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NEW YORK STATE DEPARTMENT OF TRANSPORTATION

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BRIDGE REHABILITATION OR REPLACEMENT SELECTION GUIDELINES
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For several years, the Department has struggled with the decision between rehabilitation and replacement on bridge projects. Many times this decision was based on intuition rather than on documented history, policy, or established procedures.

Written instructions currently do not exist due to inherent subjectivity of the decision and the uniqueness of each bridge and bridge project. However, with expanded program emphasis on bridge projects, the Department recognized the need for guidance in this area.

Consequently, the attached Bridge Rehabilitation or Replacement Selection Guidelines were developed. This document provides assistance by identifying the general areas to be considered on most bridge projects where this decision is necessary. It also suggests potential directions contingent on the results of these area reviews and acknowledges additional consideration areas can and do exist on individual projects. It, therefore, provides guidance without drawing absolute conclusions. Those conclusions must be reached and adequately documented by the user.

This document is the first generation of its type in this subject area. As the need to revise or expand it surfaces, it will be reissued. Any comments regarding this document are welcomed and should be directed to the Structures Division in Albany.

BRIDGE REHABILITATION OR REPLACEMENT SELECTION GUIDELINES

These guidelines are for use at the time of project initiation. They were developed for use after a decision is made to do work (either rehab or repl.) on a bridge. Although these guidelines are for use during initiation, the rationale is appropriate anytime these two alternatives are possible. For the purposes of these guidelines, a bridge rehabilitation is defined as a complete rehabilitation removing all deficiencies or justifying their retention.

These guidelines were developed to provide guidance in this difficult decision area. As such, they are intended to be guidelines and not to be taken as absolutes which must be adhered to. It is expected, however, that when these guidelines are not used or followed, it is for good reasons which will be documented in the project file.

There are several factors that must be considered in a rehabilitation/replacement decision. These factors are all inter-related and seldom can a R/R (Rehabilitation/Replacement) decision be made from investigating just one factor. They must all be investigated and considered both individually and collectively. All conclusions reached after investigations or considerations of each factor individually or collectively shall be fully documented in the project file and in all other appropriate documents such as the Design Report or the Bridge Rehabilitation Project Report.

The following factors are presented for R/R consideration. They are presented one at a time and are not necessarily in any particular order.

COST. The estimating of both rehab and replacement is many times performed after all other factors have been investigated. That is because the other factors may affect or determine the scope of the rehab or replacement option.

The replacement estimate is to be done in accordance with the current Department procedures. The current system is a shoulder break square foot unit cost basis. This method is a system developed by the Structures Division which is for use early in projects where bridge particulars, such as abutment heights and locations are not known. For your reference, a current estimating form using the shoulder break method is attached. A computer version of this system has recently been developed and issued to all Regional Pricing Engineers by memo dated March 13, 1989, from R. D. Albertin of the Management Systems Bureau. The shoulder break length and consequently the methodology provides reasonable compensation for positioning abutments anywhere within the shoulder break length along the shoulder break slope line. The form, and its cost data, is revised and distributed by the Structures Division every six months using current bid information. Please keep in mind that we are interested in total project costs, not just bridge costs. Consequently, it is important to include all extras associated with the project and the highway portion of the project, such as an allotment for Maintenance and Protection of Traffic, removal of the existing bridge, utility costs borne by the

State, railroad force accounts, construction inspection, preliminary engineering, etc.

When considering rehabilitation, the first step that should be done is to check the load rating. If the bridge is posted or if the current load rating appears suspect, re-rate the bridge. Then procede on with the estimate.

The rehabilitation estimate is a much more difficult estimate to develop. This estimate can not be developed from the biennial inspection report. It requires a close re-inspection and examination of the bridge. This inspection, done by Regional forces, is actually an inspection of sufficient detail to develop a practical idea of the extent of the necessary work. The inspector should keep in mind that the actual rehab construction work will most likely not be done for several years. Consequently, his estimate of quantities should have reasonable projections to compensate for the continued deterioration during this time.

The rehab re-inspection should examine the type and extent of deterioration of all components (abutments, piers, stringers and decks) with the intent of initial development of contract plans and an estimate for the work. It should also include actual measurements of section loss in steel girder flanges, removal of deteriorated concrete from abutment faces to determine the depth of removal and amount of replacement concrete necessary to restore to as-built or near as-built conditions, etc. In addition to the re-inspection, cores most likely will be necessary in the deck and substructure units.

