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MATES

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THE BEGINNING OF THE "END"

During the past several years, as the Department's work force has shrunk and with the loss of experienced technical personnel, there has been an admirable but often frustrating effort to continue the same high level of construction control as in the past. Realizing that it is impossible to inspect as closely with a smaller and less experienced staff, some engineers have begun to look hopefully at "end-result" specifications as a possible way to exercise more control—and thereby maintain product quality—with less staff.

If one were to ask several different scientists, engineers, or technicians for a definition of end-result specifications, the differences in answers would probably be surprising. The differences wouldn't necessarily reflect a lack of knowledge but rather would show how broadly the term "end-result specification" may legitimately be interpreted. To come to a mutually acceptable definition, we must first know the definitions of the terms "acceptance testing," "quality control," and "quality assurance."

1) Acceptance testing - measurements of dimensions, physical properties, chemical properties, etc., done by the consumer to ensure that the item being purchased meets specifications before it is accepted for use on the project.

2) Quality control - the activities of the contractor/producer to control and ensure that work performance provides the quality specified. These activies can include calibration of scales, meters, etc., as well as check tests on the product. The goal is for the producer to prevent chronic troubles by discovering them when they begin to occur, finding the causes, and providing a permanent remedy.

The producer wants to correct production problems before producing a large quantity of material that will be rejected by the consumer after acceptance testing. The Department has performed these activities for the contractor in many instances in the past, and in those cases the contractor was relieved of the responsibility for the product by virtue of having been told every step to take. The attitude of some contractors, and some persons within the Department, has been that the State inspector is responsible for stopping a contractor when defective material is being produced. If later tests showed material to be defective, and no action had been taken by the inspector, the contractor was not held to be fully responsible.

3) Quality assurance - includes all those activities that have to do with providing confidence that the quality of a product is what it should be. Quality assurance begins with the grade inspection, includes preparation of plans and specifications, quality control by the contractor, and ends with acceptance testing by the consumer. Quality assurance is the umbrella that covers all activities related to obtaining a desired product.

What is End-Result Specification?

The American Association of State Highway and Transportation Officials' standard definition of end-result specification is, "A specification that places the entire responsibility on the contractor or producer for supplying an item of construction or material of specified quality." Notice, there is no requirement that the contractor/producer do any acceptance testing. There is nothing said about statistical sampling procedures. Nothing is said about where, in the construction or production process, quality control or acceptance testing should be done, or about lot size. (A 'lot' is a measured amount of production assumed to be produced by the same process.) Such a broad definition could be interpreted to mean that acceptance testing is done by the consumer after completion of an entire project, or it could be considered as acceptance testing of a specified unit of work after completion. (Acceptance of concrete pavement for thickness has been on an end-result basis for over 40 years.)

The Relationship Between Contractor and MDOT

The key to MDOT end-result specifications, however, is that the contractor/producer would have the responsibility for producing work of a certain quality without our providing any services to help control quality during production. Quality control would be done entirely by the contractor. Upon completion of a unit of work, MDOT would simply test the product and reject or accept it at either full or reduced payment.

Let's consider the most drastic form of end-result specification; one where we would simply give the contractor plans and specifications and set him or her free to build a pavement or bridge. After the job was completed, we would take a number of samples and test them for compliance with specifications. If we waited until the job was completed before testing, however, there are some important properties that we would be unable to non-destructively evaluate, such as dowel bar alignment, proper number of dowels in pavements, reinforcing steel placement in bridges, and many others. We would be entirely dependent upon the honesty and proficiency of the contractor.

If all tests were passing, everyone would be happy. MDOT would pay in full and there would be few, if any, disagreements. If, as would happen in many cases, tests showed that quality of all or some components did not meet specifications, the struggle would begin. First, any contractor would insist on more acceptance tests. There is always a chance that the first tests were not really indicative of average quality. On the other hand, the second or third group of tests, just by chance, might be taken in an area of exceptionally high quality causing MDOT to pay in full for a product whose average quality did not meet specifications. Next, if follow-up tests still indicated poor quality, what should the penalty be? Removal, replacement, or reduced payment? The Department is usually more anxious than the contractor to open or reopen a bridge or pavement. How long would the struggle last before one side gave in? If monetary penalties were severe enough, how often would the courts be called on to

make the final decision after long argument? It seems, then, that some less drastic form of end-result should be considered.

A Relationship That Could Work

Let's consider a more workable approach. One where as each stage of a job is completed—such as subbase, base, and pavement—it is tested and either accepted or rejected. Further, the work within each stage is broken down into reasonably sized lots that are tested as soon as they are completed. Both MDOT and the contractor would be alerted to any problems while they were still manageable and where a penalty would not be disastrous.

We know that some contractors have a complete quality control capability, but that many depend upon the Department to perform most quality control functions such as preparing mix designs, making extraction tests on asphalt mixtures, or air-content tests on concrete. There would be chaos if MDOT suddenly backed-out and said that, henceforth, quality control is the contractor's problem, while the Department's role is to only do acceptance testing.

