UPGRADING RURAL INTERCHANGES ON I-80 IN NEBRASKA

The following is a guide for upgrading I-80 interchange bridges and approaches in rural areas. These guidelines are based on economic analyses that compare the benefits derived from accident cost reduction to the cost of the improvement. This should be used for interchange projects and projects involving intersecting highways at an interchange.

1. Crossroads with a design year ADT of less than 3000:

   A. If the bridge width meets "Needs Study" criteria and the structural condition is sufficient to use in place, repair the bridge as needed. Upgrade the guardrail and bridge rail, use the existing gradeline in place, and upgrade the pavement surface as needed. Sign the roadway for reduced speed, if necessary.

   B. If the bridge width does not meet "Needs Study" criteria or if the bridge has major structural deficiencies, replace the bridge to "New and Reconstructed" standards. The clear roadway width on the new bridge must meet minimum design standards and should match the width of the approach roadway plus shoulders. The new bridge should be a two-span structure providing adequate lateral clearance for the outside travel lanes on I-80. Retaining walls should be considered where it is possible to use a shorter bridge length. Upgrade the guardrail.

   C. Use the existing gradeline in place if it meets "Needs Study" criteria (max. allowable speed for crest vertical curves: 40 mph below 400 ADT and 45 mph at and above 400 ADT) and upgrade the pavement surface as needed. Sign the roadway for reduced speed, if necessary.

2. Crossroads with a design year ADT of 3000 or greater:

   A. If the bridge width meets "Needs Study" criteria and the structural condition is sufficient to use in place, repair the bridge as needed. If the existing gradeline meets "Needs Study" criteria, use the gradeline in place, widen the roadway at the ramp terminals to provide left-turn lanes if justified by the Traffic Engineering Division, upgrade the pavement surface as needed, upgrade the guardrail, and sign the roadway for reduced speed, if necessary. Further study may be needed to determine if the bridge should be widened or replaced to accommodate left-turn-lane storage.

   B. If the bridge width does not meet "Needs Study" criteria or if the bridge has major structural deficiencies, replace the bridge to meet "New and Reconstructed" standards. The new bridge should be a two-span structure providing adequate lateral clearance for the outside travel lanes on I-80. Retaining walls should be considered where it is possible to use a shorter bridge length.

   C. Rebuild the crossroad if the existing vertical alignment does not meet "New and Reconstructed" standards. However, if the impact to adjacent property is significant, consider design features closer to minimum or lower design speeds. If the vertical alignment is sufficient, upgrade the pavement surface as needed.

ORIGINAL SIGNED BY:

Approved ____ Date: 6-19-96
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SUPPLEMENT TO THE
I-80 RURAL INTERCHANGE STUDY

This supplement describes the economic analyses that provide the guidelines contained in "**UPGRADING RURAL INTERCHANGES ON I-80 IN NEBRASKA**". The information that helped develop the guidelines came from a 1995 study of rural I-80 interchanges.

BACKROUND

In Nebraska, I-80 was built between 1957 and 1974. Many of its rural interchanges have four-span bridges and vertical geometrics that do not meet modern "New and Reconstructed" standards.

The four-span bridges, typically, have piers located three to four meters from the edge of the driving lane of I-80. This does not meet the DR-1 lateral obstacle clearance of 11 meters. New two-span bridges provide the required lateral clearance.

Roadway approaches of the crossroad were originally designed to provide minimum stopping sight distances for 80 km/h (50 mph). Under modern criteria, many of these vertical alignments now have minimum stopping sight distances for only about 70 km/h (45 mph).

ACCIDENTS

A review of accidents occurring during the five-year period from June 1989 to May 1994 revealed a significant increase in the number of accidents on the crossroad over I-80 when current ADT exceeds 2,500. Most of these accidents occurred near the ramp terminals where slowing, stopping, and turning maneuvers occur.

Interchanges where the crossroad carries less than 2,500 current ADT have less than one accident per year on the average. Major improvements, such as reconstruction of the gradeline, may not be cost effective since the potential for reducing accidents is low.

Because the current ADT of 2,500 appeared to be the dividing line for accidents, a design year ADT of 3,000 is used in the recommendations.

Some accidents may be attributed to sight distance. As stated above, many of these crossroads have only 70 km/h (45 mph) speeds for minimum stopping sight distance for crest vertical curves. Stopping sight distance at the ramp terminals will generally be higher for a passenger vehicle.

