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I. INTRODUCTION

Bridge deck rehabilitation is a major component of the Department's bridge preservation program. An array of deck treatments are available which, when matched to deck condition and age, can provide cost-effective strategies for their preservation. These include asphalt and concrete overlays, as well as complete deck replacement. Selection of appropriate treatments requires that the Design Engineer know the process of evaluating and interpreting deck condition, be familiar with the treatments available, and be able to integrate condition data, treatment type, and cost into selection of a cost-effective rehabilitation strategy.

The purpose of this Manual is to provide a single document that the Designer can use to select deck evaluation methods, interpret the findings, and select treatment strategies. Requirements for reporting deck evaluation results are included. It does not provide full details on how the various evaluations are performed. This information is contained in the Materials Bureau publication titled Field Survey Manual for Bridge Deck Overlay Projects (March 1989).

The contents of this Manual are applicable to monolithic decks, two-course decks, and asphalt overlaid decks. For the last two deck types, the primary difference in applying the Manual's techniques is in methods used to evaluate condition. An asphalt overlay, in particular, masks condition of the underlying concrete deck and prevents direct observation of spalls, as well as soundings to detect delaminations. Half-cell potential measurements to detect corrosion activities cannot be performed through the asphalt.

Chapter II describes currently available deck evaluation methods. Each method's purpose is described, along with details of the information obtained. Criteria are established for selecting evaluation methods. Finally, techniques for interpreting the data in describing deck condition are reviewed.

Chapter III lists various deck treatments in use in New York. Each method is explained and criteria for its use are established. Current information on service life and statewide average cost are included. A procedure for calculating present worth of each treatment is also described.
Chapter IV outlines criteria for treatment selection. Age and current condition of the deck, together with estimates of treatment service lives, are used to select treatments providing cost-effective rehabilitation. Total cost of each treatment, including cost of construction, maintenance and protection of traffic (M&PT), protection of workers from falls and other hazards, and environmental protection is used to estimate its present worth. The additional M&PT cost and worker protection makes the treatment selection process highly dependent on site conditions and traffic volume. For very high traffic sites, user costs resulting from construction delays may also be considered. These additional costs tend to shift treatment selection toward more-complete rehabilitations at such sites.

Chapter V discusses reporting requirements. Report format has been standardized to permit easier preparation and review.

An Appendix of case studies is also included. These case studies will provide the reader with specific applications of the procedures described.
II. EVALUATION METHODS

Thorough bridge deck evaluation is required to select the best method of rehabilitation. This Chapter describes evaluation techniques for both monolithic and two-course decks. The latter with either a concrete or asphalt wearing course are evaluated using essentially the same techniques. Evaluation methods currently available, along with a brief description of their purpose, limitations, and the information obtained, are described here. The methods and their purposes are summarized in Table 1.

Each method's applicability is discussed as it relates to both monolithic and two-course bridge decks. For the latter, potential sounding evaluation techniques are either restricted or limited in their use at the design stage. The wearing course must be removed if this technique is to provide meaningful and complete information, making it difficult for the Designer to estimate removal quantities accurately on two-course decks. The Designer should use visual, coring, chloride, and possibly limited sounding data, and past experience to estimate repair quantities and locations. A potential and sounding survey should be incorporated into the bridge deck rehabilitation contract, after wearing course removal, so that areas requiring reinforcing bar exposure can be accurately identified. Two-course decks programmed for total deck replacement or 100% reinforcement bar exposure do not require potential or sounding evaluation. Similarly, these evaluations are not needed if an asphalt overlay is chosen as a short-term repair.

Specific instructions for performing and interpreting a variety of monolithic deck survey procedures are given in the Field Survey Manual For Bridge Deck Overlay Projects prepared by the Materials Bureau. These details are not repeated here. For brevity, this document will be referred to as the Field Survey Manual.

A. Visual Deck Examination

The work should begin with a visual examination of the top and bottom deck surfaces. Safe access to the underside of the deck must be arranged for this examination. This examination identifies such forms of surface distress as cracks, spalling, scaling, efflorescence, rust on stay-in-place forms, and concrete discoloration. Each type of distress should be documented on a scaled map of the deck, as described in Chapter V ("Reporting Requirements"). Visual examination will identify the need for other evaluation methods. For example, if it reveals extremely severe deck distress or concrete deterioration, there is little need to continue with other evaluation procedures because the deck must be replaced. By contrast, if visual examination indicates
relatively sound concrete with only isolated distress, such as spalling due to reinforcement corrosion, then additional evaluation procedures must be used to determine locations for reinforcing bar exposure. If visual examination reveals questionable deck bottom areas, then a more extensive evaluation will be needed to determine the extent of full-depth deck repairs.

Visual evaluation is an essential task that must be completed for both monolithic and two-course decks, using the same evaluation methods.

B. Sounding

This technique is described in the Field Survey Manual. It is used to locate areas of delaminated concrete by dragging a chain across the concrete surface or hitting it with a hammer and listening to the sound. If possible, both the top and bottom side of the deck should be sounded to identify delaminated concrete. Sounds from delaminated or hollow areas will be obvious. Sounding usually identifies delaminated concrete that results from expansive forces caused by reinforcing steel corrosion. These hollow or delaminated areas should be studied in conjunction with potential survey results. Both identify distress related to reinforcing steel corrosion. (See Chapter IV, Section A, "Deck Rehabilitation", for further information on identifying areas for concrete removal.

Sounding is used primarily on monolithic decks. On two-course decks (with both concrete and asphalt concrete wearing courses) it is difficult but possible to detect delaminations in the structural slab by pounding a hammer on the wearing course if background noise is low, but the chain drag is not sensitive enough for this application. Delaminations detected by a hammer in two-course decks should be confirmed by coring before performing an extensive survey. Experimental methods (radar and impact echo) for locating delaminations in two-course decks are described at the end of this Chapter. For two-course decks, sounding should be repeated with the wearing course removed. The contract documents should provide for this secondary sounding.

C. Potential Survey

This method locates areas of active reinforcing steel corrosion. Its use is limited to monolithic bridge decks and is detailed in the Field Survey Manual. Potential surveys cannot be used to evaluate two-course decks until the wearing course, including any protective membrane, is removed. By plotting electrical potential measurements on a grid map, areas of high and low potential can be located. As just stated regarding sounding, high potentials together with areas of spalls and delaminations are used to
determine the extent of reinforcing bar exposure. Because concrete delamination is a progressive form of failure, there will generally be substantial increases in removal quantities from those identified in design. To account for this, the Designer may want to increase removal quantities by about 20 percent per year for each year lapsed prior to planned construction (i.e., 40% would become 48% for a one-year lapse between deck evaluation and construction).

On two-course decks, the contract documents should provide for completion of a potential survey after the Contractor removes the wearing course. This enables the Engineer to identify areas for reinforcing bar exposure more accurately.

D. Coring

1. Procedure

Coring is an important tool in determining structural condition of concrete and reinforcing steel, and the extent of repair. It is used in evaluating both monolithic and two-course decks. Its importance is greater in evaluating two-course decks because it uncovers distress that may otherwise go undetected.

The primary function of cores is to verify findings of other evaluation methods, determine extent of the distress, and determine its limits and depth. They are also used to evaluate concrete condition through laboratory testing. Available tests include compression, air content, freeze-thaw, and chloride determination. Each of these laboratory tests is described later.

Visual analysis is sufficient for most cores. Only a few representative ones should be selected for laboratory testing. Concrete that looks good generally is good. Cores exhibiting distress throughout their full depth (rubble) should not be selected for laboratory testing. One of the best tests available is in-service performance of the concrete deck. Cores having no visible signs of distress have met the test of time.

Before establishing a coring pattern, the deck should be closely inspected, on both its top and bottom sides, as described in the "Visual Deck Examination" section of this Chapter. Deck condition should be documented on scaled drawings and representative photographs taken, as described in Chapter V ("Reporting Requirements for a Bridge Deck Condition Report"). Deck condition is often repetitive from span-to-span and in specific locations, such as curb lines,
transverse joints, etc. Various typical conditions should be identified. Deck locations exhibiting each type and extent of distress should be selected for core analysis. It may not be necessary to core each span of a multiple-span structure unless differing conditions exist, but the Designer must be satisfied that all these conditions are evaluated. The coring pattern should be selected so that an estimate of repair can be made. If after the initial inspection it is obvious that complete deck replacement is warranted, then no cores are necessary.

When coring, a qualified Engineer, preferably the Designer responsible for the bridge rehabilitation, must be present. Modification of the original coring pattern by a qualified Engineer, based on results for cores as they are extracted, will result in the most efficient use of coring and eliminate the possibility of misinterpreting distress observed in the core. Cores can become damaged due to improper coring (excessive down pressure, worn bit, reinforcement wedging in the core bit, etc.). The interior of the core hole should always be inspected to confirm the condition of a broken core. By inspecting the interior of the core, the orientation of the reinforcing bars, cover on the transverse and longitudinal reinforcement, and the depth of the core and of delaminations can be determined. Comparison of the core to the core hole lining can determine if cracks in the core represent the deck condition or damage caused by the drilling operation.

Cores should be taken with a maneuverable pavement core drill for access to curb line or other restricted areas, using 4-inch diameter, thin-wall, diamond-bit core barrels. They should ideally be taken completely through the deck to permit full-depth concrete and lower-mat reinforcing steel evaluation. However, when core retrieval is not possible from the deck underside, the core may be broken off just below the level of the bottom steel mat. In any case, the core bit should progress well into the structural slab. When taking them on spans having corrugated-steel stay-in-place forms, coring should be discontinued when water is lost through the perforation made in the corrugations by the drill. Coring completely through a rubble structural deck can cause surface cave-in, which may be hazardous to traffic and require continuing maintenance. If this condition is encountered, subsequent cores may be broken off short to leave a base to hold the core hole patch. On multiple-course decks, it is generally best to core through individual courses and retrieve these before continuing into the structural slab. Coring through cold-patch material should be avoided as this may gum up the coring equipment and contaminate the structural concrete core.
When coring top slabs over prestressed concrete box-beams and prestressed concrete slabs, the bit should not be allowed to penetrate through the slab into the structural member.