Deck cores are required to evaluate the deck to determine if the deck is to be retained and be repaired. The policy and procedure for deck coring is given in the Bridge Deck Evaluation Procedure Manual issued by EI 75-88, and all subsequent issuances. Substructure cores should be taken when the concrete condition isn't clearly beyond rehabilitation or clearly not in need of any significant repair. The inspector must examine the concrete areas by sounding and chipping. This should provide the inspector with a good idea of possible delaminations and poor concrete depths. Unless these investigations provide the inspector with conclusive evidence that the concrete is sound and in need of only insignificant repairs, cores should be taken. For the purposes of this discussion significant repair is defined as more than isolated repairs or more than a nominal amount of money. For example, a spot patch on a pier column during a deck replacement project can be considered insignificant.

Cores, and their subsequent testing, provide confirmation of the depth of poor concrete, provide confirmation of the presences of delaminations, provide a measure of the strength of the concrete and provide an idea of the durability against freeze thaw cycles. Cores confirm the quality of the concrete and should always be taken to finalize the type and amount of rehab work unless insignificant as discussed above. When in doubt as to whether or not they are needed, take them.

Again, please keep in mind that this bridge rehab estimate should include all highway and project costs necessary to develop the complete cost estimate.

All rehab and replacement costs shall include the cost for the appropriate Maintenance and Protection of Traffic plan chosen for that alternate.

The next thing to do in the area of cost is to determine the relationship between the rehab and replacement costs assuming both are viable possibilities. This relationship should be established in terms of the rehab cost being a percentage of the replacement cost. Due to the difficulties and inherent uncertainties of the best estimating practices, the cost percentage determinations between rehab and replacement are broken down into three ranges. These ranges were developed by examining the life cycle costs of rehabilitation and replacement for several different bridge models. These models varied the rehabilitation life and full service life to determine the effect on life cycle costs. The models assumed a gradually increasing annual maintenance cost and a 4% discount rate.

The first range, which identifies the area where the preliminary choice is rehab, is established as the RH/RP percentage up to 65%. On projects where the rehab project cost is equal to or less than 65% of the replacement project cost, the preliminary choice of work is rehab (based only on cost). The other factors must also be examined for compatibility with rehab such as the type of bridge (see below).

The second range, which identifies the area where either rehab or replacement could be the preliminary choice, is established as the RH/RP percentage from 65% to 85%. This is a range where the other factors must be examined in order to establish the appropriate type of work.

The third range, which identifies the area where the preliminary choice is replacement, is established as the RH/RP percentage of 85% and greater. Therefore, based only on cost, projects that have an RH/RP percentage of at least 85% would have their preliminary work choice be replacement. Again, as above, the other factors must also be examined for compatibility with replacement. As an example of other factors that can override cost, consider maintenance and protection of traffic. In some highly urbanized areas, detouring traffic may not be feasible from a capacity point of view. A temporary structure may not be possible from a right-of-way point of view. Construction of a new bridge along side the existing, even with stage construction, may not be possible from a right-of-way point of view. This could be a project where an expensive rehab would be done rather than a replacement.

Under the subject of costs, the question has been raised as to whether or not "user costs" should be included. For the purposes of this guideline, user costs will not be included in the total costs associated with rehabilitation or replacement. That is because in either rehab or replacement work, traffic is restored, and usually to the same condition that it was before construction. On bridge removal

and bridge capacity improvement projects, it may be necessary to take user costs into account since there would be a change that would impact the travelling public on a permanent basis. These costs would be considered on an individual project basis as they are only significant in a small percentage of situations.

The reasons for conclusions drawn in the area of cost shall be fully documented.

SAFETY. Accident history and accident potential must be examined. The accident history examination involves the review of accident reports. Although sometimes inconclusive, the review should concentrate on whether or not the bridge contributed or caused the accidents. This review should look for trends in accident patterns that would point to a safety problem.

In terms of safety for the RH/RP decision, accident history is the most important element. However, consideration should be given to accident potential. While not as significant as accident history, geometrics which contain clear potential for accident problems should be considered for improvement. That improvement may have a direct impact on the RH/RP decision. The review of geometrics should include but not be limited to: sight distance, horizontal clearances, alignments, etc. These elements should be compared to the standards and evaluated with regard to accident potential. The current bridge standards are:

- CURRENT BRIDGE STANDARDS -

Fund Source	FUNCTIONAL CLASS				
	Interstates	Freeways	Arterials	Collectors	Local Rds. & Streets
Federal	A	A	A	B	B
State	A	A	C	C	C

A - Current AASHTO
B - Current NYSDOT Geometric Design Policy for Bridges
C - Current 3R Standards*

*When using the 3R standards specific attention should be paid to the narrative directions for their use.

