Commission Briefing Paper 4I-01

THE POTENTIAL OF ADVANCED CONSTRUCTION MATERIALS TECHNIQUES AND TECHNOLOGIES TO ALLOW CAPACITY INCREASES WITH REDUCED COMMUNITY DISRUPTION

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Introduction

This paper is part of a series of briefing papers to be prepared for the National Surface Transportation Policy and Revenue Study Commission authorized in Section 1909 of SAFETEA-LU. The papers are intended to synthesize the state-of-the-practice on issues that are relevant to the Commission's charge outlined in Section 1909, and will serve as background material in developing the analyses to be presented in the final report of the Commission.

This paper presents information on the benefits that recent and anticipated advances in construction materials, techniques, and technologies can provide in the design and construction of transportation infrastructure. In particular, the potential to accelerate construction activity and otherwise reduce community disruption during construction is assessed.

Background and Key Findings

Historically, transportation procurements have focused on identifying the lowest initial investment cost rather than minimizing the ongoing lifecycle costs of building and maintaining transportation infrastructure over time. Similarly, investment decisions driven by low initial cost usually have not considered the economic costs of traffic delays, safety, or quality-of-life associated with construction projects. Against the backdrop of limited resources and pressure to implement as many projects as possible, the challenge is to make investment decisions that will achieve long-term lifecycle savings. Key means for achieving these goals include:

- Mainstreaming life-cycle cost decisions into planning, design, and implementation;
- Accounting for the economic benefits of accelerated construction;
- Reducing emphasis on minimizing initial implementation costs;
- Supporting research on new materials and quantitative systems analysis;
- Providing flexibility to use research funds to respond to new ideas and findings;
- Documenting and incentivizing best practices; and
- Promoting and disseminating best practices through programs such as the Highways for LIFE program and the Accelerated Construction Technology Transfer (ACTT) program.

1. Motivations for using advanced materials, techniques and technologies to allow capacity increases with reduced community disruption.

The essence of good engineering is efficiency. While the surface transportation sector has embraced this ethic in the United States, Federal and State procurement law and practice has focused on achieving the lowest initial investment cost rather than minimizing the overall lifecycle costs of building, operating and maintaining transportation infrastructure over time.

There are two emerging changes to this philosophy. The first is a movement within departments of transportation (DOTs) towards an asset management philosophy. While there are many obstacles – including limited capital funding, the need to implement multiple projects, and the need to distribute construction funds with geographic equity across entire states – the desire to seek lifecycle optimization is driven by internal business efficiency objectives of maximizing benefits and minimizing costs and disruption over time.

The motivation to reduce community disruption stems from an increasing outward focus on customers. FHWA estimates that roadway construction is responsible for 10 percent of the congestion in the United States. Using 2003 estimates prepared by the Texas Transportation Institute, the 85 largest metropolitan areas in the U.S. experienced 370 million vehicle-hours of construction-related delay, wasting 230 million gallons of fuel and $6.3 billion in lost economic productivity. These numbers are mere indicators of the palpable impacts on people, on businesses, and on entire communities and their social and economic wellbeing too often associated with surface transportation construction and repair.

Construction methodologies have been driven historically by the cost of the project rather than the cost to the community. The change in priorities to reflect community impacts is evidenced in Michigan where legislation was enacted requiring the state to take user costs into consideration when considering transportation improvements.

The Federal Government encourages DOTs to minimize community impacts and follow asset management principles. The Accelerated Construction Technology Transfer (ACTT) program was established in 2003 with the goal of publicizing effective solutions that enable transportation projects to be constructed more quickly and with fewer impacts to surrounding communities. The program revolves around 2-day workshops with participants drawn from a 175-member national resource pool comprised of 11 different skill sets. Thirty-one ACTT workshops have been held focusing on projects ranging from $1 million to $3.5 billion. Each workshop has resulted in a number of recommendations, many of which could be applied to other projects, both locally and nationally.

SAFETEA-LU initiated Highways for Long-lasting, Innovative, Fast construction of Efficient (LIFE) and safe pavements and bridges pilot program. The “Highways for LIFE” pilot program encourages the use of new technologies to build better quality and longer lasting transportation improvements and reduce congestion caused by construction. The program provides up to $5 million in supplemental funding for projects that provide best practices in the use of technologies and is assembling a library of case studies.

