Preventive Measures for Obtaining Scale-Free Concrete Bridge Structures

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The problem of scaling and subsequent deterioration of concrete highway bridge superstructure elements has become a major concern to highway engineers, especially in the northern states. This paper deals primarily with adherence to proven control procedures as a logical approach to the realization of scale-free structures.

The subject is divided into (a) preventive measures before construction, (b) preventive measures during construction, and (c) preventive measures after construction. Essential factors related to design, construction, or maintenance practices are presented, based on experience obtained from many years of field study and laboratory research by the Michigan State Highway Department.

The problem appears to be one of strict adherence to specification requirements and the elimination of construction irregularities through proper control procedures. To accomplish these objectives, there must be closer coordination between the engineer and the contractor. In addition, greater effort must be made by highway departments to train contractors' men, state inspection personnel, and transit-mix operators in the fundamentals of the problem. Finally, it may be necessary to require higher prequalifications for contractors and even to impose strong penalties on contractors who consistently produce structures that scale.

• **THIS REPORT** deals with the prevention of concrete scaling common to highway bridge decks and other superstructure elements constructed with air-entrained concrete.

The term "scaling of concrete" refers here in particular to forms of concrete surface disfiguration manifested by surface laitance scale, mass pitting of small aggregate particles, and localized areas of deep disintegration.

Most of the scaling on bridge superstructures develops in curb faces, sidewalk sections, concrete railing posts, dividing strips, gutter areas, and only occasionally in the deck slab in the traffic lanes. Further, the scale pattern in most cases is generally sporadic rather than continuous. Any of these scaling manifestations may be accelerated in various configurations by frost action in the presence of de-icing chemicals. However, scaling often occurs without the presence of de-icing chemicals when concrete conditions are conducive.

The problem of concrete scaling is not new to highway engineers. During the 1930's, highway engineers were vitally concerned with the problem of concrete scaling on pavements and structures. This phenomenon became more serious in northern states as the use of de-icing chemicals increased, especially after World War II.

The seriousness of the situation eventually led to a concerted program of research in which many agencies participated through laboratory research and the construction of independent test pavements. The outstanding results of this early research were the discovery of the principle of air entrainment and the subsequent application of this principle to concrete construction practice for the purpose of creating more durable pavements. Although these researches established beyond any possibility of doubt the benefit of air entrainment in improving the resistance of concrete to scaling, bridge designers were reluctant to accept the use of air entrainment until several years later.

Experience with air-entrained concrete in bridge deck construction over the past 15 years has been less successful than in the case of highway pavements. This may be attributed to several factors inherent in the construction of bridges as compared to pavements:

1. Bridges are usually built in segments involving complicated form work containing bar reinforcement of different sizes, shapes, and patterns, all of which add to the complexity of obtaining uniform concrete throughout any one section.
2. Handling, finishing, and curing operations are done largely by hand labor.
3. Bridge concrete is either manufactured in the contractor's plant on the site, which is not necessarily a continuous process, or furnished by transit-mix operators, giving rise to recognized control difficulties.
4. Finally, because of snow removal difficulties, bridge decks, and bridge sidewalks in particular, are subject to continuing deposits of snow and ice containing de-icing chemicals, more severe than on pavements.

All these factors create a situation within any one structure calling for not only vigilant inspection and rigid enforcement of specification requirements but also administrative support of the project engineer and his inspection staff. On the other hand, the contractor and his men must have the willingness to follow the specifications and perform good workmanship in all phases of the job.

The construction of sound, scale-free concrete pavements is now an accomplished fact. It is based on following fundamental principles:

1. Design and construction practices should insure proper transverse and longitudinal drainage and a minimum of seepage through expansion and contraction joints.
2. Concrete should contain the proper amount of entrained air, uniformly dispersed.
3. Proper control and inspection should be provided throughout the manufacturing, handling, placing, finishing, and curing of the concrete to insure a uniform product.
4. Only the best available aggregates should be used in the concrete.
5. Winter and summer maintenance should be adequate for prevention of undue accumulations of snow and ice in winter, and dirt-clogged gutters at all times, both of which tend to retain considerable quantities of de-icing chemicals.
6. De-icing chemicals should not be applied to the structure until concrete has had sufficient time to cure properly.

The results of many surveys of scaled bridges in Michigan clearly indicate that concrete weaknesses conducive to subsequent scaling and surface deterioration are for the most part built into the structure at time of construction due to violations of one or more of these basic principles.

It is believed that many of the factors responsible for the various types of concrete deterioration encountered in older structures are gradually being eliminated through automation, improved personnel training programs, and recent changes in design and construction practices.

Studies still reveal, however, that the most outstanding cause of sporadic deterioration of concrete in various parts of modern air-entrained concrete structures is the use of concrete of variable quality resulting from construction irregularities. Possible solutions to the problem of eliminating this major source of scaling are discussed in the following sections.

