U.S. Department of Transportation
Federal Highway Administration

Memorandum

Subject: **GUIDANCE – <u>INFORMATION</u>:** Review of State Geometric Design Procedures or Design Criteria for Resurfacing, Restoration, and Rehabilitation Projects on the NHS

Date: March 1, 2023

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Reply to Attn. of: HICP-10

To: Division Administrators
Directors of Field Services
Division Directors

Regulatory changes to part 625 of title 23, Code of Federal Regulations (23 CFR part 625 or Part 625), published on January 3, 2022 (87 FR 32), allow State departments of transportation to adopt procedures or design criteria for the geometric design of resurfacing, restoration, and rehabilitation (RRR) projects on the National Highway System, including freeways, subject to FHWA approval (23 CFR 625.4(a)(3)).

FHWA Division offices are responsible for reviewing and approving State RRR procedures or design criteria. FHWA will consider RRR procedures or design criteria that differ from established design guides and standards adopted by FHWA, particularly in the low-speed environment, to support improving safety for all roadway users. The attached implementation guidance clarifies FHWA regulations for FHWA Division Offices to consider when reviewing State RRR procedures or design criteria that support State safety and other performance goals and ensure compliance with applicable Federal statutory and regulatory provisions. This guidance replaces FHWA Technical Advisory 5040.28, *Developing Geometric Design Criteria and Processes for Nonfreeway RRR Projects* (October 17, 1988).

Except for the statutes and regulations cited, the contents of this document do not have the force and effect of law and are not meant to bind the States or the public in any way. This document is intended only to provide information regarding existing requirements under the law or agency policies. However, compliance with applicable statutes or regulations cited in this document is required.

If there are questions, please contact Robert Mooney at (202) 366-2221 or by e-mail at Robert.Mooney@dot.gov of the Office of Preconstruction, Construction and Pavements (HICP-10).

Attachment

Review of State Geometric Design Procedures or Design Criteria for Resurfacing, Restoration, and Rehabilitation Projects on the NHS

Implementation Guidance
March 1, 2023

Regulatory changes to part 625 of title 23, Code of Federal Regulations (23 CFR part 625 or Part 625), published on January 3, 2022 (87 FR 32), allow State departments of transportation (State DOT) to adopt procedures or design criteria for the geometric design of resurfacing, restoration, and rehabilitation (RRR) projects on the National Highway System (NHS), including freeways, subject to the approval of those procedures or design criteria by FHWA. If a State does not adopt geometric design procedures or design criteria for RRR projects on the NHS, the minimum geometric design criteria for new construction and reconstruction will apply. *See* 23 CFR 625.4(a)(3). Each State may select one or a combination of approaches when considering their RRR policies. They may develop and adopt, subject to FHWA approval, geometric design procedures or design criteria specifically for RRR projects on various types of roadways (freeway, non-freeway, etc.). They may also choose to apply current geometric design criteria for new construction and reconstruction to RRR projects. *See* 23 CFR 625.4(a)(1) and 625.4(a)(2).

FHWA Division offices are responsible for reviewing and approving State RRR procedures or design criteria. FHWA will consider RRR procedures or design criteria that differ from established design guides and standards adopted by FHWA, particularly in the low-speed environment, to support improving safety for all roadway users. FHWA should encourage States to coordinate with local governments, Metropolitan Planning Organizations, and Tribal governments when developing or modifying procedures or design criteria for RRR projects on the NHS. The RRR procedures or design criteria developed by a State should indicate the types of projects covered, the applicability to specific combinations of functional and context classification, and shall be consistent with applicable Federal statutory and regulatory provisions, including 23 U.S.C. 109(a), 109(c)(1), 109(c)(2) and 109(n). See Appendix A for FHWA's definition of RRR.

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This guidance provides clarity on FHWA regulations and provides information that may be helpful when reviewing State RRR procedures or design criteria for the NHS that support State safety and other performance goals and ensure compliance with applicable Federal statutory and regulatory provisions.

I. FEDERAL STATUTORY AND REGULATORY PROVISIONS

If a State chooses to develop such RRR procedures or criteria for use on the NHS, the following applicable Federal statutory and regulatory provisions must be met. This list does not contain all Federal statutory and regulatory provisions that apply to Federal-aid projects.

A. Statutes governing all Federal-aid projects, including those on the NHS.

1. The RRR procedures or design criteria must provide for a facility that will adequately serve the existing and planned future traffic of the highway in a manner that is conducive to safety, durability, and economy of maintenance, and conform to the particular needs of each locality. *See* 23 U.S.C. 109(a). For the purposes of this guidance, FHWA interprets 'traffic' and 'safety' to encompass all roadway users.
2. When highway bridge decks are rehabilitated with Federal financial participation, pedestrians or bicyclists generally must be accommodated. *See* 23 U.S.C. 217(e). Refer to FHWA Bridge Formula Program (BFP) Implementation Guidance at www.fhwa.dot.gov/bridge/bfp/20220114.cfm for more information.
3. RRR projects must be constructed in accordance with standards to preserve and extend the service life of highways and enhance highway safety. *See* 23 U.S.C. 109(n).
4. RRR projects must not result in the severance of an existing major nonmotorized route or have significant adverse impact on the safety for nonmotorized transportation traffic and light motorcycles, unless such project provides for a reasonable alternate route or such a route exists. *See* 23 U.S.C. 109(m).

B. Statutes governing the NHS regardless of project funding.

1. In accordance with 23 U.S.C. 109(c)(1), the RRR procedures or design criteria applicable to projects on the NHS (other than a highway also on the Interstate System) must consider:
   a. the constructed and natural environment of the area;
   b. the environmental, scenic, aesthetic, historic, community, and preservation impacts of the activity;
   c. cost savings by utilizing flexibility that exists in current design guidance and regulations; and
   d. access for other modes of transportation.
2. When determining whether to approve the RRR procedures or design criteria developed by a State, the FHWA will also evaluate whether the State has considered the materials specified in 23 U.S.C. 109(c)(2):
   a. the results of the AASHTO committee process as used in adopting and publishing "A Policy on Geometric Design of Highways and Streets," including comments submitted by interested parties as part of such process;

b. the FHWA publication entitled "Flexibility in Highway Design" (https://www.fhwa.dot.gov/environment/publications/flexibility/flexibility.pdf);

c. "Eight Characteristics of Process to Yield Excellence and the Seven Qualities of Excellence in Transportation Design" developed by the conference held during 1998 entitled "Thinking Beyond the Pavement National Workshop on Integrating Highway Development with Communities and the Environment while Maintaining Safety and Performance" (https://www.fhwa.dot.gov/planning/css/resources/thinkbeyond/tbtp_brochure.cfm);

d. the AASHTO publication entitled "Highway Safety Manual" (HSM);

e. the publication entitled "Urban Street Design Guide" of the National Association of City Transportation Officials;

f. the FHWA publication entitled 'Wildlife Crossing Structure Handbook: Design and Evaluation in North America' and dated March 2011; and

g. any other material that the Secretary[1] determines to be appropriate.

