BRIDGE FLOOR REPAIRS

CONSTRUCTION DEPARTMENT

IOWA STATE HIGHWAY COMMISSION

MAY 1968

FOREWORD

The procedures required to obtain a truly satisfactory and lasting repair of a deteriorated area of a bridge floor are radically different from ordinary new construction. The specifications outlining these procedures were developed after considerable experimentation and have, if closely adhered to, been found to yield highly satisfactory results. Thorough inspection is necessary to insure full compliance with the detailed requirements.

This discussion of bridge floor repairs is issued as an aid to inspectors on this type of work. The author is bridge designer John Whiting, who prepares the floor repair plans and who is largely responsible for the preparation of the floor repair specifications.

Since the supply is limited, it is suggested that these booklets be preserved in the resident engineer's office when not in use, so they will be available on future projects.

Construction Department

REPAIR OF PORTLAND CEMENT CONCRETE BRIDGE FLOORS

INTRODUCTION

The incidence of deterioration of surface concrete in bridge floors has grown during the past few years. Factors related to this problem include entrained air content of the concrete, especially near the surface, the presence of reinforcing steel near the top surface of the floor, the presence of cracks in the floor surface, the use of chlorides to control snow and ice, and the density and weight of traffic loads. The increased use of chlorides, combined with the increased density of traffic, undoubtedly accounts for the increased incidence of deterioration problems during recent years. Traffic density projections are sharply upward so it is reasonable to expect an increase in bridge floor repair projects.

Three programs are currently under way to counter the problem of floor deterioration:

1. Improved design and construction of new bridges.

2. Preventive maintenance of existing bridges.

3. Permanent repair of existing bridges suffering deterioration.

Bridge floors are now designed with 2-inch cover over top reinforcing and on construction a positive check is made to insure that this cover is obtained. Additional controls are applied during construction to obtain better quality concrete with uniform entrained air and slump control.

The Maintenance Department has put into operation a program to seal the floors and other exposed concrete elements of existing bridges on a continuing basis. This is expected to greatly reduce the incidence of scaling and, hopefully, to reduce the extent of deterioration by spalling.

Finally, on those bridges where deterioration of surface concrete is extensive but with floors still basically sound, permanent repairs with portland cement concrete are being made.

DISCUSSION

Two principal types of floor surface deterioration occur which are considered sufficiently serious to warrant reasonably prompt repair. Spalling is the breaking out in pieces of surface concrete. Generally, the pieces separate from the main body of the floor concrete at or near the level of the top reinforcing, and wheel action breaks up and throws out the thin separated layer. Scaling is disintegration of the concrete as mortar between the aggregates fails. Scaling always begins at the surface and progresses deeper.

Deep scaling often provides a way for chlorides to reach the reinforcing and spalling will occur when the reinforcing corrodes.

Floor surface repair consists of removing all of the deteriorated concrete, preparing the surface of the remaining sound concrete, and placing and curing the new portland cement concrete to either restore the wearing surface in the area being repaired or to produce a new wearing surface either over the entire floor or a major predetermined part of the floor.

Repair has been divided into three classes. These classes differ, primarily, in the removal part of the work.

Class III repair requires the full depth removal of old floor concrete, the setting of forms, and replacement with new concrete. The surface may be finished to match abutting old concrete or it may be finished as part of a new wearing surface placed to a higher profile than the original floor.

Class II repair involves removal of old concrete from about 1/2 inch deep to any depth not more than 50 percent of the nominal existing floor. When unsound concrete extends through one half the depth of the floor or deeper, Class III repair is required. Again, the new concrete may be placed to match the surface of the abutting old concrete or it may be finished as part of a new wearing surface over the old.

Class I repair requires removal of a thin layer of old concrete and placing new concrete to form a new wearing surface. The object is to obtain a clean surface by the removal of laitance, oil droppings, chloride contamination and other impurities which may have penetrated the floor surface. It is imperative that at least 1/4 inch of sound surface concrete be removed and that a roughened surface be provided to which new concrete will bond. "Tennant Machines" or similar scarifiers have been utilized on past contract work. Grinders may leave too smooth a surface and should be tested before approval for their use is granted.

Before plans were prepared, preliminary studies were made to determine the nature and extent of floor damage and the appropriate repairs to be made. Complete resurfacing is usually chosen if very little cover exists over top reinforcing or if scaling is widespread. In the case of insufficient cover over top steel, the profile is raised to provide additional cover. If scaling has occurred and sufficient cover exists, resurfacing at the existing grade following allover removal down to top steel is indicated. When investigation shows that a considerable proportion of the surface is damaged, resurfacing is usually chosen.