2. Core Tests

The following core tests are equally applicable to evaluation of both monolithic and two-course bridge decks.

a. Visual Analysis Of Cores

Because the primary reason for taking concrete deck cores is to verify apparent surface condition, such as reinforcing bar corrosion, most cores should be taken for visual analysis only. When evaluating top reinforcement, the core need only be taken to the top reinforcing mat. When a core is taken to evaluate visible distress of the deck underside, a full-depth core should be obtained where possible.

Visual examination of deck cores is the primary means of determining the soundness of deck concrete. Cores should be physically tested only to resolve questions that cannot be answered by visual examination.

Visual examination must include written documentation to detail general condition of each core. The examination should be completed by a qualified Engineer and include depth of coring, rebars encountered and their position within the core, and field data and notes to help differentiate between coring damage and concrete deterioration.

Visual examination should include using a magnifying glass. A clean broken face examined under magnification will show hidden details such as fine cracking, and/or the presence of entrained air.

Visual examination and documentation of each core should include the following:

Deck Condition. Deck surface and underside condition in the area of the core should be noted to record the purpose of the core.

Depth Of Coring. Note core depth and whether it is partial-or full-depth.
Layer Thickness. If all concrete layers are intact, this will only entail measurement of the core. If rubble or broken layers are encountered, thickness and original position in the deck must be determined by measuring inside the core hole. Thickness, type, and condition of all materials, including bituminous overlays or patches, should be noted. Where a membrane is present, its thickness, type, and condition should also be recorded.

Reinforcing. Size, location, and condition should be noted. The rebar may have to be broken out of the core to verify potential measurements by observing corrosion deposits on both the reinforcement and adjoining concrete surfaces.

Concrete Condition. This could range from sound to rubble. Smooth and dense mortar in the core circumference indicates sound concrete. Rough, porous mortar indicates poor-quality concrete. Poor concrete consolidation during placement can result in excessive entrapped air (honeycombing, bugholes), resulting in poor concrete strength and durability.

Cracking description should include whether it is horizontal, layered (series of horizontal cracks), or vertical, and whether it goes through or around the coarse aggregate. Cracks through coarse aggregate indicate that they occurred after the concrete developed strength. Cracks going around coarse aggregate indicate shrinkage or a one-time overstressing very early in life of the deck, before concrete could develop strength needed to resist the loading condition.

Core Photographs. Closeup photographs of each core should be taken for permanent visual documentation. Cracks which are a result of the coring operation should be identified.

b. Laboratory Core Testing

Cores submitted to the Materials Bureau for testing must be properly marked with Core ID Number and tests to be performed (using a permanent marker). A memorandum describing test instructions, where the results should be sent, and who should be contacted if questions arise, must accompany the cores. Do not send wearing course segments or other portions of a core unless they are to be tested. No test can be performed on rubble. If there are segments, each should be marked with Core ID Number and test to be performed. Multiple testing on the same
concrete specimen results in erroneous results, and thus must not be requested. Chloride testing, however, can be performed on a specimen before a freeze-thaw or air content test without affecting later results. If more than one test is desired on a whole core, it may be segmented to allow for multiple testing. The core should be marked to locate each cut; avoid cuts through reinforcing steel. Resultant segments should have Core ID number and test to be performed marked on them, as follows:

(1) Compressive Strength Testing

This quantifies the degree of concrete soundness. Concrete with no deterioration or visible cracking is proved strong and sound using this test. It is not necessary or desirable to test all cores for compression. Only a few carefully selected cores should be tested. Cores should be in good condition. Ideally, they should be at least 8 in. long, but lengths as short as 4 in. may be tested. They should not have reinforcing steel in their sides; steel through the core midpoint is okay.

Concrete strengths of 3,500 psi or less may be unable to withstand the rigors of repair with jack hammers and high-pressure water blasters. Additional cores and evaluation should be made before a decision on the appropriate deck treatment is made. There is no minimum concrete strength below which rehabilitation would be prohibited without additional study.
Air Content of Concrete Cores

The high pressure air (HPA) test measures total air content of hardened concrete. About 1 to 2% of this total is entrapped air, and the rest entrained air. Air entrainment, with air bubbles of the proper size and dispersion, provides concrete with resistance to water freeze-thaw damage. As with compression testing, only a few select cores should be tested for air. This does not require a whole core; a 3 in. or larger piece of concrete can be used.

Usually, air testing is not even necessary. Concrete that has resisted freeze-thaw distress for years has withstood the test of time. Existing deck concrete still in repairable condition, whether air entrained or not, will be protected by an overlay system.

Total air contents ranging from 4 to 9% assure good durability. Concrete with less than 4% entrained air usually has poor resistance to freeze-thaw damage and must be protected if retained. Concrete with high total air (greater than 9%) may be investigated for strength, as compressive strength decreases with increased air content. However, if the deck is still in good condition then compressive strength should be okay.

Concrete from older structures (built before 1950) probably will not contain intentionally entrained air and testing should not be necessary. Between 1950 and 1960, natural cements were used with dry powdered air-agent admixtures, and special specifications calling for separate air entraining admixtures. All this provided some entrained air and varying protection; these structures may be tested for air content. Monolithic decks showing distress such as scaling should be tested for air content.

Freeze-Thaw Testing Of Concrete

This complements the air content test. Adequate air yields little or no freeze-thaw loss of concrete but low air produces high loss. The test measures percent loss (by weight) of a concrete sample completely submerged in a salt (NaCl) solution and subjected to cyclic freezing and thawing. Freeze-thaw losses of less than 1% at 25 cycles usually indicate good durability. Those greater than 1% indicate poor durability. Older (before 1950)
non-air-entrained concrete will generally show high or 100% loss, but properly air-entrained concrete will have low loss or none.

These results are an indicator of concrete durability. Concrete with no freeze-thaw loss will perform well when wet in winter, but that with freeze-thaw loss will slowly disintegrate. Test losses of less than 100% but more than 1% indicate concrete that will continue to deteriorate when exposed to additional cycles.

This test will not predict time to deterioration, because exposure conditions in the field are different and more variable than laboratory conditions. Concrete with high losses will perform well in service if it is protected and kept dry. As with air content testing, if freeze-thaw loss is to be evaluated, only a limited representative number of cores should be selected for testing. This cannot be run on cores tested for high pressure air or compression, unless the core is segmented as previously described.

E. Chloride Measurement

This technique consists of obtaining and testing powdered concrete samples, and is described in the Field Survey Manual. Samples can be obtained directly from the structural slab or cores taken from it. Chloride testing should be confined only to sound deck areas that are to remain after rehabilitation. High levels of chloride (≥ 1.3 lb/c.y. of concrete), when moisture and air are present, cause accelerated rates of steel corrosion. Because overlay materials prevent or minimize moisture and air from reaching the underlying concrete, Department policy is to leave high chloride-contaminated concrete in place. This testing thus is not required for monolithic decks because it has no bearing on the type of repair.

Chloride testing on two-course decks may help a Designer estimate concrete removal quantities for the underlying structural slab. Structural slabs with low chlorides have been effectively protected over time, and thus will probably require little if any concrete removal resulting from corroding reinforcing steel. This testing is used only for estimating removal quantities. Final decisions on removal should be based on delamination and potential surveys made after the wearing course has been removed.
F. Thermography

This method is used to detect delaminations with an electronic thermometer device mounted in a moving vehicle. It is effective only on monolithic bridge decks and thus is inappropriate for two-course decks. Because data are collected from a moving vehicle, M&PT requirements are minimal. Its use should be limited to high-traffic locations where safety and cost are prime considerations. The Structures Division or the Field Engineering I Section of the Materials Bureau should be contacted before using thermography to assure its proper use. Thermography data plotted on a grid map identify areas for concrete removal.

G. Radar And Impact Echo

These are methods that have been used experimentally on several small bridge decks, and are not yet perfected for detecting delaminations. Although they can be used on monolithic decks, they are most advantageous on two-course decks. Results of the impact echo are very promising. The Materials Bureau is still developing these evaluation procedures. If interested in using these methods contact the Field Engineering I Section of the Materials Bureau (518-457-5956).
<table>
<thead>
<tr>
<th>Evaluation Method</th>
<th>Purpose</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual Examination</td>
<td>Locate cracks, spalls, patches, and other obvious signs of distress.</td>
<td>Distress Map</td>
</tr>
<tr>
<td>Sounding</td>
<td>Locate delaminated areas not visually evident.</td>
<td>Delamination Map</td>
</tr>
<tr>
<td>Potential Survey</td>
<td>Locate areas of actively corroding reinforcing steel.</td>
<td>Potential Map</td>
</tr>
<tr>
<td>Coring</td>
<td>Investigate areas where deck structural integrity is suspect or where depth of deterioration is unknown. Use in any questionable areas not adequately defined by other techniques, and to verify accuracy of sounding and potential surveys.</td>
<td>Core Data</td>
</tr>
<tr>
<td>Chloride Measurement</td>
<td>Determine quantity of chloride ion concentration at the rebars.</td>
<td>Chloride Data</td>
</tr>
<tr>
<td>Thermography</td>
<td>Locate delaminated areas through measurement of deck temperature differences.</td>
<td>Delamination Map</td>
</tr>
<tr>
<td>Radar and Impact Echo</td>
<td>Experimental methods of locating deck delaminations. May be especially useful on two-course decks.</td>
<td>Delamination Map</td>
</tr>
</tbody>
</table>
III. DECK TREATMENTS

This chapter defines various deck treatment options and describes their advantages and limitations. Information is provided on rehabilitation tasks included in the treatments, expected service life and treatment cost, and a procedure for economic analysis of the alternatives.