PREVENTIVE MEASURES BEFORE CONSTRUCTION

Design and Specifications

Bridge structures vary widely in details of design and in erection problems. The starting point then is a good design and adequate specifications. Essential design features for satisfactory concrete performance include the following:

1. Providing sufficient grade, deck camber, and crown to insure that the contractor can construct the necessary longitudinal and transverse deck profile to permit adequate drainage of deck water;

2. Eliminating or reducing to a minimum such concrete superstructure elements as sidewalks, curbs, and rail posts;
3. Reducing transverse joints to a minimum to prevent water seepage onto beams and substructures;
4. Providing adequate gutter drainage systems to remove deck water quickly away from substructure elements;
5. Including adequate waterstop design at construction joints to prevent water seepage into the bridge structure; and
6. Providing ample concrete coverage for deck reinforcing steel.

Among other things, the specifications should specifically provide for the following:

1. Air entrainment;
2. Sound aggregates with an absolute minimum of deleterious particles susceptible to frost action;
3. Automatic batching of concrete material;
4. Absolute control over transit-mix concrete; and
5. Satisfactory curing and adequate protection during both high and low temperature concreting.

Prequalification of the Contractor and Control of Materials

All bidders should be prequalified as evidence that they possess the competence and capability of performing the work on which they bid. Certified statements should set forth fully the financial resources; adequacy of plant, equipment, and organization; prior experience; and such other pertinent and material facts as may be desirable.

Upon award of the contract, the contractor should be required to furnish complete information on source of all materials to be used in the work. The materials must be approved by the state or authorized testing agencies as being satisfactory for use. Once approved, the source of material supply should not be changed unless it cannot possibly be avoided. Also, the use of several aggregate sources or cement sources in one structure should not be condoned. Such material changes usually require changes in mix design and batching procedures which, if not carefully controlled, can result in concrete of different quality in the same structure.

Cooperation Between Engineer and Contractor

Understanding and cooperation on the parts of the design engineer, construction engineer, and contractor at all times are essential to a scale-free job. To this end, a conference between the construction engineer and contractor should be held before starting of the project to determine such important factors as the following:

1. Construction procedures and progress;
2. Adequacy of contractor's equipment and men for job at hand;
3. Handling of material supplies and source of concrete in case of transit-mix; and
4. Date of completion in relation to local weather conditions to determine necessity for low temperature protection of concrete during placing or from de-icing chemicals.

Air Entrainment

The principle of air entrainment is now universally accepted and widely used in concrete practice. Excellent sources of authoritative information are available concerning the design and control of air-entrained concrete. Evidence supports the use of air-entrained concrete in bridge structures. However, air entrainment does not eliminate the need for good aggregates, proper mix design, or sound construction practice.

Under normal design conditions, the air content generally specified falls between 4 and 7 percent of the volume of the concrete, with performance toward the upper limit. However, in the case of bridge decks, sidewalks, and curb sections, where strength is not a load design factor, perhaps a higher air content could be specified to give added assurance against scaling. Further, the current trend toward use of aggregate of smaller maximum size will naturally call for higher air content because of the increased proportion of mortar in such cases.

Because the manufacture of air-entrained concrete involves many variables, including materials, design, and mixing conditions, the measurement of air content and control of air entrainment within specified limits are of the utmost importance. Some of the more important variables affecting the amount and distribution in the resulting hardened concrete are (a) amount and type of air-entraining agent, (b) water-cement ratio, (c) consistency of mix, (d) mix time and method, (e) mix temperature, (f) type and grading of aggregate (g) compaction and vibration in placing, (h) the use of calcium chloride, and (i) set-retarding or water-reducing admixtures. The type and amount of air-entraining agent, in large measure, determine the total percent entrained air, the specific surface, and the spacing factor of the air-void system.

In continuous mixing operations the more important variables, as far as air entrainment is concerned, are the amount of air-entraining agent, the mixing time, and the consistency. This assumes, of course, that close control at the batching plant is being exercised in maintaining the right amounts of materials. With more and more automatic equipment being used both in batching and the mixing-placing phases of concrete construction, the only positive way of controlling quality, and in particular, proper air entrainment, is continual close inspection and maintenance of the equipment. A good share of the trouble in obtaining specified air contents in fresh concrete is due to improper functioning of automatic or manual dispensers of air-entraining agent.

Aggregate Materials

Sound aggregates, coarse and fine, are necessary prerequisites for scale-free concrete. Air entrainment will not compensate for inferior materials.

Typical examples of surface pitting and popouts in air-entrained concrete, caused by materials with high percentages of poor aggregate constituents, such as shale, chert, and soft or hard absorbent particles, are shown in Figures 1 and 2.

Michigan specifies gravel, stone, and slag coarse aggregate materials for bridge superstructure construction. The total amount of deleterious particles is held to a maximum of 3 percent. In the case of gravel, the allowable percentage of chert or hard absorbent particles may be increased, provided the combination of soft particles, chert, and hard absorbent particles does not exceed the maximum of 3 percent.