Although our transportation decision making and resource allocation policies remain largely focused on minimizing the initial cost of investments, we appear to be on the cusp of identifying more optimal solutions to build longer lasting project with reduced community impacts. DOTs around the country are utilizing a variety of advanced construction materials, techniques and procurement tools to expedite the completion of transportation improvement projects and build longer-lasting and better performing facilities with reduced community disruption stemming from shorter construction schedules and less frequent maintenance and repair. The following section of this paper identifies the various innovations that DOTs are using to expedite the construction of projects and optimize life cycle costs.

2. Techniques to allow capacity increases with reduced community disruption

2.1 Advanced Construction Materials

New research is being conducted to improve the quality of construction materials to extend durability and facilitate quicker construction. Recent advances have been made in concrete and steel, which remain the most important materials for structural work. Improvements in asphalt and concrete paving materials are also increasingly being applied in practice. Notable advances include:

Ultra-high performance concrete (UHPC). UHPC includes a matrix of steel fibers that increases its tensile strength. It also lacks the coarse aggregates common in other types of concrete and instead includes fine particles of sand, ground quartz, cement, and silica fume. This results in a dense material that is difficult for water to penetrate. With less potential for corrosion to embedded steel the material has greatly expanded durability. Although UHPC costs up to ten times as much as more conventional concrete mixes, structures using UHPC last longer and require less concrete. Despite the higher density, pre-cast bridge elements are lighter because of their greater strength. They are easier to transport and can be put into place more quickly, reducing disruption as well as labor costs. Further research is required into new, thinner shapes to maximize the efficiency of bridge elements. These various benefits, together with the economies of scale associated with greater production of UHPC, will make the use of this material increasingly cost efficient in the future.

Self Consolidating Concrete (SCC). Within the past two decades, use of self consolidating concrete has made its way into the precasting and cast-in-place industry. With SCC, a chemical admixture is added to the concrete to improve its "flowability" as well as to eliminate the debonding of the aggregates from the cement paste during concreting. Use of this concrete has several advantages:

- Reduces labor requirements during the placement operation
- Reduces construction timeframes
- Improves the ability to avoid surface honeycombing and internal voids, greatly reducing the finishing operation
- Helps to assure proper concreting of heavily reinforced areas
- Increases flexibility in the placement of concrete, and as such improves durability.

Though SCC has gained wide acceptance in the building industry, it has yet to gain a solid foothold in the bridge market.

High performance steel (HPS). The properties used to characterize the performance of steel include: strength, weldability, toughness, ductility, corrosion resistance, and formability. HPS has an optimized balance of these properties to give maximum performance in bridge structures while remaining cost-effective. The main differences compared to conventional steels are improved weldability and toughness. Use of HPS generally results in smaller members and lighter structures. HPS can reduce the first cost of steel bridges by reducing the weight of steel in the structure. Although great strides in the adoption of HPS has occurred in the country in the past decade, higher initial cost of HPS has yet to be overcome. Greater savings are likely in the future when fabrication procedures are optimized and production capacity is expanded.

Fiber reinforced polymers (FRP). Fiber-reinforced polymers combine resin, additives and fillers with a reinforcing agent such as glass or carbon and can be used as alternatives to concrete or steel. FRP's are strong, durable, and highly resistant to corrosive action. They also have a high strength to weight ratio and are well suited for assembly into modular units that can be erected quickly. When used in bridge deck applications initial fabrication costs are greater than that of traditional decks, but the longer lives and lower maintenance costs of FRP decks may outweigh the initial expense. FPRs also offer afford significant weight reductions as an 8-inch deep FRP deck weighs approximately 20 lbs./sq. ft. as compared to 100 lbs./sq. ft. for a concrete deck of the same depth. In addition, FRP decks can be constructed faster than conventional cast-in-place decks.