A. Deck Treatments

1. Non-Protective Treatments

Maintenance of the existing surface or applying an asphalt overlay without a waterproof membrane are considered non-protective. Under these treatments, the deck continues to deteriorate, resulting in further structural damage. This damage in turn increases the cost of subsequent treatments whether those are protective or non-protective. Thus, although their initial cost is low, the long-term penalty must be recognized.

Because deterioration continues under non-protective treatments, their use should be limited to short-term applications. Asphalt overlays or maintenance treatments are effective for keeping a deck in service until it can be replaced. Maintenance filling of isolated potholes during the period between evaluation and design of a deck rehabilitation and its construction is also an appropriate use of asphalt concrete.

2. Protective Treatments

Asphalt overlays with waterproof membranes and concrete overlays are all protective treatments, extending deck service life.

Asphalt overlays with protective membranes have shorter service lives than rigid concrete overlays. Given favorable roadway geometrics and traffic, the overlays average up to 11 years of service. The protective membrane has an estimated life of 22 years.

Asphalt concrete, especially in combination with a protective membrane, is very sensitive to plastic deformation (shoving/slippage) failure. The asphalt/membrane system thus should not be used on high-traffic roadways (> 5,000 AADT), steep grades (> 4%), sharp curves (i.e., ramps), and major interchanges with on/off ramps, which subject the pavement to severe acceleration and deceleration forces. In such situations, asphalt concrete service life will be significantly reduced and a rigid concrete overlay system...
should be selected. Asphalt concrete/membrane systems are best suited to rural, through-traffic structures where longer service lives are desired.

For both protective treatments, the extent of deep removal is the major factor in service life and cost. It is not possible to determine reliably the influence of variations in amount of deep removal on service life. Accordingly, selection of the appropriate amount of deep removal must be based on technical rather than economic factors. Delaminated areas and those experiencing active corrosion are the initial indicators in determining how much concrete to remove. Small islands and narrow peninsulas of concrete surrounded by areas of high half-cell potential readings should also be cleared. These areas may deteriorate rapidly after uncontaminated concrete is placed adjoining them. In general, islands and peninsulas should be removed when there area is less than 100 sq ft or the smallest dimension is less than 5 ft.

In addition, the percentage of removal should be considered. If only a small area requires repair the work should be confined to that area, but where the percentage is high it may be desirable to remove 100 percent. These issues are discussed further in Chapter IV.

3. Deck Replacement

Deck replacement is the treatment option with the highest first cost and should be considered to be a last resort. Deck maintenance and rehabilitation must be carefully managed to delay replacement for the longest possible time. A deck may have only localized areas of deterioration through its full thickness. Full-depth repair should be limited to those areas unless economic analysis shows complete replacement to be justified.

B. Deck Rehabilitation Tasks

Regardless of the deck treatment selected, several common construction tasks may be performed:

1. Wearing Course Removal

Removal of asphalt or concrete overlay.

2. Structural Slab Scarification

Deck concrete is removed by mechanical scarification. Unless a greater depth is indicated on the plans, the concrete is removed to a minimum of 1/4 in. and a maximum of 1/2 in. When 100% deep removal is specified, this pay item is not used.
3. Reinforcing Bar Exposure

In this operation, commonly referred to as deep removal, structural concrete is removed from the periphery of the uppermat reinforcing bars to provide a minimum 1-in. clearance between the reinforcing bar surface and remaining concrete surface. Deeper concrete removal may be needed to reach sound concrete.

4. Reinforcing Bar Cleaning

Blast cleaning to remove all grease, dirt, concrete, mortar, and injurious rust from reinforcing bars. Injurious rust includes all scale, loose rust deposits, or all rust not firmly bonded to the steel. Bar cleaning is paid under the payment item for concrete overlays.

5. Slab Reconstruction

Placement of concrete around exposed reinforcing bars to the level of the surrounding concrete or to 1/2 in. above the reinforcing steel. Bonding grout is placed on all surfaces receiving slab reconstruction concrete, which may be either Class D or one of the specialized concretes used for overlays.

6. Waterproof Membrane Application

Protective membranes applied to the concrete deck. An asphalt overlay is placed over the membrane.

7. Overlays

Asphalt and concrete overlays are used. Asphalt overlays are the same material and installed by the same procedures as highway pavement top courses. Specialized concrete materials are used for concrete overlays. Class E Concrete is used when the final overlay thickness will be greater than 3 in. One of the specialized concretes, at the Contractor's option, is used for overlays 3 in. and less in thickness. The specialized concretes include:

a. High Density Concrete

A portland cement concrete of very high density made from standard concreting materials, with a required slump between 1/2 and 1 in. The minimum thickness of overlay concrete is 2 in.
b. **Latex Modified Concrete**

A portland cement concrete with a styrene-butadiene latex admixture. The minimum thickness of overlay concrete is 1-1/2 in.

c. **Microsilica Concrete**

A portland cement concrete with a microsilica admixture. The minimum thickness of overlay concrete is 1-1/2 in.

8. **Transverse Saw Cut Grinding** - Required to achieve macro-texturing.

Application of these tasks to the various rehabilitation treatments is given in Table 2.

<table>
<thead>
<tr>
<th>Task</th>
<th>Asphalt</th>
<th>Concrete</th>
<th>Concrete</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wearing Course Removal</td>
<td>As Needed</td>
<td>As Needed</td>
<td>As Needed</td>
</tr>
<tr>
<td>Scarification</td>
<td>Not Required</td>
<td>Not Regd.</td>
<td>Required</td>
</tr>
<tr>
<td>Rebar Exposure</td>
<td>As Needed</td>
<td>As Needed</td>
<td>As Needed</td>
</tr>
<tr>
<td>Rebar Cleaning</td>
<td>As Needed</td>
<td>As Needed</td>
<td>As Needed</td>
</tr>
<tr>
<td>Slab Reconstruction</td>
<td>As Needed</td>
<td>As Needed</td>
<td>As Needed</td>
</tr>
<tr>
<td>Waterproof Membrane Overlay</td>
<td>Not Required</td>
<td>Required</td>
<td>Required</td>
</tr>
<tr>
<td></td>
<td>Required</td>
<td>Required</td>
<td>Required</td>
</tr>
</tbody>
</table>

**C. Service Estimates**

Service life has been estimated for each treatment. "Service Life" means length of time that a particular treatment will last before additional deck work is needed. The formal definition is the age at which 50% of decks develop delaminations over 40% of their surface areas. The original estimates (1986) were based on interpretation and evaluation of deck deterioration data by the Technical Services Division. More recent studies have not improved those estimates, but suggest that amount of deep removal and quality of the removal and reconstruction specifications strongly influence the service life obtained. Thus, there is evidence that service life depends on the amount of deep removal, but insufficient data to reliably predict the magnitude of this effect. It is recognized that local conditions and experience may support use of different values for service life. Table 3 indicates service lives for each treatment.
Table 3 - Performance Estimates

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Service Life, Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maintenance Only</td>
<td>--</td>
</tr>
<tr>
<td>Asphalt Overlay</td>
<td>4</td>
</tr>
<tr>
<td>Asphalt With Membrane</td>
<td>22*</td>
</tr>
<tr>
<td>Concrete Overlay (Select Deep Removal)</td>
<td>25</td>
</tr>
<tr>
<td>Concrete Overlay (100% Deep Removal)</td>
<td>35</td>
</tr>
<tr>
<td>Replacement Deck</td>
<td>40</td>
</tr>
</tbody>
</table>

* The asphalt overlay with waterproof membrane treatment requires resurfacing after 11 years.

D. Treatment Costs

Determination of treatment costs is difficult because of the many variables involved. For specific projects costs should be estimated using regional values. The bridge rehabilitation module of the Preliminary Estimate Program (PEP) should be used for this purpose.

Analysis of 1989 weighted average bid prices produced the statewide average values shown in Table 4. It must be emphasized that these values and all cost values shown in this Manual are for illustrative purpose only, and should not be taken to represent actual cost experienced in any region. In addition, conclusions resulting from applying these costs are not intended to be absolute. Only costs specific to a project should be used in selecting deck treatments.
Table 4. Statewide 1989 average weighted bid prices.

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asphalt W.C. Removal</td>
<td>$ 1.34/Sq.Ft.</td>
</tr>
<tr>
<td>Scarification</td>
<td>$ .99/Sq.Ft.</td>
</tr>
<tr>
<td>Rebar Exposure</td>
<td>$12.61/Sq.Ft.</td>
</tr>
<tr>
<td>Waterproof Membrane</td>
<td>$ 2.07/Sq.Ft.</td>
</tr>
<tr>
<td>Type 6F Top Course</td>
<td>$39.49/Ton</td>
</tr>
<tr>
<td>Type 3 Binder Course</td>
<td>$36.50/Ton</td>
</tr>
<tr>
<td>Concrete Overlay*</td>
<td>$ 4.89/Sq.Ft.</td>
</tr>
<tr>
<td>Concrete Removal</td>
<td>$12.30/Sq.Ft.</td>
</tr>
<tr>
<td>Concrete Placement</td>
<td>$22.34/Sq.Ft.</td>
</tr>
<tr>
<td>Steel Reinforcement</td>
<td>$ 0.78/Lb.</td>
</tr>
<tr>
<td>Transverse Saw Cut Grooving</td>
<td>$ 0.64/Sq.Ft.</td>
</tr>
</tbody>
</table>

* Composite of specialized concrete overlay materials.

