NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM
SYNTHESIS OF HIGHWAY PRACTICE 102

MATERIAL CERTIFICATION AND MATERIAL-CERTIFICATION EFFECTIVENESS

TRANSPORTATION RESEARCH BOARD
National Research Council

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RESEARCH SPONSORED BY THE AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS IN COOPERATION WITH THE FEDERAL HIGHWAY ADMINISTRATION

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NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

Systematic, well-designed research provides the most effective approach to the solution of many problems facing highway administrators and engineers. Often, highway problems are of local interest and can best be studied by highway departments individually or in cooperation with their state universities and others. However, the accelerating growth of highway transportation develops increasingly complex problems of wide interest to highway authorities. These problems are best studied through a coordinated program of cooperative research.

In recognition of these needs, the highway administrators of the American Association of State Highway and Transportation Officials initiated in 1962 an objective national highway research program employing modern scientific techniques. This program is supported on a continuing basis by funds from participating member states of the Association and it receives the full cooperation and support of the Federal Highway Administration, United States Department of Transportation.

The Transportation Research Board of the National Research Council was requested by the Association to administer the research program because of the Board's recognized objectivity and understanding of modern research practices. The Board is uniquely suited for this purpose as: it maintains an extensive committee structure from which authorities on any highway transportation subject may be drawn; it possesses avenues of communications and cooperation with federal, state, and local governmental agencies, universities, and industry; its relationship to its parent organization, the National Academy of Sciences, a private, nonprofit institution, is an assurance of objectivity; it maintains a full-time research correlation staff of specialists in highway transportation matters to bring the findings of research directly to those who are in a position to use them.

The program is developed on the basis of research needs identified by chief administrators of the highway and transportation departments and by committees of AASHTO. Each year, specific areas of research needs to be included in the program are proposed to the Academy and the Board by the American Association of State Highway and Transportation Officials. Research projects to fulfill these needs are defined by the Board, and qualified research agencies are selected from those that have submitted proposals. Administration and surveillance of research contracts are the responsibilities of the Academy and its Transportation Research Board.

The needs for highway research are many, and the National Cooperative Highway Research Program can make significant contributions to the solution of highway transportation problems of mutual concern to many responsible groups. The program, however, is intended to complement rather than to substitute for or duplicate other highway research programs.

NOTE: The Transportation Research Board, the National Academy of Sciences, the Federal Highway Administration, the American Association of State Highway and Transportation Officials, and the individual states participating in the National Cooperative Highway Research Program do not endorse products or manufacturers. Trade or manufacturers' names appear herein solely because they are considered essential to the object of this report.

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PREFACE

A vast storehouse of information exists on nearly every subject of concern to highway administrators and engineers. Much of this information has resulted from both research and the successful application of solutions to the problems faced by practitioners in their daily work. Because previously there has been no systematic means for compiling such useful information and making it available to the entire highway community, the American Association of State Highway and Transportation Officials has, through the mechanism of the National Cooperative Highway Research Program, authorized the Transportation Research Board to undertake a continuing project to search out and synthesize useful knowledge from all available sources and to prepare documented reports on current practices in the subject areas of concern.

This synthesis series reports on various practices, making specific recommendations where appropriate but without the detailed directions usually found in handbooks or design manuals. Nonetheless, these documents can serve similar purposes, for each is a compendium of the best knowledge available on those measures found to be the most successful in resolving specific problems. The extent to which these reports are useful will be tempered by the user's knowledge and experience in the particular problem area.

FOREWORD

By Staff
Transportation
Research Board

This synthesis will be of interest to materials engineers and others concerned with procedures for assuring the quality of materials used in the construction of highway facilities. Detailed information is presented on various types of certification plans and on the characteristics that determine their degree of success.

Administrators, engineers, and researchers are continually faced with highway problems on which much information exists, either in the form of reports or in terms of undocumented experience and practice. Unfortunately, this information often is scattered and unevaluated, and, as a consequence, in seeking solutions, full information on what has been learned about a problem frequently is not assembled. Costly research findings may go unused, valuable experience may be overlooked, and full consideration may not be given to available practices for solving or alleviating the problem. In an effort to correct this situation, a continuing NCHRP project, carried out by the Transportation Research Board as the research agency, has the objective of reporting on common highway problems and synthesizing available information. The synthesis reports from this endeavor constitute an NCHRP publication series in which various forms of relevant information are assembled into single, concise documents pertaining to specific highway problems or sets of closely related problems.

Highway agencies carry out procedures for inspection, testing, and evaluation of materials used in construction of their facilities. Some agencies employ certification acceptance as part of their quality assurance programs. This approach can save time and money as well as improve quality. This report of the Transportation Research Board includes information on various approaches to material certification and em-

phasizes the importance of verification of the validity of the certification by use of independent random sampling and testing.

To develop this synthesis in a comprehensive manner and to ensure inclusion of significant knowledge, the Board analyzed available information assembled from numerous sources, including a large number of state highway and transportation departments. A topic panel of experts in the subject area was established to guide the researcher in organizing and evaluating the collected data, and to review the final synthesis report.

This synthesis is an immediately useful document that records practices that were acceptable within the limitations of the knowledge available at the time of its preparation. As the processes of advancement continue, new knowledge can be expected to be added to that now at hand.

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Information on current practice was provided by many highway and transportation agencies. Their cooperation and assistance were most helpful.

MATERIAL CERTIFICATION AND MATERIAL-CERTIFICATION EFFECTIVENESS

SUMMARY

State agencies responsible for the construction and maintenance of highways, bridges, and related structures have been in the forefront of the construction industry in the development of programs for the inspection, testing, and evaluation of the materials used in these facilities. Advances in technology and productivity in the industry have resulted in increases in the complexity of and need for these programs and the awareness of their importance by those involved in their use.

The nature of these quality assurance plans is such that the data generated are also of value to the producer in control of the quality of the product. Often this has led to a duplication of materials testing effort with a resulting waste of time, money, and materials. As a means of bringing about economies without a loss of quality in their facilities, some agencies have employed acceptance by certification as a quality assurance device. Losses in personnel available for inspection and materials testing have spurred the agencies to increase the use of this procedure in order that they may use the personnel available to the best advantage.

A properly conceived and implemented certification plan can be of benefit not only to the agency but to the contractor and manufacturer as well. It permits the manufacturer to control production scheduling, inventory, and shipping without fear of interruption or delay caused by rejection of materials at the project site or elsewhere. It allows the contractor to arrange for acquisition and delivery of materials and to proceed with construction operations in an orderly fashion without waiting for inspection and approval based on sometimes time-consuming tests. It is also suggested that relying more on the producer's quality control, which is inherent in the certification process, may in some cases result in an enhancement of the quality and consistency of the product to the benefit of all concerned.

Certification plans have not always been successful in the past. Along with them come certain liabilities. Failures that are due to these problems have caused a number of specifying agencies to be hesitant in their acceptance of materials through certification. These shortcomings include deliberate or inadvertent falsification, the masking of contamination or other shipping or handling damage, and, in some cases, an increase in the final cost of the item.

Materials engineers experienced in the use of certifications agree that no such plan can be expected to succeed without provisions for verification of the validity of the certification document. This verification must be based on the testing of a randomly taken sample of the material by the agency's laboratory or at least by one independent of the routine producing and certifying operation. It is also generally agreed that the basis of the certification must be test properties cited in the agency's specification for the item. Wherever possible, these properties should be those used in nationally recognized standards, such as AASHTO and ASTM.