3. Geometric standards adopted for the Interstate System, as applied to each actual construction project, must be adequate to enable such project to accommodate the types and volumes of traffic anticipated for such project for the 20-year period commencing on the date FHWA approves the plans, specifications, and estimates for actual construction of such project under 23 U.S.C. 106. *See* 23 U.S.C. 109(b). Except for projects on the Interstate System, there is no Federally mandated timeframe or design year for RRR projects.

C. Design Regulations and Policy

1. The RRR procedures or design criteria developed by each State pursuant to 23 CFR part 625, and approved by the FHWA, constitute the geometric standards required by 23 U.S.C. 109 for use on RRR projects. If a State does not adopt geometric design procedures or design criteria for RRR projects on the NHS, the minimum geometric design criteria for new construction and reconstruction will apply. *See* 23 CFR 625.4(a)(3).

2. Adoption of RRR procedures or design criteria for the geometric elements does not relieve State DOTs from meeting new construction policies, standards, or standard specifications, as adopted in 23 CFR part 625, for all non-geometric elements.

3. Design exceptions may be approved on a project-by-project basis. *See* 23 CFR 625.3(f)(1)). FHWA has established controlling criteria for administering this provision when the geometric design criteria are not met. (FHWA memorandum, 2016)

[1] Authority delegated to FHWA in 49 CFR 1.85.

On “low-speed” NHS roadways, defined as non-freeway roadways with a design speed of less than 50 mph, the only controlling criteria are design loading structural capacity and design speed.

On “high-speed” NHS roadways, defined as Interstate highways, other freeways, and roadways with a design speed greater than or equal to 50 mph, the following ten controlling criteria apply: lane width, shoulder width, horizontal curve radius, superelevation rate, stopping sight distance, maximum grade, cross slope, vertical clearance, design loading structural capacity, and design speed.

The level of analysis for design exceptions should be commensurate with the complexity of the project. Exceptions to RRR standards for the controlling criteria for projects on the NHS are subject to approval by FHWA or on behalf of FHWA if a State has assumed the responsibility through a Stewardship and Oversight agreement. *See* 23 CFR 625.3(f)(1)(i).

4. RRR projects that are considered alterations under the Americans with Disabilities Act require the installation or upgrading of curb ramps that serve altered crosswalks at intersections where curb ramps are missing or not in compliance with applicable accessibility standards. *See* 23 CFR 35.151(i). Refer to the Department of Justice/Department of Transportation Joint Technical Assistance on the Title II of the Americans with Disabilities Act Requirements to Provide Curb Ramps when Streets, Roads, or Highways are Altered through Resurfacing at https://www.fhwa.dot.gov/civilrights/programs/ada/doj_fhwa_ta.cfm and related questions and answers at https://www.fhwa.dot.gov/civilrights/programs/ada/ada_resurfacing_qa.cfm for more information.
5. Pavement rehabilitation strategies are to be developed in accordance with current FHWA pavement policy. *See* 23 CFR part 626.
6. RRR projects that change the dead or live load on a bridge require a re-evaluation of the bridge load rating. *See* 23 CFR 650.313(k)(2).

II. GUIDANCE

The following discussion is intended to provide FHWA Division Offices with information that may be helpful when reviewing State RRR procedures or design criteria for the NHS that support State safety and other performance goals and ensure compliance with applicable Federal statutory and regulatory provisions. These are focus areas that FHWA may choose to discuss with the State DOT when evaluating proposed RRR procedures or design criteria submitted for FHWA approval.

A. Project Scoping

An effective RRR policy can be a powerful tool to inform the State on whether RRR is the appropriate strategy for a given project. When applying their RRR policy, a State may identify significant needs (safety for all users, traffic operations, multimodal network needs, etc.) that lead to a decision to reconstruct, rather than resurface, restore, or rehabilitate the existing facility. When possible, RRR projects should include other needed work in or adjacent to the project area. While the need for RRR and other modifications may originate from separate and distinct processes for identifying projects, they should be coordinated, as the implementation of projects in one area of concern may influence priorities or performance in another. Combining separate projects in the same area into a single contract may achieve cost savings and avoid needless duplication of construction and traffic disruption. Multiple funding sources can generally be combined to achieve the desired outcome.

The scope of a RRR projects is best developed when it is informed by a review of a variety of documents, including:

- Projected land use maps;
- Bicyclist and pedestrian planning documents;
- Americans with Disabilities Act (ADA) Transition Plans;
- State DOT's Strategic Highway Safety Plan;
- State DOT's Highway Safety Improvement Program Implementation Plan;
- Regional or Local Safety Action Plans;
- Network screening efforts or location lists;
- Road safety audit reports;
- Vulnerable Road User Safety Assessments; and the
- State's statewide comprehensive outdoor recreation plan.

B. Improving Safety

The National Roadway Safety Strategy (NRSS) (issued January 27, 2022) commits the USDOT and FHWA to respond to the current crisis in traffic fatalities by "taking substantial, comprehensive action to significantly reduce serious and fatal injuries on the Nation's roadways," in pursuit of the goal of achieving zero highway deaths. FHWA recognizes that zero is the only acceptable number of deaths on our roads and achieving that is our safety goal. FHWA therefore seeks to prioritize safety in all Federal highway investments and in all appropriate projects.

The concept of nominal safety is a consideration of whether a roadway design element meets minimum design criteria. In actuality, the safety effects of incremental differences in a given design dimension can be expected to produce an incremental, not absolute, change in the frequency and severity of crashes. The nominal safety concept is limited in that it does not necessarily examine or express the actual or expected safety performance of a highway. The practice of design is transitioning toward a performance-based approach, with a focus on meeting explicit safety performance criteria, generally referred to as substantive safety. For more information on these concepts, see the HSM Implementation Guide for Managers, available at https://safety.fhwa.dot.gov/hsm/hsm_mgrsguide/sec1.cfm.