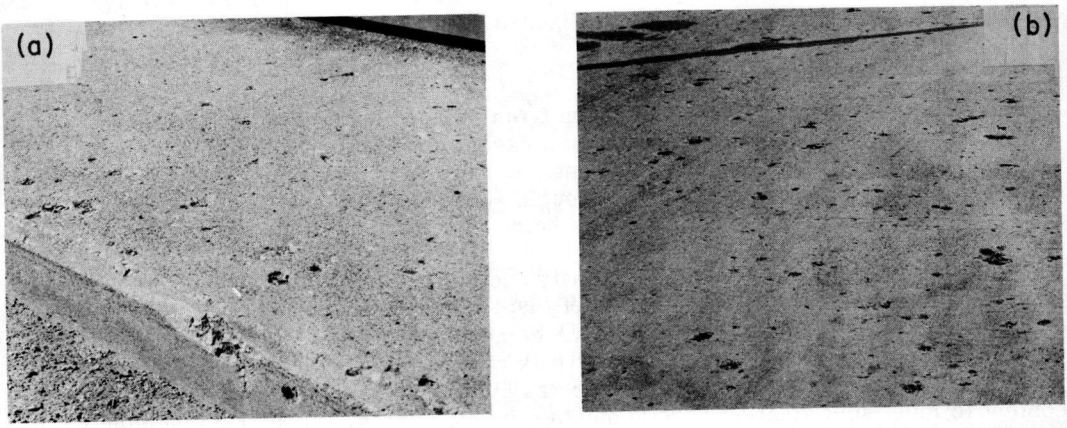


Figure 1. Popouts due to inferior particles of coarse aggregate with surrounding air-entrained concrete surfaces generally sound. Project at left included air-entrained sidewalk only; non-air-entrained deck was later resurfaced with bituminous concrete. (a) Built 1941, photographed 1959 (18 winters). (b) Built 1947, photographed 1959 (12 winters).

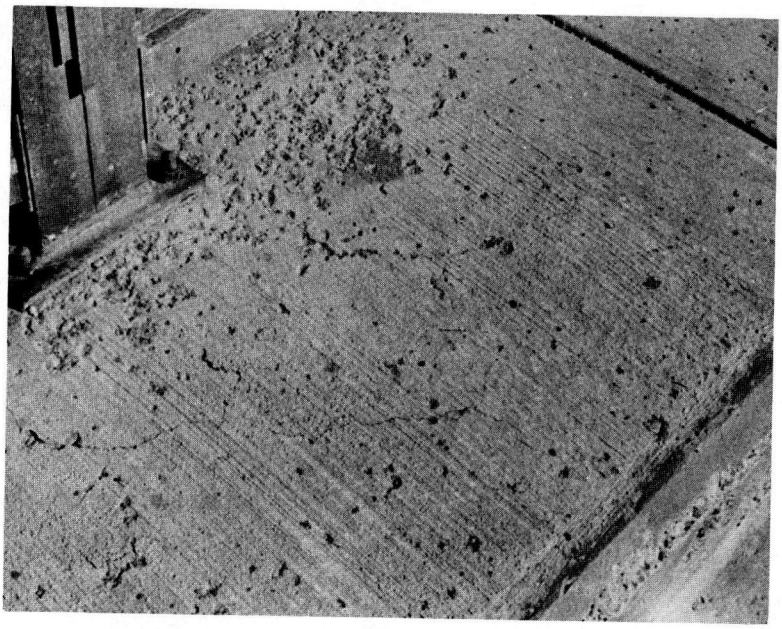


Figure 2. Fine pitting with scaling due to inferior particles of fine aggregate. Built 1955, photographed 1956 (1 winter).

PREVENTIVE MEASURES DURING CONSTRUCTION

Proper control of all concreting operations is imperative. Any relaxation in control procedures invariably leads to some surface disfiguration as defined under scaling in this report. Scaling due to construction irregularities has been traced to five major causes: (a) insufficient air content, (b) variable quality of concrete batches, (c) unsound aggregate particles, (d) using excess water in the concrete for added workability, and (f) lack of protection during cold weather operations.

With reference to the first major cause of scaling, there is always the possibility that concreting operations may unbalance the proper size and distribution relationship of the air-void system, thus decreasing the ability of the entrained air to impart scale resistance to the concrete. Typical examples of scaling caused by known irregularities in construction practices are shown in Figures 3 through 14.

Control of Entrained Air

Invariably, air contents of cores taken from scaled areas have been found to be below specification limits, whereas cores from adjacent good areas have had air contents well above the minimum specified percent. Occasional air checks during deck pours, daily or at greater intervals, are not enough. Sufficient air checks should be made to make sure that the correct air content is being maintained uniformly throughout each complete pour.

Variation in air content, both in quantity and uniformity, from batch to batch or pour to pour may be due to malfunction of dispensing equipment, to variation in percentage of air-entraining agent in Type 1A cement, or to other factors known to affect the efficacy of the air-entraining agent. It is often necessary when using Type 1A cement to make small additions of an air-entraining agent at the mixer to boost the air content to meet specification requirements. In such cases, air-entraining agents should be added to the batch materials through approved dispenser devices and not directly to the batch by hand. Dispensing devices should be checked often to detect collection of sediment and clogging of the opening which affect the discharge rate.

Type 1A cement is used in place of non-air-entraining cements because of the added safety factor in providing a minimum of air content in case of malfunction of admixture-dispensing equipment.

Figure 3. Variable condition of concrete in three deck lanes due to differing mix quality. Built 1955, photographed 1957 (2 winters).

