

Bridge Maintenance

HENRY E. DIERS
Bertram D. Tallamy Associates
Springfield, Illinois

INTRODUCTION

This discussion is confined to bridges found on average state and county highways throughout the states of the Midwest. Included are structures of all types from the span length of approximately 20 feet to those of 200 feet or 300 feet, frequently with multiple approach spans. There are, of course, quite a few major river crossings in several states in the Midwest, including such bridges as found across the Illinois River.

There are also bridges which are state-line bridges, and maintained jointly by the bordering states. Some of these are structures across the Wabash River maintained by Illinois and Indiana, and several across the Ohio and Mississippi Rivers which are maintained jointly between Illinois and the adjoining States of Kentucky, Missouri and Iowa. Such large major bridges, however, are special problems, and generally offer few difficulties to state highway departments. This is a fortunate thing but, nevertheless, a fact, so they will not be considered.

Types of structures considered will be confined to the type found on the highways rather than on railroads. Structure types will include steel through trusses, concrete deck girder, and a few of the concrete through girder type, continuous beam spans and, in a few cases, pre-stressed concrete structures.

Many changes have taken place in bridges since the early highway days. There have been changes in types of bridges, design features, and in construction materials. Each of these changes has brought about improvements and a general lessening in the maintenance problems per structure. However, the number of structures now being built on modern highways has greatly increased so that the volume of work involving routine maintenance has greatly increased.

DESIGN FOR EASY MAINTENANCE

Many changes have been brought about by improvements in design. Today the through truss type structure is used only if it is not economical or feasible to use another type such as a deck truss or deck girder type, or the continuous beam structure. Today designers give much more at-

tention to items which permit better and more convenient opportunities for adequate inspection and maintenance of the structures. These would include catwalks and certain ladders on larger structures, and space for placing jacks for resetting rockers, rollers, etc.; improved drainage facilities to permit better maintenance around pierheads and abutments, and for keeping rollers and shoes clean and adequately lubricated; better access to steel members for inspection; improved methods of deck drainage to prevent leakages of these decks onto the members below the decks. Enclosed drains have been a big improvement, and paved slope walls have prevented much erosion. Other items of improvement include the design of channel changes and angles of intersection of structure and channels. Designers have also confined the use of open steel decking to structures so located as to eliminate potential hazards to traffic due to icing of such decks. On high speed highways these decks have been the cause of many and serious accidents.

ROUTINE AND NONROUTINE MAINTENANCE

Bridge maintenance problems can be divided into two general classes. First, a routine type of maintenance which includes housekeeping with its deck cleaning, cleaning of abutment and pier tops, painting of steel, and the sealing of cracks and joints. Also, there is required proper and adequate attention to the expansion devices in the decks and the drainage of the deck surfaces. Cleaning, painting and lubricating of rollers, bearings, etc. are also generally classed as routine housekeeping items. Second, we have the nonroutine type of problems which generally are brought about as a result of storm damage, undermining of footings, creation of scour holes in the channels under bridges, the displacement of superstructures, and damage to slope walls.

Traffic accidents are a cause of frequent, and sometimes serious, damage. These are the result of heavy loads striking a substructure or superstructure, depending on whether it is a grade separation or a road crossing. Many times we find handrails knocked off by traffic. Sometimes a complete span is knocked out into a creek or onto the road below. Steel truss overhead members are frequently struck by loads which are tied down and become loose in transit. Other nonroutine problems include painting of large bridge structures, special steel corrosion problems due to de-icing salts and poor drainage of the deck.

At the present time one of the most serious of our problems has to do with structure concrete in bridge decks, sidewalks, and handrails. This has resulted from the use of de-icing salts during the past ten or fifteen years. The use of these salts, together with certain design changes,

have apparently brought on some serious problems. De-icing salts used on the thin deck designs of today may expose some steel reinforcing bars due to the fact that they are too close to the surface. Why they are too close to the surface has not yet been determined in Illinois. Some bridges also appear to have excessive vibration due perhaps to the change in design, possibly involving the high tensile steel used today. We believe something has also occurred in the construction of bridges which has permitted the de-icing salts to be far more severe in causing corrosion and exposing of reinforcing bars.

Some additional maintenance problems have changed as a result of the traffic itself. The mere change in volume of traffic has brought wider roadways, as well as safety walks for pedestrians. Higher speeds have contributed to the severity of damage in traffic accidents when bridges are struck.

Abutments and Piers

Some of the serious problems, experienced in the past, were found in abutments and piers due to foundation difficulties. For a number of years now, foundation studies have been quite extensive in the design stage, and this has eliminated most of our difficulties on that score. There is still, however, some adjustment experienced in abutments and wing walls which results in badly disrupted copper seals at the joint between the wings and abutments.

Bridge Approach Slabs

Perhaps one of the most common problems related to bridges today in many states is settlement of bridge approach slabs. These settlements occur soon after a highway is opened to traffic. The cause is not yet completely understood, and there is continual discussion as to whether this is a design or a construction shortcoming.

