Robert D. Schmidt, Illinois Department of Transportation, chairman

Workshop Topic 6 PRODUCTION AND CONSTRUCTION TECHNIQUES

The 3 groups that discussed this topic perceived the objective and approached the problem from different angles, but generally came to the same conclusions. The discussion, which centered on 3 main subject areas, is summarized below. The order of listing under each heading does not indicate any priority of importance.

ACCEPTABLE CURRENT PRACTICES AND TECHNOLOGY

1. Permit higher moisture contents in aggregate and lower mixing temperatures in a conventional hot-mix asphalt plant.

The range of moisture and temperature should be similar to that used in dryer-drum plants. This is now being done in Oregon. Several times during the discussion the use of dryer-drum mixers was described as an accepted practice. Dryer drums are apparently being permitted by all the states when a contractor requests their use in areas where there are a large number of fixed plants. However, dryer drums are not expected to come into widespread use in the near future.

During the discussions, the question was raised as to whether the higher moisture contents and lower mixing temperatures used in the dryer-drum mixer process could also be used in the conventional hot-mix plant operation. Everyone agreed that the moisture content of in-place hot-mixed material is much higher than the moisture content of the freshly mixed material. Oregon engineers examined this question and decided that the higher moisture contents in conventional hot-mix plant operation probably would not affect the mix most of the time. Consequently, they are not requiring the usually low moistures that have been prevalent in conventional hot-mix operations. They are also permitting mix temperatures as low as 190 F (88 C). All of this is being done with apparent successful results even in areas where the humidity is high most of the time. The main control being exercised is to reject the truck load of mix showing obvious deficiencies because of excess moisture in the mix.

2. Permit uniform width ramps on interchanges with tapered ends to be defined by paint or seal coats.

The construction of interchange ramps is an expensive operation because of the long delays required. Because this is slow work, energy is undoubtedly unnecessarily expended while the pieces of equipment have to wait. Participants in the discussion speculated that, if the interchange ramps could be placed in a uniform width, using the same slip-form equipment as is used on the main line, the whole operation could be speeded up. This would result in fewer delays during construction, a smoother ride on the finished surface, lasting benefit to the driving public, no apparent loss of efficiency, and possible lower cost.

3. Standardize repetitive dimensions on bridge designs to permit maximum reuse of forms.

Bridge contractors have long made the point that designers have failed to standardize repetitive dimensions on things such as columns, footings, beam spacing, bridge curbs, and bridge skews. All of these things cause waste of form lumber, of specially built metal forms, of carpenter time, and of energy used for air compressors, portable generators, and other pieces of equipment used in the operation. Standardizing many of these dimensions would not affect the appearance of the structures and could well result in considerable saving of material and possible saving of energy.

4. Permit surfaces for structural concrete to be painted with epoxy, acrylic, or other plastic materials instead of being rubbed.

Although epoxies, acrylics, and plastics are energy intensive, the amount of these materials needed to coat concrete surfaces is relatively small. There is also considerable energy involved in running air compressors or portable generators for long periods of time during the slow, laborious process of rubbing concrete surfaces. In addition, many felt that the process of rubbing structural concrete reduces the durability of the surfaces and results in a loss of material effectiveness. The other obvious alternative, of course, is to eliminate any surface treatment of the structural concrete.

5. Reexamine hot-mixed asphalt lift thickness requirements to reduce passes with lay-down equipment and permit maximum use of vibratory rollers.

Many states and contracting agencies have limitations on lift thicknesses for hot-mixed asphalt that may be a result of historical problems caused by low plant production, underpowered pavers, or compaction difficulties due to the types of rollers being used. There has been a rapid development in all of these types of equipment, and the maximum lift thickness should be determined after attempts have been made to place much thicker lifts using equipment currently available.

6. Reexamine restrictions on cold weather construction to determine whether changes are possible as a result of recent equipment developments and protective materials now available.

Because of the need to complete many projects, much work is done during the cold weather season. Working during cold weather allows maximum use of equipment and reduction of peak load demands on equipment manufacturers, material producers, and labor. Spreading the use of equipment and labor over a longer time period is certainly more efficient. Most of the cold weather specifications were prepared for protective materials used during World War II. Since then, plastic insulation with extremely long surface life and equipment that permits cold weather operations with no sacrifice in quality of the finished work have been developed. A complete reexamination of the specifications is not advocated, but a serious review of the efficiencies of these new methods should begin as soon as possible.

7. Develop procedures to routinely use hydrated lime and quicklime, cement, fly ash, and other available products to modify or stabilize earth materials in subgrade locations or in areas that will permit work to continue in wet weather or in wet materials found on the site.