Repair of only the damaged areas is indicated when these areas represent a small proportion of the total area and sufficient cover exists over top reinforcing.

Maintenance forces have been making permanent floor repairs for several years. During the past few years bridge floors have been repaired under contract with a high degree of success. This success was due in large measure to the efforts of the individuals who were responsible for inspection and administration of the contracts. Our experience was limited and many unforeseen problems came to light but for the most part have been solved. The discussion which follows will attempt to review the procedures usually followed and point out problems to anticipate, and solutions to those problems.

The project should be set up to include the required safety provisions to both workmen and traffic. It is important to insure that the proper equipment is assembled to maintain speedy progress of the work. Inadequate equipment has been the cause of poor quality work.

The location of areas to be repaired is the responsibility of the engineer. A thorough survey of the floor surface is necessary. Sounding with a hammer will reveal areas where separation has occurred beyond those areas where unsound surface concrete can be detected visually. Sounding is ineffective when moisture or frost exists in the void spaces.

A vertical saw cut is made around each area to be repaired. It should be as deep as practicable without cutting into the top reinforcing. Removal of old concrete must be at least sufficient to provide space for a 3/4-inch thickness of new concrete. When two or more areas requiring removal are close together they should be joined into one larger area. There is serious probability that the old concrete between such areas will fail soon and by combining areas the amount of saw cutting is reduced.

The first stage of concrete removal is usually done with pneumatic jack hammers. As work progresses

and sound concrete is encountered, smaller pneumatic hammers and hand tools should be used to insure the removal of all pieces broken loose but locked in. The prepared surface must be unbroken, uncracked, sound concrete of sufficient quality to serve as part of a permanent bridge floor after new concrete has bonded to the old. Care must be exercised to avoid loss of bond between reinforcing and concrete beyond the limits of removal. Heavy jack hammers applied vertically or nearly so may break through the sound portion of the floor or produce cracks in the portion to remain. The condition of the jack hammer bit will largely determine its effectiveness when the hammer is operated at an angle less than 90 degrees with the floor surface. A dull bit will be ineffective and probably unmanageable.

Removal should begin within the area, not at the saw cut. If the saw-cut edge is broken, a new cut should be made to insure a clean vertical face against which new concrete can be placed. A thin, tapered featheredge in new concrete will fail early and is therefore unacceptable.

The presence of rust on a reinforcing bar is ample evidence that it has lost bond with the old concrete. Vibration induced with a jack hammer also breaks the original bond. In either case the concrete surrounding the bar must be removed for a distance from the bar equal to one and one half times the size of the coarse aggregate. This removal should be done with sufficient care to avoid breaking additional bond beyond the affected area and to avoid stretching or otherwise damaging the bars. Exposed rebars must be fastened in correct position, if necessary, to insure that at least the minimum concrete cover is obtained. This may in some cases require additional concrete removal beneath some bars.

Clearance between the new concrete surface and existing concrete or reinforcing must be checked to insure that all new concrete is at least 3/4 inch thick.

The final stage of concrete removal requires considerable care. Cracks not plainly visible can be "brought out" by lightly fogging the area with a water mist. Surfaces dry fast but moisture will reveal cracks where it has penetrated. Cracks in the face of the boundary saw cut reveal separation beyond the boundary selected and the area being prepared should in such case be enlarged.

The exposed reinforcing and concrete are to be sandblast cleaned. The area is to be air cleaned of all loose and foreign material. As work progresses, care should be exercised to prevent oil leakage out

of equipment from coming in contact with prepared areas. Precautions should be taken, also, to prevent oil carry-over in air lines from being deposited on these areas.

The prepared surface must be clean and dry when grout is applied. Reinforcing must be rust-free and clean. If the preparation has been completed for some time, overnight or longer, sandblast cleaning may need to be repeated. The sand and cement grout is to be thoroughly brushed into the surface. All air film between old concrete and grout is to be eliminated. The coating of grout should be thin and even. It should not be permitted to puddle in pockets. Any grout which becomes sufficiently dry to change surface color should be removed by sandblasting and replaced with fresh grout.

New concrete should be placed immediately following the application of grout. Quality control checks should be made on every batch. The concrete should be placed and shaped slightly high. The vibrating screed should then be used to consolidate and finish at the required level. The joint which forms the boundary between new concrete and old should be painted with thinned grout.

As soon as the repair concrete has been placed and finished, the first application of the liquid membrane curing compound is to be made. If the first coating does not cover completely or does not appear to seal the surface, a second coating, applied immediately, should be required. Delay in applying the curing compound or an imperfect coating may result in detrimental shrinkage cracking.

The requirements of the specifications regarding the air content, slump, water reducer, mixing, placing and finishing concrete must be carefully and completely followed.