1. ***Safe System Approach.*** The focus of the safety performance measures on reducing fatalities and serious injuries (as opposed to total crashes), is consistent with the principles of the Safe System approach which recognizes that people will inevitably make mistakes that can lead to crashes.[2] 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. With respect to the development of RRR procedures or design criteria, consider the following key concepts:

    a. Addressing the safety of all road users, including those who walk, bike, drive, ride transit, and travel by other modes.

    b. Designing to accommodate human mistakes and injury tolerances can greatly reduce the severity of crashes that occur. Examples include physically separating user groups traveling at different speeds, providing dedicated times for different users to move through a space, and increasing awareness of other road users and alerting users to potential hazards.

    c. Implementing safety enhancements should be proactive. Strive to identify latent risks and mitigate those risks proactively, rather than reacting after crashes have occurred.

    d. Revising speed limits and implementing other speed management strategies[3] in conjunction with RRR projects. Addressing speed is fundamental to the Safe System Approach, and a growing body of research shows that speed limit changes alone can lead to measurable declines in speeds and crashes.[4]

2. ***Safe Streets for All.*** As one approach to ensuring the safety of all roadway users, FHWA recommends the application of a complete streets design model (see Appendix A) on roadways where adjacent land use suggests that trips could be served by varied modes, and to achieve complete travel networks for various types of road users. Section 11206(a) of the Infrastructure Investment and Jobs Act (IIJA) (Pub. L. 117-58, also known as the "Bipartisan Infrastructure Law" (BIL)), defines Complete Streets standards or policies as those which "ensure the safe and adequate accommodation of all users of the transportation system, including pedestrians, bicyclists, public transportation users, children, older individuals, individuals with disabilities, motorists, and freight vehicles." A complete street includes but is not limited to, sidewalks, bike lanes (or wide paved shoulders), special bus lanes, accessible public transportation stops, safe and accommodating crossing options, median islands, pedestrian signals, curb extensions, narrower travel lanes, and roundabouts. A Complete Street is safe, and feels safe, for everyone using the street.

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[2] FHWA, The Safe System Approach flyer, FHWA-SA-20-015, July 2020, *available at:* https://safety.fhwa.dot.gov/zerodeaths/docs/FHWA_SafeSystem_Brochure_V9_508_200717.pdf
[3] FHWA Speed Management Safety website at https://highways.dot.gov/safety/speed-management
[4] FHWA Proven Safety Countermeasure "Appropriate Speed Limits for All Road Users" at https://safety.fhwa.dot.gov/provencountermeasures/appropriate-speed-limits.cfm

RRR projects provide an opportunity to update roadways at little additional cost and are therefore a key strategy for improving safe access for all road users. The complete streets design model prioritizes safety, comfort, and connectivity to destinations for everyone who uses the street network and is a powerful tool to help reverse the trend of increasing fatalities and serious injuries and creating a healthier, greener, and more equitable roadway system. FHWA encourages the incorporation of a complete streets design model in RRR procedures or design criteria that are applicable to urban and suburban non-freeway arterials with posted speed limits less than 50 miles per hour (mph), or to rural arterials that serve as main streets in smaller communities. This model improves safety on roadways that must serve both mobility needs and local access, particularly when multiple modes are present, such as public transportation, pedestrians, and/or bicyclists. The application of the model is particularly important in neighborhoods where the population may be expected to rely on these forms of transportation. More information on complete streets can be found at https://highways.dot.gov/complete-streets.

3. ***Integrating Safety.*** A process that incorporates safety as an integral part of project development is recommended, consisting of the following elements:

   a. The determination of existing geometric, safety and operational features throughout the project for all modes.

   b. A procedure to gather and analyze crash, speed and volume data, including unmet travel demand by underserved modes. The analysis of this information can be used to identify specific safety or operational problems and develop appropriate countermeasures.

   c. A method to obtain speed data, using generally accepted study procedures, at various locations within the project limits and an evaluation of the travel speeds appropriate given the project context.

   d. A thorough field review by personnel knowledgeable about and trained in design, safety, and traffic operations for all users as well as maintenance to identify potentially hazardous locations and features, and the ability to recommend appropriate safety countermeasures. Field reviews are also beneficial to verify existing conditions and identify recent changes. A Road Safety Audit (https://safety.fhwa.dot.gov/rsa/) is a proven way to qualitatively evaluate and report on potential road safety issues and identify opportunities for safety improvements for all road users.

   e. An assessment of the transportation safety and access needs of adjacent communities is encouraged through consultation of existing documents, data, or community outreach. Studies have demonstrated that people living in underserved communities are more exposed to or put at higher risk of dying or being injured in a motor vehicle-involved crash and have less access to affordable and high-quality transportation choices.

f. Consideration of the opportunity afforded by the RRR project to implement a complete streets design model that prioritizes safety, comfort, and connectivity to destinations for everyone who uses the street network. FHWA has identified Proven Safety Countermeasures at https://safety.fhwa.dot.gov/provencountermeasures/. See also the Data Driven Safety Analysis section below.

g. A procedure for routine review of interim designs during project development by traffic, nonmotorized, and safety specialists. This should include periodic consultation with these specialists before final approval of the project plans.

4. ***Data-Driven Safety Analysis (DDSA).*** DDSA employs newer, evidence-based models that provide State and local agencies with the means to quantify safety impacts, similar to the way they do other impacts such as environmental effects, traffic operations and pavement life. The analyses provide scientifically sound, data-driven approaches to identifying high-risk roadway features and implementing the most beneficial projects with limited resources to achieve fewer fatal and serious injury crashes.

   a. Predictive analysis helps identify roadway sites with the greatest potential for improvement and quantify the expected safety performance of different project alternatives. Predictive approaches combine crash, roadway inventory, and traffic volume data to provide more reliable estimates of an existing or proposed roadway's expected safety performance. The results inform roadway safety management and project development decision-making. The data not only help agencies make better decisions, but also inform the public as to what safety benefits they can expect from their investment.

   b. Systemic analysis uses crash and roadway data in combination to identify high-risk roadway features that correlate with particular crash types. Agencies have traditionally relied on crash history data to identify "hot spots," or sites with high crash frequency. However, severe crashes are widely dispersed over road networks, and their location and frequency fluctuate over time. Systemic analysis identifies locations that are at risk for severe crashes, even if there is not a high crash frequency. Practitioners can then apply low-cost countermeasures to those locations. The benefit is wider, but more targeted, safety investments.

5. ***Performance-Based Practical Design (PBPD) Approach.*** PBPD modifies the traditional design approach to a "design up" approach where transportation decision makers exercise engineering judgment to build up the modifications from existing conditions to meet both project and system objectives, such as safety and operational performance for all users, context sensitivity, accessibility for individuals with disabilities, life-cycle costs, long-range corridor goals, livability, and sustainability. PBPD uses appropriate performance-analysis tools, considers both short- and long-term project and system goals while addressing project purpose and need.

6. ***Roadside Safety.*** NCHRP Report 876 discusses several potential improvements to roadside features applicable to RRR projects on high-speed roadways.

Consider removing objects that are greater than 4 inches above the ground and not of breakaway design, including trees. Utility poles that are accommodated in the right-of-way can be relocated further from the traveled way or the number reduced by locating multiple utilities on the same pole. Improve traversability of culvert ends, where appropriate, by removing headwalls, beveling the ends to match the slope, and adding bars to larger culverts. As alternatives to removing roadside objects, consider replacing the object with a similar object of breakaway design, relocating the object behind an existing guardrail or traffic barrier, or installing a new guardrail or traffic barrier. Refer to the AASHTO *Roadside Design Guide* to assess the need for guardrail or other roadside barriers.