Sight distance for vehicles turning onto the crossroad from the ramp was evaluated. Vehicles on the crossroad would normally have to slow down to less than 85 percent of the mainline speed of 90 km/h (55 mph) when a passenger vehicle pulls out from a stop condition at the ramp terminal, turns either left or right, and proceeds. Sight distance requirements are met for a 90 km/h (55 mph) design speed to allow a passenger vehicle to turn left onto the crossroad and not interfere with a passenger vehicle approaching from the left.

Accidents on I-80 near interchanges are relatively few. Most occur at a grade separation, normally hitting the guardrail and occasionally the piers.

GEOMETRIC DEFICIENCIES

Three primary geometric deficiencies exist at many of the interchanges. First, there is the lateral obstacle clearance deficiency for through-traffic lanes on I-80 because of pier location. Second, there is a bridge width deficiency for the crossroad over I-80. Third, there is also less than a 90 km/h (55 mph) minimum sight distance on the crossroad. Replacing the bridge with a two-span structure which meets "New and Reconstructed" standards would correct the first of these deficiencies, but not the third.

A substantial investment went into constructing the I-80 interchanges and justification for correcting the current deficiencies should be based on an effective cost analysis. A benefit/cost analysis compares the reduction in accident costs derived from a safety improvement to the cost of the improvement.

Depending on the pavement history, the guardrail would normally be replaced three times (minimum) or four times (maximum) over a 50-year period. The benefit/cost analysis considers both possibilities.

BRIDGE WIDTH

For new or reconstructed bridges on state highways, the clear roadway width must meet minimum design standards and should match the width of the approach roadway plus shoulders. The width of most bridge approaches is 44' (24' roadway and 10' shoulders).

CALCULATIONS AND CONCLUSIONS

1. If bridge widening is required, it is more cost effective to replace the existing four-span bridge with a two-span bridge that meets "New and Reconstructed" standards, than to widen and redeck the existing bridge.

   A. Assuming an average bridge length of 235' and a crossroad approach of 44', the cost of widening and redecking an existing bridge to 46.4' (44' plus 2.4' for width of rails) is $501,584.

      235' x 46.4' x $46 / sf = $501,584

   B. Assuming that the average bridge could be shortened by 35' using retaining walls, the latter costing $115,000, the cost of replacing an existing bridge with a new structure is $642,104.

      200' x 46.4' x $56.80 / sf = $527,104
      $527,104 + $115,000 = $642,104

   C. A life-cycle, 50-year, cost analysis of upgrading the guardrail three or four times to protect the outside piers of an existing four-span bridge indicates the following additional cost for widening an existing bridge. The costs of installation, maintenance, and accidents are included.

	Three Guardrail Upgrades	Four Guardrail Upgrades
Low volume traffic	$130,170	$148,175
Medium volume traffic	$175,878	$193,878
High volume traffic	$218,196	$236,196

Note: "Low volume traffic" refers to western I-80, Wyoming border to I-76 (5,800 ADT). "Medium volume traffic" refers to central I-80, I-76 to Grand Island (12,460 ADT). "High volume traffic" refers to eastern I-80, Grand Island to Seward (17,680 ADT).

D. Therefore, the total cost of widening and redecking an overpass bridge is:

Three Guardrail Upgrades

Low volume traffic	$501,584 + $301,170 = $631,754
Medium volume traffic	$501,584 + $175,878 = $677,462
High volume traffic	$501,584 + $218,196 = $719,780

Four Guardrail Upgrades

Low volume traffic	$501,584 + $148,175 = $649,759
Medium volume traffic	$501,584 + $193,878 = $695,462
High volume traffic	$501,584 + $236,196 = $737,780

E. Comparing the cost to replace an overpass bridge ($642,104) to the figures in paragraph D above, it is more cost effective to replace a bridge than to widen and redeck it. Note that for low volume, three guardrail upgrades, the life-cycle cost is slightly less than the cost of replacement. The difference is less than two percent and, therefore, is considered adequate justification for replacement.

2. Along I-80, it is cost effective to remove the outside guardrail at pier locations and provide adequate lateral obstacle clearance. This is true for both low-volume and high-volume traffic sections. The clearance would be provided if the four-span bridges were replaced with two-span bridges. For two-span bridges, the center pier still requires guardrail. This conclusion supplements the cost effectiveness of paragraph one above.

3. On low-volume crossroads (under 3,000 design year ADT), it is not cost effective to build short left-turn lanes between the ramp terminals and the overpass bridge. The cost to add short left-turn lanes at the ramp terminals is about $180,000. Evaluating the accident report information indicated that there are very few cases where a separate left-turn lane would have prevented the accident. However, for design year ADT’s exceeding 3,000, accidents prevented using left-turn lanes may actually be cost effective where sight distance is restricted.