Bridge Maintenance Problems

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● THE subject of this paper was suggested by the Chairman of the Committee on Bridge and Culvert Maintenance. At first, it seemed relatively simple as the subject had been covered in the questionnaire prepared by the Committee some years ago. However, as the coauthors discussed details, it appeared that many things of local importance had not been mentioned in the replies to the questionnaire.

It was further decided that while many of our problems were in common with most of the country, our experience and findings could only be directed toward other states with similar historical, geographical and weather situations.

Not too many years ago, maintenance of structures was provided for in a routine manner by highway maintenance forces. As traffic increased, highway systems were expanded, and larger and more elaborate bridges were constructed. The use and value of the bridges soon became so great that it was obvious that a separate specialized organization would have to be established to properly maintain them. In about 70 percent of the states, bridge maintenance sections are now an important part of the maintenance division. However the problems are no longer simple and their solution no longer routine.

Massachusetts, like many other states, has embarked on a heavy program of highway and bridge construction. The demands of traffic and the limits of available funds are such that the reconstruction of older bridges has many times had to be by-passed while new modern expressways have been constructed. The result is that our old bridge maintenance problems are still with us and we are rapidly acquiring new ones which in most cases are more complicated than the originals.

When the Massachusetts Highway Commission, which was the forerunner of the Massachusetts Department of Public Works, was first formed, all structures were either wet bridges or railroad bridges. In some of the latter type where the railroad bridge was over the highway, the maintenance of the structure was entirely by the railroad but on others the maintenance was too often divided between the railroad company and the highway commission. Generally speaking, when a bridge was built over a railroad, the framework, flooring, and abutments were maintained by the railroad and the wearing surface and approaches to the bridge by the highway commission. This division of maintenance continued in effect unless altered by mutual agreement or by court order.

Obviously, there is a problem of maintenance under these conditions. The roadway surfaces are subject to much more wear than originally intended and the framing for the structures certainly was not designed for present day traffic density or loadings. We therefore have the surface material frequently failing and the surface supporting members sometimes failing in themselves or at connections. In making repairs or improvements in our portion it is difficult to arrange with the other agency to have their work performed at the same time the surface is replaced. Although their cooperation is usually good, it is the contention of most of the railroad companies that the bridges were designed by them for "horse and buggy" traffic and that any increase in that traffic is not of their making. Therefore any improvements in the bridges should be made by the highway department. It is difficult to refute this statement and these conditions are being taken into consideration when making maintenance agreements for new or reconstructed bridges. On the bridges which are not being replaced but require deck repairs, we are trying to have all necessary work on the supporting system performed by the railroad, after which we install a mineral surfaced asphalt plank wearing surface over a treated timber floor. While this does not increase the bridge capacity it does prolong its life.

In the making of new agreements covering divided maintenance on railroad bridges, it is recommended that the highway department assume the responsibility for all of the structure above the deck supporting members and the railroad company assume the responsibility for the balance of the bridge.

Repairs to steel or iron bridges are not required frequently, but they are usually extensive and costly when needed. Most state highway departments have had the experience of acquiring through legislative action, bridges which had been long neglected or at least in need of prompt repairs to insure their continued, safe use. Immediate detailed inspections after acquisition usually point up the need for early attention. The portable welding unit has made reinforcement or replacement of steel members fairly simple but extensive replacement requires careful study to maintain the structure under traffic during the course of repairs. Iron bridges were mentioned above because we still have a number of wrought iron structures which were built in the latter part of the 19th century and are still giving good service with low maintenance costs. Most are scheduled for replacement because of deficiencies in width and capacity.

Since most of our steel bridges have a reinforced concrete deck and other concrete details it is difficult to confine steel bridge problems to the steel alone.

Painting is of course our most costly steel problem. Even this however is tied in to concrete problems as leakage of water through concrete bridge decks is responsible for reducing the interval between paintings of the steel members under the deck. While there are ways in which we can improve our steel painting procedures, we feel that for ordinary circumstances it is well under control. Recent publications of the Steel Structures Painting Council have outlined techniques and materials to cover almost every exposure. Our practices are in conformance with their recommendations, but our experiences in some areas have not been satisfactory. Where there is exposure to salt water spray, our success has been limited. We find that our normal painting system fails in about 2 to 3 years against 8 to 15 years under other conditions. It therefore appears that the procurement and use of a satisfactory material for protecting our bridge steel against effects of salt water saturated air is one of our problems.

Some of our steel bridges have steel grid decks. These are especially desirable on drawbridges. A majority are of the open grid type and after they become worn from traffic, they become polished on top and at the very least, contribute to vehicle skidding. We have endeavored to counteract this condition by regrooving the grid members and by welding lugs or strips of metal on to the top of the grid members in a staggered serpentine pattern. Both of these measures have been effective but they are expensive and their life is short. In Illinois the same problem has been taken care of by placing expanded metal over the steel grid and surfacing with bituminous mix. A cheap effective adhesive to hold abrasive to steel surfaces would be a desirable development.