Figure 4. Variable condition of concrete in adjacent pours--poor surface in foreground resulted from overwatering the mix and improper finishing (air content by coring: 3.5 percent), with better concrete in background (air content by coring: 6.5 percent). Built 1957, photographed 1960 (3 winters).

Generally, concrete supplied through a transit-mix contract is more difficult to control than that produced on the site by the contractor's men and equipment. In the case of transit-mix concrete, each batch should be checked for proper air content. Limited use of central-mix concrete indicates it is more satsifactory than transit-mix.

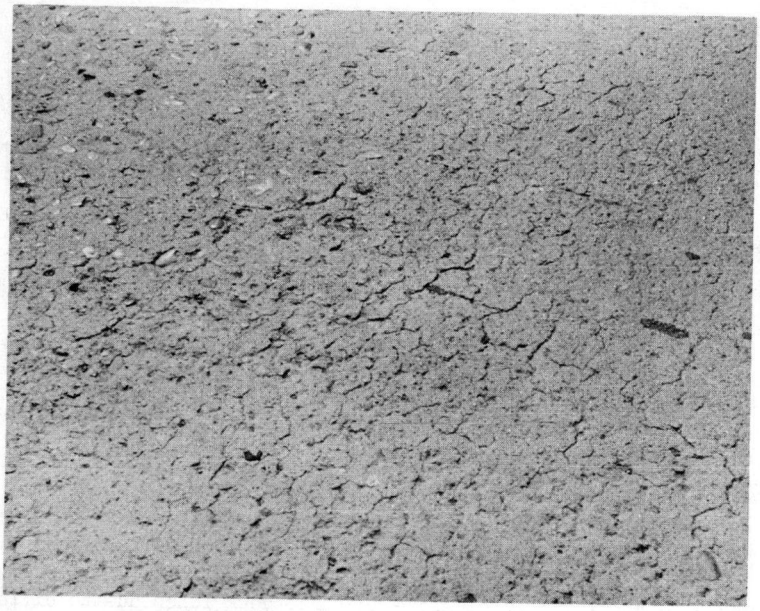


Figure 5. "Crazing" or "hair checking" resulting from inferior concrete (air content by coring: 2.1 percent). Built 1955, photographed 1956 (1 winter).

Figure 6. Scaling along curb face due to weak mortar layer against curb form, probably accelerated by de-icing salts. Built 1957, photographed 1959 (2 winters).

Figure 7. Disfiguration due to faulty pouring and finishing operations (air content by coring: 3.1 percent). Built, 1957, photographed 1960 (3 winters).

Figure 8. Light laitance scale along curb, probably due to overfinishing or to sprinkling water on surface to aid finishing (air content by coring: 4.1 percent). Built 1957, photographed 1960 (3 winters).

Control of Concreting Operations

In addition to air control, examples of scaled concrete are abundant where deterioration can be traced to irregularities in concreting operations associated with one or more of the other five categories previously outlined.

Major surface disfigurations are generally caused by variations in concrete quality in occasional batches, mostly related to variations in aggregate gradation in batching and mixing operations, segregation due to overvibration, overwatering, or changes in quality of materials. These factors may be controlled by rigid inspection.

Small unsound aggregate particles are a potential source of scale when they occur in sufficient number and concentration. Under vibration they tend to migrate in mass to the face of a concrete element. In this exposed state, the particles deteriorate under freeze-thaw action to produce sporadic light scale, particularly along curb faces and on sidewalk surfaces. Unsound coarse aggregate particles that come to the surface generally pop out, but in such a pattern that the surface is not seriously disfigured. The use of sound aggregates will solve this problem.

The failure of thin mortar films and patching mixtures is another source of scaling. Such treatments by the contractor to cover up the results of faulty finishing should be eliminated by rigid inspection during concreting operations.

The ever-persisting tendency of workmen to add excess water to the mixture to gain added workability is no doubt responsible for high water content, due to localized water gain, at tops of abutments and piers, in handrail posts, and at joints. Examination of cores indicates that such conditions result in a loss of air near the surface with a corresponding increase in the tendency for development of scale.

A possible method of increasing durability of the top surfaces of deep structural members is building up the concrete slightly higher than the finished dimension and striking off to the proper height when bleeding is over. This procedure eliminates the weak top layer formed with excess water, and is required by Michigan in all bridge construction.

The practice of sprinkling water on the concrete surface to facilitate finishing should not be permitted because of the surface laitance formed by such operations.

Figure 9. "Birdbath" at gutter caused by improper construction practices. Built 1957, photographed 1960 (3 winters).

Figure 10. Result of contractor trying to correct a faulty area by patching. Built 1957, photographed 1960 (3 winters).

Low temperatures during concreting operations and concrete surface deterioration go hand in hand unless proper curing and freezing protection are provided by the contractor. Under the pressure of meeting modern deadlines it sometimes becomes necessary to complete final concrete operations during late fall or even during winter months. On such occasions the contractor may violate specifications by permitting fresh deck pours to freeze during a sudden drop in temperature, thus resulting in partial scaling of the surface.

Transit-Mix Concrete

Michigan's experience with transit-mix air-entrained concrete on structures has indicated the need for frequent air measurements on the fresh concrete and close control of mixing and consistency. Variations in mixing are greatly increased when so many individual transit-mix trucks and operators are involved, instead of the normal one or two dual-drum pavers used in pavement construction.