If either the accident history or accident potential indicates the bridge geometrics are unacceptable, the safety problem must be addressed by either rehab with widening or replacement.

The reasons for conclusions drawn in the area of safety shall be fully documented.

TYPE OF BRIDGE. Some bridges, by their very type, will signal a probable rehab or replacement strategy. Within type, one significant factor is redundancy. The Department has, given special consideration to non-redundant bridges. Non-redundant bridges are definded as those where a failure of one principal load carrying member would result in the failure of the bridge. This special consideration includes; a review of the type of non-redundant structure and its sensitivity to being non-redundant, the consequences of no action, and the possiblity of adding redundancy to the bridge.

Some non-redundant structures, such as a truss, are less of a concern regarding failure than others, such as a two girder bridge with welded construction. Thus, whether or not a bridge is redundant should influence the decision on rehabilitation versus replacement with non-redundant bridges a candidate for replacement due to their type.

Other bridges, because of their type of construction, should also be considered for replacement, but for a different reason. For example, a concrete arch, a concrete rigid frame and a jack arch, because of the monolithic type construction, are difficult and expensive to rehabilitate. Past rehab work on these types of bridges have proven to be costly which provides adequate evidence that these types should generally not be rehabilitated. Also, because of their long life and life cycle costs, it is often most cost effective to let these bridges "live out" their full useful life.

Another example of construction types impacting R/R decisions is, existing stream substructure units demonstrating scour problems without piles. The "no pile" situation may push the decision toward replacement.

The reasons for conclusions drawn based on type of bridge shall be fully documented.

BRIDGE STANDARDS. When any bridge is being considered for rehabilitation, that bridge should be reviewed for compliance with standards. Vertical clearances, horizontal clearance, load capacity, free board, lane and shoulder width, should be determined and compared to the standard. Even the hydraulic history of the bridge should be reviewed. If any of the existing features are sub-standard, consideration should be given towards improving under rehab or replacing the bridge. If improvements can not be made or they can be made but not to standards, substructure feature justification will be required and that should be taken into account when making the R/R decision.

In considering standards, one must be aware that there probably is more than a single bridge standard that could be used on an individual bridge, see SAFETY, above. This could have a significant impact on costs, depending on the funding source. Also substandard feature approval is more easily obtained without Federal Aid. The costs necessary to satisfy standards should reflect the standards that are being proposed for that project.

The reasons for conclusions drawn in the area of standards shall be fully documented.

MAINTENANCE AND PROTECTION OF TRAFFIC

All bridge work involves managing existing traffic in some manner. Managing traffic can involve detouring traffic from the project site, maintaining traffic on a temporary bridge, or maintaining restricted traffic by staging construction. In some cases, we maintain traffic on the existing bridge while we either rehab that bridge or build a new bridge on a different alignment. Many times there are several feasible alternatives regarding managing traffic. These alternatives must be carefully considered as to their cost, delay, impact to the community, praticality, etc. Sometimes, the only practical solutation to traffic may dictate the type of bridge project.

The reasons for conclusions drawn in the area of MPT shall be fully documented.

FEATURE CROSSED. In the R/R work-up, you must consider what the bridge is over. Many times the feature crossed can have a significant effect on the type of work chosen and its cost. Environmental or Coast Guard concerns may push the decision in the direction of the rehab. Hydraulic inadequacies and poor stream alignment may push the decision toward replacement. All will have an impact on the ultimate select of the work alternate.

The reasons for conclusions drawn due to the feature crossed shall be fully documented.

OTHER FACTORS. There are other considerations in the R/R decision methodology which may influence the outcome. Some of these considerations are: historical, social, political and capacity related. These are real considerations that can and do influence the decision on individual bridge projects. They are, by their very nature, difficult to categorize into specific indicators which trigger a particular R/R direction. Consequently, they have not been included in our narrative or worksheet. When these or any other considerations surface on a project, they should be treated as additional subjective factors and given the weight they deserve on that project.

As a general note, all bridge replacement candidates must first be considered for superstructure replacement only. In considering superstructure replacement, the substructures must be evaluated. This evaluation may include a reinspection of these units and cores to verify their condition.