Consider flattening roadside slopes where existing roadside slopes are steeper than 1V:4H and sufficient right-of-way is available (or could be acquired) and where slope flattening would not adversely affect adjacent properties, structures, or environmentally sensitive areas, such as wetlands. Where roadside slope flattening is considered, but not implemented, consider mitigation measures such as removing roadside objects or providing traffic barriers.

Decisions about roadside improvements including removal or relocation of fixed objects, slope flattening or the use of a barrier may be based on benefit-cost analysis as described in NCHRP Report 876. The AASHTO *Highway Safety Manual* and the Crash Modification Factor (CMF) Clearinghouse contain CMFs that can help quantify the benefits of these improvements. In addition, tools like the Roadside Safety Analysis Program (RSAP) can be used to compare alternatives based on the benefit-cost ratio.

7. ***Design and Safety Report.*** A systematic process to accomplish the necessary data and information collection and analysis involves a series of activities which can culminate in a design and safety report. This report can serve as documentation of the design process undertaken to develop the RRR project, assist in design decisions and provide the background information needed to obtain any necessary design approvals.

    a. The report should discuss the existing and proposed geometric and roadside features, crash frequency and severity, current and estimated future traffic volumes, speeds, land use, accessibility needs for pedestrians with disabilities, modal needs, applicable design standards, and design options.

    b. The report should identify specific safety concerns and options, costs, and recommendations to mitigate those concerns.

    c. Any identified design exceptions and appropriate mitigations should also be included in this report.

8. ***Safety Performance Management.*** Federal regulations at 23 CFR part 490, subpart B, National Performance Management Measures for the Highway Safety Improvement Program, require State Departments of Transportation and Metropolitan Planning

Organizations (MPO) to establish and report safety performance according to five performance measures based on the five-year rolling averages:

- Number of Fatalities
- Rate of Fatalities per 100 million Vehicle Miles Traveled (VMT)
- Number of Serious Injuries
- Rate of Serious Injuries per 100 million VMT
- Number of Nonmotorized Fatalities and Nonmotorized Serious Injuries

The contribution that a RRR project can make toward improving the safety performance of the network for all modes should play a key role in the development of RRR procedures or design criteria.

C. Multimodal Networks

RRR projects often provide an opportunity to expand multimodal networks at little additional cost. The DOT policy is to incorporate safe and convenient walking and bicycling facilities into transportation projects.[5] The design of a RRR project on the NHS (non-Interstate) must consider access for other modes of transportation. *See* 23 U.S.C. 109(c)(1)(D).

1. ***Route Continuity.*** RRR projects must not result in the severance of an existing major nonmotorized route or have significant adverse impact on the safety for nonmotorized transportation traffic and light motorcycles, unless such project provides for a reasonable alternate route or such a route exists. *See* 23 U.S.C. 109(m). Severance, as used here, has the common meaning of breaking up or disjoining a route used by nonmotorized modes such as bicycling and walking. FHWA interprets this statute to include providing appropriate replacement accommodations in the event of permanent or temporary closures.

   In determining whether severing a route would have a significant adverse impact, State RRR procedures or design criteria should consider the following:

   a. How much further will users have to travel as a result of a closure? Excessive out-of-direction distance is frequently noted as a powerful deterrent to bicycling and walking.
   b. How will the design of an alternate route compare to that of the severed route? Facilities that do not provide sufficient space or separation from motor vehicle traffic for bicyclists and pedestrians to travel may have a significant adverse impact on the safety for nonmotorized transportation traffic.
   c. How does the perceived quality of the route to be severed compare to alternatives? People walking and biking are highly sensitive to perceptions of safety, which may vary based on speed and volume of adjacent motor vehicles, the amount of separation from motor vehicle traffic, and the availability of safe crossing opportunities.

[5] United States Department of Transportation Policy Statement on Bicycle and Pedestrian Accommodation Regulations and Recommendations, March 11, 2010, available at: https://www.fhwa.dot.gov/environment/bicycle_pedestrian/guidance/policy_accom.cfm

d. How many nonmotorized users travel the route to be severed, relative to any alternate routes?
e. Has the route to be severed been included within a State or local pedestrian or bicycle plan?

2. ***Resurfacing Opportunities.*** Installing bicycle facilities during roadway resurfacing projects is an efficient and cost-effective way for communities to create connected networks of bicycle facilities. FHWA's *Incorporating On-Road Bicycle Networks into Resurfacing Projects* provides recommendations for how roadway agencies can integrate bicycle facilities into their resurfacing program. It also provides methods for fitting bicycle facilities onto existing roadways, cost considerations, and case studies. https://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/resurfacing/

3. ***Measuring Connectivity.*** Measuring the connectivity of walking and bicycling networks can help transportation practitioners identify high priority network gaps, implement cost-effective solutions that address multiple needs, optimize potential co-benefits, and measure the long-term impacts of strategic pedestrian and bicycle investments. Analyzing multimodal connectivity may assist agencies in proactively identifying bicycling and walking needs to inform RRR project planning. The FHWA *Guidebook for Measuring Multimodal Network Connectivity* provides information on incorporating connectivity measures into state, metropolitan, and local transportation planning processes. https://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/multimodal_connectivity/

4. ***Design Flexibility.*** Retrofitting an existing RRR project location with constrained rights-of-way to include new or enhanced pedestrian and bicycle infrastructure may involve exercising design flexibility. FHWA *Achieving Multimodal Networks: Applying Design Flexibility and Reducing Conflicts* is a resource that provides information on existing national guidelines that provide specific information about flexible design treatments and approaches. https://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/multimodal_networks/

5. ***Bikeway Selection.*** The FHWA *Bikeway Selection Guide* is a resource to help transportation practitioners consider and make informed decisions about tradeoffs relating to the selection of specific bikeway types for the context. https://safety.fhwa.dot.gov/ped_bike/tools_solve/docs/fhwasa18077.pdf

D. Traffic Operations

Current and predicted traffic performance for all roadway users is an important consideration in the determination of the appropriate project scope (i.e. reconstruction vs. RRR), modal accommodations, and in the selection of values for the various geometric features.

1. ***Operational Analysis.*** A traffic operations analysis should be performed to evaluate the ability of the proposed facility to accommodate the projected future traffic for the facility

over the life of the RRR project. The operational analysis should consider the connectivity to destinations for everyone who uses the street network, particularly on roadways that qualify for the complete streets design model. The operational analysis should be based on the latest analysis methodology such as the Transportation Research Board's *Highway Capacity Manual* (HCM) or simulation software, depending on the existing and projected traffic volumes. Refer to FHWA's Traffic Analysis Tools at https://ops.fhwa.dot.gov/trafficanalysistools/ for more information.