However, the introduction of modern batching equipment, handling techniques, and formal inspection procedures for plants and equipment of the transit-mix concrete industry will no doubt eventually greatly reduce or entirely eliminate many of the present undesirable aspects associated with the use of transit-mix concrete in highway pavements and structures.

In Michigan, transit-mix concrete is used only by authorization, in which case the authorized transit-mix plant and equipment is thoroughly inspected by personnel of the Office of Testing and Research. Inspection forms, found in the Appendix, illustrate the nature of information gathered during these inspections. On the basis of this information, the plant is approved either in full or in part. In the latter case, the Department must decide whether the deficiencies can be waived or whether the transit-mix contractor must correct them. Generally approval of a transit-mix plant may be good for only one project, or until changes may be made in plant or equipment, in which case a new inspection is authorized.

Machine Finishing

The advent of machine finishing of bridge decks to reduce roughness may have an added effect in reducing scale on the deck surface by reducing the amount of hand finishing normally required.

Michigan is experimenting with machine finishing of bridge decks but it is too early for conclusions as to the effect of this operation on scale resistance. It has been found that the power-actuated finishing machine does not eliminate the need for hand finishing by floating, followed by testing with a 10-ft straight edge.

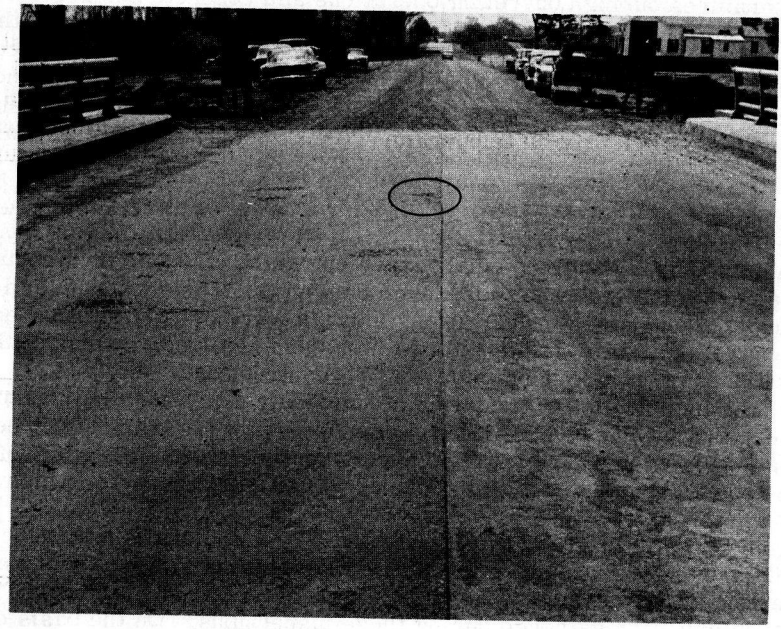
Retarders

The judicious use of approved retarders may be beneficial in reducing scaling caused by overwatering the concrete or sprinkling the surface to facilitate finishing operations, especially during dry, hot weather. Retarders are being used on a limited basis in Michigan in deck construction under certain temperature conditions to control time of set. Bridges in which retarders are used will be watched for performance in relation to scale resistance.

PREVENTIVE MEASURES AFTER CONSTRUCTION

Over the years engineers have experimented with different materials and surface treatments in an attempt to protect new and old concrete surfaces against the destructive action of de-icing agents. Experience now indicates, however, that such preventive measures are generally unnecessary in the case of sound, properly cured, air-entrained concrete.

Because it now seems impossible to construct every bridge as a scale-free structure, engineers keep searching for the panacea to protect bridges after opening to traffic. In this connection, three important factors should be considered: (a) resistance of new concrete to de-icing agents, (b) maintenance practices, and (c) surface treatments.