We have seen a real improvement in the matter of foundations. Investigations now being carried out by soils studies and foundation borings have brought about an almost complete elimination of the bridge foundation troubles that were experienced in the past. Further improvements make it possible to consider such problems most unlikely in the future. The one continuing serious problem has to do with the approach fill, or backfill to the structures. More about this below.

Bridge Decks

Probably the most common serious problem today, is the deterioration of bridge decks. Second, perhaps, is the maintenance of adequate expansion freedom. Third, I believe, is the damage to superstructures due to impact and vibration caused by bad approach pavements. There are

a number of other problems more or less serious, but quite overshadowed by the first three.

Consider the most common problem, namely, the deterioration of the decks. This involves deterioration of concrete decks, curbing and sidewalks, exposed reinforcement, disintegrated concrete and, frequently, deposits of lime or other minerals on the under side of the deck due to water percolating through the deck.

During the past few years highway administrators and members of their staffs have been seriously concerned with scaling and disintegration occurring in concrete structures and pavements of recent construction in spite of the fact that air-entraining cement was used in their construction.

It was, and is, believed that the use of de-icing salts in the winter programs in states in the snowbelt is a definite contributor to this serious problem. It was, and is, believed that air-entrained concrete is capable of resisting de-icing salts, but it is also believed that air-entrained concrete must be carefully and properly inspected and manipulated, and have a drying-out period before it attains its ability to resist the effects of de-icing salts. It is for that reason that several highway departments specify that all pavements and exposed concrete in bridge structures shall be treated with linseed oil if the pavement or structure was completed after a specific date in the fall of the year. This is usually specified as September 15.

Recently we have experienced a pattern of cracking and scaling of concrete from above the grid of reinforcing bars in the decks. When this has occurred, and it has occurred in a number of states, the upper bars have been found too high. They vary from barely below the surface of the pavement to as deep as 1 in., and generally not in the intended position for such steel. These conditions have been found in sidewalks, as well as in the roadway surface of the decks.

Some construction and bridge design engineers have stated that this common trouble, originally believed to be entirely a fault of inadequate inspection, may in reality be related to some construction practice. This may involve the method of puddling of concrete, or the vibrating of concrete which causes a displacement of the previously positioned steel. It is presently a matter of considerable investigation and study.

The disintegration of concrete in decks has been under study for some time, particularly decks resurfaced with bituminous concrete. There is ample evidence that serious disintegration occurs in the concrete decks of bridges resurfaced with bituminous concrete. Some decks have completely disintegrated only a relatively few years after resurfacing. This is believed to be the result of poor drainage of the solutions of de-icing salts, and the freeze and thaw cycles. Some states have now written

specs requiring the placement of a vapor barrier, or water-proofing layer, on bridge decks before a bituminous resurfacing may be placed. Various types of vapor barriers are being studied. They may be a bituminous type, a coating of epoxy resin, or a membrane of bituminous materials or epoxy resin, with glass fabric, asbestos fiber, or other materials. A satisfactory and economical system for water-proofing the deck should bridge possible cracks to prevent reflective cracking.

The problems just related certainly justify the most careful inspection of the steel placement in decks and a study for possible displacement during the construction operation. There is also an indication of the need to be sure of the proper air content in each batch of the plastic concrete placed in the decks, followed by careful attention to the curing of that concrete. The need for determining the reasons for high and displaced reinforcing steel in concrete decks is also urgent.

The Highway Research Board has published a good report on bridge concrete repair. It is NCHRP Report No. 1, "Evaluation of Methods of Replacement of Deteriorated Concrete in Structures."

Joints

The second most common problem need never have occurred. Many maintenance engineers failed to realize for too long a time the failure of open joints in concrete approach pavements adjacent to structures. These joints, usually filled with a blown asphalt type filler, permitted incompressible materials to filter down through the asphalt and effectively destroy the functioning of the joint when that joint still had 1 in. or more of apparent opening. This resulted in jammed structures, parapet or abutment walls cracked or displaced, and failure of the deck slab over the abutment.

The solution to this problem is simply a program of regular cleaning of asphalt-filled type joints to the bottom of the approach pavement, and subsequent refilling to insure continuous free operating joints. An alternate would be to fill those joints with a premolded bituminous fibre material.

Superstructures

The third serious and prevalent problem is damage to superstructures resulting from impact and vibration. Certainly, much of the damage results from impact due to rough approach slabs.

Rough approach slabs set up motion in loads coming onto the bridge which, in some cases, has broken the ends of deck slabs, and also shoved decks out of line. Displaced rollers and shoes usually accompany such a condition in deck type structures. Impact of this kind, and the vibration

under heavy loads, also contributes to cracked decks. This may be more noticeable in continued beam type structures than in others.

It is a matter of conjecture, and a possible item for study, as to whether spalling of concrete from over the reinforcing bars is related in part to the impact of heavy loads on structures having rough approaches.

CONCLUSION

There are other problems in the maintenance of bridges. Some are most challenging, particularly those involving foundations, but these are the unusual problems. Others are the tearing and severance of steel members of truss structures, and even the loss of entire spans in traffic accidents or floods. These classify as the spectacular ones which generally make the news media. These are all challenging and interesting problems but they are also the unusual problems.