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TECH BRIEF

Design Decision Documentation and Mitigation Strategies for Design Exceptions

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This document is a technical summary of the Federal Highway Administration (FHWA) report *Design Decision Documentation and Mitigation Strategies for Design Exceptions* (FHWA-SA-23-009).

OBJECTIVE

There have been changes in FHWA's controlling design criteria and in the project development philosophies of many departments of transportation (DOTs). These changes have resulted in State DOTs shifting from standards-driven design toward context-based and performance-based decision-making, all of which can add value for road users and flexibility during project development.

Design Decision Documentation and Mitigation Strategies for Design Exceptions provides information to transportation practitioners, especially planners and designers, about FHWA's 10 controlling criteria, their impacts on safety and operations, the inter-relationships with other controlling criteria, and potential mitigation strategies for design exceptions. The report also includes an overview of concepts such as nominal and substantive safety, performance-based and context-based design, equity in transportation, Complete Streets, transportations systems management and operations (TSMO), Safe System Approach, risk management, and design documentation practices. Appendix A in the report includes real-world examples of noteworthy practices from States' projects and procedures.

FHWA'S 10 CONTROLLING CRITERIA

In 2016, FHWA revised the controlling criteria to 10 criteria for the design of projects on the National Highway System (NHS). Of the 10 controlling criteria, only design loading structural capacity and design speed apply to all NHS facility types. The remaining eight criteria are applicable only to high-speed NHS roadways, defined as interstate highways, other freeways, and roadways with a design speed greater than or equal to 50 miles per hour (80 kilometers per hour). The 10 controlling criteria are:[1]

- **Design Speed:** A selected speed used to determine most of the geometric design features of the roadway. The assumed design speed should be a logical one with respect to the topography, anticipated operating speed, modal mix, vulnerability of users, adjacent land use, and functional classification of the highway.
- **Lane Width:** The lateral roadway distance available to accommodate a single line of vehicles.
- **Shoulder Width:** The lateral roadway distance located outside the vehicular lanes primarily provided for the accommodation of stopped vehicles for emergency use and for lateral support of base and surface course.
- **Horizontal Curve Radius:** The distance from the central point to the circumference of a circular curve.

[1] Robert B. Mooney to Director of Field Services, Division Administrators, Director of Technical Services, Federal Lands Highway Division Engineers, "INFORMATION: Revisions to the Controlling Criteria for Design and Documentation for Design Exceptions," memorandum (Washington, DC: USDOT, May 5, 2016), https://www.fhwa.dot.gov/design/standards/160505.pdf.

Source: Getty Images.

- **Superelevation Rate:** The ratio of the difference in pavement elevation—from edge to edge—to the width of the pavement.
- **Stopping Sight Distance:** The length of roadway available to a driver to perceive, react, and bring a vehicle traveling at or below design speed to a controlled stop in advance of an obstacle.[2]
- **Maximum Grade:** Maximum grade is the highest rate at which vehicles can operate without an appreciable loss in speed below that normally maintained on level roadways.
- **Cross Slope:** Cross slope is the rate of change in elevation of the roadway surface measured perpendicular to the direction of travel.
- **Vertical Clearance:** Vertical clearance is the unobstructed height measured from the roadway surface to the lowest surface element of an overhead structure.
- **Design Loading Structural Capacity:** A structure's ability to support the design loading and remain operationally serviceable.

The report includes a chapter for each controlling criterion. Each chapter describes potential mitigation strategies for design exception impacts. The chapters do not include every possible mitigation strategy; they are intended to present common and innovative alternatives. The mitigation strategies may be used together or separately as part of an overall approach.

EVOLUTION OF DESIGN DECISIONS

Planning and designing roadway projects have become more than following standards. Practitioners consider safety, mobility, cost, environmental, historical, and cultural impacts in the project development process. They consider a variety of users and multimodal elements, equity and social aspects, safety and operational performance factors, and energy consumption and emissions. Navigating and balancing the relationships among these intertwined factors can help practitioners achieve a project's goals and intentions.

Design Decision Documentation and Mitigation Strategies for Design Exceptions describes the following key concepts for practitioners to understand when making design decisions:

- **Nominal safety** is a safety performance evaluation of whether a roadway, design alternative, or design element meets the design criteria. Nominal safety is measured by comparing design element dimensions (e.g., lane width, shoulder width, stopping sight distance) to the adopted design criteria and engineering standards referenced in manuals.
- **Substantive safety** is the actual or expected safety performance of a roadway in terms of crash frequency and severity.
- **Performance-based planning and design**, also known as performance-based practical design, is a multimodal decision-making process to help agencies better manage project investments and achieve systemwide performance goals.
- **Context-based design** uses a collaborative, multidisciplinary approach to tailor a transportation facility to the context of the project and local characteristics. Identifying context classifications (rural, rural town, suburban, urban, urban core) helps establish factors to be assessed, initial project design features, and acceptable levels of performance for each mode.
- **Equity in transportation** ensures the specific needs of underserved communities are taken into account and addressed. Considering transportation equity early and often, through methods such as public engagement and data collection and analysis, can help improve a transportation agency's ability to adequately respond to the community's safety, mobility, and connectivity needs.