The frequency and use of certification varies for different materials. Very little use is made in the specification of unprocessed native materials. Exceptions are to be found in the specification of plants, shrubs, seed, and similar landscaping materials but few other such items are so accepted. Certain component materials manufactured or processed for use in the preparation of products or mixtures used in on-site construction operations are found to have a reasonably wide acceptance by certification. Portland cement, asphalt cement, and the additives and admixtures used in the preparation of paving and other concrete mixtures are accepted to some extent by the majority of the member agencies of the AASHTO Subcommittee on Materials. Similarly, manufactured materials that are produced at a location remote from the project and shipped thereto for use without further processing are often accepted on the basis of certification. Typical of these are hardware, signs, traffic signals, and lighting equipment. To a lesser degree concrete and metal pipes, paints, and pavement markings are also considered to be materials that lend themselves to certification acceptance.

Although there is considerable variation in the identity of the materials that are more commonly accepted by certification, there are certain similarities. The manufacturing processes that produce these items are usually controlled by well-established and effective quality control systems initiated and carried forward by the manufacturer. Most of these items are described by test properties that are measured by nationally standardized test procedures. The limits set by the specifying agencies for these properties sometimes vary from area to area but are usually found to be in substantial agreement among the agencies in a given marketing area for the product. Another characteristic that the items that have been most successfully subjected to the process share is that of physical stability of the properties stipulated in the specifications by the agency. Where all parties concerned can be confident that there will be no change in these properties between the time of certification and the time of use the entire process can be given more credence by the agency. Quite naturally this enhances the use of certification.

The success of a certification system depends first on the ability of the specifying agency to establish the validity of the certification. The agency must be in a position to do this by independent random sampling and testing of the material carried out by its own staff and laboratory or at least an entity of its choosing that is completely independent of the normal quality control testing and certifying procedures carried out during production.

CHAPTER ONE

INTRODUCTION

BACKGROUND

As the transportation construction industry has developed, state agencies responsible for construction and maintenance of highways, bridges, and related structures have been in the forefront in the development of inspection and testing programs. These programs have been designed to generate the necessary data to assure the agency that the materials and workmanship built into the facility conformed to the requirements in the construction contract.

The inspection programs have increased in magnitude and complexity along with recent rapid advances in technology and productivity in the construction industry. Additional impetus has been given by the Federal Aid Highway Programs under which the states assume the responsibility for the expenditure of federal funds and are required to provide the federal government—FHWA—with documentation demonstrating that full value has been received for those funds. As these systems have evolved, a more thorough understanding of the needs, benefits, and limitations of materials testing and evaluation programs has been achieved.

Because the data generated by these programs establish physical properties of the materials, they are of use to the manufacturer and the contractor as well as the specifying agency. This has often led to the duplication of effort where testing for production control and for quality assurance has been carried out by the separate interested parties for their own purposes. On occasion the producer has looked to the agency to carry out the testing needed for control of production of the product.

As materials control programs have developed, the assignment and assumption of responsibility for sampling, testing, and data evaluation have shifted about among the various levels in the production chain. These levels include the producers of raw and processed materials, the contractor, and the specifying agency. As the ultimate owner and operator as well as the original designer of the facility, it is clearly the responsibility of the agency to establish its requirements in its specifications. This is normally done through the use of qualitative and quantitative designations of selected properties of the materials. To ensure that these needs are being met, it also behooves the agency to specify the degree of control that it believes is appropriate to maintain the material at the desired level of quality. The agency must also stipulate how and by whom these controls are to be applied.

One of the devices used by agencies in their efforts to ensure the quality of their facilities is that of certification. Specific motives for its use vary somewhat but in general the justification is economy of time or money or both. Obviously one prime target is the elimination of redundant or unnecessary testing. Other concerns include the need for special testing equipment, the cost of testing, or the value of the article destroyed in the testing process. On occasion, the cost of dispatching representatives to a remote manufacturing site or the cost of delays brought on by the time required for sampling, testing, and reporting become important considerations. Many agencies find that they simply do not have adequate staff to accomplish all of the acceptance testing needed without delaying the progress of construction. Of perhaps less importance, but still considered to be justification for the use of certifications in some cases, are the relative criticality of the item to the successful performance of the facility and the quantity of the material to be incorporated into a particular project.

Constraints against the use of products or components of foreign origin (buy-American clauses) often look to the use of certifications in order to accomplish their purposes. In this instance the process of verification can prove to be quite difficult. In a similar manner certifications can be used to advantage in situations in which articles of foreign manufacture are acceptable for use under the specifications. Here the certification process must be designed to take into account possible differences in standards and nomenclature as well as difficulties brought on by the locale.

The types and contents of certification documents required by specifying agencies tend to vary with the characteristics of the materials involved as well as with the complexities of the tests to be run to verify conformance to specifications. The level of sophistication of the production methods employed is also a factor in determining the nature of the certification. The frequency of use and the requirements set down in the specifications often reflect the specifying agency's past experience with the procedure.

A primary concern of the agencies, which affects their use of certification, is the validity of the document. In addition to deliberate falsification, there exist such possibilities as change of physical characteristics during handling, confusion among lots, and improper or biased testing.

As noted above, the reason for the use of certification can generally be traced to efforts to save time or money. At the same time, materials engineers are aware of and greatly influenced by the economic losses that can be generated by invalid certifications. These losses are experienced by the owning agency in the form of untimely maintenance, early replacement or rehabilitation, or even catastrophic failure of the facility. It is their concern with these possibilities that prompts many agencies to limit the use of certifications.

A properly designed and faithfully implemented certification system can be expected to produce the following benefits and open up the possibility of the following liabilities to the principal entities involved in the construction process.

- Agency
  - Benefits
    - Efficient utilization of available staff
    - Efficient utilization of available equipment
    - Assurance of quality and uniformity of product
  - Liabilities
    - Possibility of falsification
    - Masking of contamination
    - Masking of handling damage

- Contractor
  - Benefits
    - Permits timely acquisition of materials
    - Enhances orderly prosecution of work
    - Avoids costly removal and replacement
  - Liabilities
    - Responsible for manufacturer's inadequacy
    - Need to increase staff
    - Increased cost of materials
- Manufacturer
  - Benefits
    - Enhances control of inventory and shipping
    - Avoids rejection at project site
    - Aids in acceptance of product by other agencies
  - Liabilities
    - Need to increase staff
    - Need to refine production methods
    - Need to increase record keeping

CERTIFICATION TYPES AND CONTENTS

A survey of AASHTO member agencies has revealed that an acceptable certification not only states that the item or material it represents conforms to applicable specifications but carries with it the expressed or implied assurance that all such material to be furnished from the same lot or production period will do so as well. This presupposes the existence of an adequate quality control system governing the production process and the use of appropriate raw materials. In many cases the specifying agency stipulates that it must be accorded the opportunity to review and approve the quality control system before a certification is to be considered. This makes it desirable that certifications be issued by the manufacturer of the product because it is normally the manufacturer who is responsible for the quality and consistency of the product.

Where the item involved is manufactured, transported, and installed without being changed or combined with other materials, the process of certification becomes a simple, straightforward one. For example, a section of culvert pipe, discounting the occurrence of obvious physical damage during handling, can be expected to maintain its physical characteristics intact from the time of manufacture through shipment and installation. Thus a certification provided by a dependable pipe producer can be expected to provide the specifying agency with the assurance that the finished product meets its requirements and, if properly installed, will give satisfactory service.