The availability and suitability of agents such as quicklime, fly ash, and conventional additives have opened up new possibilities for continuation of construction work during inclement weather. In addition, there is a growing belief among many engineers that subgrade stabilization or strengthening of the earth support of pavement structure is a necessary element in proper pavement design. The possible benefits to be gained from procedures for inexpensively strengthening the earth subgrade are exciting. More practical effects include solving availability problems, providing readily available trucking facilities for these materials, and providing an opportunity for the contractors and engineers in the field to gain experience and understand the use of these materials. Contractors have said many times that the states will save money in the overall construction cost when they agree to provide a stable working platform that the contractor can use as a haul road and as protection against rains, which cause delays in construction operations and associated loss in money and wasted energy.

8. To minimize equipment delays, use nuclear density gauges and nuclear moisture gauges on a routine basis for inspecting and accepting materials.

The construction operations today move at a much faster speed than those of a few years ago. The equipment is more sophisticated, the materials are better understood, and production schedules require a rapid construction operation. The contractor can no longer be expected to wait several hours for a test result that will determine whether a large-scale operation can be continued. Energy is wasted when equipment is idling. Demonstrations have shown that nuclear equipment can be used for many construction control tests, and states or contracting agencies should make the maximum possible use of this equipment. It reduces the costs of personnel, equipment, and materials and delays to the contractor. Information on the types of tests that can be made with nuclear equipment should be made available to all states so that they can use this equipment without a long introductory period.

9. Permit surge bins and storage bins for hot-mixed asphalt so that plant capacity is fully used and permit minor plant adjustments so that truck fleets are more fully used.

The batch hot-mix plant appears to be the predominant type of equipment used in the United States. This type of plant results in periodic delivery of the mix and a set amount of material being ejected from the plant at any time. These and other factors cause problems in scheduling trucks and fully using their carrying capacity. The use of surge bins or storage bins between the plant and the truck provides a flexibility to the plant operation so that the truck fleet is fully used and energy is not wasted. Information on methods for using these bins should be made available to all states and contracting agencies so that regional restrictions will not be placed on their use because of unfamiliarity with them.

10. Make greater use of in-place mixing of on-site materials.

One of the results of the development of sophisticated equipment appears to be elimination of in-place mxing of on-site materials. A few years ago a common sight was a traveling mixer incorporating cement, lime, bituminous materials, and water into materials that existed on the site. Although this type of operation is inexpensive, provides exceptional uniformity, and likely uses a low amount of energy, it is seldom used now because of the availability of more sophisticated equipment and the tendency to require an imported aggregate. The structural capacity of the facility that is being built should determine whether improved methods are needed. Engineers should examine the product desired to make sure that it cannot be built by using the old-fashioned but still effective methods.

11. Provide specifications to permit and encourage slip-form placement of barrier walls, bridge curbs, curb and gutters, and other miscellaneous items.

The use of the slip-form paver has had difficulty in gaining approval throughout the country, but now appears to be universally accepted. Experience has shown that the items mentioned above, which are built of concrete or hot-mixed asphalt, can be formed, consolidated, and finished effectively with a slip-form operation. Specifications should be examined to remove any restrictions to this type of operation. The last paragraph of article 108.05 in the AASHTO guide specifications adequately covers the possibility for changes in operation by the contractor.

12. Provide stability in the work program from year to year and in the types of work and specifications.

The items of construction progress and specifications appear to be highly related to the energy use of a contractor. Workshop participants, however, indicated that the overall operations of a construction contractor are seriously affected by fluctuations in the type of work being advertised on lettings and by sudden chances in major specifications. These large variations make it difficult for the contractor to plan equipment purchases, organizational changes, and operating capital needs and to retain supervisory personnel who understand the state's specifications. Major changes in any of these items may require complete change in equipment types, relocation of contracting operations, opening or closing of quarry operations, and resultant loss of money, time, and energy in making all of these adjustments.

INNOVATIONS THAT MIGHT BE TRIED

1. Design bridge decks that will permit pavement operation to be continuous across the structure to eliminate costly approach construction and lost time in

moving across or around the structure with equipment and materials.

For many years, a problem throughout the country has been the bump at the end of the bridge. No state has completely and successfully solved this problem although a large amount of money is spent every year in attempts to solve it. In addition, the serious hindrance to continuous paving is the necessity to move equipment and materials across a bridge or around it. The state of Texas, among others, has tried the innovation of continuing the regular pavement operation across the structure. This pavement probably does not provide any structural support to the bridge and, in fact, may cause an additional dead load to the bridge. To determine whether there is a saving in energy with this type of operation will require much more experience with it.