These costs are combined as necessary to estimate expense of a treatment on a specific project. For example:

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Cost/Sq.Ft.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asphalt With Membrane</td>
<td>$11.52</td>
</tr>
<tr>
<td>Concrete (Select Deep Removal)</td>
<td>$15.27</td>
</tr>
<tr>
<td>Concrete (100% Deep Removal)</td>
<td>$23.03</td>
</tr>
<tr>
<td>Replacement Deck</td>
<td>$39.60</td>
</tr>
</tbody>
</table>

Select deep concrete removal is assumed to involve 50% of the deck area. Cost of deep removal is large with respect to the other items comprising a deck rehabilitation. It is thus appropriate for the specific deck being investigated here. It is important to remember that amount of deep removal is a function of deck condition, not influenced by the type of overlay to be used. Using pay item data, cost of the treatment can be expressed as a function of percent deep removal.
E. Life-Cycle-Cost Analysis

Because of the different service lives demonstrated by the various treatments, a comparison based on initial cost is inappropriate. The present worth method accounts for service life differences and the time value of money.

Although deck rehabilitation treatment decisions are dictated primarily by technical considerations, life cycle cost of suitable treatments must be analyzed. Four fundamental decisions are required before such an analysis can be completed: 1) analysis method, 2) discount rate, 3) analysis life or planning horizon, and 4) sequence of treatments over the analysis life.

The first two are dictated by Department policy, which requires using the present worth method with a 4% discount rate. This method converts expenditures occurring at different times into equivalent amounts occurring at the present. For a particular expenditure, the present worth is computed as

\[ PW = C \times SPPWF_y \]

where \( PW \) = present worth of the expenditure,
\( C \) = future cost of the expenditure.

and \( SPPWF_y \) = single-payment present worth factor for an expenditure at year \( Y \).

Total present worth for all treatments needed to extend deck life through the planning horizon equals the sum of the individual values.

Other economic analysis relationships needed are:

\[ USPWF_y = \text{uniform series present worth factor for} \ y \text{ payments}, \]
\[ \text{and} \]
\[ CRF_y = \text{capital recovery factor over} \ y \text{ years}. \]

These terms are defined mathematically in Appendix A.

The planning horizon should be selected on the basis of the unique characteristics of the bridge being rehabilitated. Generalized average data on bridge lives are irrelevant in a project-specific decision.
Except for non-protective treatments, bridge deck rehabilitation alternatives have service lives over 20 years. Because of these long lives, there has been no experience with retreatment. Lacking such experience, it may be assumed that the same sequence of actions will be repeated, except when the present treatment is non-protective. Thus, the possible treatment sequences are 1) a non-protective treatment followed at the end of its service life by repeated applications of a protective treatment, 2) deck replacement followed by repeated applications of one of the protective treatments, or 3) one of the protective treatments repeated as needed.

As an example of life-cycle-cost analysis, assume the following treatment costs and service lives:

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Cost</th>
<th>Service Life Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asphalt Overlay</td>
<td>$1.92</td>
<td>4</td>
</tr>
<tr>
<td>Select Deep Removal</td>
<td>$15.27</td>
<td>25</td>
</tr>
<tr>
<td>Replacement</td>
<td>$39.60</td>
<td>40</td>
</tr>
</tbody>
</table>

Two treatment sequences have been determined to provide technically appropriate solutions for a deteriorated deck. Sequence A involves an immediate asphalt overlay with a deck replacement in 4 years. Sequence B involves select deep removal and overlaying at 25-year intervals. Compare the life cycle costs of these treatments using a discount rate of 4%.

Sequence A = 1.92 + 39.60 \times SPPWF_4 = $35.77/sq. ft.

For Sequence B, two applications provide 50 years of service compared to the 44 years provided by Sequence A. Accordingly, Sequence B costs must be adjusted to a planning horizon of 44 years:

Sequence B = 15.27 + 15.27 \times CRF_{25} \times USPWF_{19} \times SPPWF_{25} = $20.09/sq. ft.

Sequence B clearly has the lower life-cycle cost.
IV. TREATMENT SELECTION

Various treatments and technical recommendations for selecting suitable applications have been described in Chapter III. Based on technical considerations, criteria can be established that eliminate particular treatments from further consideration. Having narrowed the field of possible selections, a final choice can be based on economic comparisons. Clearly, such comparisons should not be performed on treatments that do not satisfy the project’s technical needs.

A. Deck Rehabilitation

A fundamental consideration in identifying suitable treatments is determining whether protective or non-protective action is appropriate. In general, non-protective treatments should not be used except where the deck must be kept in service relatively briefly until replacement. Use of non-protective treatments to provide service until a protective treatment can be applied should be discouraged. Deck deterioration develops gradually and only rarely can appropriate protective treatments not be normally programmed. Under a non-protective treatment deck deterioration may accelerate, resulting in increased cost for future protective treatments.

For protective treatments, two independent decisions are needed - area of concrete deep removal from around the top rebar mat and type of overlay material. Deep removal area is the more important and difficult decision. Both technical and economic considerations should be examined to resolve this issue. Appropriate area of deep removal does not depend on type of overlay material.

The following discussion is directly applicable to both two-course and monolithic bridge decks. For two-course decks, whether the top course is concrete or asphalt, deck condition evaluation methods differ as discussed in Chapter II. Except for condition evaluation, however, there should be no difference in the way rehabilitation treatments are selected. The objectives of a condition evaluation are to determine if the deck can be rehabilitated, and if so the minimum amount of rebar exposure required. With this minimum determined, the appropriate treatment is selected independent of existing deck type.

Three indicators of monolithic deck condition are used in determining the need for deep concrete removal and its extent -- spalls, delaminations, and half-cell potential measurements greater than 0.35 v. Spalls are the primary indicator because without this visible indication of deck failure further deck evaluation is
unnecessary. Delamination and half-cell potential would not ordinarily be measured unless such evidence of deterioration were apparent.

Deck deterioration is conveniently reported in two ways — as area of spalls, or as total damaged area, both expressed as percent of deck area. Total damaged area is taken as the sum of non-overlapping area of spalls, delaminations, and half-cell potentials greater than 0.35 v.

These indicators provide a quantitative measure of deck condition and identify deck areas that are currently damaged or actively corroding. The total damaged concrete area, as a minimum, must be removed to a level at least 1 in. below the top mat of reinforcement. There are additional, less objective reasons for increasing the area of deep concrete removal. Half-cell potential measurements on recently repaired decks indicate that corrosion activity often increases dramatically in concrete that is left in place. Thus, concrete that did not warrant removal because of half-cell potential readings before repair may show values that would justify removal after repair. This concrete generally has medium potential (0.15 to 0.34) before removal and represents a deck area less than the total damaged area. To eliminate the possibility of premature failure of the rehabilitated deck, these areas should be removed according to the following criteria:

1. If the sum of all medium-potential areas equals or is less than total damaged area, then they should be removed. This comparison should be on a span basis.

2. If any medium-potential area is less than 100 sq. ft. or has a minimum dimension equaling or less than 5 ft., it should be removed.

The total area to be removed is defined as the sum of total damaged area and the areas just identified by Criteria 1 and 2.

The total removal area is based solely on technical considerations and represents that necessary to assure that at least half of the repaired deck achieve the service lives given in Chapter III. At some locations, conditions may exist requiring greater confidence in longevity of the rehabilitation. Specifically, 100% deep concrete removal may be justified on bridges in urban areas with high-traffic density whenever one or more of the following conditions are met:

1. Area of spalls exceeds 2%,

2. Area of delamination exceeds 30%,
3. Area of half-cell potential greater than 0.35 exceeds 40%, or
4. Total damaged area exceeds 50%.

These conditions are exclusive of distress within 2 ft. of a bridge joint.

For two-course bridge decks, electrical potential cannot be tested before construction because of presence of either a non-conductive asphalt overlay or mesh-reinforced concrete overlay. Because of absence of this information, amount of reinforcing bar exposure required must be estimated. Cores, sounding (chain drag or hammer), visual examination of the underside of the deck surface, and the experience of the Designer should all be used in estimating quantity to be removed. After the wearing surface is removed, the monolithic deck evaluation criteria can be used to establish the final removal limits.

Absolute traffic levels cannot be established at which 100% deep-removal is justified, but two additional considerations can be included in a rehabilitation plan to permit comprehensive comparison of deck treatments -- 1) M&PT cost and 2) user cost associated with construction delays. M&PT costs cannot be generalized, but they can be estimated accurately on a project basis. User costs associated with construction delays are estimated in terms of vehicle-hours. It is generally assumed that there must be a minimum delay (5 minutes) before any cost is assessed. Estimating duration of construction delays is considerably more complex than estimating costs of maintaining and protecting traffic.

Because M&PT and user costs are strongly influenced by site characteristics and only secondarily by type of deck treatment, including these costs increases treatment costs by a constant dollar amount on a specific project. Thus, proportionate change in cost is less for longer-lived treatments having higher initial cost. The net effect is to tilt the present worth comparison in the direction of treatments with longer lives.

As previously noted, the overlays appropriate for protective treatments are asphalt with waterproof membrane, Class E concrete, and the three specialized concretes – (high density, latex modified, and microsilica). Limitations on use of asphalt with waterproof membrane are described in Chapter III (Section A2).

The Class E concrete is restricted to overlay thicknesses greater than 3 in. because of permeability and aggregate size. If specialized concrete overlays are specified, selection of one of the three possibilities is the Contractor’s option. Current service life data are inadequate to demonstrate a difference in durability of any of the rigid overlay materials.
B. **Deck Replacement**

Although cost of a deck replacement is substantially greater than that of a deck rehabilitation, the decision to replace is primarily technical. Indications of deck underside dampness or efflorescence strongly suggest need for replacement. Presence of delaminations or spalls on the underside of the deck necessitate replacement. These conditions may be local, and partial full-depth repair may be all that is necessary to restore the deck. Nevertheless, M & PT cost and user delays may justify complete replacement.