It would make more sense to require that contractors on end-result jobs have a specific quality control system in place before the job begins. The Department could draw upon its years of experience in quality control, to require that a minimum number of tests be done in accordance with strict procedures and through the use of certified technical personnel. All contractors on end-result projects would then have a uniform quality control system that MDOT could easily monitor. The Department would simply take a certain number of samples for check testing the contractor's system in a manner similar to the current certification program.

Although the Deparment would still do its own acceptance testing of completed units of work, major effort by MDOT inspectors in the field would be directed toward monitoring the contractor's quality control operation. Also, some acceptance could be based upon the contractor's tests. This system would meet the criteria for an end-result specification system that would optimize the use of Department inspectors, get the contractors more involved in watching quality, and cause a minimum of confusion during system installation.

In a later MATES issue, we will discuss the details of how an effective end-result system might be implemented by MDOT.

-Fred Copple

TECHADVISORIES

The brief information items that follow here are intended to aid MDOT technologists by advising or clarifying, for them, current technical developments, changes or other activities that may affect their technical duties or responsibilities.

MDOT RESEARCH PUBLICATIONS

Evaluation of Lime, Fly Ash Base Course Mixtures: Construction Report, Research Report No. R-1281, by V. T. Barnhart. This is the initial construction report describing the construction of shoulder base courses using bituminous and aggregate mixtures containing fly ash. Cooperating in this project are the Federal Highway Administration, the University of Michigan, and the Michigan Ash Sales Co., in an attempt to discover possible uses for this industrial by-product. The experimental installation, on M 29 in St. Clair County, involved constructing shoulder bases using two types of fly ash material: fly ash-extended bituminous base course, and a lime/fly ash/aggregate base course, along with control sections of conventional bituminous base course. The fly ash-extended bituminous base was installed without difficulty; there were some minor installation problems with the lime/fly ash/aggregate base, but it did not appear that these would affect the integrity of the shoulder cross-section. Condition surveys, performance evaluations, and core-extraction for laboratory testing will be conducted for the next three years. Subsequent reports will be issued as significant findings appear.

MATERIALS ADVISORY

Battery-Operated Warning Flashers. Tests of warning lights randomly selected from construction projects have shown that the intensity of some is sub-par due to low battery power, and also because of the use of some makes of bulbs manufactured outside of the U.S.A. The better performing flashers contained industrial strength rated batteries (labeled variously as: 'Eveready Super Heavy Duty,' 'Duracell Alkaline,' 'Hercules HS90 or HS 190,' 'Panasonic Long Life,' or 'Rayovac Heavy Duty No. 944,' or equivalent). The brighter flashers have bulbs of domestic manufacture. The name of the country or origin is usually stamped on the base of the bulb.

Flashers should be maintained with heavy duty batteries and proper lamps so that they will be visible from a reasonable distance, approximately 3,000 ft on a clear night, for a Type A Low Intensity Flashing Warning Light, and approximately 1,000 ft during a sunny day for a Type B High Intensity Flashing Warning Light. We will again be sampling warning flashers for testing as soon as the 1987 construction season gets underway. Project personnel can ensure better performance by checking for the types of batteries and bulbs indicated above.

-George Smith

NEW MATERIALS ACTION

The New Materials Committee recently:

Approved the following products:

- Flex Block Armored Stabilization Mattress
- Geoweb Soil Stabilization System
- Bar-L-Cade Plastic Barrel II
- PB-85 Commander Plastic Barrel
- PB-55 Econo-Drum
- Keligrout Chemical Anchoring System
- Celtite 21-30 Anchortite Epoxy Grout
- Celtite Resin Cartridges
- Celtite 21-24 TX Grout
- Celtite Anchorbond

For details contact Don Malott at (517) 322-5687.

SPECIFICATION UPDATE

Temporary Steel Sheet Piling, 5.01 (1), dated 08-26-86. This is a new specification which requires the Contractor to design the temporary steel sheet piling. The reason for the specification is to permit the Contractor to use his own preferred sheeting technique and stock of sheeting panels, as this is information not available to the Design Division.

Permanent Steel Sheet Piling, 5.01 (2), dated 08-27-86. This is a new specification which changes the required section modulus from 5.4 to 18.1 cu in. per ft of wall for permanent steel sheet piling. The reason for the change is that the steel industry has discontinued the production of the section designated as PMA 22 (section modulus 5.4) and is now producing a different shape (section modulus 18.1) which weighs approximately the same as the discontinued section PMA 22. Further, the specification requires that the hot-rolled steel type be used unless the cold-rolled sheeting is permitted on the plans or authorized by the Engineer. The Project Engineer should contact the Design Engineer - Bridge, before permitting the cold-rolled sheeting if the cold-rolled sheeting is not called for on the plans.

This document is disseminated as an element of MDOT's technical transfer program. It is intended primarily as a means for timely transfer of technical information to those MDOT technologists engaged in transportation design, construction, maintenance, operation, and program development. Suggestions or questions from district or central office technologists concerning MATES subjects are invited and should be directed to M&T's Technology Transfer Unit.

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