Guidelines for Integrating Safety and Cost-Effectiveness into Resurfacing, Restoration, and Rehabilitation Projects

NCHRP Project 15-50

July 2017
Research Objective

• Develop guidelines for safe and cost-effective practices for resurfacing, restoration, and/or rehabilitation (3R) projects to update or replace TRB Special Report 214
Scope

• Focus on rural two-lane highways, but also consider rural multilane highways, urban/suburban arterials, and rural and urban freeways

• Consider both roadway and roadside improvements

• Consider 3R projects regardless of funding source (Federal and state/local projects)
Key Issues for Candidate 3R Projects

3R projects are usually initiated because of the need for pavement resurfacing:

- Which 3R projects should be resurfaced WITHOUT accompanying geometric improvements?
- Which 3R projects should be resurfaced WITH accompanying geometric improvements? (and which geometric improvements should be implemented?)
- How should highway agencies make such decisions?
- How can highway agencies make better decisions given current safety knowledge?
Key Products of the Research

• Design guidelines document
• Two spreadsheet-based benefit-cost analysis tools
Alternative Approaches to Presenting Design Guidelines

• Dimensional design criteria
3R Design Guidelines in TRB Special Report 214

Minimum Lane and Shoulder Widths

Table 22. Recommended Minimum Lane and Shoulder Widths for Rural Two-Lane Highways (4)

<table>
<thead>
<tr>
<th>Design year volume (ADT)(^a)</th>
<th>Running speed(^b) (mph)</th>
<th>Lane width (ft)</th>
<th>Combined lane and shoulder width(^d)</th>
<th>Lane width (ft)</th>
<th>Combined lane and shoulder width (ft)(^d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-750</td>
<td>Under 50</td>
<td>10</td>
<td>12</td>
<td>9</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>50 and over</td>
<td>10</td>
<td>12</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>751-2,000</td>
<td>Under 50</td>
<td>11</td>
<td>13</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>50 and over</td>
<td>12</td>
<td>15</td>
<td>11</td>
<td>14</td>
</tr>
<tr>
<td>Over 2,500</td>
<td>All</td>
<td>12</td>
<td>18</td>
<td>11</td>
<td>17</td>
</tr>
</tbody>
</table>

\(^a\) Design volume for a given highway feature should match average traffic anticipated over the expected performance of that feature.

\(^b\) Highway segments should be classified as “under 50” only if most vehicles have an average speed of less than 50 mph over the length of the segment.

\(^c\) For this comparison, trucks are defined as heavy vehicles with six or more tires.

\(^d\) One foot less for highways in mountainous terrain.
Alternative Approaches to Presenting Design Guidelines

• Dimensional design criteria
• Minimum AADT levels to initiate consideration of specific improvement types (acceptable approach)
Potential Design Guidelines Based on Benefit-Cost Analysis

• Lane Widening
  – If existing lane width is 9 ft:
    • widen to 10 ft for AADT ≥ 3,000**
    • widen to 11 ft for AADT ≥ 2,000
    • widen to 12 ft for AADT ≥ 3,000
  – If existing lane width is 10 ft:
    • widen to 11 ft for AADT ≥ 3,000**
    • widen to 12 ft for AADT ≥ 3,000
  – If existing lane width is 11 ft:
    • widen to 12 ft for AADT ≥ 12,000

**Do not consider unless physical constraints or high costs make additional widening impractical
Alternative Approaches to Presenting Design Guidelines

• Dimensional design criteria
• Minimum AADT levels to initiate consideration of specific improvement types (acceptable approach)
• Performance-based analyses (preferred approach)
Performance-Based Analyses for 3R Projects

• Geometric design improvements should be considered as part of a 3R project in the following situations:
  – an analysis of the crash history of the existing road identifies one or more crash patterns that are potentially correctable by a specific design improvement, or
  – an analysis of the traffic operational LOS indicates that the LOS is currently lower than the agency’s target LOS for the project or will become lower than the target LOS within the service life of the planned pavement resurfacing (typically 7 to 12 years), or
  – a design improvement would reduce sufficient crashes over its service life to be cost-effective (i.e., anticipated benefits will exceed the anticipated costs)
Performance-Based Analyses for 3R Projects

PRIORITIES

• In the absence of any of the three situations defined on the previous slide:
  – there is no indication that a geometric improvement is needed
  – improvement funds would be better spent on other 3R projects

POTENTIAL EXCEPTIONS

• Geometric design elements without effectiveness measures (CMFs), e.g., pavement cross slope
• Such exceptions are addressed in design guidelines
Benefit Cost Analysis Tools

- Spreadsheet Tool 1 – analysis of a single design alternative or a specific combination of alternatives for a given site
- Spreadsheet Tool 2 – comparison of several design alternatives or combinations of alternatives for a given site

Tools developed in Microsoft Excel for easy application. A familiar user, with access to site-specific data on the project, can evaluate a project design alternative in 5 to 10 minutes.
Benefit-Cost Analysis Tools

• The tools implement a systemic or risk-based approach:
  – decisions are driven by HSM crash prediction models
  – actual site-specific crash history data may also be used, if available

• The tools can be used to:
  – review individual candidate 3R projects to assess whether design improvement would be cost-effective in conjunction with a 3R project
  – review representative sites to establish AADT-based guidelines for consideration of design improvements
Benefit-Cost Analysis Tools

• The tools address projects on:
  – rural two-lane highways
  – rural multilane highways (divided and undivided)
  – rural and urban freeways

• Decisions are made by the highway agency; the tools merely supply information to inform those decisions
Benefit-Cost Analysis Tools

• Highway agencies can customize the tools with local data for:
  – unit construction costs or overall project cost
  – right-of-way cost per acre (user option to include/exclude right-of-way costs)
  – crash costs
  – service lives for specific improvement types
  – discount rate/minimum attractive rate of return

• Safety effectiveness of projects (CMFs) will be based on HSM or literature values

• User may supply actual site-specific crash history data
Benefit-Cost Analysis Tools

• Spreadsheet Tool 1 functions as follows:
  – for a specific candidate project site, user enters existing roadway geometrics, traffic volume, and proposed design improvement
  – the tool determines:
    • expected crash reduction
    • benefit-cost ratio
    • net present benefits
Benefit-Cost Analysis

• Spreadsheet Tool 2 functions as follows:
  – for a specific candidate project site, user enters existing roadway geometrics and traffic volume
  – user specifies a range of design improvements to consider
  – user specifies maximum available improvement budget
  – tool determines the specific improvement (or combination of improvements) that maximizes the benefits while not exceeding the budget constraint
Questions ?