C. **Treatment Selection Considerations**

Using the methods explained in Chapter III, total present worth of each deck treatment that will remedy the deck’s technical deficiencies can be estimated. Although this estimate is a representative value for true cost of deck rehabilitation, it is not appropriate simply to select the treatment with lowest present worth. Cost estimating is not an exact science and even bid prices will not necessarily reflect actual cost to perform the work.

Treatment selection should favor the treatment with longest expected service life. Thus, small premiums for additional service life are warranted. The size of an acceptable premium is sensitive to local conditions and concerns and is thus left to the discretion of the individual regions.

D. **Examples**

Two examples of cost estimating and project selection are given in Appendix B. In the first, a 6,400 sq ft deck, the difference in present worth between 100% deep removal (35-year life) and 50% deep removal (25-year life) is only $5,850 (less than 3%). Total initial cost of the treatment with longer life is 23% larger ($51,600) than the 50% removal option. Deck treatment costs are 56% of total project cost.

In the second example, two interstate bridges with a total area of 12,960 sq ft are being rehabilitated. Present worth of Alternative 2 with the longer life exceeds the 50% removal option by $20,426 (5%). The difference in initial cost is $104,593 (25%) greater than the 50% option. Deck treatment costs are 58% of the total cost.

Cost estimating generally involves comparison between cost of the minimum amount of deck removal that will satisfy technical requirements of the job and that of 100% deep removal. In determining the technically acceptable removal quantity, care should be taken to follow all provisions of this Manual for deck evaluation. Questionable deck areas should always be removed.
V. REPORTING REQUIREMENTS

This Chapter explains how to document findings of the deck evaluation and present them in a manner consistent with the evaluation methods outlined in Chapter II.

It is important that all sections of this Chapter be completely satisfied to document deck condition properly, and to support the recommendation to repair or replace the deck. Content of the sections may vary because of the severity of deck deterioration or extensiveness of the proposed rehabilitation. Appendix C shows a sample Bridge Deck Evaluation Report.

A. TITLE: BRIDGE DECK EVALUATION REPORT

Identify Structure
- BIN Number
- County
- Town, City, Village
- Region
- Feature Carried
- Feature Crossed

B. INTRODUCTION

Bridge History
- Year Built
- Bridge Type
- Structure Length and Out-To-Out Width
- Previous Work Done, particularly on the deck
- Planned Future Work

Highway Classification
- Traffic Volumes
- Plan for Maintenance and Protection of Traffic

C. DECK INSPECTION FINDINGS

This includes data collected and developed during deck evaluation field work. All survey work must be recorded by span for both the top and bottom of the deck. The following should be provided for review:

1. SKETCH OF DECK UNDERSIDE:

a) Framing system
b) Cracks
c) Damp areas
d) Areas of efflorescence
e) Rusted stay-in-place Forms
f) Spalls and exposed rebars
g) Other indications of deterioration

- 27 -
All deterioration should be quantified based on percentage of the deck exhibiting the respective type of deterioration.

2. COLOR PHOTO OF UNDERDECK:
   a) Typical good areas
   b) Areas of deterioration in each span, showing any of the seven types of deterioration just listed.

3. SKETCH OF DECK SURFACE:
   a) Spalls
   b) Cracks
   c) Joint problems
   d) Patches
   e) Other indications of deterioration
   f) Core locations
   g) Areas of high potential (0.35v), as appropriate
   h) Areas of delamination, as appropriate

All deterioration should be quantified on percentage of deck exhibiting the particular type of deterioration.

4. COLOR PHOTOS OF DECK SURFACE:
   a) Typical good areas
   b) Areas of deterioration in each span, showing any of the seven types of deterioration.

5. Color photos of the bridge in elevation, approaches, substructures, and any problem areas.

6. Photo layout sheets indicating location of photographer and camera orientation.

7. Inspection Forms: Copies of Forms TP349 and TP350 from the most-recent biennial inspection should be reviewed for comments prior to the start of the deck inspection. These forms should be attached to the deck report with additional comments added, as appropriate.

D. DECK CORE EVALUATION AND TEST RESULTS

1. DETAILED VISUAL EXAMINATION:
   General description of core(s) and any defects. Examination complemented by field data and notes to help differentiate between any coring damage and concrete deterioration. Examination should also determine depth and location of materials encountered in the core.
For each core or series of cores, report the following:

a) Explain why this core location was selected.

b) Depth of Coring: Note whether core is full-depth or partial-depth and if appropriate the reason for partial-depth coring. Also note deck surface and underside condition in the core vicinity.

c) Note the thickness of layers making up the core. If all concrete layers are intact, this will only entail measurements. If rubble or broken layers are encountered, their thickness and original position in the deck should be determined during coring by measuring inside the core hole. Thicknesses, type, and condition of bituminous overlays or patches should be noted.

d) Presence of a membrane, and its thickness, type, and condition.

e) Reinforcing steel location, size, and condition, e.g. 1-1/2 in. cover, No. 5 bar, no rust. A rebar will often have to be broken out of the core after completing its examination, to check for corrosion.

f) Concrete: Condition of the concrete may range from sound to rubble. (This discussion should include all observations resulting from the evaluation techniques suggested in Chapter II.)

   1) Concrete Mortar Quality: type, depth, and amounts of deterioration should be noted.

      a. Concrete mortar scaled away due to moisture freezing and thawing.

      b. Concrete spalling caused by internal pressures such as expansive corrosion.

      c. A smooth, dense mortar on the core circumference indicates sound concrete.

      d. A rough, porous core circumference indicates possible deterioration. Coring may wash away poor-quality mortar, leaving a rough irregular surface.

   2) Any voids and honeycombing due to lack of consolidation, or excess entrapped air voids should be noted.
3) Cracking (whether horizontal, layered, or vertical) should be described.

This information can be summarized in the Bridge Deck Core Record (Appendix D).

Close-up photos of each core with proper identification (including BIN Number) on a card in the photos. They should be taken straight-on, with a scale used as a reference in each shot. In addition to the photos, each core should be documented as follows:

SAMPLE BRIDGE DECK CORE RECORD

Core No.: 1
Depth: 18" full depth, depression in asphalt overlay, underside normal
Overlay: 5" total, two 1" layers of top course over a 3" binder
Wearing Course: 4", total deterioration, steel mesh 1/2" from bottom
Membrane: None
Structural Slab: 9" total, slight 1/8" scaling at top, layered layered cracking through mortar around crushed stone, coarse aggregate in top 3", No. 5 bar top rebar 1-1/2" down shows heavy corrosion; remaining 6" of concrete appears sound, no excess voids, good consolidation, no corrosion on bottom steel, no staining on bottom of core.
Tests: (As Appropriate) Compression: 5000 psi, structural slab. (It not necessary to test each core. This will be determined by the Engineer.)
Freeze-Thaw: NaCl Solution: 3" section of structural slab, 100% loss in 20 cycles.
Air Content: Structural slab 1.2% entrapped, 0.17% entrained.
NOTE: See Appendix E for form to mount core photo along with appropriate documentation description.
E. RECOMMENDATIONS

A recommendation for scope of work should be included based on the engineering evaluation. All recommended repairs should be described with sketches provided for other than routine recommendations.
APPENDIX A. FORMULAS FOR ECONOMIC ANALYSIS

Given a future expenditure of $1, find its value today, n periods earlier at compound interest i. This is the single-payment present worth factor:

\[ SPPWF = \frac{1}{n} \frac{n}{(1 + i)^n} \]

The capital recovery factor CRF is the value of future periodic payments that will recover a present amount of $1 over period n with compound interest i

\[ CRF = \frac{n}{i (1 + i)^n - 1} \]

This is the relationship used to determine size of loan repayments. For example, a 10-year loan of $10,000 at 12% would require annual payments of

\[ 10,000 \times \frac{(0.12)(1 + 0.12)^{10}}{(1 + 0.12)^{10} - 1} = \$1,769.84 \text{ Per Year} \]

This amount can be considered the annual cost of a $10,000 loan.

The uniform series present worth factor is the inverse of the capital recovery factor. It provides the present value of a uniform series of payments of $1 for n periods at compound interest i.

\[ USPWF = \frac{1}{n} \frac{n}{(1 + i)^n - 1} = \frac{CRF}{i (1 + i)} \]

The capital recovery factor and uniform series present worth factor are used to adjust present worth of a treatment to a common time frame (the planning horizon). This is accomplished by calculating annual cost of the treatment over its service life. This annual cost is multiplied by the uniform series present worth factor computed for the desired time period. For example, what is the present worth of a deck treatment that costs $20 /sq ft with a 25-year service life if the planning horizon is 20 years? (Discount rate 4%.)

A1
Step 1

Annual cost is:

\[
\frac{\$20 \times \text{CRF}}{25} = \frac{\$20 \times 25}{(0.04) (1 + 0.04)} = 1.28 \text{ Per Year}
\]

Step 2

The present worth of 20 years of annual payments of 1.28 is

\[
\frac{\$1.28 \times \text{USPWF}}{20} = \frac{1.28 \times [(1 + 0.04)^{-20} - 1]}{(0.04) (1 + 0.04)} = 17.40 \text{ Per Year}
\]
APPENDIX B. EXAMPLE OF DECK EVALUATION/TREATMENT
SELECTION PROCESS

The following examples illustrate comparison of technically suitable rehabilitation alternatives. Costs used are based on average bid prices and are for illustrative purposes only. In practice, prices specific to the job being estimated should be used.

The cost comparison should include all costs associated with deck rehabilitation, including roadway work, M&PT, and mobilization. User costs have not been included in these examples, although they may be significant at high-traffic locations.

Example 1

Assume a 200' long by 32' wide (curb-to-curb) two-course bridge deck is a candidate for a protective overlay of some type. The three possibilities are:

1. Asphalt concrete with membrane.
2. Concrete with select deep removal.
3. Concrete with 100% deep removal.

It has been determined that 50% of the deck area needs deep removal.