Filled grid decks also become slippery but the treatment has been simple and permanent; the deck has been covered with a wearing surface of bituminous concrete without seriously detracting from its live load capacity.

On many of our larger bridges, especially of the deck truss type, there is the problem of roosting birds on the truss members. Our principal problem involves starlings, but pigeons also are troublesome. The starlings arrive by the thousands just before sunset and spend the night under the bridges. We have tried to dislodge them by smoke, by firing rockets and Roman candles, and by directing high frequency sounds toward and into their nesting areas. None of these methods met with any appreciable success. It was brought to our attention that the starlings stay clear of a distress call by any other starling. We made a tape recording of the noise and cries of a group of starlings when they were held by their feet in an inverted position and well shaken. The recording was played back through strategically located speakers and all of the starlings vacated the area. By experimenting we found that we could clear the area for five to six nights. It became evident later that the starlings acquired a sort of immunity to the sounds and left the area for only a short time thereafter. The pigeons never did leave. At present we still have both types of birds roosting in the truss members and their droppings accumulating to a depth of 2 to 6 inches. It is very difficult to make adequate inspections, and painting and repair is impossible without extensive cleaning. We are not alone in this problem, according to newspaper reports. If the costs of others for preliminary cleaning before maintenance are comparable to ours, some research to find an economical, effective solution is certainly justified.

In Massachusetts, our major bridge maintenance problem has to do with concrete maintenance and repair. Most of the repairs are made necessary by the entrance of water into the concrete and subsequent freezing and thawing cycles. The condition varies within the state and those areas with an extremely high frequency of weather cycles cause the most difficulty.

Present bridge design has either an open expansion joint or one through which water can pass, located directly over piers or abutments. The water passing through the joint drops to the bridge seat and either penetrates into the concrete or runs down the face of the substructure or both. In any case, the results soon become evident.

In the last two years, we have experimented with the silicones, both water soluble and those soluble in hydrocarbons. Their use on vertical surfaces unquestionably retards the penetration of water into concrete. The life of such treatments is of course unknown but we do know that it is still effective after two years although its efficiency is somewhat lower after that period.

Based on the assumption that concrete, as well as steel and timber, should be given protective treatment, we have applied several types of surface coatings. These have been considered necessary over repaired structures for appearance as well as protection. The most successful so far has been a plastic finish containing sand and tinting pigment which, after application has the appearance and texture of new concrete. Its original cost is not low but its effectiveness appears to warrant its use.

Concrete slabs without waterproofing, under loose textured bituminous surfaces, present a particularly difficult problem. From our first few slab failures we were able to detect factors which they had in common. From our records we prepared a list of every other bridge having the same characteristics. A special inspection was made of each and from the reports a long range program was developed. A few were found to be beyond repair and have been replaced. Others are stripped, chipped free of distressed material, levelled, waterproofed, and resurfaced. In some instances it has been found necessary to replace portions of the slab; in others, resurfacing with concrete has been the most satisfactory and economical method.

It has been our policy that repairs should be made with concurrent measures to correct the cause of the original failure. There have been times when we have found our first analysis incorrect.

Whether the concrete repair is made with mortar, poured concrete, gunite or other means, one thing is certain: the cost is out of proportion compared to the cost of the material it is replacing. It is hoped that the study of this subject which is on the agenda of the Committee on Bridge and Culvert Maintenance will bring out an effective, economical method of repair.

The advent of the elevated expressway has brought new problems to the bridge maintenance engineer. The drainage systems are very elaborate and require far more than catch basin or scupper cleaning.

Even though the road is elevated, the gutters accumulate an amazing variety of debris. As some of this inevitably finds its way into the downspouts and is responsible for blocks in the system, constant vigilance is required. Plugged drainage is particularly undesirable to pedestrians and vehicles below.

On an ordinary bridge, repairs on or from the surface can usually be carried out during regular working hours. On the expressways we have found that due to the speed and density of traffic, maintenance operations are best carried out in periods of light traffic. This is usually on premium time for the employees.

The new John F. Fitzgerald Expressway in Boston has introduced still another problem. All of the Boston ramps are equipped with a snow melting system. This consists of an antifreeze solution heated by steam, being pumped through pipe coils located about 5 inches below the road surface of the ramps. There are five separate pumping stations and the operation and maintenance of the system is under the direction of the bridge maintenance engineer. This is the second year of its operation and thus far the problems have been mainly operational. The snow melting system works very well provided the road surface is at a temperature of 50° F or higher when the snow begins to fall. From the standpoint of maintenance in any section of expressway in which heating, pumping, lighting or ventilating equipment is incorporated, uniformity is a pressing requirement. If it is lacking, spare parts stocks may well be excessive or repairs too slow. In either event maintenance must bear the criticism for others' faults.

As brought out in the returns of the questionnaire on bridge maintenance, the problem of adequate funds is one most of us have in common. We might as well resign ourselves to the fact that funds, glamour, and publicity are associated with new construction or new projects envisioned by the designers. It is our duty to take what is left, correct the mistakes and expend every effort to prove that the latest construction was a good investment for the highway user.