Unfortunately, in many cases materials must go through a series of steps in a production chain or sequence between original raw material production and final installation into the structure of which they form a part. As an example that can be considered to be typical of a large portion of the materials used in the construction of transportation facilities, consider a shipment of asphalt cement or portland cement. These materials are normally produced by well-controlled manufacturing processes that include adequate quality control systems. As a result, the cement producer is able to include an appropriate certification with each shipment. Such a certification is of value to the mixing plant operator because it gives assurance that the cementing agent is of the type and grade specified and has the physical properties needed. The certification is also of interest to the specifying agency because it tells the agency that the concrete producer is introducing the desired cement into the mixture. Still, it does not assure the agency that the mixture to be produced will meet its needs. A certification as to the quality of the mixture would have to be prepared by the plant operator based on tests of not only the raw materials but also of the completed mixture. In turn, the contractor installs the material. The contractor's operations may or may not include the on-site addition of additives or combination with other materials. In any case, the handling and installation activities can be expected to affect the properties of the mixture and its ability to produce the performance anticipated by the designer. At each step in the sequence of operations the material undergoes some alteration to its physical properties. Although these alterations are essential to producing a material appropriate for use in the completed facility, they limit the significance of certifications that may have been accumulated along the way and that refer to the qualities of components.

Specifying agencies have found that it is essential in many cases that they include requirements as to the properties of component materials, such as those just discussed, in order to assure themselves that the end product will have the properties they desire. Where this is done, certifications, if they are to be meaningful, must be issued by the entity responsible for each step in the system in which changes to physical properties have been made.

For the most part, agencies stipulate that a certification include the assurance that the material it represents meets the requirements established in the agency's own specifications. Credence is given to the statement that the material meets the standards of another agency or a nationally recognized organization, such as ASTM or AASHTO, only where the cited requirements coincide with or are more restrictive than those of the specifying agency.

The specifying agencies are generally more comfortable with a document that includes test data derived from a representative sample of the material. These data are normally expected to be developed by the manufacturer's own laboratory. Similar information provided by the laboratory of a reputable commercial testing agency or another public agency is also found to be generally acceptable. Periodic comparison tests of replicate samples of the materials involved are often required to provide assurance that the laboratories involved are all conducting the tests in the proper fashion. Such test programs, as conducted by the Cement and Concrete Reference Laboratory (CCRL), the AASHTO Materials Reference Laboratory (AMRL), and by ASTM subcommittees, can also generate a valid statistical base for establishing the precision of the tests involved and thus provide a sound basis for judging the validity of the certification documents.

The quantity of material to be represented by a certification is usually stated in the agency's specification. There is some variation in this factor owing primarily to the characteristics of the material, particularly with regard to consistency of production and shelf life. Most agencies require that a certification refer to all of the like material to be used on a particular project. Because this is not always practical, reference is sometimes made to specific, identifiable lots or batches of material that may be used on one or on a number of projects. At the other extreme, certain very stable materials produced by consistent and well-

monitored manufacturing methods are sometimes accepted on an annual or semiannual basis.

In virtually every case, specifying agencies find that it is desirable to verify the accuracy of certifications. This is usually accomplished by a random sampling of the material at the project site and subsequent testing by the agency's own laboratory. Where this is not practical, sampling is made as near to the end of the production sequence as possible. Where testing of the item is beyond the capabilities of the agency's laboratories, it is carried out at another facility of the accepting agency's choosing.

Along with certifications that ensure compliance of materials to specifications, similar documents referring to the capabilities of personnel or equipment are sometimes required. These may be designed to ensure acceptable workmanship in the construction of the facility or to assure the owner that the inspection and supervision of that construction is carried out by qualified individuals using appropriate equipment.

In addition to the survey of materials engineers representing the member agencies of the AASHTO Subcommittee on Materials, which was conducted in gathering information for the preparation of this synthesis, contact was made with a number of national associations of contractors and manufacturers of various specific construction materials. Their responses brought out essentially the same concerns as did the agency representatives. They pointed out that standardization of products and of tests was needed to make a certification program work. They indicated that not all products are appropriate for certification programs but that those with dependable quality control programs to back up their certifications are the most likely to succeed. They agreed that agency verification is required to ensure the effectiveness of certification. It was pointed out that some savings can be achieved by the elimination of duplication in testing effort and it was also mentioned that it is important to be able to assign the responsibility for specification compliance in component materials in a multilevel production process. Thus it is clear that the various parties involved in the construction of quality transportation are aware of their own and others' duties, responsibilities, and problems in the application of certification acceptance.

CHAPTER TWO

MATERIALS AND PRODUCTS

UNPROCESSED NATIVE MATERIALS

Very seldom does an agency specify that unprocessed materials be furnished on a certification basis. The single exception to this general rule is to be found in the category of plants, shrubs, and similar materials. Over half of the agencies contacted in connection with this study do require that a certification attesting to the identity and quality of such items be furnished with the materials.

Other unprocessed materials do not lend themselves too well to acceptance by certification. Such materials as top soil, borrow soil for embankment, and bank sand and gravel are often quite variable in character even in a discrete deposit. As a result, governing specifications are quite broad in their description of physical characteristics. Although experience has taught engineers and contractors how to construct satisfactory embankments using the wide variety of materials that are economically available in their area, the critical control is on the methods of installation more than the specific characteristics of the material itself. Thus, to be of real significance, a certification would have to attest to the properties of the finished structure. In recent years a considerable amount of attention has been given to the development of procedures wherein the contractor assumes responsibility for the testing of embankments, subgrades, and other parts of the pavement structure. However, the established approach at this time is for the specifying agency to furnish the necessary technicians and testing equipment for the development of quality evaluation at each project. As long as this procedure is being followed, a certification by the contractor would represent a duplication of effort or simply refer to the agency's own data.

At the same time, changes in the magnitude and character of highway construction projects seem to point to a time when the use of unprocessed native materials will become a smaller portion of the work. This may well have the effect of making on-site control of these materials, including the testing for quality and compaction, a function that can be more economically undertaken by the contractor doing the work. If and when this becomes the case, the use of certifications in this area can be expected to become more frequent. In addition, the development of rapid in-place moisture and density measuring devices has enhanced the control of embankment, subgrade, and base construction. Where these properties can be determined rapidly and appropriate adjustments made as construction proceeds, contractor control and certification becomes a much more workable system.

Although it is reasonable to expect an increase in the use of certification of unprocessed native materials in the future, it appears that, with the exception of plant materials as discussed above, such procedures are presently confined to unusual situations in which the quantities involved are small and the uses to which the materials are put are not critical to the successful performance of the facility.

