

Bridge Repair vs. Replacement

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INTRODUCTION

The subtitle for this talk could be "Please ask questions."

Most of you here today are representatives of the Owner, and you have a very heavy obligation to protect the best interests of the Owner. The Owner, of course, is the general public, or more particularly the taxpayers. You are often under considerable pressure from citizens, politicians, improvement associations, and other pressure groups to replace certain bridges. Some of these groups may talk as though tax revenues, and particularly federal funds, are almost unlimited. One of your responsibilities is to make the best possible use of tax revenue.

In my case the Owner is usually a railroad, which is usually only marginally profitable, or even close to bankruptcy. In your case, the Owner is also often having a hard time raising enough money to do all the things he has to do.

When it comes to bridges, the best way you can be a good representative of the Owner is to ask questions. I will try to indicate some of the questions you can ask.

INSPECTION

All bridges should be looked over at least once a year. This is particularly true of larger bridges and those which are noted to have problems. Take along a copy of any previous inspection reports and look closely for any changes in condition. The principal tool you'll need is a chipping hammer. You have to climb around on the structure, use a ladder if necessary and physically touch the bridge, even pound on it with the chipping hammer. You don't have to be experienced if you have an inspection report by an experienced engineer.

I have two safety rules you may want to include. Never go inspecting alone and never climb anywhere if you don't feel secure in doing it. Never hesitate to admit you don't like to climb. Climbing is a talent that not everyone has to the same extent.

Then compare your notes with those from previous inspections. If there are differences, ask questions. If the previous inspection was

prepared by a consultant, ask him about his findings although if it has been some time since his report, you may have to pay a fee to review it. If there are discrepancies in the notes, ask whether it is something you missed, something the previous report missed, or some change in field conditions. The latter may wave a red flag at you.

RATING.

After a bridge has been inspected, it is rated to determine its load carrying capacity. Frequently bridges are over-designed, which is a practice I applaud. Ask whether the corrosion loss has really hurt the structure.

We are currently advising a railroad on the repair of a series of subways in Chicago. These involve over 10,000 steel beams, most of which have lost 10% to 80% of their section. We have determined that many of them can stand a loss of 50, 60 or 70% and still carry the required loads.

Reduction of section on a beam flange near an end is not as serious as the same loss near the center of a span. A bend in a tension member caused by a blow from an errant vehicle or ice is not as serious as the same bend in a compression member.

If an engineer has recommended the repair or replacement of a bridge, ask to see his rating computations. Ask if the computations take into account corrosion losses and any possible over-design. Check to see if wind forces are taken into account and ask why. It is my belief that very few bridges are ever in danger of being destroyed by wind.

REHABILITATION

When you are convinced that a bridge needs attention, always ask whether it might be better to repair it, rather than replace it. Repair, even with extensive strengthening, is usually much less expensive than replacement.

On masonry structures, or the masonry portion of other structures, we have had very good results with pressure grouting and shot-crete patching. Pressure grouting is a technique where holes are drilled into masonry piers or abutments that have voids or cracks, and then a cement grout is forced in under pressure to fill the voids and seal the cracks.

Shot-crete is a method of restoring the surface of masonry where it has spalled off or deteriorated. It can also be used to provide an entirely new surface all over. If poor masonry is your problem, ask whether one of these repair methods may be useful.

Some bridges are adequate except for width so check if it is possible to widen the structure. Some bridges have adequate substructure, but

the superstructure is deteriorated. See if new beams can be placed on the old foundations.

REPLACEMENT.

When it has been determined that no portion of a bridge can be salvaged, there are still a number of questions that need to be asked. Does the amount of traffic warrant the expenditure, or would it be possible to abandon the site? Should the new structure be on the present alignment, or would there be significant savings if the new bridge were built in a new location?

During the design of a new bridge there are several questions which still need to be answered. One principle to keep in mind is that simple, clean lines usually mean a structure that is less expensive to build and maintain. For instance, if you can make a web plate thicker and thereby eliminate stiffeners, you may have a heavier total weight but a reduced total cost, since stiffeners may cost three times as much as web plate. Whenever you can eliminate fancy work on handrails or other so-called ginger-bread, you have not only saved money on original construction, but you have also reduced maintenance problems.

Another question which should always be asked, but one which many competent engineers often fail to ask, is whether you can save money by overdesign. For steel structures, the benefits of using heavier steel can be surprisingly good.

For instance, take a typical structure where the design specifications say the metal should be one-half inch thick. Assume that you, as representative of the Owner, arbitrarily increase that thickness to 5/8 inch. You have increased the steel weight by 25% but you haven't changed the fabrication or erection costs, so you have only increased the cost of the steel by about 12%. For our typical structure, the cost of the steel is generally about one-fourth of the total cost of the improvement. The rest of the budget goes for substructure, deck, approaches, detours, and such, so heavier steel has only increased the cost of the improvement by 3%.

Now let us assume the steel is subjected to severe corrosion problems, such that after 30 years the steel has lost one-sixteenth inch from each surface. The steel as originally specified would be reduced to 75% of its original thickness, and the Owner would be facing a decision to repair or replace the structure. But since you arbitrarily made the steel heavier, it would still be the required one-half inch thick and would have many years of useful life remaining.

Observations during the inspection of hundreds of corroded bridges lead me to the inescapable conclusion that the use of an extra

one-eighth inch thickness for all steel that may be subject to corrosion would extend the life of an average structure at least 50%. In summary, you can often extend the useful life of a steel structure 50% by increasing the budget only 3%.