To accomplish the work, an alternating one-way traffic scheme has been selected as the appropriate method to maintain traffic. Minimal approach work is required.

Costs of only the overlays or bridge work are as follows:

1. Asphalt Concrete With Membrane
   A. Asphalt Wearing Course Removal.
      (200')(32')(1.34/sq yd) = $8,576
   B. Rebar Exposure
      (6400)(50%)(12.61/sq yd) = $40,352
   C. Slab Reconstruction
      (6400)(50%)(4.89/sq yd) = $15,648
D. Membrane
   \[(6400 \text{ sq yd})(2.07/\text{sq yd})\]  
   \[= \$13,248\]

E. Top Course \((2-1/2\'\)"
   \[(2.5)(6400 \text{ sq yd}) (1 \text{ ton})(\$40/\text{ton})\]  
   \[= \frac{9 \text{ SF/Sq yd}}{(19 \text{ Sq yd})} \]  
   \[= \$3,743\]  
   \[\text{TOTAL} = \$81,567\]

\[\$81,567 = \$12.74/\text{sq yd}\]

6400 Sq ft

2. Concrete With 50\% Deep Removal

A. Asphalt Wearing Course Removal  
   \[= \$8,576\]

B. Scarification  
   \[= \$6,400\]

C. Rebar Exposure  
   \[= \$40,352\]

D. Overlay 6400 \((1.5)(\$4.89)\)  
   \[= \$46,944\]

E. Transverse Saw Cut Grooving  
   \[(6400)(\$.64)\]  
   \[= \$4,096\]  
   \[\text{TOTAL} = \$106,368\]

\[\$106,368 = \$16.62/\text{sq ft}\]

6400 Sq ft

3. Concrete With 100\% Deep Removal

A. Asphalt Wearing Surface Removal  
   \[= \$8,576\]

B. Rebar Exposure \((6400)(\$12.61)\)  
   \[= \$80,704\]

C. Overlay \((6400)(2)(\$4.89)\)  
   \[= \$62,592\]

D. Transverse Saw Cut Grooving  
   \[(6400)(\$.64)\]  
   \[= \$4,096\]  
   \[\text{TOTAL} = \$155,968\]

\[\$155,968 - \$24.37/\text{sq ft}\]

6400 Sq ft

Cost of all roadway work required to adjust the highway approach is $30,000. Included are such items as survey and stakeout, Engineer's office, telephone-answering device, microcomputer, permanent striping, paving, and pavement milling.

Roadway Costs Common To All Overlays

The cost of M\&PT items common to all alternatives are as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>619.01</td>
<td>$20,000</td>
</tr>
<tr>
<td>619.02</td>
<td>$8,000</td>
</tr>
<tr>
<td>619.0502</td>
<td>$15,000</td>
</tr>
<tr>
<td>619.17</td>
<td>$25,000(1000 Lin.Ft.)</td>
</tr>
<tr>
<td>619.13</td>
<td>$25,000</td>
</tr>
<tr>
<td>619.15</td>
<td>$1,500</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>$81,000</strong></td>
</tr>
</tbody>
</table>

It should be noted that duration of the Contract for each alternative in this instance did not significantly alter assessment of Item 619.01 at $20,000.

Mobilization is 4\% of all items in the Contract.
Costs are summarized as follows for each alternative:

<table>
<thead>
<tr>
<th>Alternative (Expected Life)</th>
<th>First Cost (PV) Including Roadway And M&amp;PT And Mobilization (4%)</th>
<th>Total Project Present (22-Year Planning Horizon)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (22 Years)</td>
<td>$ 200,270*</td>
<td>$200,270.</td>
</tr>
<tr>
<td>2 (25 Years)</td>
<td>$ 226,063</td>
<td>$209,120.</td>
</tr>
<tr>
<td>3 (35 Years)</td>
<td>$ 277,647</td>
<td>$214,970.</td>
</tr>
</tbody>
</table>

*NOTE: The cost to overlay Alternative 1 after 11 years has not been included. The $8,850 difference in present worth between Alternatives 1 and 2 is equivalent to a $13,600 expenditure after 11 years. Estimated cost of the overlay, excluding M&PT, exceeds this amount. Alternative 1 is unlikely to be an economical choice if M&PT costs for the eleventh year overlay are considered.

Example 2

Two adjacent interstate bridges over a local road are candidates for protective overlay. Each monolithic deck is 180’ long and 36’ wide curb-to-curb. Possible appropriate treatments are:

1. Concrete Overlay With Select Deep Removal.
2. Concrete Overlay With 100% Deep Removal.

Traffic can be maintained on the structures by phase construction techniques. It has been determined by delamination and potential surveys that 50% of the total area for each deck will require deep removal. Approach work is the minimum required.

Costs of Overlays are as follows:

1. Concrete With 50% DR
   \( (180)(36)(2)(\$15.27) \) = $197,899
2. Concrete With 100% DR
   \( (180)(36)(2)(\$23.03) \) = $298,469

The cost of highway approach work is $75,000, including such items as survey and stakeout, Engineer’s office, telephone-answering device, microcomputer, permanent striping, asphalt paving, and pavement milling.

B3
For both alternatives, M&PT cost us:

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>619.01</td>
<td>$35,000</td>
</tr>
<tr>
<td>619.02</td>
<td>$20,000</td>
</tr>
<tr>
<td>619.03</td>
<td>$6,000</td>
</tr>
<tr>
<td>619.17</td>
<td>$60,000</td>
</tr>
<tr>
<td>619.15</td>
<td>$2,000 (2400 Lin Ft)</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>$123,000</strong></td>
</tr>
</tbody>
</table>

Mobilization is 4% of all items in the Contract.

Costs are summarized as follows for each alternative:

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Present Value (Expected Life)</th>
<th>Total Project Present Including Roadway M&amp;PT And Mobilization Costs</th>
<th>Present Worth (25-Year Life Planning Horizon*)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (25 Years)</td>
<td>$411,735</td>
<td></td>
<td>$411,735</td>
</tr>
<tr>
<td>2 (35 Years)</td>
<td>$516,328</td>
<td></td>
<td>$432,161</td>
</tr>
</tbody>
</table>

* For long service lives the present worth comparison is not strongly influenced by length of time to the planning horizon.
A. Structure Identification

Description: Route 922A, Mohawk Street Over Conrail - BIN 2205910, Town Of Whitestown - Oneida County
Region 2

Reference Marker: 922A-2601-1004

Milepoint: CS011 MP 0.37

State Highway: S.H. 9463, Clinton & Mohawk Streets

Design Criteria: 3R Standards

Project Type: Monolithic Bridge Deck Overlay

B. Introduction

History Of Bridge

The structure is located in the Town of Whitestown in Oneida County and carries Mohawk Street Over Conrail. It was built in 1968 as part of Contract PSC 21998 with a total length of 169’. The structure is a multiple steel simple-span rolled beam girder bridge, composed of three spans with lengths of 46’6", 69’6", and 46’-6" between the bearings. The bridge width is 37.6’ resulting in a total deck area of 6,355 sq ft (37.6’ x 169’). No work has been done on this structure since original construction.

Structural Ratings & Rankings

<table>
<thead>
<tr>
<th>Rating</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Federal Sufficiency</td>
<td>82.0</td>
</tr>
<tr>
<td>Condition Rating</td>
<td>6.203</td>
</tr>
<tr>
<td>General Recommendation</td>
<td>6</td>
</tr>
<tr>
<td>Statewide Priority No.</td>
<td>N/A</td>
</tr>
<tr>
<td>Regional Priority No.</td>
<td>N/A</td>
</tr>
<tr>
<td>Priority Ranking</td>
<td>N/A</td>
</tr>
</tbody>
</table>
Highway Classification

Federal Aid System: Federal Aid Urban System

Functional Classification: Minor Arterial

Traffic Volumes:

<table>
<thead>
<tr>
<th>YEAR</th>
<th>AADT</th>
<th>1-WAY DHV</th>
<th>2-WAY DHV</th>
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<tbody>
<tr>
<td>1991</td>
<td>13,625</td>
<td>820</td>
<td>1,420</td>
</tr>
<tr>
<td>2011</td>
<td>17,700</td>
<td>1,065</td>
<td>1,840</td>
</tr>
<tr>
<td>2021</td>
<td>20,350</td>
<td>1,225</td>
<td>2,120</td>
</tr>
</tbody>
</table>

Maintenance And Protection of Traffic Plan:

M&PT will be achieved by an off-site detour and the bridge bridge will be closed to traffic for the life of the Contract.
FUNCTIONAL/FEDERAL AID MAP

BIN 2205910

NORTH

1" = 2000'

URBAN SYSTEM

<table>
<thead>
<tr>
<th>FEDERAL-AID CLASSIFICATION</th>
<th>FUNCTIONAL CLASSIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>FA Interstate (I)</td>
<td>Interstate</td>
</tr>
<tr>
<td>FA Primary (P)</td>
<td>Principal Arterial (Expressway)</td>
</tr>
<tr>
<td>FA Urban System (U)</td>
<td>Connecting Link</td>
</tr>
<tr>
<td></td>
<td>Non-connecting Link</td>
</tr>
<tr>
<td>FA Primary (P)</td>
<td>Principal Arterial (Street)</td>
</tr>
<tr>
<td>FA Urban System (U)</td>
<td>Connecting Link</td>
</tr>
<tr>
<td></td>
<td>Non-connecting Link</td>
</tr>
<tr>
<td>FA Urban System (U)</td>
<td>Minor Arterial</td>
</tr>
<tr>
<td>FA Urban System (U)</td>
<td>Collector</td>
</tr>
<tr>
<td>Non-system</td>
<td>Local</td>
</tr>
</tbody>
</table>