Table 1 gives the extent to which member agencies of the AASHTO Subcommittee on Materials were using certifications in their acceptance of certain unprocessed native materials in

TABLE 1

USE OF CERTIFICATIONS FOR UNPROCESSED MATERIALS

	Bank Sand and Gravel	Plants and Shrubs	Embankment Soil	Top Soil
Arizona		A		A
California		L		
Colorado	L	A	L	A
Illinois	L	A		L
Indiana		A		
Iowa		A		
Kentucky	L			
Maryland	L	A		
Massachusetts		A		
Michigan		A		
Missouri		A		
Montana	L	L	L	L
Nevada		A		A
New York	L	A		
North Carolina		A		
North Dakota		A		
Oklahoma		A		
Oregon	L	L	L	L
Rhode Island		A		
South Carolina		A		
South Dakota		A		
Tennessee		A		
Utah	L	A	L	A
Vermont		A		
Virginia		A		
Wisconsin	L	A		
Nova Scotia	A		A	
Ontario	L	A	L	L
Guam	L	A	L	L

A - signifies that the agency always accepts the item by certification.
L - signifies that the agency accepts the item by certification under limited circumstances.

the fall of 1982. In the table an "A" indicates that the agency always accepts the item by certification and an "L" signifies that such acceptance is made under limited circumstances.

PROCESSED COMPONENT MATERIALS

Component materials that are produced at one location, then transported and combined with other materials and/or further processed at the project site or at a plant convenient thereto, make up a considerable portion of the materials described in the specifications for highways and related transportation facilities. Such materials are typified by the aggregates and cements combined to produce portland cement or bituminous concrete mixtures for structures and pavements.

Approximately one third of the agencies contacted report that they normally accept asphalt binder materials on the basis of a certification by the producer. An almost equal number do so to a limited degree. About half of the agencies routinely accept portland cement in this fashion and another fourth will do so under special circumstances. Commonly used additives to portland cement concrete mixtures, such as water reducers and air-entraining agents, are accepted on the basis of certification by about half of the agencies. More recently developed and less commonly used additives, such as antistrip agents for asphalt mixtures and high-range water reducers for portland cement concrete, are generally specified and accepted on the basis of tests of the completed mixture rather than on the additives' characteristics.

A typical approach to the acceptance of a component material by the use of a certification by the manufacturer that appears to address the concerns of most materials engineers is one employed successfully at an eastern state for the control of bituminous materials. The following are the principal provisions written into the specifications establishing the procedure.

1. The vendor must maintain an adequate quality control system during the manufacture and shipment of the material. The details of this system must be submitted to the agency for review and approval before the source is approved for use.
2. Material must be identified, controlled, and certified in discrete batches. A batch is defined as a completely or partially filled storage tank released by the vendor for shipment. Whenever new material is added to a tank, a new batch is automatically created and the certification process for the material in the tank is begun anew.
3. With the creation and designation of a batch, the tank is sampled and the sample split. One portion is tested against the agency's specifications by the vendor. The results of those tests and the second portion of the sample are submitted to the agency's materials division.
4. Random samples of the material are taken by the agency at the point of use for check testing at its laboratory.
5. Data from the vendor's and the agency's tests are used to evaluate the producer's quality control and to establish a "Level of Certification" for that producer.
6. The "Level of Certification" assigned each vendor determines the degree of inspection to be undertaken by the agency. This, in turn, establishes the frequency of sampling and testing as well as introducing certain constraints on the shipping and field use of the material.
7. Periodic checks are made of the accumulated data and appropriate adjustments are made to the level of certification assigned.
8. Each delivery of material to a project site or mixing plant must be accompanied by a certification document that identifies the type and grade of the material, the batch number assigned by the vendor, and specific test data derived from the vendor's tests of a representative sample taken from that batch.

This system, conscientiously followed by both vendor and agency personnel, should ensure that the proper type and grade or class of bituminous cementing material is delivered to the mixing plants. This should reduce the testing load and therefore cost of inspection by the agency without materially increasing the cost of process control testing to the producers.

Similar procedures are used in many agencies for the acceptance of structural steel or portland cement through the use of mill-test certificates or certificates of analysis.

A little over one third of the agencies contacted use some sort of certification procedure in the acceptance of reinforcing bars and another third do so to a limited extent. A typical procedure requires that the steel used in producing the bar to be able to be associated positively with a particular heat number through which the type and grade of steel and a certified mill analysis can be identified. Such analysis will normally refer to a standard AASHTO or ASTM specification. In addition to the identification of the parent material, satisfactory comparison testing between concerned laboratories and a random check sampling and testing program are also usual features of a certification system for this type of material. Appropriate limits covering the degree of agreement between tests are established using a statistical analysis of the precision of various tests as a basis.

The acceptance of structural steel for use in the fabrication of bridges and other structures is handled in a similar fashion by most of the agencies reporting.

It is to be observed that those component materials for which nationally recognized grading systems and specifications have been developed by ASTM, AASHTO, or similar organizations are the ones that are more frequently accepted on a certification basis. Along with the development of nationally recognized specifications, provisions for laboratory inspection and comparison test programs have been made through CCRL and AMRL. The existence of standardized specifications and tests and the reference laboratories has facilitated the establishment and use of certification acceptance programs.

In general it is those materials that are described in the specifications by physical and chemical characteristics and that are not likely to change with time or handling that lend themselves best to acceptance by certification.

Table 2 gives the extent to which member agencies of the AASHTO Subcommittee on Materials were using certifications in their acceptance of various processed component materials in the fall of 1982.

END PRODUCTS

Two distinct types of end products are to be found in most transportation projects. The most common, in terms of quantity used, are those in which several components are combined in a mixing plant at or convenient to the project site to produce a blend or mixture that is then used in the construction of the facility. Portland cement concrete, bituminous concrete, stabilized bases with and without cementing agents, and other paving materials are typical of this grouping.

Not many materials of this sort are accepted on certification. Historically plant inspection by the specifying agency has included the conduct of physical tests of the mixture and some or all of its components by the agency's representatives using equipment furnished by the agency. In many cases the information developed by these acceptance tests was used by the plant management for production control and no effort was made to duplicate the tests by the producer. As more high-production central plants were developed, the producers expanded their markets to include a variety of work and many have found it advantageous to initiate their own control testing programs. This, to a great extent, duplicated the efforts of the agency personnel and in this instance made the use of certification reasonable. At the same time, many plant owners have not yet undertaken these control testing functions or have not developed them to the extent considered necessary by the specifying agencies. Add to this the relatively high variability of some of the properties specified and tested for evaluation and the reasons for slow acceptance of certification in certain areas become apparent.

One agency has developed a system of Quality Assurance Specifications, which is in fact a form of certification acceptance. This specification is applied as an end-product specification to bituminous concrete and pugmill aggregate base course mixtures. The procedure requires first that the contractor or producer have a certified technician present at the plant at all times during production. This technician must be capable of designing and making necessary adjustments to the mixtures produced at the plant. The producer is also required to maintain adequate quality control of the production and keep the necessary records of tests relating to the mixture and its components. Sampling frequency and testing regimens are established by the agency for implementation by the producer. The plant, including everything relating to the production process control techniques, is inspected by the agency before and during production.

During normal production, the agency's representative conducts two monitoring tests per week for each type of mixture being produced. These monitoring tests include the taking of split samples for comparison testing, observation of the producer's technician's techniques, and inspection of the quality control test records and the plant production records relating to state projects. During start-up and when a statistically supported comparison of test results indicates a lack of agreement or inadequate control, monitoring tests are conducted more frequently until the problem is resolved.

In addition to the blends or mixtures of separately specified components used in forming end products at the project site, there are products that are essentially complete at the point of manufacture. In many cases this is at a location well away from the project. It is also frequently the case that the tests necessary to assure the agency that the product conforms to its requirements can be and are conducted at the fabrication site by the agency or by a reputable testing agency having personnel and equipment located so as to be able to carry out those tests. The physical characteristics of these products are such that in normal use they can be expected to remain unchanged throughout shipping, handling, and installation operations.

