic and social development, uses functional classification as an important planning tool. The emergence of functional classification as the predominant method of grouping highways is consistent with the policies contained in this publication.

1.2 THE CONCEPT OF FUNCTIONAL CLASSIFICATION

This section introduces the basic concepts needed for understanding the functional classification of highway facilities and systems.

1.2.1 Hierarchies of Movements and Components

While the accommodation of bicyclists, pedestrians, and transit users is an important consideration in the planning and design of highways and streets, the functional classification of a highway or street is primarily based on motor vehicle travel characteristics and the degree of access provided to adjacent properties. Motor vehicle travel involves a series of distinct travel movements. The six recognizable stages in most trips include main movement, transition, distribution, collection, access, and termination. For example, Figure 1-1 shows a hypothetical highway trip using a freeway, where the main movement of vehicles is uninterrupted, high-speed flow. When approaching destinations from the freeway, vehicles reduce speed on freeway ramps, which act as transition roadways. The vehicles then enter moderate-speed arterials (distributor facilities)