[2] Stopping sight distance applies to horizontal alignments and vertical alignments except for sag vertical curves.

Source: Getty Images.

- **Complete Streets** policies prioritize the safety of all users of the transportation system. The Complete Streets design model prioritizes safety, comfort, and connectivity to destinations for everyone who uses the roadway network. There is no one-size-fits-all approach for Complete Streets, because it will vary depending on community context and needs.[3]
- **TSMO** is the use of strategies, technologies, mobility services, and programs to optimize the safety, mobility, and reliability of the existing and planned transportation system.[4] TSMO involves implementing multimodal and intermodal systems, services, and projects across jurisdictional boundaries to manage travel demand of all modes.
- **The Safe System Approach** seeks to implement a roadway system that is designed and operated to anticipate human mistakes and accommodate injury tolerances to avoid fatal and serious injuries. Road design and management should encourage safe speeds and manipulate appropriate crash angles to reduce injury severity. Designing safe roads that encourage safer speeds can help mitigate human mistakes, account for injury tolerances, encourage safer behaviors, and facilitate safe travel for vulnerable road users.[5]

RISK MANAGEMENT

Design exceptions can create a perception of legal vulnerability among practitioners, but risk management practices may decrease this perception and encourage design flexibility. The two most common design exception risks are tort liability risk (i.e., lawsuits arising from crashes allegedly associated with design) and engineering risk (i.e., design solutions not performing as expected in terms of safety, serviceability, and operations). Practitioners should be aware that choosing design solutions that conform to standards while ignoring other factors—such as substantive safety for all users, environmental, historical, and economic concerns—also carries risk. When considering design options, practitioners need to balance these factors within the given context and use their professional judgement to develop a creative solution while managing risk.[6]

Design Decision Documentation and Mitigation Strategies for Design Exceptions provides risk management strategies to help reduce litigation, such as keeping agency manuals up to date and establishing a records management policy.

DESIGN DECISION DOCUMENTATION

When FHWA's controlling criteria are not met on an NHS project, practitioners must prepare a design exception, regardless of project funding.[7] Practitioners must document design exceptions based on an evaluation of the context of the facility, needs of all users, safety performance, operational performance, human and environmental impacts, and project costs.[8] It is important to not only document why a particular design was selected, but also why a different design was not selected. The level of analysis should be proportional to the complexity and associated risks of the project.

3 FHWA, "Complete Streets," accessed April 20, 2023, https://highways.dot.gov/complete-streets.

4 FHWA, "What is TSMO?," accessed April 20, 2023, https://ops.fhwa.dot.gov/tsmo/.

5 FHWA, "Zero Deaths and a Safe System," accessed April 20, 2023, https://highways.dot.gov/safety/zero-deaths.

6 National Academies of Sciences, Engineering, and Medicine, Legal Research Digest 57: *Tort Liability Defense Practices for Design Flexibility* (Washington, DC, The National Academies Press, March 2012), https://doi.org/10.17226/14656.

7 23 C.F.R. § 625.3.

8 23 C.F.R. § 625.3.

Source: Getty Images.

Design exception documentation should describe all the following:

- Specific design criteria that will not be met
- Existing roadway characteristics
- Alternatives considered
- Comparison of the safety and operational performance of the roadway and other impacts, such as right-of-way, community, environmental, cost, and usability by all modes of transportation
- Proposed mitigation measures
- Compatibility with adjacent sections of roadway

It is best practice for State DOTs to document all decisions during project planning and design. Design decision documentation practices vary among States, but many State DOTs have developed forms or templates for staff to use. This document becomes a living document that starts early in the planning stage and is updated throughout project development. Design decision documentation is then archived with the project files and serves as a history of the project, including the purpose and need, characteristics and goals, alternatives considered, evaluation methods and results, and final design decisions.

NOTEWORTHY PRACTICES

The appendix in *Design Decision Documentation and Mitigation Strategies for Design Exceptions* provides noteworthy practices from various States. The noteworthy practices illustrate design flexibility concepts and strategies described in the report, such as Complete Streets, multimodal design approaches, practical- and context-based design decisions, and TSMO strategies. Each noteworthy practice discusses the background information, solutions and approaches, lessons learned, and outcomes.

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