One agency's recently implemented policy covering portland cement concrete pipe and masonry units establishes a workable procedure for certification acceptance for this type of material.

As with the bituminous material acceptance plan discussed above, this certification procedure identifies the producer as having the capabilities considered necessary to furnish an acceptable product. The producer is required to maintain approved quality control methods and procedures and to organize production into discrete, identifiable lots. In this case it is practical to physically mark each item in such a way as to identify it with the certification system and, therefore, this is required.

Under this procedure, the engineer reserves the right to review the control test records of the producer at any time. Records of these tests must be retained by the producer for a period of at least three years.

As is the case with many manufactured end products specified by state highway or transportation agencies, these specifications

TABLE 2

USE OF CERTIFICATIONS FOR PROCESSED COMPONENT MATERIALS

	Air-Entraining Agents	Antistrip Additives	Asphalt Cement	Asphalt Emulsions	Coarse Aggregates	Fine Aggregates	Mineral Filler	Portland Cement	Reinforcing Bars	Structural Steel	Water Reducers
Alabama	L	L	A	A	L	L		L	A	A	L
Alaska			L	L					A	A	
Arizona	A	A	A	A			A	A	A	A	A
Arkansas	A		A	A				A			A
California	L							L	L	L	L
Colorado	A	A	L	L	L	L	L	A	L	L	A
Connecticut	A		L					A	L	L	A
Delaware	L	L	A	L				A	A	A	L
Georgia										A	
Idaho	A	A						A	A	A	A
Illinois	L	L	L	L	L	L	L	L	L	L	L
Indiana	A										A
Iowa	A	A	A	A	L	L		A	A	A	A
Kansas	A		A	A				A		A	A
Kentucky	A		L	L	L	L			L	A	A
Louisiana			L	L				L		A	
Maryland			L	L				L		L	
Massachusetts	L	L	L					A			L
Michigan	A		A	A	L		L	A	L		A
Minnesota	L	L	A	A				A	L		L
Missouri	A	A	A	A				A	L	A	A
Montana	L	L	L	L	L	L	L	L	L	L	L
Nebraska									L	A	
Nevada	A		L	L			A	A	A	A	A
New Hampshire	A	A						A	L	A	A
New Jersey	L			L						L	
New York	L	L	L	L			A	L	L	L	L
North Carolina	A							L	L	L	A
North Dakota	A		A	A				A	A	A	A
Ohio	A		A	A				A		A	
Oklahoma	A		A	A				A		A	A
Oregon			A	A	L	L	L	L	A	L	L
Pennsylvania	A		A	L				A	A		A
Rhode Island	A	A	A	A			A	A	A	L	A
South Carolina	A		A	A				A		A	A
South Dakota									A	A	
Tennessee	A									L	L
Utah	A	A	A	L	L	L	A	L	L	L	
Vermont	A		L	L				A		A	A
Virginia	A	L						A			L
Washington	A	A	A	A				A	L	L	A
West Virginia	A										A
Wisconsin	A		L	L	L			L	A	A	A
Nova Scotia	L		L	A	A	A	A	L	L	L	L
Ontario	L	L	L	L	L	L	L	L	A	A	
Alberta	A				A	A		A	A	A	A
Guam	A	A	L	A	L	L	L	A	A	A	A

A - signifies that the agency always accepts the item by certification.
L - signifies that the agency accepts the item by certification under limited circumstances.

TABLE 3

USE OF CERTIFICATIONS FOR MANUFACTURED PRODUCTS

	Bituminous Concrete	Bricks and Blocks	Concrete Pipe	Epoxies	Hardware	Incidental Concrete	Lighting Equipment	Metal Pipe	Paints	Signs	Structural Concrete	Traffic Signals
Alabama				L	L							
Alaska			L		L	L	L	A	L	L		
Arizona				A	A		A	A		A		A
Arkansas				L	L	L	A	A				A
California			L	L	L	L		L		L		
Colorado	L	A	L	A	A	L	A	L	L	L	L	A
Connecticut			A	A	A	A	A		L	A		A
Delaware				L	A		A	A	L	A		A
Georgia					L		L			L		
Idaho			A		L		L			A		A
Illinois	L	L	L	A	A	L	A	L	L	A	L	A
Indiana				L			A			A		A
Iowa			A	A	L	L	A	A	L	L		A
Kansas	L			A		L	A	A				A
Kentucky	L			L	L	L	A	A		L		A
Louisiana					L		A					L
Maryland		L			L	L	L	L	L	L		L
Massachusetts			L		A		A	L		A		A
Michigan			L		A		L					L
Minnesota				L	L	L	L	A	L	L		L
Missouri		L		A	A	L	A	L		L		A
Montana	L	L	L	L	L	L	A	L	L	L	L	L
Nebraska					L		A			A		A
Nevada		L	A	A	A		A	L	L	L		A
New Hampshire			L	A	A		A	A		A		A
New Jersey					L		A	A				A
New York	L					L	A	L		A	L	A
North Carolina				L	L		A	A		L		
North Dakota		A		A	A		A	A	A	A		A
Ohio				L			A			A		A
Oklahoma				L	A			A	L			
Oregon	L		L			L	A	A	L	L	L	A
Pennsylvania	L		A		L	L	A	A	A	L	L	A
Rhode Island				A	A	A	A	A	A	A		A
South Carolina				A	L		A	A	L	L		A
South Dakota				A		L	L	A	L	A		L
Tennessee				L	L		A		L	A		A
Utah	L	A	L	A	A	L	A	L	L	A	L	A
Vermont		A	A	A	A		A	A	A	A		A
Virginia					A	L	L					
Washington		A			L	L		L	L	L		
West Virginia				L	A		A		L			A
Wisconsin	L	L	L	A	L	L	A	L	L	L		A
Nova Scotia	A		A	L		L			L		A	
Ontario	L	A	L	L	A	L	A	A	L	A	L	A
Alberta				A	A		A	A		A		A
Guam	L	L	L	A	A	L	L	A	A	A	L	A

A - signifies that the agency always accepts the item by certification.
L - signifies that the agency accepts the item by certification under limited circumstances.

put certain quality requirements on the component materials to be used by the producers of concrete pipe and masonry units. In view of this, the agency reserves the right to sample, test, and approve all component materials before use. The producer is also required to notify the agency immediately when sources of component materials are changed.

Plants producing concrete pipe and other concrete products for use on the agency's projects are classified as "certified," "decertified," or "noncertified." A certified plant is one that has passed and continues to pass the inspection of a "certification team" representing the agency. Plants are inspected annually unless circumstances indicate the need for a more frequent recheck. A decertified plant has had its certified status rescinded because satisfactory conditions have not been maintained. Such plants can regain certified status by correcting the shortcomings that brought about the decertification. If appropriate corrections are not made within a period of two months, the plant reverts to the status of noncertified. Noncertified plants are those that are not considered to be qualified to supply materials to state projects. Materials from noncertified plants will not be accepted for use on state projects.