Light-weight aggregates. There are a variety of concretes that can be produced with lightweight aggregates. Low-density concrete generally is produced with perlite or vermiculite aggregates, rarely exceeds 50 lbs per square foot and has very low compressive strengths in the range of 100 to 1,000 psi (0.7 to 6.7 MPa). Structural lightweight concretes are typically produced with expanded shales, clays, slates and slag. They can also be made with pumice or scoria. Structural lightweight concretes have a minimum compressive strength of 2,500 psi and an air-dried unit weight of 90 to 115 pounds per square foot. Moderate strength concretes fall somewhere in between low-density and structural lightweight concrete. For comparison, normal-weight concretes have a typical dry unit weight of 145 to 150 pounds per square foot.[1] These concretes are often used to create light-weight pre-cast units that are easier to transport and place.

Light-Weight Fills. Lately use of lightweight fills for embankments or backfills for either temporary or permanent situations have taken a foothold. One method that has shown a lot of promise is the use of Expanded Polystyrene blocks (EPS). They are rectangular blocks of uniform depth, pre-engineered to meet weight and density specifications, cast in molds and transported to the site on trucks. They are extremely lightweight, 15-20 pounds/cubic feet. They are placed in the field like building blocks and protected from traffic and the environment. They eliminate the need to consolidate poor soils, are faster to place, reduce lateral loads on abutments, and reduce manpower and equipment requirements during placing. They can be used to construct embankments up to 40 foot high and can be reused if prior uses were temporary.

Long-life pavements. Significant advances have also been made in the development of long-life asphalt and concrete pavements. Flexible bituminous (asphalt) pavements are used on 93 percent of paved roads in the United States. They are composed of multiple layers of different materials that can accommodate the flexing. Many DOTs are now installing perpetual asphalt pavements which are designed to last longer than 50 years without requiring major structural rehabilitation. Perpetual pavements utilize three layers, each one tailored to resist specific stresses. The pavement rests on a strong, hot-mix asphalt (HMA) base designed to resist fatigue cracking. This is accomplished by using a total thickness great enough that tensile strains at the bottom of the foundation are not damaging. Alternatively, the HMA base layer can be made using an extra-flexible HMA with a higher asphalt content. Combinations of these two approaches can also work. The intermediate layer is designed to carry most of the traffic load. Therefore it must be durable and resist rutting. Stability is achieved by using stone-on-stone contact in the coarse

[1] "Lighten your load with low-density aggregates," Dean A. Frank, P.E. http://www.precast.org/publications/mc/TechArticles/03_Summer_Lightweight_Aggregates.htm#

aggregate and using a binder with the appropriate high-temperature grading. Finally the wearing surface is designed specifically to resist surface-initiated distresses such as top-down cracking and rutting.

In the past, concrete pavements were routinely designed and constructed to provide low-maintenance service lives of 20 to 25 years. More recently, there has been a movement toward a longer initial service life of 40 or more years, particularly in high-volume, urban corridors where traffic disruptions and user delays associated with maintenance activities can be especially acute. This has been facilitated by advances in design, construction, and concrete materials technology. Many state DOTs are teaming with industry to develop innovative structural designs and concrete mixtures and to utilize new construction equipment, construction process management procedures, and testing protocols to increase the durability of pavements.[2]

2.2 Advanced construction technologies

A systems approach from the "ground up" is essential in developing strategies to accelerate construction programs. Prefabrication, preassembly, incremental launching, lift-in and roll-in are important techniques that are increasingly being used to accelerate the construction of transportation improvements around the country. Designers need to be more aware of these options and should identify construction schemes that can minimize disruption and expedite project completion.

Among the most fertile areas for reducing the duration of construction are prefabrication and precasting. Prefabricated structural elements and systems may be manufactured on-site or off-site and brought to the job location ready to install. Prefabrication of bridge elements and systems can be accomplished in a controlled environment without concern for job-site limitations, which can increase quality and lower costs. Prefabricated bridge elements especially tend to reduce costs where use of sophisticated techniques would be needed for cast-in-place, such as in long water crossings or higher structures such as multi-level interchanges.

In general, using prefabricated structural elements and systems can:

- Minimize traffic impacts of bridge construction projects by compressing schedules;
- Improve construction zone safety by reducing the duration of traffic diversions;
- Reduce construction impacts on the environment;
- Makes bridge designs more constructible; and
- Increase quality and reduce life-cycle costs.