2. ***Performance Metrics.*** RRR projects present an opportunity to enhance operational performance to meet performance metrics, including those established under 23 U.S.C. 150 and 23 CFR part 490 and others adopted by the State. The use of Level-of-Service (LOS) as a performance metric is not required. While LOS has traditionally been used, other performance measures such as travel time, reliability, person-throughput, delay for all users, and multimodal metrics may be used. The analysis process can be aided with a number of non-binding references to include:

    a. NCHRP Synthesis 427: *Extent of Highway Capacity Manual Use in Planning*. This report assesses how State departments of transportation, small and large metropolitan planning organizations, and local governments are using or might use the *Highway Capacity Manual* for planning analyses, or more specifically, for performance monitoring, problem identification, project prioritization, programming, and decision-making processes.

    b. NCHRP Report 825: *Planning and Preliminary Engineering Applications Guide to the Highway Capacity Manual*. This guide helps planners apply the methodologies of the 6th Edition of the Highway Capacity Manual (HCM) to common planning and preliminary engineering analyses, including scenario planning and system performance monitoring. It shows how the HCM can interact with travel demand forecasting, mobile source emissions, and simulation models and its application to multimodal analyses and oversaturated conditions.

    c. Transportation Research Board *Highway Capacity Manual (HCM)*. The HCM is a fundamental reference for concepts, performance measures, and analysis techniques for evaluating the multimodal operation of streets, highways, freeways, and off-street paths. The 7th Edition contains new information, including updated methodologies for pedestrian operations at uncontrolled and signalized crossings, and a new procedure for evaluating systems of freeways and arterials with queue spillback.

E. Geometric Design Modifications

Procedures or design criteria adopted for the geometric design of RRR projects should consider overall highway geometry, design of adjacent segments, project context, modal accommodations, expected trends in traffic growth and land use, truck volumes, and whether the route is part of the Department of Defense's Strategic Highway Network (STRAHNET) or the National Network. On RRR projects, decisions on whether to make geometric design modifications should focus on addressing identified performance issues for all users of the street network, roadway context, and community and multimodal network needs. The performance-based approach to establishing the goals and objectives of the project enables the designer to focus on addressing those objectives. By limiting a project's scope to focus on performance improvement goals, more resources are available to be spent on other needs throughout the road and street system.

Specifically, procedures should reflect the consideration of geometric design modifications as part of RRR projects when one or more of the following situations apply:

1. An analysis of the current and future multimodal safety performance of the existing road identifies one or more crash patterns that are potentially mitigated by a specific design modification;
2. A specific design modification would be expected to reduce sufficient crashes over its service life to be cost effective; i.e., the anticipated crash reduction benefits over the service life of the project exceeds the implementation cost;
3. An analysis of the current and predicted operational performance for all users indicates that performance will not meet the State DOT's goals within the service life of the RRR project;
4. A multimodal network analysis identifies a missing link in a connected walking or bicycling network that may be improved by a specific design modification; or
5. A systemic multimodal safety analysis has identified latent risks in the transportation system that are potentially mitigated by a specific design modification.

See Appendix B for more discussion of individual geometric design criteria based on the findings of NCHRP Report 783, *Evaluation of the 13 Controlling Criteria for Geometric Design*, and NCHRP Report 876, *Guidelines for Integrating Safety and Cost-Effectiveness into Resurfacing, Restoration, and Rehabilitation (3R) Projects*.

F. Bridges

If roadway widening is planned as part of the RRR project, consider the interaction between the usable bridge width and the planned width of the approaches after they are widened. When a RRR project includes resurfacing on a bridge, FHWA encourages coordination with the owner of the bridge to ensure that additional paving material will not negatively affect the live load carrying capacity of the bridge.

The evaluation of bridges located within the limits of a RRR project should include consideration of bridge rails and safety hardware as follows:

1. Safety at narrow bridges can be improved by transition guardrails at bridge approaches, new or rehabilitated bridge rails, and warning devices.
2. State DOTs are encouraged (via the AASHTO/FHWA MASH joint implementation agreement, available at https://design.transportation.org/wp-content/uploads/sites/21/2018/06/MASH-Implementation-Agreement-Final.pdf) to develop policies to identify bridge rails and transitions that should be replaced with

bridge rails and transitions tested under MASH. If an existing bridge is to be retained, existing bridge rails and transitions should be updated in accordance with those policies.
3. If upgrading an open railing to parapets or a curbed rail that impedes deck drainage, perform a hydraulic analysis to identify any needs for additional deck drainage to prevent runoff from spreading into the travel lanes.

G. Pavement

Consider the safety and operational performance of the existing roadway in tandem with the extent of needed pavement improvements to determine the overall scope of a needed project and whether RRR work is appropriate.

Most RRR projects are considered alterations under the Americans with Disabilities Act and will therefore require the installation or upgrading of curb ramps that serve altered crosswalks at intersections where curb ramps are missing or not in compliance with applicable accessibility standards. *See* 28 CFR 35.151(i). Where on-street parking spaces are designated as part of a RRR project, a portion of the parking spaces must be accessible to individuals with disabilities. *See* 28 CFR 35.151(b).

RRR projects should ensure that new pavement surfaces are designed, constructed, and maintained to provide adequate and durable friction properties that are appropriate for the friction demand scenario, in order to prioritize the use of resources to reduce friction-related vehicle crashes in a cost-effective manner. This includes identifying and evaluating high friction demand locations such as horizontal curves, intersections and crosswalk approaches, and carefully reviewing crash and safety data to determine if enhanced friction properties may be an effective strategy for enhancing safety, particularly where there may be elevated friction-related crash rates. See FHWA Technical Advisory on Pavement Friction Management at https://www.fhwa.dot.gov/pavement/t504038.cfm. Any paving of the shoulder area should incorporate a pavement structure capable of supporting anticipated loadings.

RRR procedures or design criteria should include procedures and practices to reduce the occurrence of pavement edge drop-offs along existing highways and minimize the likelihood that a drop-off will develop in the future. Several practices can reduce the occurrence or mitigate the impact of edge drop-offs. These practices include:

1. paving the full top width between shoulder breaks;
2. selectively paving shoulders at points where vehicle encroachments are likely to create pavement edge drops, such as on the inside of horizontal curves; or
3. constructing a beveled or tapered pavement edge (i.e. safety edge) so that any edge drop-off that develops has a reduced impact on the recovery maneuver. More information on this Proven Safety Countermeasure is available at https://safety.fhwa.dot.gov/provencountermeasures/safety_edge/.

H. Intersections

Intersections are particularly important highway features, since an average of one-quarter of traffic fatalities and roughly half of all traffic injuries are attributed to intersections.[6] Varied modes of transportation cross paths at intersections – pedestrians, bicyclists, public transportation vehicles and riders, freight drivers and motor vehicle operators, among others. Implementation of a complete streets design model when evaluating intersections on urban and suburban non-freeway arterials, and in rural towns, can greatly improve safety.