*Includes only urban collectors with FAUS identification

Federal-Aid Urban Boundary
C. DECK INSPECTION FINDINGS
UNDERSIDE
DECK CONDITION

No damp areas
No efflorescence

See Fig. #DC-5 for details

STATE OF NEW YORK
DEPARTMENT OF TRANSPORT

DECK CONDITION SI

Drawn 6/27/70

SPAN 1

<table>
<thead>
<tr>
<th>Area</th>
<th>Quantity (%)</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demolition</td>
<td>0%</td>
<td></td>
</tr>
<tr>
<td>Area of Patch</td>
<td>0%</td>
<td></td>
</tr>
<tr>
<td>Area of Ball</td>
<td>0%</td>
<td></td>
</tr>
<tr>
<td>Cracks</td>
<td>&lt;1%</td>
<td></td>
</tr>
</tbody>
</table>

UNDERSIDE DECK CONDITION

SPAN 2

No damp areas
No efflorescence

See Doc. #DC-5 for Details
PHOTOGRAPHS
### Bridge Inspection and Condition Report

**Feature Carried:** RTE. 922A (Mollusk St.)  
**Feature Crossed:** CONRAIL  
**Location:** P, E  
**Description:** Feature crossed: CONRAIL  
**Date:** 08/22/89

<table>
<thead>
<tr>
<th>Photo No.</th>
<th>Location</th>
<th>Description</th>
<th>References</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>REG. ABUT. SLOPE</td>
<td>PROTECTION</td>
<td>TP 349 32 EROSION</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>Span #2, Mono Deck</td>
<td>Surface</td>
<td>TP 350 20 Mono Deck</td>
<td>4</td>
</tr>
</tbody>
</table>

**References:**
- TP 349 32: Erosion
- TP 350 20: Mono Deck
<table>
<thead>
<tr>
<th>Photo No.</th>
<th>Location</th>
<th>Description</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>SPAN #3, BAY #1, LT. FASCIA BEAM</td>
<td>PAINT 5% DETER. w/ CORROSION</td>
<td>TP 350 [22] PAINT RATED 4</td>
</tr>
<tr>
<td>4</td>
<td>JOINT ABOVE PIER #1</td>
<td>JOINT MATERIAL DETER.</td>
<td>TP 350 [33] JOINT RATED 4</td>
</tr>
<tr>
<td>Location</td>
<td>Description</td>
<td>References</td>
<td></td>
</tr>
<tr>
<td>----------------</td>
<td>---------------------------------------</td>
<td>------------</td>
<td></td>
</tr>
<tr>
<td>BEGINNING APPROACH</td>
<td>GENERAL CONFIGURATION</td>
<td>NONE</td>
<td></td>
</tr>
<tr>
<td>TOP OF BRIDGE - TYPICAL</td>
<td>GENERAL CONFIGURATION</td>
<td>NONE</td>
<td></td>
</tr>
<tr>
<td>Photo No.</td>
<td>Location</td>
<td>Description</td>
<td>References</td>
</tr>
<tr>
<td>----------</td>
<td>----------------</td>
<td>---------------------------</td>
<td>------------</td>
</tr>
<tr>
<td>3</td>
<td>END APPROACH</td>
<td>GENERAL CONFIGURATION</td>
<td>None</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>RIGHT ELEVATION</td>
<td>GENERAL CONFIGURATION</td>
<td>NONE</td>
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<tr>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>
Location: UNDERBRIDGE SPAN 2
Description: GENERAL CONFIGURATION
References: NONE

Location: UNDERDECK SPAN 2
Description: GENERAL CONFIGURATION
References: NONE
B R I D G E  I N S P E C T I O N  A N D  C O N D I T I O N  R E P O R T

FEATURE CARRIED: 922A

FEATURE CROSSED: CONRAIL

DATE 10/3/85

Photo No. 9

Location SPAN 1 JOINT - TOP

Description MINOR LEAKAGE BELOW

HEADER CRACKED & SPOOLED

References TP 250 B31 JOINT RATED 4 SPAN 1

Photo No. 10

Location BEGINNING APARTMENT

Description EMBANKMENT BLOCKS DISPLACED

References TP 249 331 EROS RATED 4
Photo No. 11

Location  SPAN 3 LEFT FASCIA GIRDERS

Description  TYPICAL FASCIA PAINT CONDITION

References  TP 250 [22] PAINT RATED 4 ALL SPANS
### New York State Department of Transportation

**Bridge Inspection and Condition Report**

**Date:** 08/22/89

**Inspected By:** John E. Bank

**Title:** C.E.

**R/C Code:** 26

**Bridge ID Number:** 2205910

**Ramp Bridge Attached to Span:** Bin

**Inspection Agency:** 10

**Type of Inspection:** 1-Biennial 3-In Depth 5-Special

**Region:** 2

**County:** Oneida

**Polit. Unit:** Whitesboro

**State Hwy No.:** 9463

**Milepoint:** 0000000

**Feature Carried:** 922A922A 2G011003

**Bridge Type:** Steel

**Stringer/Mult-Beam or Girder:**

### Vertical Clearance and Load Postings

<table>
<thead>
<tr>
<th>Abutments</th>
<th>Begin</th>
<th>End</th>
</tr>
</thead>
<tbody>
<tr>
<td>Joint with Deck</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Bearings, Anchor Bolts, Pads</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Bridge Seat &amp; Pedestals</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Backwall</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Stem/Breastwall</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Erosion or Scour</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Footings &amp; Piles</td>
<td>9</td>
<td>9</td>
</tr>
</tbody>
</table>

**Recommendation:** 7 7

### Approach Bridges:

<table>
<thead>
<tr>
<th>Approach Bridges</th>
<th>Begin</th>
<th>End</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drainage</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Erosion &amp; Scour</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Erosion</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Channel Siltation</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Bank Protection</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Guide Railing</td>
<td>6</td>
<td></td>
</tr>
</tbody>
</table>

**General Recommendation:** 6

### Repair

<table>
<thead>
<tr>
<th>Repair Necessary</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete Deck H15 (CY)</td>
<td></td>
</tr>
<tr>
<td>Deck Repair HS1 (SF)</td>
<td></td>
</tr>
<tr>
<td>Joint Repair HS3 (LF)</td>
<td></td>
</tr>
<tr>
<td>Replace Wearing Surface HS9 (SF)</td>
<td></td>
</tr>
<tr>
<td>Curb &amp; Fascia Repair HS1 (LF)</td>
<td></td>
</tr>
<tr>
<td>Fix Sidewalk HS3 (SF)</td>
<td></td>
</tr>
<tr>
<td>Repair Railing HS5 (LF)</td>
<td></td>
</tr>
<tr>
<td>Paint Steel HS1 (Gal)</td>
<td></td>
</tr>
<tr>
<td>Sandblast H2 (Bags)</td>
<td></td>
</tr>
</tbody>
</table>

### Remarks:

- **Critical Welds @ Ends of Cover Plates on Span # 2 Were Inspected
- "100% Hands-On" And Are Okay
### Remarks

See continuation sheet
BIN #: 2205910

INSPECTION TEAM: TEAM LEADER: J. Bron K
ASS'T. TEAM LEADER: M. Ge Aso
OTHER PERSONNEL: D. Paciello, R. Bell

DATE: 08/22/89
TIME ARRIVED: 7:10 AM
TIME LEFT: 1:45 PM
WEATHER: CLOUDY ± 70°

TYPE OF INSPECTION: B

(INSPCTION ACCESS) CHECK EQUIPMENT USED:

<table>
<thead>
<tr>
<th>UB1U</th>
<th>SCAFFOLDING</th>
<th>BUCKET TRUCK</th>
<th>LADDER</th>
<th>WALKING</th>
<th>BOAT</th>
<th>OTHER</th>
</tr>
</thead>
<tbody>
<tr>
<td>✔</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

COMMENTS:
No problem completing inspection. Used UB1U to inspect Per #1 & critical cover plate welds near Per #1. Used bucket for Per #2 & critical welds @ ends of cover plates near Per #2. Critical welds are only on span #2 and they are okay. Completed inspection. We were later told that wires believed to be power were actually communications. Could have used ladder instead of UB1U.
CONTINUED FROM TP 349


CONTINUED FROM TP 350


TP 350 [32] PAINT SYSTEM ON SPAN #3 IS 55% DETERIORATED W/ CORROSION ALONG TOP FLANGES @ VARIOUS LOCATIONS. SEE PHOTO #3 (1989) PAINT DETER. IS LESS THAN 5% ON SPANS #1 & 2

TP 350 [33] SPAN #1 JOINT MATERIAL IS DETERIORATED. (TORN, DEFORMED, BURIED SEAL) SEE PHOTO #4 (1989)
Bridge Inspection and Condition Report

Feature Carried: RTE. 922A
Feature Crossed: Conrail

Inspected By: [Signature]
Title: TL
Date: 08/22/89

Not to Scale

Numbers represent longitudinal coordinates of grid pattern as found at bridge on this date. Sounding were taken at all locations marked on pavement as marks of grid for apparent deck survey.

ثلث represent approximate locations where hollow sounding (reductions) of deck was made.