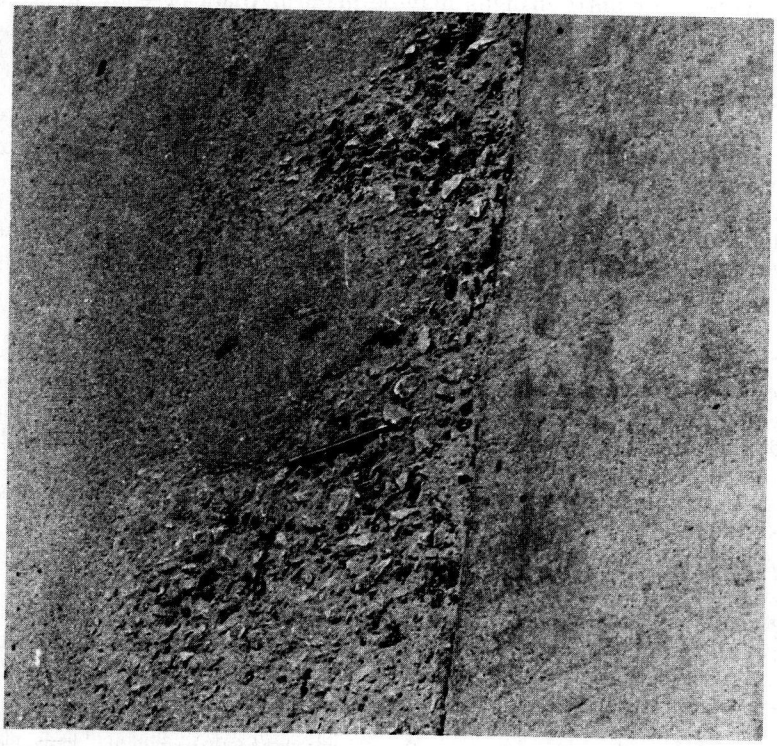


Figure 11. Pour at left placed and cured during descending temperatures shows scaling in wheel track near curb and at other points. Curing protection was inadequate. Pour at right, placed under normal conditions, did not scale. Detail shows joint area between the two pours. Built 1959, photographed 1960 (1 winter).

Resistance of New Concrete to Scaling from De-Icing Agents

Michigan has conducted numerous studies concerned with the scale resistance of new concrete. Some of the first major studies were conducted on air-entrained concrete pavement in 1940-1941 in conjunction with the Michigan Test Road, reported in the 1959 Proceedings of Highway Research Board. In these studies air-entrained concrete two months old did not scale after 93 cycles of field freeze-thaw tests with calcium chloride during two consecutive winter test periods.

More recent studies, started in 1957, consisting of the application of raw chemicals to new air-entrained concrete pavement one, two, and three months old, revealed no scaling after four winter seasons.

The best insurance against scaling is completing deck construction as early in the year as possible to allow more time for the concrete to built up an immunity to chemical action. Experience indicates a minimum 30-day curing period at 50 F or above before applying de-icing agents should be ample for sound concrete with proper air content.

A classic example of chemical action on concrete and paint is shown in Figure 15, which illustrates pitting of a concrete railing post poured in cold weather and corrosion of paint on a metal rail section facing the direction of traffic. The opposite side of the post not subject to splashing from traffic is in perfect condition.

Maintenance Practices

The ever-increasing number of bridges being added each year to the various state

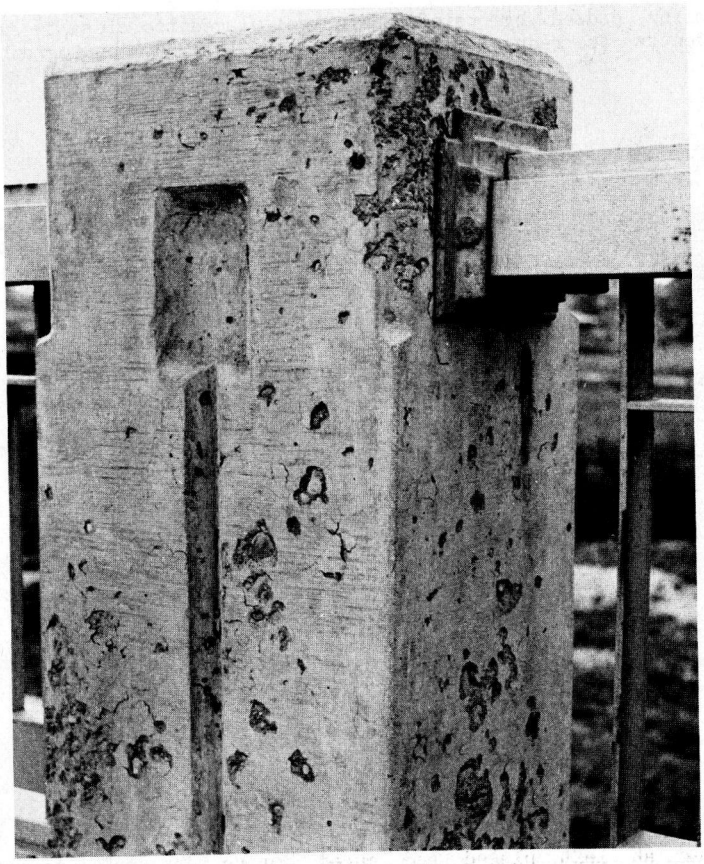


Figure 12. Scale and exfoliation on concrete post placed in cold weather, probably accelerated by splashed slush and banked snow containing de-icing chemicals. Built 1957, photographed 1960 (3 winters).

Figure 13. Scaling caused by reinforcing steel placed too close to surface. Bridge scored subsequently to reduce slipperiness. Built 1948, photographed 1958 (10 winters).

Figure 14. Complete scaling of sidewalk surface illustrates effect of deficiency of air content (core near curb contained 1.5 percent air) in transit-mix concrete; probably accelerated by deposition of de-icing salts. Built 1958, photographed 1960 (2 winters).