The great majority of the member agencies of AASHTO cite the need for special testing equipment as being one of the main motives for the use of acceptance by certification. This would apply particularly to a class of products that are relatively complex and are to a certain extent new in terms of installation under contract by highway and bridge construction contractors. Traffic control devices and lighting fixtures fall into this category. These specialty items are normally manufactured in highly sophisticated plants using components from similar manufacturing processes. Quality control techniques are well established in the industries producing these items and duplication of their testing programs by transportation agencies, which make up a small portion of the total market for their products, would bring about an expensive duplication of effort. Certification methods take the form of specification by brand names ("or approved equal") or the use of catalogue cuts and shop drawings submitted by the contractor for approval.

Table 3 gives the extent to which member agencies of the AASHTO Subcommittee on Materials were using certifications in their acceptance of various manufactured products in the fall of 1982.

CHAPTER THREE

CERTIFICATION OF PERSONNEL AND EQUIPMENT

PERSONNEL

Approximately 80 percent of the agencies responsible for the construction of transportation facilities report that they require that welders working on those facilities be certified as to their capabilities in their craft. Generally, the agencies stipulate that only welders or welding machine operators qualified by the agency itself, or by a recognized testing agency specializing in the examination of welders, are to be allowed to perform any work on structures or components being fabricated for use in structures for their facilities. The basis of this qualification is usually established by reference to the American Welding Society's Structural Welding Code or an adaptation of this code by AASHTO.

A typical procedure of this sort requires that the welder carry a card obtained from the agency's division of materials and research. This card is issued after the welder has carried out specific welding tasks under the observation of a representative of that division. Generally these test welds are made at the agency's central laboratory although arrangements can also be made to produce them at the fabrication shop or other convenient facility. The actual welds are examined and tested by the agency's laboratory.

The certification cards indicate the types of welds for which the welder has qualified with the agency. Although state highway agencies do not usually consider themselves to be licensing or qualifying authorities for any but their own projects, it is not unusual to find other agencies and private employers making the possession of a card from the state a prerequisite for employment on their work.

In addition to the requirements for welder certification by a large number of states, a somewhat smaller number require that certain other personnel be certified. Approximately one third of the agencies contacted require qualification on the part of test technicians, inspectors, or both. Generally training and testing programs for such qualification are conducted by the specifying agency or by a consultant retained by the agency for the purpose. Often such programs include as their trainees both agency and contractor personnel. Associations dedicated to the advancement of knowledge and use of specific materials, such as the American Concrete Institute, the Portland Cement Association, and the Asphalt Institute, develop instruction courses covering the techniques of sampling, testing, and use of the materials of particular interest to them. These courses are made available to specifying agencies and local industry associations for use in training sessions, which can be used as a basis for certification of personnel capabilities where it is desired.

The National Society of Professional Engineers, through a grant from the Federal Highway Administration, has set up a nationwide program for certifying transportation engineering technicians. This program was administered by the National Institute for Certification in Engineering Technology. It makes available a system of examination and classification through which personnel may be certified at several levels of competence.

EQUIPMENT

In the same way that the agencies responding to the inquiry were in substantial agreement that welders should be required to be certified, an even larger majority believed that equipment used for weighing, such as scales, should be certified. This comes as no surprise because many of the materials furnished to the agencies under contract are measured and paid for on a unit-weight basis and with some other materials the proportioning into mixtures is controlled by weight. In both instances the scales or other weighing devices are furnished by the producer. Certification as to their accuracy by a disinterested third party or by its own facility is required by the purchasing agency. Similarly, many agencies require that tank trucks used for the delivery or application of liquid asphalts be calibrated and certified so that quantities purchased and rates of application may be readily determined with accuracy in the field.

To a lesser degree it was found that some agencies look to a certification by their own inspection teams or by a third party qualified to make an evaluation before allowing the use of certain types of equipment on their projects. Mixing plants, mixer trucks, and placing and compaction devices for paving mixtures are included in the equipment so specified. As the trend toward end-product specification and certification acceptance continues, one would expect the requirement of certified equipment to decrease in areas other than those involved in critical proportioning or quantities for payment.

CHAPTER FOUR

VERIFICATION AND REMEDIES FOR NONCOMPLIANCE

A survey of state and other transportation agencies asked whether or not the agencies used certification acceptance in the approval of materials for use in construction. Virtually all (96 percent) stated that they do so to some degree. Most qualified their responses to limit the use to noncritical items, small quantities, or to items that the agency found impractical to sample and/or test. A corollary question in the same survey asked whether or not certification was able to ensure good quality. Approximately two thirds of the agencies expressed the belief that adequate quality could be obtained but most of these respondents added a qualifying comment to the effect that some sort of verification was essential. The one third who stated that certification would not provide assurance of acceptable quality were almost unanimous in their belief that verification is a must.

Thus it is clear that a workable certification procedure must include a system through which the specifying agency can be assured of the validity of the certifying document. All agencies commenting on the subject agreed that verification must be accomplished by random sampling and testing by the agency's representatives. However, to make these check tests truly significant, comparable test data generated by the manufacturer must be available for the purposes of comparison. This makes it necessary that the manufacturer be able to demonstrate to the agency that an adequate quality control testing system is being maintained during the production of the material for which a certification is being issued. The establishment of a system that will provide the producer with the information needed for control in terms that the agency can use for assurance depends first on the availability of standardized specification requirements and test procedures. This standardization should be supplemented by comparison tests of replicate samples by the concerned laboratories to assure the participants that test results are truly comparable.

The mechanics of verification systems and of certification procedures in general must of necessity vary because of variations in the characteristics of the materials being considered. The basic requirement that must be met is the establishment of a system that can provide a certification document that can assure the agency that its specifications are being met. Experience has shown that independent checks are needed from time to time to ensure continuing accuracy of the certifications. With some materials only a few properties need be tested to obtain an indication that all properties specified will be within acceptable limits. With others, visual observation of some physical property or even the presence of a recognizable stamp or marking may suffice. It is materials of these types that are most easily verified and as a result are most readily accepted on a certification basis.

Other materials have properties such that they may be readily altered by time, handling, contamination, or other external influences between the time they are produced and the time of use. For example, the viscosity of some asphalt emulsions tends to change with time and can also be altered by pumping. Often coarse aggregates or mixtures containing them can be segregated by improper dumping or other rehandling. In cases of this type the process of verification becomes difficult but not necessarily impossible. The specifying agency may have to determine whether or not the apparent change in test values truly reflects the existence of an off-test batch of material or is the result of some anomalous characteristic.

Unless a positive verification procedure can be devised and incorporated into a certification system, there is little likelihood that a certification document will be given any credence by the materials engineers responsible for the acceptance of materials used in the construction of transportation facilities.

The strong expression of the need for verification makes it apparent that past certifications have not always been acceptable. The suggested causes of these failures range from deliberate falsification to inherent instability of the materials. These matters need not be explored further here. However, corrective

action or remedies for noncompliance are of interest to the specifying agencies. Although it might appear to be desirable to indicate appropriate remedial action as a part of the certification acceptance program, it is not always practical to do so. Most agencies reserve the right to determine the nature and degree of corrective or punitive action on a case-by-case basis. This allows them to take into consideration the extent of noncompliance, the nature of the material, the previous record of the producer, and other factors they consider to be pertinent. Even though remedial action may not be spelled out in the certification program, it should be made clear that continued acceptance of materials by certification requires that (a) material supplied consistently meets specifications, (b) precision limits for quality control testing are met, (c) the originally approved quality control program is continued, (d) required records are maintained, and (e) shipments are properly documented.