Although specific RRR guidelines for intersection modifications are generally not appropriate because of the wide variety of physical and operational features affecting safety, FHWA recommends that consistent procedures and checklists be developed for evaluating intersection modifications on RRR projects. NCHRP Report 948, *Guide for Pedestrian and Bicyclist Safety at Alternative and Other Intersections and Interchanges*, is a useful tool to help transportation practitioners improve and integrate pedestrian and bicycle safety considerations at intersections and interchanges.

Intersection modifications should be tailored to each individual situation with due recognition being given to the modes of traffic and volumes on each of the intersecting roadways, crash experience, and physical characteristics of the site. The modifications at intersections generally focus on reducing conflicts for all users and improving guidance and accessibility. Reducing approach speed and improving pavement friction can also be important. In addition to ensuring accessible curb ramps at intersections, additional accessibility improvements for pedestrians with disabilities may be included in RRR projects.

There are several useful analysis procedures, such as Intersection Control Evaluation (ICE), available to assist in selecting safety improvements, including collision diagrams, condition diagrams, and a field review of the intersection. See https://safety.fhwa.dot.gov/intersection/ for more information.

Intersection turn-lane modifications are often a cost-effective way to improve traffic operations for motor vehicles but their safety and operational impact on other modes of transportation should also be carefully considered.

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[6] FHWA Intersection Safety website, accessed December 2, 2021, available at https://safety.fhwa.dot.gov/intersection/about/index.cfm.

APPENDIX A

Defined Terms

FHWA uses the following terms for purposes of this guidance.

A. Complete Streets Design Model

A complete streets design model prioritizes safety, comfort and connectivity for all users of the roadway, including but not limited to pedestrians, bicyclists, motorists, and transit riders of all ages and abilities. In general, this design model includes careful consideration of measures to set and design for appropriate speeds; separation of various users in time and space; improvement of connectivity and access for pedestrians, bicyclists and transit riders, including for people with disabilities; and implementation of safety countermeasures. Implementation of the model includes systematically changing policies, rules, and procedures to consistently prioritize safety for all users across all project types. By addressing Safer Streets and Safer Speeds, the Complete Streets Design Model serves as an implementation strategy of the Safe System Approach.

B. Crash Modification Factor (CMF)

A Crash Modification Factor represents the relative change in crash frequency due to a change in one specific condition. A CMF may serve as an estimate of the effect of a particular geometric design or traffic control feature or the effectiveness of a particular treatment, also known as a countermeasure, intervention, action, or alternative design.

C. Resurfacing, Restoration, and Rehabilitation (RRR) projects

Under 23 CFR 625.2(b), "resurfacing, restoration, and rehabilitation work includes placement of additional surface material and/or other work necessary to return an existing roadway, including shoulders, bridges, the roadside, and appurtenances to a condition of structural or functional adequacy." RRR projects preserve and extend the service life of the existing road and enhance highway safety without making changes, such as adding through motor vehicle lanes, that change the basic roadway type.

The scope of RRR work is usually accomplished within the existing right of way. The scope of work may include the upgrading of geometric and structural features such as:

- Adding facilities and safety features for walking and bicycling;
- Improving access to transit stops;
- Minor roadway widening;
- Minor horizontal or vertical realignment;
- Lane reconfigurations (road diets);
- Adding turning lanes or channelizing islands;
- Access management strategies to improve safety and operations; and
- Improving bridges to meet current standards for structural loading and to accommodate the approach roadway width (i.e. superstructure widening or replacement).

In addition, for the purposes of determining geometric design criteria, full-depth pavement replacement projects that generally retain existing geometrics are considered RRR projects.

Projects that change the overall geometric character of a roadway, such as widening to provide additional motor vehicle through lanes or substantially modifying horizontal or vertical roadway alignment, are not considered RRR projects. The replacement of an existing bridge is also not considered to be RRR work.

APPENDIX B

Controlling Criteria for Geometric Design

This section discusses the FHWA controlling criteria for geometric design, which differ for low- and high-speed roadways. (FHWA memorandum, 2016) It summarizes the findings of NCHRP Report 783, *Evaluation of the 13 Controlling Criteria for Geometric Design*, and NCHRP Report 876, *Guidelines for Integrating Safety and Cost-Effectiveness into Resurfacing, Restoration, and Rehabilitation (3R) Projects*.

A. **Low-speed roadways.** On low-speed roadways (non-freeway roadways with a design speed of less than 50 mph), use of a complete streets design model is encouraged to prioritize safety, comfort, and connectivity to destinations for everyone who uses the street network. RRR standards for low-speed roadways on the NHS generally include provisions for overall highway geometry, but design exceptions are needed only when the RRR criteria are not met for design loading structural capacity or design speed.

   1. ***Design Speed.*** The selected design speed should take into account the desired operating speed (target speed) of vehicles given the potential for conflicts with other road users, topography, the adjacent land use, context, and the functional classification of the roadway. Choosing a design speed that is too high can have unintended consequences – higher operating speeds often result in higher fatal and serious injury crashes, particularly where vulnerable road users such as pedestrians or bicyclists are present.[7] In addition, simply lowering the design speed without accompanying geometric changes may not result in lower operating speeds.

   2. ***Alignment.*** Information about elements of the horizontal and vertical alignment of low-speed roadways, as they pertain to RRR projects, are described below.

      (a) Horizontal Curve Radius. On low-speed urban and suburban roadways, horizontal curves can have traffic calming impacts and are generally retained with the RRR project.

      (b) Superelevation Rate**.** Superelevation is generally not utilized on low-speed urban and suburban roadways. There are no CMFs for superelevation of horizontal curves on urban and suburban roadways in HSM Chapter 12 and there is no definitive research on this topic.

      (c) Maximum Grade. Maximum grade is not usually a concern on low-speed urban and suburban roadways.

      (d) Stopping Sight Distance (SSD). As noted in NCHRP Report 783, stopping sight distance has little effect on the safety of low-speed urban and suburban roadways unless an approaching intersection or driveway is hidden from the driver by the stopping sight distance limitation. There is no discussion of sight distance with respect to urban and suburban roadways in NCHRP Report 876.

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[7] FHWA's Noteworthy Speed Management Practices: Consistent Speed Limits for Vulnerable Road Users, accessed December 2, 2021, available at https://safety.fhwa.dot.gov/speedmgt/ref_mats/fhwasa20047/sec8.cfm.

(e) Vertical Clearance. RRR projects provide an opportunity to improve or restore vertical clearance. If vertical clearance is reduced by a RRR project, consider the size and weight of trucks legally allowed to operate on the affected route and the impact on the potential needs of military vehicles. Coordination with the owners of bridges crossing over the affected route is encouraged.