Presented above are factors for consideration when determining whether to rehab or replace a bridge. There may be more factors on specific bridges that we have not covered here such as how important a function the bridge serves and how important it is to the overall transportation system of the area. No matter how many factors are identified and considered, they all play an essential role and must be evaluated individually and as they relate to one another. Since many factors involve subjectivity, there could be different conclusions from the various people and agencies

involved. We look at this as a good opportunity to discuss differing view points and gain the knowledge and experience of others in this area of our work. We should all be striving to spend the funds we have in the most cost effective manner possible.

The rehab versus replacement decision is a very difficult one. Most bridges and their surrounding conditions and circumstances represent a unique situation that must be evaluated based on their own merits. This document, consequently, represents a guide or checklist of areas that should be considered in this decision-making process. It doesn't, because it can't, represent "rules" which should or must be followed. It is for these reasons that it is extremely important that the conclusions reached and the reasons why, be well documented. Care should be taken to see that this is done.

4/28/89

BRIDGE REHAB OR REPLACEMENT SELECTION GUIDELINE WORKSHEET

Factor	Review	Preliminary RH/RP Direction (if any)
I. Cost	I. A. Is the rehab ≤ .65 of repl. cost?	Yes.....RH No.....Proceed to I.B.
	B. Is the rehab cost between .65 and .85 of the repl. cost?	Yes.....Consider other factors No.....Proceed to I.C.
	C. Is the rehab ≥ .85 of the repl. cost?	Yes.....RP
II. Safety	II. A. Are there accidents attributable to the bridge geometry or highway approach geometry?	Yes.....Proceed to II. B). No.....Br. can be either RP'd or RH'd.
	B. If there were accidents, were there any fatalities or is the number of accidents above the State-wide average?	Yes.....Br. should be RP'd or RH'd with corrections to the safety problem. No.....Br. can be either RP'd or RH'd
	C. Is there an accident potential?	Yes.....Br. should be RP'd or RH'd with corrections to accident potential problem. No.....Br. can be either RP'd or RH'd
III. Type of Bridge	III. A. Is the bridge non-redundant?	Yes.....RP or RH including adding redundancy. No.....Br. can be either RP'd or RH'd
	B. Does the bridge have fatigue sensitive details?	Yes.....RP or RH removing or modifying critical details. No.....Br. can be either RP'd or RH'd
	C. Is bridge concrete arch, concrete rigid frame, jack arch, etc.	Yes.....Br. Generally not RH'd No.....Br. can be either RP'd or RH'd
IV. Standards	IV. A. Does the existing bridge conform to all current standards?	Yes.....Br. can be either RP'd or RH'd No.....Proceed to IV. B).
	B. If not, can the bridge be rehabed and brought up to standards?	Yes.....Br. may be RH'd No.....Proceed to IV. C).
	C. If not, can the sub-stand feature(s) be justified?	Yes.....Br. may be RH'd No.....Br. Generally not RH'd

BRIDGE REHAB OR REPLACEMENT [illegible]RUCTION GUIDELINE WORKSHEET

Factor	Review	Preliminary RH/RP Direction (if any)
V. Under Feature	V. A. If the existing bridge is over water, have there been hydraulic problems that would indicate there is an inadequate opening or poor stream alignment which would require a span adjustment?	Yes.....Br. must be RP'd No.....Br. can be either RP'd or RH'd
	B. Does the existing bridge span anything that requires special treatment or does it have special conditions associated with it, such as the railroad or a historic feature, or an environmental sensitive feature, or a politically sensitive feature?	Yes.....Br. may be RP'd or RH'd* No.....Br. can be either RP'd or RH'd
	*The sensitive feature must be thoroughly examined and considered in RH/RP analysis with special attention given to the cost necessary to accommodate the sensitivity.	
VI. Maintenance and Protection of Traffic	VI. A. Can the traffic be detoured off the project site?	Yes.....Br. can be either RP'd or RH'd No.....Proceed to V. B).
	B. If not, can a temporary structure be used on the project site?	Yes.....Br. can be either RP'd or RH'd No.....Proceed to V. C).
	C. If not, can the construction be staged?	Yes.....Br. can be either RP'd or RH'd No.....Proceed to V. D).
	D. If not, can traffic be maintained on the existing bridge with a new bridge being built along side?	Yes.....Br. must be RP'd No.....Stop, all traffic strategies have been rejected.