The actual remedies include actions against the manufacturer, such as removal from an approved source list or the rescinding of a preferred producer classification under which the source is eligible to supply materials without prior inspection and approval. These actions normally result in more stringent inspection by the agency, if not complete disqualification, until corrective action has been taken by the producer and observed by the agency.

Other remedies are directed against the contractor. In some cases the suspect material must be removed and replaced at the contractor's expense. In others, where it is believed that the material will serve its intended purpose but to a less effective degree, it is allowed to remain in place but payment is made at a reduced rate or not at all. Where a direct mathematical association can be made between the degree of noncompliance as measured by one or more of the specified test characteristics of the material and the value of the structure to the owner in terms of service life or some other quantifiable property, it is possible to establish reduced payment factors in advance and include them in the specification as a part of the acceptance system. Regrettably, situations in which this combination occurs are rare in the specification and use of transportation structures. Such relationships are being sought in the FHWA's Federally Coordinated Program project 6G. Success in this and allied research efforts should simplify the process of establishing the cost to the owner of noncompliance by the contractor.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

Acceptance of materials used in the construction and maintenance of transportation facilities on the basis of certification by the manufacturer is a device that can be employed successfully by specifying agencies. Where it is properly conceived and implemented it can prove to be cost effective through the elimination of redundant testing and the avoidance of construction delays caused by the time required for sampling, testing, and evaluation. Certification acceptance can be conducted in such a way as to provide the owner with assurance that the items so covered are the quality specified.

There are certain necessary qualifications to the applicability of certification acceptance. The material or item concerned must be stable with respect to time and reasonably immune to contamination, alteration, or damage during shipping, handling, and installation. The certification must be issued by the manufacturer or producer responsible for putting the item into the form specified and certified. The manufacturing process involved must be continually controlled by an adequate quality control system. The specifying agency must be accorded the right of reviewing this system in advance and of having access to the data generated by it during and for a reasonable time following production of the material produced for use on its projects.

The point at which the sampling and testing from which the data supporting the certification are drawn must be clearly established. The producer can neither lay claim to nor be held responsible for success or failure caused by alterations to the item that are brought about by operations subsequent to certification. In the same way, the owner cannot assume that a certification made for some component early in the production sequence guarantees the quality of the finished product. Separate certifications may be needed to cover successive operations in a construction sequence. Items subject to usual inspection procedures may include the use of certified component materials without the assumption that the certification ensures the quality of the end product.

Wherever possible, the description of items to be accepted on the basis of certification should refer to standardized materials tested and evaluated by standardized methods. AASHTO and ASTM are the most common sources of such standardization. Testing facilities used for the evaluation of materials against the applicable specifications for use in the support of certifications should also be standardized by comparison testing and laboratory inspection by appropriate agencies. CCRL and AMRL are useful in this regard, as is direct testing of replicate samples by agency and producer laboratories.

Where available, statistically based evaluations of the test properties used in specifying materials should be employed in establishing the limits to be observed in determining the acceptability of the materials and the validity of the certification documents. The certification itself should contain, or indicate the ready availability of, data that demonstrate that the item has been tested and found to be in compliance with the agency's requirements.

Provisions must be made to verify certifications by check

sampling and testing by the accepting agency's representatives. Details, such as sampling frequency and location, as well as the specific properties to be examined should be left to the discretion of the agency to be adjusted as circumstances dictate.

The means for the agency to enforce reasonable remedies for noncompliance must be provided in the specifications but the mechanics and severity are best determined on a case-by-case basis.

Successful certification procedures have been formulated by agencies acting on recommendations of committees made up of their own engineers and local representatives of producers. (Another approach comprises the preparation of certification procedures by the agency with subsequent review and input from the producers.) Although allowance must be made for local customs and established procedures, such committees are well advised to examine systems already in use in other areas where such information is available.

Not all items or materials are appropriate for acceptance by certification. It may well be that new innovations in manufacturing techniques, specifications, or test procedures may be needed before a workable certification process can be devised for certain items. Attempts to implement certification regimens for their own sake may result in increased cost of the item without significant improvement in the quality or serviceability of the completed facility.

RECOMMENDATIONS

The following recommendations are directed specifically to the transportation agency interested in the formulation of a procedure for acceptance by certification. However, because such systems depend to a great degree on the participation and cooperation of a number of interested parties for their success, the features set forth herein should be of equal interest and assistance to the manufacturer, supplier, or contractor interested in the initiation of such procedures. The benefits to be derived from well-conceived and well-implemented certification acceptance regimens are shared by producer and consumer alike through the economies brought about by more consistent and efficient quality control and assurance operations.

Selection of the Item

The item to be considered must be one that is, or can be, specified by the use of test characteristics that reflect the utility of the item in use. Materials must also have a reasonable degree of stability in their physical characteristics from the time they are measured and certification is made, through shipping, handling, and use.

Formation of a Committee

The ultimate responsibility for preparing and implementing the procedure lies with the specifying agency. At the same time it is important that input be obtained from all parties who will have some part in the making, handling or using of the item.

The specifying agency should create a committee to be responsible for the recommendation of a certification procedure. This group could include agency personnel experienced in design, specification writing, construction inspection, and materials evaluation relating to the item(s) to be considered. Several individuals may well be needed to cover all of these disciplines adequately. If a local contractors' association is available it could be encouraged to provide representation in the form of one or more contractor's employees who are knowledgeable in the use of the item of concern. Lacking such an association, selection of appropriate individual contractor assistance could be made by the agency, possibly at the recommendation of the staff individuals already designated to serve. Where the item is one that is normally manufactured by an entity other than the contractor, representation on behalf of one or more of the leading producers currently supplying the item could be sought. Circumstances can also be envisioned where transporters or other intermediate handlers should be included. A local representative of FHWA could also be asked to serve in the group. In some cases, consultant or commercial testing agencies may be in a position to provide assistance. In short, the group should be made up of people familiar with the item in question, current specifications, and local use and experience with it.

Review of the Specification

If the certification is to be of value to the specifying agency, it must be made in terms of that agency's own specification. At the same time, experience has shown that certification programs work best when well-standardized specifications and test methods are used. The study of a potential change in acceptance procedures for a material also provides an ideal opportunity for a review and possible updating of specifications describing the material. This is particularly true where the study group has been selected for its knowledge of the use of the specific material.

It may be found that in some cases the agency and the industry involved will each be better served if the certification process is introduced as an acceptable alternative to existing sampling and testing methods.

Review of Test Precision

As a part of the specification review, the precision and accuracy of the tests used in the evaluation of the material should be determined. Local experience, controlled comparison tests, and any available published precision information should be reviewed so that statistically valid limits of test values can be established for control and acceptance.

Adjust Specification

To the extent appropriate, the committee should propose and the agency consider specification revisions that will enhance the certification process if it can be done without sacrificing quality or uniformity of the finished product.

Quality Control Evaluation

An evaluation procedure and a set of minimum standards to be applied in the examination of candidate certifier's quality control systems should be developed. The procedure should cover such features as sampling location and frequency, test techniques, control limits, data reporting, and record keeping.

The evaluation should also reveal for the agency's information the steps through which the producer intends to adjust the process and correct any off-test trends as they are shown by the quality control system. These detailed standards need not be included in the agency's specification for the item in question except by reference but must be available for the information and use of interested manufacturers.