[] Indicate approximate locations of patches

[] Indicate spalls (all & l/sf)
D. DECK CORE EVALUATION AND TEST RESULTS
<table>
<thead>
<tr>
<th>CORE NO.</th>
<th>LOCATION</th>
<th>DEPTH OF COVER</th>
<th>DELAMINATION</th>
<th>CORROSION POTENTIAL</th>
<th>STEEL CORROSION</th>
<th>CRACKS</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>130' 12'</td>
<td>2&quot; 2&quot;</td>
<td>No No</td>
<td>.30</td>
<td>Light</td>
<td>None</td>
<td>Span #3, Core Intact</td>
</tr>
<tr>
<td>2</td>
<td>72' 18'</td>
<td>2&quot; 18&quot;</td>
<td>No No</td>
<td>.35</td>
<td>Medium</td>
<td>None</td>
<td>Span #2, Core Intact</td>
</tr>
<tr>
<td>3</td>
<td>37' 9'</td>
<td>2 5/8&quot; 2&quot;</td>
<td>No No</td>
<td>.19</td>
<td>None</td>
<td>None</td>
<td>Span #1, Core Intact</td>
</tr>
<tr>
<td>4</td>
<td>144' 28'</td>
<td>2 7/8&quot; 2&quot;</td>
<td>No No</td>
<td>.18</td>
<td>None</td>
<td>None</td>
<td>Span #3, Core Intact</td>
</tr>
<tr>
<td>5</td>
<td>79' 23'</td>
<td>1 7/8&quot; 1 3/4&quot;</td>
<td>No No</td>
<td>.31</td>
<td>Medium</td>
<td>None</td>
<td>Span #2, Core Intact</td>
</tr>
<tr>
<td>6</td>
<td>6' 29'</td>
<td>2 5/8&quot; 1 3/4&quot;</td>
<td>No No</td>
<td>.30</td>
<td>Light</td>
<td>None</td>
<td>Span #1, Core Intact</td>
</tr>
</tbody>
</table>
FEATURE CARRIED  Route 922A

FEATURE CROSSED  Conrail

B.I.N.  2205910  Core # 1
Dated Cored  9/25/90

P.I.N.  275217

Total Depth

Core

6 ½"  Sound Concrete

NA  Vertical Crack

Light Rust on Top

Steel: air-entrained
good

Severe voids, concrete appears sound

Disintegrated  partially  entirely

Horizontal cracking  light  severe

Top 2" Bit 6½" Rebars: measured from top

Wearing Deck:  Sound Concrete

Good

Concrete Bond to reinforcement  X  good  bad

Horizontally Cracking  light  severe

Disintegrated  partially  entirely

Bituminous Surface  good  bad

Core Hole Location:

Span #  3
Direction  EB
Lane  1

Distance & Offset:

OA  10'  OB  12'

---

RESULTS

54/96  62/28

(Circle one) TEST REQUESTED

Compression Freeze thaw High Pressure Air None

C29
FEATURE CARRIED Route 922A  
B.I.N. 2205910  Core # 2
Dated Cored 9/25/90

FEATURE CROSSED Conrail  
P.I.N. 2752.17

Core # 2
Total Depth 6 7/8"
STRUCTURAL SLAB: 6 7/8" Sound Concrete  
Depth to bottom steel: 1/4
Concrete sound: 1/2

REMARKS:
Disintegrated: partially
Horizontal cracking: light
Lightly disintegrated
Mild cracking

Sound:
Bituminous Surface:good
Concrete Bond to reinforcement: good

Core Hole Location:
Span # 2
Direction EB
Lane 1
Distance & Offset:
North 48'
West 18'

RESULTS
(Circle One)
Compressed
Freeze Thaw
High Pressure Air
None

0%
FEATURE CARRIED: Route 922A

B.I.N.: 2205910  Core #: 3
Dated Cored: 9/15/90

FEATURE CROSSED: Conrail

P.I.N.: 275217  Total Depth: 6''

REMARKS:

- No visible rust on top
- No steel or entrainment
- Good couple of voids
- Core concrete sound

- Structural Slab: 6'' Sound Concrete
- Horizontal cracking: Light
- Disintegrated: Partially
- 2'' Top: Sound
- Rebars: Measured from top
- Conc. Bond to reinforcement: X Good

WEARING DECK:
- Sound Concrete
- Horizontal cracking: Light
- Disintegrated: Partially
- Bituminous Surface: Good

Core Hole Location:

Span #: 1  Direction: EB
Lane: 1

Distance & Offset: 

- N/A: 37'  O/V: 9'

RESULTS:

Compressional: X
Freeze thaw: 
High Pressure Air: 
None

(Circle one)

TEST REQUESTED:

- 0%
Core Hole Location:
Span # 3
Direction W B
Lane 1
Distance & Offset:
X 25' Y 10'

FEATURE CARRIED Route 922A
B.I.N. 2205910 Core # 4 P.I.N. 2752.17
Dated Cored 9/26/90

RESULTS
5.872 lbs
6.685 lbs

(Circle One)
Compression Freeze thaw
High Pressure Air
None

FEATURE CROSSED Conrail

REMARKS:
Air entrainment fair to good, numerous voids in concrete appears sound
No rust on top rebar

Sound Concrete

Horizontal cracking light severe
Disintegrated partially entirely

2" Top, 5/8" But Rebars: measured from top

Conc. Bond to reinforcement good

WEARING DECK: Sound Concrete

Horizontal cracking light severe
Disintegrated partially entirely

Bituminous Surface good bad

TOTAL DEPTH 6 3/4"
STRUCTURAL SLAB; 6 3/4" Sound Concrete

CORE #: 4 E.B.
I-90/I-95 SPUR
BIN: 1-09258-9

C32
FEATURE CARRIED  Route 922A  

B.I.N.  2205910  Core # 5  
Dated Cored  9/26/90  

FEATURE CROSSED  Conrail  

P.I.N.  2752.17  
Total Depth  
6 1/2"  

STRUCTURAL SLAB:  6 1/2"  Sound Concrete  

Horizontal cracking  light  severe  
Disintegrated  partially  entirely  
1 3/4" Top  Rebars: measured from top  
Good  

Conc. Bond to reinforcement  X  good  bad  

WEARING DECK:  ________  Sound Concrete  

Horizontal cracking  light  severe  
Disintegrated  partially  entirely  
Bituminous Surface  good  bad  

Core Hole Location:  
Span # 2  
Direction (W)B  
Lane 1  

Distance & Offset:  
X (A) 41'  Y (B) 15'  

RESULTS  
G120  5.9%  

(Circle One)  
TEST REQUESTED  Compression  Freeze thaw  High Pressure Air  None  

C33
FEATURE CARRIED: Bottle 922A

B.I.N. 2205910
Core # 6
Dated Cored 9/26/90

REMARKS:
Depth to bottom steel: unknown
Light rust on top steel, air entrapment
Mush of voids, concrete appears sound

Core Hole Location:
Span # 1
Direction WB
Lane 1

Distance & Offset:
XA 43' WB 9'

FEATURE CROSSED: Conrail

P.I.N. 275217

Total Depth
6½”
STRUCTURAL SLAB: 6½” Sound Concrete

Horizontal cracking: light ______ severe ______
Disintegrated: partially ______ entirely ______
12" Top: Rebars: measured from top
Good
Conc. Bond to reinforcement: X good____ bad____
WEARING DECK: ______ Sound Concrete

Horizontal cracking: light ______ severe ______
Disintegrated: partially ______ entirely ______
Bituminous Surface: ______ good____ bad____

RESULTS

(Circle One) COMPRESSION
FREEZE THAW
HIGH PRESSURE AIR
NONE

CORE #6 E.B.
I-90/ CONRAIL
SPUR
BIN 1-09258-9

C 34
E. Recommendations

The total damaged area (the sum of non-overlapping areas of spalls, delaminations, and half-cell potentials greater than 0.35 v, is approximately 50% of the total deck area. The sum of the medium potential areas (0.15 to 0.34 v) is about 40% of the total deck area. Most of these areas are small rectangular islands or long, narrow strips, except on Span 1 which has a larger area (400 sq ft) in the westbound lane with medium potential values. The small rectangular islands and long narrow strips with medium potential values should be included in the total removal area to eliminate the possibility of premature corrosion and subsequent overlay failure. In addition, corrosion will continue, leading to more delamination and spalling. This will increase the total damaged area before construction. Thus, we recommend 100% deep removal and replacement with a concrete overlay. This alternative will result in the longest, most cost effective repair for this structure.

The scope of work is thus to expose rebars 100%, overlay with a specialized concrete overlay, raise approaches to meet the new deck surface, install new armored joints at the approaches, and paint the structural steel.

Total estimated cost of this alternative is $0.345M.
APPENDIX D

BRIDGE DECK CORE RECORD
NEW YORK STATE
DEPARTMENT OF TRANSPORTATION
MATERIALS BUREAU

BRIDGE DECK CORE RECORD

RT# ___________________________ OVER ___________________________ DATE ___________________________
BIN# ___________________________ REGION ___________________________
COUNTY ___________________________ FILLED OUT BY ___________________________

<table>
<thead>
<tr>
<th>CORE NO.</th>
<th>LOCATION</th>
<th>DEPTH OF COVER</th>
<th>DELAMINATION</th>
<th>CORROSION PREFERRED</th>
<th>STEEL CORROSION</th>
<th>CRACKS</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LONG.</td>
<td>TRANS.</td>
<td>PACH.</td>
<td>CHAIN DRAG</td>
<td>CORE EXAM.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>003</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
APPENDIX E

DECK CORE EVALUATION FORM
FEATURE CARRIED

FEATURE CROSSED

B.I.N. _______________ Core # _______________ P.I.N. _______________

Dated Cored _______________

REMARKS:

Core Hole Location:

Span # _______________

Direction _______________

Lane _______________

Distance & Offset:

X/A _____ Y/B _____

Total Depth

STRUCTURAL SLAB; _______ Sound Concrete

Horizontal cracking ______ light ______ severe

Disintegrated ______ partially ______ entirely

Rebars: measured from top

Conc. Bond to reinforcement _______ good _______ bad

WEARING DECK; _______ Sound Concrete

Horizontal cracking ______ light ______ severe

Disintegrated ______ partially ______ entirely

Bituminous Surface ______ good ______ bad

Test Requested

(Circle One)

Compression

Freeze thaw

High Pressure Air

None

Top of pavement this end

E3