2. Design bridge decks to use precast, prestressed thin concrete panels to serve as bridge deck forms and also as part of the load-carrying capacity of the bridge.

Several bridges in the state of Texas and elsewhere have been constructed with precast panels, which offer the possibility of continuing work during inclement weather and also eliminate time-consuming operations at the job site. In addition, both the amount of concrete and the amount of steel placed at the job site are reduced. The result is a saving of time, and an investigation should determine whether there is a saving in energy.

3. Adapt high-pressure water tunneling excavation technique to roadway rock excavation operations in urban areas.

The successful use of high-pressure water tunneling is relatively new and is still being developed. If successful, the process may be adaptable to roadway rock excavation in urban areas or in areas where explosives are not usable because of objectionable noise from the rock drills and damage from blasting. This high-pressure water method might require a large amount of energy, but it could well be energy in a form more available than that used in blasting.

4. Use laser beams for grade and line controls on excavators and pavers.

Use of laser beams with curvilinear alignment might require minicomputers to control grade properly.

5. Build dense mats or bituminous base courses with emulsion.

This will provide an opportunity to gain experience regarding aggregate-emulsion compatibility, effects of weather conditions, emulsion consistency, effect of water quality, effect of crude base on emulsion, and possibility of making emulsion on site immediately before use to eliminate the need to transport large water quantities.

6. Adapt aggregate dryers to burn coal.

A contractor in Texas is working on the use of coal to provide heat in the aggregate drier for a hot-mix plant operation. The coal is burned in a powdered state and in a controlled atmosphere. This type of burner is difficult to start but has no serious technological problems. Power plants throughout the country are using this type of burner to power generators, and an Ohio contractor stated that his company's asphalt plants have used coal as a power for dryers. Whether the Btu requirement is any less and may, in fact, be greater is not known, but the trade-off from a scarce energy source to a readily available energy source might have great advantages.

APPLICABLE RESEARCH NEEDS

1. Develop ways to minimize handwork wherever it is still performed.

Elimination of handwork at first glance may not appear to offer any savings in energy, but the use of handwork in construction operations seldom occurs by itself. Handwork in a construction operation usually occurs in the middle of the massive mechanized operations. The handwork also is, in many cases, not so exact or reproducible as mechanical work. Eliminating handwork would reduce energy loss in preceding and subsequent operations that are delayed or made less efficient by handwork.

2. Determine the maximum thickness of hot-mixed asphalt that can be successfully placed under various conditions and applications.

Workshop participants had various opinions as to the proper dimensions for the maximum thickness of hot-mixed asphalt that could be placed. Many limitations and present specifications do not appear to be based on actual field experience. The result is that equipment may be underused or that additional energy is being used to provide aggregate at a smaller size merely for the purpose of accommodating a thinner lift. In addition, the capability of pavers or rollers may be wasted if they are never used to maximum capability.

3. Develop a test method to measure consolidation of concrete to permit proper use of consolidation equipment, maximum paver speed, and proper finishing methods that will ensure good rideability and skid-resistant pavement texture.

4. Determine objective and reproducible tests to measure noise, air quality, water quality, and safety requirements that give proper attention to energy and material requirements to attain standards.

5. Develop methods, equipment, and additives to permit more efficient drying of earth materials being placed in compacted embankments.

It became obvious during the discussions that the problem of drying earth materials is a major deterrent to construction progress. Much of the time spent on a construction project is consumed during the building of the earth embankments or earth cuts. This operation is almost totally dependent on the weather for any drying action that occurs in the material. Excavating wet material and pulling disks or tillers through it require a great amount of energy. An improved method might require more money or materials, but it may save energy.

6. Make a complete systems analysis of quarry operations or crushing operations in the production of aggregates to determine the energy requirements needed for various gradations and quality of aggregates so that energy needs of aggregates can be considered during specification preparation.

7. Update the report on fuel usage factors.

The report could be enlarged by the TRB Committee on Construction Equipment to include other features that users might find desirable.

8. Prepare a state-of-the-art report on performance specifications or end result specifications.

This report would demonstrate where this type of specification could best be used and would also discuss the amount or type of data base needed for implementing successful performance specifications.

CLOSING REMARKS

The 3 major ideas that resulted from discussions under this topic are

1. Using higher moisture contents and lower temperatures in a conventional hot-mix plant,
2. Burning coal in an aggregate dryer, and
3. Developing a state-of-the-art report on performance specifications and associated data base.