3. ***Cross-Section.*** Information about the cross-sectional elements of low-speed roadways as well as the roadside, as they pertain to RRR projects, are described below.

(a) Lane Width. On low-speed urban and suburban roadways (non-freeway), where a complete streets design model is recommended, research shows that there are generally no substantial differences in safety performance between 10-, 11-, and 12-ft lanes. In addition, narrower through travel lanes can have substantive advantages on urban and suburban arterials by providing space in the cross section for turn lanes, median treatments, bicycle lanes, and shorter pedestrian crossings, all of which can themselves reduce crashes and enable implementation of a complete streets design model. Lane widening is generally not a desirable investment in RRR projects on urban and suburban roadways with existing lane widths of 10 ft or more. Refer to NCHRP Report 876 for additional information.

(b) Shoulder Width. On low-speed urban and suburban roadways (non-freeway), curb-and-gutter sections with no shoulder are often utilized. For sections with shoulders, shoulder widening is generally not recommended in RRR projects on urban and suburban roadways unless there is a documented crash pattern that can potentially be mitigated with wider shoulders or there is an operational need for wider shoulders.

(c) Cross Slope. Consider restoring the pavement cross slope to the State DOT's new construction design criteria if the existing pavement does not have sufficient cross slope for drainage. The AASHTO Green Book recommends a normal cross slope of 1.5 to 2 percent for paved roadways.

B. High-speed roadways. High-speed NHS roadways are defined as Interstate highways, other freeways, and roadways with a design speed greater than or equal to 50 mph. RRR standards for high-speed roadways should include provisions for overall highway geometry, and design exceptions are needed when the ten controlling criteria are not met.

1. ***Design Speed.*** The design speed is a selected speed used to determine the various geometric design features of the roadway. There are two methods that are generally used to select the design speed for a RRR project. In either case, the objective is to coordinate the various geometric elements to produce a safe roadway for all users of the public right of way.

- An overall project design speed may be selected. This may be the posted or regulatory speed on the section of roadway being improved or it may be higher or lower than the posted speed depending on the desired performance outcomes. All the various geometric elements on the project are correlated by this one design speed.

- A series of design speeds may be selected for sections of the project in different context zones, with appropriate design features to transition between each section.

2. ***Alignment.*** Information about the elements of the horizontal and vertical alignment of high-speed roadways, as they pertain to RRR projects, are described below.

   (a) Horizontal Curve Radius. On rural highways, where curve flattening projects are often not cost effective, consider realigning curves on a case-by-case basis based on past and predicted performance. Sharp horizontal curves often result in a reduction in operating speeds on rural highways and freeways. FHWA's Interactive Highway Safety Design Model (IHSDM) includes a series of models for predicting the reduction in vehicle speed on horizontal curves on two-lane rural highways from the design speed or tangent speed. CMFs for rural two-lane highways are discussed in NCHRP Report 876: Guidelines for Integrating Safety and Cost-Effectiveness into Resurfacing, Restoration, and Rehabilitation (3R) Projects.

   NCHRP Report 783 quantified the effect of horizontal curve radius on traffic speed for rural multilane highways and for urban and suburban arterials. Crash modification factors for freeways and four-lane divided highways can be found in this report.

   No methodology to determine the effect of horizontal curvature on base free-flow speed has been developed for freeways.

   (b) Superelevation Rate. The pavement cross slope on superelevated curves for high-speed rural two-lane and multilane highways is addressed by a CMF in the HSM. Therefore, the need for superelevation improvement or restoration for horizontal curves on these facility types can be considered through cost-effectiveness analyses presented in NCHRP Report 876. Based on this report, consider restoration of superelevation to the Green Book value as part of any RRR project on urban and rural freeways where the superelevation of an existing curve is less than the design superelevation value in the AASHTO *A Policy on Geometric Design of Highways and Streets* (Green Book) by more than 1 percent.

   (c) Maximum Grade. Excessive grades can create operational and safety issues on high-speed highways. On two-lane rural highways, grades exceeding the maximum grade criteria for new construction can affect safety performance. On rural highways and freeways, traffic operations are generally impacted. Refer to the HCM methodology for determining the effect of grades on highway operations. Refer to the HSM for CMFs related to maximum grade.

   (d) Stopping Sight Distance (SSD). On high-speed highways and freeways, the SSD controlling criterion applies to horizontal alignments and vertical alignments except for sag vertical curves. Research findings related to SSD are summarized below.

i. NCHRP Report 783 found that limited SSD on rural two-lane highways is unlikely to lead to crashes unless the portion of the roadway hidden from the driver's view by the sight distance limitation includes a roadway feature that may require drivers to take steering or braking action, such as an intersection, a driveway, or a horizontal curve. Other features to consider include frequent lane use by slow-moving traffic, such as tractors, bicyclists, and horse-drawn carriages. NCHRP Report 876 suggests that extending the research findings for rural two-lane highways to rural multilane highways is appropriate.

ii. Where a rural two-lane or multilane highway (non-freeway) has SSD less than the Green Book design criteria, but there are no hidden features such as intersections, driveways, or horizontal curves, infrequent use by slow-moving traffic, and no history of crashes related to limited SSD, stopping sight distance improvements are unlikely to have any effect on crash frequency or severity and are, therefore, unlikely to be cost-effective.

iii. On freeways, the presence of roadway features such as horizontal curves, ramp terminals, and locations where standing queues are frequently present (e.g., on a daily basis) may indicate the need for a sight distance improvement or mitigation measures. Where such features are present in an area with limited sight distance, consider alignment improvements to provide more sight distance.

(e) Vertical Clearance. RRR projects provide an opportunity to improve or restore vertical clearance. The policy in 23 U.S.C. 101(b)(3)(D) states that the safe, efficient, and reliable travel movements essential for national security are "among the foremost needs that the surface transportation system must meet to provide for a strong and vigorous national economy." The policy places special emphasis on providing safe and efficient connections for military vehicles accessing NHS intermodal freight terminals. Prioritize for improvement locations with vertical clearances of less than 16-feet that are located on STRAHNET routes as these can limit military movements. If vertical clearance is reduced by a RRR project, consider the size and weight of trucks legally allowed to operate on the affected route. Coordination with the owners of bridges crossing over the affected route is encouraged.

When evaluating vertical clearance for Interstate routes, it is important to remember that all Interstate highways are part of the STRAHNET and are critical to the Department of Defense's domestic operations. Projects that do not achieve the minimum vertical clearance contained in the AASHTO *A Policy on Design Standards: Interstate System* should be coordinated with the Military's Surface Deployment and Distribution Command Transportation Engineering Agency. See https://www.fhwa.dot.gov/design/090415.cfm for additional information about the necessary coordination.