Verification

An appropriate plan for verification of compliance must be established. This plan should be based on the established precision and accuracy limits for the tests involved. It should recognize the possibility of differences among competing suppliers in the areas of capability, productive capacity, and desire to cooperate. With these differences in mind it is appropriate that the agency provide enough flexibility in its check-testing program to permit it to concentrate its efforts where they are most needed.

Documentation

Necessary forms and the most efficient flow of paper should be established so that the agency's field personnel are afforded timely assurance of compliance. Paper should be kept to a minimum, consistent with adequate communications, and all producers of a given item should be required to follow the same documentation procedures.

Coordination

As it happens, many of the items that lend themselves best to acceptance through certification are also items that are fairly well standardized nationally. In addition, quite frequently the same suppliers provide identical items to several agencies within a given area. Agencies or their duly appointed committees examining the feasibility of certification acceptance of a particular item should examine existing systems in the area with a thought to possible coordination as a part of their study. Where no such procedures are already in existence, contact with neighboring agencies might lead to a multistate effort to the benefit of all concerned.

Issues to Be Addressed

Because of the diversity in the characteristics of the materials and the processes through which the materials are produced, it is not practical to set forth a single certification acceptance plan that can be applied to all situations. However, the following list sets forth the major questions that must be addressed in arriving at a workable certification system for a particular item.

1. Is the material reasonably stable with respect to the specified characteristics?
2. Do the specified characteristics relate to the performance of the material in use?
3. Are the specified characteristics and the test methods by which they are measured generally recognized and accepted in the industry?
4. Is the certifying entity the one responsible for the production of the item?
5. Do the producers of the item maintain an effective quality control system?
6. Are the quality control records readily available to the using agency?
7. Does the certification provide assurance that specified component materials have been used?
8. Does the certification document provide data that are truly representative of the material delivered to the project?
9. Can all of the certified material used in the project be positively identified with the certification?
10. Has the using agency made provision for adequate random independent verification sampling and testing?
11. Can the frequency and intensity of verification testing be increased or decreased as the situation demands?
12. Has provision been made for appropriate remedies for noncompliance?
13. Is the system truly cost effective?

Although it may not be possible or even appropriate to provide an ideal resolution to each of these considerations in each case, all should be examined. At worst, the agency will be able to recognize any weaknesses in advance and direct its efforts toward the development of appropriate adjustments.

APPENDIX

SUMMARY OF QUESTIONNAIRE RESPONSES

The following tabulation summarizes the responses received to a questionnaire sent to 59 member agencies of the AASHTO Subcommittee on Materials. A total of 49 returns were received.

1. Do you accept materials based on certification of their quality?

   a. 2 No
   b. 23 Yes, when the item(s) involved are considered to be noncritical to the successful use of the facility.
   c. 23 Yes, when the quantity of the item(s) is small.
   d. ___ Yes, when (please state limitation).
      - 17 impractical to test components and/or item.
      - 10 manufacturer has a good track record.
      - 8 item is manufactured under strict Q.C. procedures.
      - 3 accompanied by certified test report.
      - 3 special test at distant location.
      - 2 allowed in specification and supplemented by our own sampling and testing.
      - 1 tested according to AASHTO, ASTM, or our own specification.
      - 2 (no limitation cited)

2. Do you feel that certification provides adequate control of quality?

   a. 30 Yes
   b. 16 No

   Comments:
   - 17 if subject to check sampling and testing.
   - 9 variation in quality of certification; false documentation; not worth the paper; etc.
   - 7 under certain circumstances; in most cases.

3. The following list includes the most common justifications for the use of certification in the acceptance of materials for transportation facilities construction projects. Please check those that normally apply to your agency.

   a. 43 Need for special test equipment
   b. 33 Cost of inspection or test
   c. 28 Distance to vendor
   d. 26 Time required for test
   e. 28 Noncritical item
   f. 35 Small quantity of items
   g. ___ Other (please state):
      - 4 Experience with manufacturer
      - 2 Cost of item
      - 2 Lack of personnel
      - 2 No appropriate test

1 Still need independent checks
1 Infrequent use
1 We've always done it

4. Certifications are generally based on inspection, sampling, and field or laboratory test data generated by one of the following entities. Please designate those you consider to be acceptable sources of information for certification.

a. 43 Consultant or commercial testing agency
b. 7 Contractor's lab
c. 47 Federal, state, or other public agency
d. 41 Manufacturer's lab
e. 4 Middleman (hauler, bulk station, etc.)
f. ___ Other (please state):
2 our own lab
1 subject to periodic check
1 where no conflict of interests.

5. On occasion certifications are offered along with representative test data showing compliance with a specification other than that of the using agency. Which, if any, of the following would you accept?

a. 12 Another state
b. 22 AASHTO
c. 21 ASTM
d. 18 Federal
e. 9 Trade association (e.g., PCA, TAI, AWS, NAPA, etc.)
f. 5 Manufacturer's own
g. ___ Other (please state):
20 none
1 each case on its own
1 independent lab
1 previous use

6. Certifications are sometimes offered without substantiating data but with assurances that the material will comply with certain standards. Which, if any, would you accept?

a. 18 A range of typical test values.
b. 36 The statement that the material will meet your spec.
c. 16 The statement that the material will meet some national standard.
d. ___ Other (please state):
8 AASHTO
7 ASTM
1 APWA
1 UL label
1 Federal
1 depends on item
1 if applicable to our spec

7. Certifications vary in the amount of material they are expected to represent. Does your agency require that a certification cover:

a. 41 A single identifiable lot
b. 27 A stipulated unit of production
c. 11 Material produced within a stated period (how long)
2 one year
1 six months
1 one day
2 depends on material and/or performance history
d. ___ Other (please state):
4 one project
2 each delivery
3 varies

8. How do you verify that the material delivered is up to the standard stated in the certification?

   a. 22 Comparison tests with certifying lab
   b. 17 Shipping ticket identification
   c. 19 Tabs, stencils, etc.
   d. 40 Tests of random samples from job site
   e. 7 Not at all
   f. ___ Other (please state):
      1 samples from producer
      1 varies

9. What do you do about noncompliance?

   a. 28 Disqualify as approved source
   b. 43 Require removal
   c. 40 Reduced payment
   d. ___ Other (please state):
      9 varies
      1 require prior to use tests on future work

10. The list of materials below includes most of those offered for acceptance by certification. Please mark those that you might handle this way assuming that a certification in which you had complete confidence was provided. Designate those that you always accept this way with an "A" and those accepted under limited circumstances with an "L."

    (The responses to this question are tabulated in Tables 1, 2, and 3 in Chapter Two.)

11. Certifications are sometimes furnished attesting to the capabilities of personnel who will provide some service to your agency or to a contractor working on a facility for your agency. For which of the following would you require such a document?

    a. 0 Equipment operators
    b. 14 Inspectors
    c. 9 Plant inspectors
    d. 17 Test technician
    e. 39 Welders
    f. ___ Other (please state):
       1 NDT operator
       1 aggregate technician

12. Equipment to be used in construction or the control of construction is sometimes required to be certified by an appropriate agency. Which of the following do you handle in this way?

    a. 7 Asphalt mixing plants
    b. 7 Concrete mixing plants
    c. 7 Concrete mixer trucks
    d. 2 Pavers
    e. 43 Scales
    f. 14 Testing equipment
    g. 1 Rollers
    h. ___ Other (please state):
       1 automatic plants
       1 bituminous distributors
       1 prestressed concrete plants

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