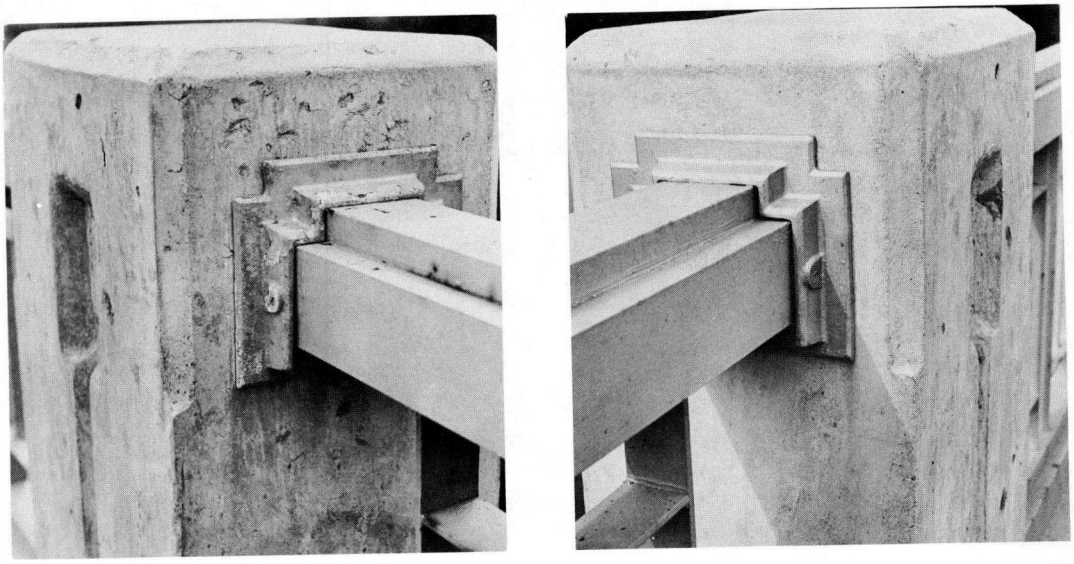


Figure 15. Scaling and corrosion showing effect of de-icing chemicals on cold-weather concrete and on metal. Left view shows side exposed to splashing by oncoming vehicles; right view shows side protected from splash. Built 1957, photographed 1960 (3 winters).

trunkline systems poses a major maintenance problem for the future. This fact in itself should encourage highway officials to demand sound construction practices in order to minimize future bridge maintenance repair costs.

Two important features of bridge maintenance that may encourage scaling and damage to borderline concrete are (a) failure to keep bridges clear of chemical-laden accumulations of snow and ice along the gutter and on sidewalk sections, and (b) failure to remove soil, debris, and other obstructions along the gutter which can interfere with the bridge drainage system (Figs. 16 and 17). Water and salt solutions standing in gutter areas or retained in damp soil for long periods may saturate the underlying concrete and make it more susceptible to frost action and scaling. Standing water also may seep through construction joints and cracks, causing interior damage to the concrete deck and substructure.

Surface Treatments

The current problem of bridge deck scaling has naturally produced numerous preventive treatments on the market in the form of water repellents; surface penetrants and sealers; thin surface treatments consisting of bituminous materials, epoxy resins, and latex emulsions; and special curing compounds. Such treatments are intended for application to the new concrete to seal the surface and thus prevent the damaging action of de-icing chemicals during at least the first winter and as long as possible thereafter.

Michigan has considered and studied such treatments and materials for some time. Laboratory and field results so far, however, have not been too promising. Experience indicates that such treatments may delay but not prevent concrete from scaling when surface weaknesses become an inherent part of the structure through improper construction practices.

Michigan has experimented, in particular, with water repellents and surface penetrants, mostly in the laboratory. However, a few field trial installations of such products have been made with no success. Laboratory tests indicate two coats of linseed oil to be as good or better in preventing surface scale than any of the proprietary products studied. In the fall of 1960 the Department selected 42 bridges to be included in a scale-prevention study. Nine bridges were untreated and 33 bridges treated with two coats of linseed oil before opening to traffic. The last concrete pours on the bridges

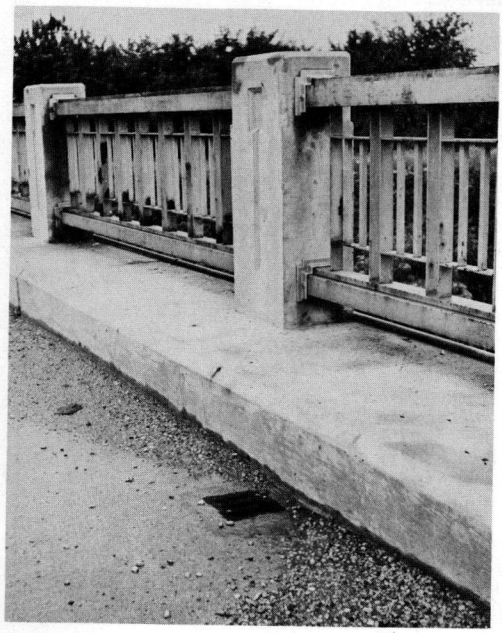


Figure 16. Soil accumulations in gutter obstructing drainage of surface water. Built 1947, photographed 1959 (12 winters).