3. ***Cross-Section.*** Information about the cross-sectional elements of high-speed roadways as well as the roadside, as they pertain to RRR projects, are described below.

   (a) Lane Width. Consider lane widening on RRR projects located on rural two-lane highways, rural multilane highways (divided and undivided), and urban and rural freeways with existing lane widths less than 12 feet. The benefit-cost analysis procedures described in NCHRP Report 876 should inform decisions about lane widening for RRR projects on these facilities.

   (b) Shoulder Width. Shoulder widening should be considered on RRR projects on high-speed roadways when one of the following conditions is present:

      i. On rural two-lane highways or multilane undivided highways with existing shoulder widths less than 6 feet;
      ii. On rural multilane divided non-freeways with existing outside shoulder widths less than 8 feet;
      iii. On urban and rural freeways with existing inside or outside shoulder widths less than the new construction standard contained in the AASHTO *A Policy on Design Standards – Interstate System* or the Green Book, as applicable.

   The benefit-cost analysis procedures described in NCHRP Report 876 should inform decisions about shoulder widening for RRR projects on high-speed roadways. On rural projects, decisions about shoulder widening should also consider rural bicycle network plans. FHWA's *Bikeway Selection Guide* (2019) includes guidance for selecting a preferred shoulder width to accommodate bicyclists based on volumes and posted speeds in the rural context.

   (c) Combination of Lane and Shoulder Width. RRR projects afford an opportunity to re-evaluate how the existing roadway width can be distributed most effectively between the lane and shoulder. The optimal distribution will depend on site-specific characteristics such as highway type, traffic and truck volumes, geometry, modal use, drainage, crash history and crash type. With this information, various combinations of lane and shoulder widths can be evaluated with the goal of optimizing safety and traffic operations. Refer to the HCM for information on adjustment factors needed for various combinations of lane and shoulder width.

   (d) Cross Slope. On high-speed roadways, the pavement cross slope should generally be restored to the State DOT's new construction design criteria for pavement cross slope if the existing pavement cross section within the limits of a RRR project does not have sufficient cross slope on tangent sections for drainage. The

AASHTO Green Book recommends a normal cross slope of 1.5 to 2 percent for paved roadways.

No existing cost-effectiveness analysis procedures are included in NCHRP Report 876 to address the selection of normal cross slope values. However, providing proper drainage requires adequate pavement cross slope to reduce hydroplaning risk and mitigate loss of driver visibility from road spray. Therefore, it is recommended that tangent pavement cross slope be increased to the criteria applicable to new construction and reconstruction as part of RRR projects. This guidance applies only to normal pavement cross slope on tangent sections. See section V.B.2.b above regarding superelevation in curves.

In some instances, pavement drainage performance modeling may indicate that deviation from normal tangent cross slope is appropriate or that corrective action is not expected to reduce hydroplaning risk.

APPENDIX C

References

The following references were used in the development of this guidance or provide additional information that may be useful when reviewing State RRR standards.

Statutes and Regulations

- 23 U.S.C. 109, "Standards"
- 23 U.S.C. 217, "Bicycle Transportation and Pedestrian Walkways"
- 23 CFR part 625, "Design Standards for Highways."
- 23 CFR part 626, "Pavement Policy."
- 28 CFR part 35, subpart D, "Program Accessibility."

FHWA References

- Webpage – "National Roadway Safety Strategy," https://www.transportation.gov/NRSS
- Webpage – "Proven Safety Countermeasures," (https://safety.fhwa.dot.gov/provencountermeasures/)
- Webpage – "Complete Streets," (https://highways.dot.gov/complete-streets)
- Memorandum – "Relationship between Design Speed and Posted Speed," October 7, 2015 (www.fhwa.dot.gov/design/standards/151007.cfm)
- Memorandum – "Revisions to the Controlling Criteria for Design and Documentation for Design Exceptions," May 5, 2016 (www.fhwa.dot.gov/design/standards/160505.cfm)
- Memorandum – "Coordination of Vertical Clearance Design Exceptions on the Interstate System," April 15, 2009 (www.fhwa.dot.gov/design/090415.cfm)
- Webpage – "Guidance on NHS Design Standards and Design Exceptions," (www.fhwa.dot.gov/design/standards/qa.cfm)
- United States Department of Transportation Policy Statement on Bicycle and Pedestrian Accommodation Regulations and Recommendations, March 11, 2010 (www.fhwa.dot.gov/environment/bicycle_pedestrian/guidance/policy_accom.cfm)
- Federal Highway Administration Bicycle and Pedestrian Planning, Program, and Project Development, September 26, 2019 (www.fhwa.dot.gov/environment/bicycle_pedestrian/guidance/guidance_2019.cfm)
- Department of Justice/Department of Transportation Joint Technical Assistance on the Title II of the Americans with Disabilities Act Requirements to Provide Curb Ramps when Streets, Roads, or Highways are Altered through Resurfacing, July 8, 2013 (www.fhwa.dot.gov/civilrights/programs/ada/doj_fhwa_ta.cfm), Glossary (www.fhwa.dot.gov/civilrights/programs/ada/doj_fhwa_ta_glossary.cfm), and Questions & Answers (www.fhwa.dot.gov/civilrights/programs/ada/ada_resurfacing_qa.cfm)
- Pavements program page: www.fhwa.dot.gov/pavement/
- Bridges and Structures program page: www.fhwa.dot.gov/bridge/
- FHWA's Traffic Analysis Tools at https://ops.fhwa.dot.gov/trafficanalysistools/ for more information.
- Pedestrian and bicycle planning and design resources: https://www.fhwa.dot.gov/environment/bicycle_pedestrian/guidance/guidance_2019.cfm#bp11

- Pedestrian and bicycle safety resources: https://safety.fhwa.dot.gov/ped_bike/ped_bike_order/

Other References

- NCHRP Report 876 “Guidelines for Integrating Safety and Cost-Effectiveness into Resurfacing, Restoration, and Rehabilitation (3R) Projects,” NCHRP, 2021.
- NCHRP Report 783 “Evaluation of the 13 Controlling Criteria for Geometric Design,” NCHRP, 2014.
- “Highway Safety Manual,” AASHTO, 2010 with 2014 Supplement.
- "A Policy on Geometric Design of Highways and Streets," AASHTO, 2018 (Green Book).
- “A Policy on Design Standards---Interstate System,” AASHTO, 2016.
- “Highway Capacity Manual,” TRB, 6th Edition, 2016.
- “Highway Capacity Manual,” TRB, 7th Edition, 2022.
- “Roadside Design Guide,” AASHTO, 2011.
- “Guide for the Development of Bicycle Facilities,” AASHTO, 2012.
- “Guide for the Planning, Design, and Operation of Pedestrian Facilities,” AASHTO, 2021.
- State of the Art Report 9: Utilities and Roadside Safety,” TRB, 2004.