Figure 17. Excess joint seal material at expansion joint, obstructing drainage of surface water in gutter, and functioning as dike for salt-laden slush during winter freeze-thaw conditions. Built 1957, photographed 1960 (3 winters).

varied in ages from one to two months when receiving de-icing treatments. After one winter season, no scale was detected on any of the 42 bridges. Perhaps scale may develop on some of the bridges when the effectiveness of the treatment wears off. However, experience indicates that bridges that survive the first winter without scaling usually remain scale-free for a good many years or until some deep-seated weakness makes its appearance through causes other than action of de-icing chemicals; for example, spalling, cracking, deep pitting, or general abrading of the surface.

CONCLUSION

The essential requirements discussed here are not new to the engineer or the contractor. The problem appears to be one of strict adherence to specification requirements, elimination of construction irregularities through proper control procedures, and requiring sound maintenance practices. Closer coordination between the engineer and contractor is indicated and greater effort would certainly be beneficial in the training of contractors' men, state inspection personnel, and transit-mix operators. Higher prequalification requirements may be necessary for contractors; eventually to accomplish the desired end, perhaps strong penalties will even have to be imposed on contractors who produce structures that scale. Research is urgently needed in the areas of bridge design, construction, maintenance practices, quality control, automatic equipment, inspector training, and project management. The need for this research is recognized by AASHO, which has set up a committee on research needs and project initiation that has given top priority to this subject, and as further evidence, the Portland Cement Association has initiated a study of concrete bridge deck deterioration, nationwide in scope.

ACKNOWLEDGMENTS

The statements in this report are based on experience obtained from many years of field study and laboratory research by the Michigan State Highway Department under Research Project 39 B-11, Durability of Concrete, included in the program of the Research Laboratory Division.

The Laboratory is a Division of the Department's Office of Testing and Research, headed by W. W. McLaughlin, Testing and Research Engineer.

The author wishes to acknowledge with appreciation the help of the Laboratory staff and, in particular, W. W. McLaughlin and C. C. Rhodes, Assistant Director, Research Laboratory, for their critical review of this work, and also Nelson C. Jones, Engineer of Bridge and Road Design, and Paul A. Nordgren, Bridge Construction Engineer, for their helpful suggestions.

APPENDIX

MICHIGAN FORMS FOR TRANSIT-MIX INSPECTIONS

Form 578
(page 2 of 3)

AGGREGATE UNIT (FOR STATE WORK)

Source of C.A. _____ F.A. _____

Tested Aggregate Storage (Stockpiles): _____ cyd. (Bins): _____ cyd.

Method of charging bins. _____

Number of Compartments _____ Capacity, Tons 1. _____ 2. _____ 3. _____ 4. _____ 5. _____

Number of compartments in the weigh hopper _____ Bins Heated: Yes _____ No _____

Can Tested Aggregates be batched separately? C.A. _____ F.A. _____

Aggregate Scales - Mfg. _____ Type _____

Total Capacity _____ pounds in _____ pound increments

or Beam 1 _____ pounds in _____ pound increments

Beam 2 _____ pounds in _____ pound increments

Beam 3 _____ pounds in _____ pound increments

Beam 4 _____ pounds in _____ pound increments

Does scale have an Interlocking Device? _____

Can Operator By-Pass Interlocking Device? _____ How? _____

Type of Batching Operation, Method of Control _____

Does Scale Weigh Accumulatively? _____ If Accumulatively, can Operator underload coarse agg. and overload fine agg. in individual batches? _____

Does Scale have Load Markers? _____

Remarks _____

Form 578
(page 1 of 3)

MICHIGAN
STATE HIGHWAY DEPARTMENT
OFFICE OF TESTING AND RESEARCH

TRANSIT MIX CONCRETE PLANT INSPECTION

Producer _____

Address _____

_____

Date _____

Project No _____

Number of independent batcher units Cement_____ Aggregate _____

Remarks _____

CEMENT UNIT (FOR STATE WORK)

Source of Cement _____

	Type of Storage Unit	Capacity	Method of Feed	Weigh hopper or other storage unit, etc
1	_____	_____ Bbls	_____ to	_____
2	_____	_____ Bbls	_____ to	_____
3	_____	_____ Bbls	_____ to	_____
4	_____	_____ Bbls	_____ to	_____

Indicate unit that can be set aside for State Tested Cement _____

Automatic feed to weight hopper (if used), one of two Speeds _____

Cement scales - Manufacturer_____ Type _____

Capacity_____ pounds in _____ pound increments

Does scale have an interlocking device?_____

Can operator by-pass interlocking device?_____ How?_____

_____

_____

Is scale used for weighing cement only?_____

Type of batching operation, method of control_____

Provisions for removal of overload from weigh hopper _____

Remarks _____

_____

MISCELLANEOUS

Form 578
(page 3 of 3)

Type of Water measuring device _____ Brand Name _____

Capacity_____(lbs) (Gal) in _____(lb) (Gal) increments

Type of AEA Dispenser _____ Brand Name _____

Are Inspector's quarters available and adequate?_____

MIXER FLEET

Name					
Year of Manufacture					
Number					
Rated Capacity					
Guaranteed Capacity					
Agitator Capacity					
Mixing Speed					
Agitating Speed					
Capacity Mix Water Tank					
Minimum Graduation					
Capacity Wash Water Tank					
Minimum Graduation					
Revoltuion Counters					
Condition of Mixer					
Condition of Mixer Blades					

Inspection By _____

Title _____