Precasting technology has improved considerably in the last two decades. The durability of the precast components has been proven. Recent examples show that entire bridges can be precast, brought to the site in pieces, erected either as single elements or assembled off-site into larger units, and, by sliding in or using heavy lift cranes or self-propelled modular transporters, erected quickly. This supports the increasingly popular “Get In, Get Out and Stay Out” philosophy. In this regard, standardization of connection details of the different elements, development and adaptation of standard shapes to reduce cost and elimination of connecting components such as bearings and expansion joints which have their own durability issues, would be of benefit.

In the area of long span bridges, adoption of precast or prefabricated pylons, greater use of composite cable anchorages, greater use of ungrouted stay cables, use of mono-strand jacking

[2] http://www.fhwa.dot.gov/pavement/concrete/2006conf.cfm

systems and adoption of health monitoring systems would improve the durability of these bridges and also reduce the time required for construction.

2.3 Constructability Reviews

Even in the early phases of concept development, and certainly as the engineering work progresses toward final design of transportation projects, it is extremely helpful for designs to be reviewed by contractors or construction engineers with extensive "hands on" experience in the field. These reviews should include all areas that can affect the feasibility, costs, and time required for construction, such as access to work sites for workers and equipment, materials delivery and storage areas, staging required for proper sequencing, maintenance of traffic phases, need for temporary pavements or structures, availability of stock materials, access to adjacent properties, and environmental impacts during construction on nearby areas.

Until recently if constructability reviews occurred at all they were normally done when design work was nearly completed. When reviews occur at this late date, design changes that could improve constructability significantly are often sidelined due to the time and cost of redesigning the project. It is more beneficial when constructability reviews begin during the preliminary design concept phase and continue at periodic intervals. With larger and more complex projects, constructability reviews should occur virtually continuously during the design phase.

Without constructability reviews DOTs depend upon the contractor to resolve these types of issues and often incur needless and potentially costly construction delays while they are sorted out. As a result, many DOTs are now passing on the risk of constructability claims directly to the design engineer. This trend is motivating the design industry to conduct earlier, more frequent and more substantive constructability reviews and is helping to expedite the implementation of transportation improvements around the country.

2.4 Construction Management and Scheduling

Advances in construction management are helping to compress the time required for construction projects on heavily traveled highway corridors around the country. Effective scheduling is an important tool and can involve simultaneous phasing, maximizing night and weekend work, including nighttime concrete pours, nighttime paving and marking, nighttime closures, and nighttime delivery of construction materials. In a number of instances, the decision is being made to close highway facilities to traffic completely for relatively brief and well advertised time periods in order to complete work in the shortest time possible. This provides contractors with full access to work areas and allows them to work full time at the site. With closures of this nature work that might otherwise require two years or more to complete with complex and costly maintenance of traffic schemes can often be finished within a few months. Full closures require extensive public outreach and coordination between state DOTs and local governments and their citizens – particularly communities and user groups directly affected. They may also benefit from strategic improvements the local street system and temporary traffic management measures.

2.5 Proactive Coordination

Conflicts with utilities and railroads regularly delay the completion of projects. Earlier and more "proactive" coordination can reduce construction delays. Successful approaches include incentive-based utility agreements, corridor approaches to utility agreements, direct contracting for utility or railroad work, and non-destructive methods of utility relocation.

Close coordination with railroad operators is essential for a project for construction access or work impacting the railroad lines. Due to the extremely high cost of railroad closures and their widespread economic impacts, it is interesting to note that a large proportion of projects utilizing innovative construction techniques such as prefabrication and the placement of large structural elements involve railroad bridges and overpasses above active rail lines. A particularly impressive example involved the placement of a 320-foot, 850-ton truss above the New Haven Interlocking and Rail Yard in Connecticut in a single night.

2.6 Procurement tools

In addition to new materials and construction techniques there are many different procurement tools that are being used to create incentives for engineers and contractors to expedite the implementation and improve the quality of transportation improvements.

Design-build procurement. Design-build is a project delivery method under which a project owner – having defined its outcome and performance expectations to a sufficient extent – executes a single contract for both architectural/engineering services and construction. The design-build entity may be a single firm, a consortium, joint venture, or other organization assembled for a particular project. This single entity assumes responsibility for the majority of the design and all of the construction. With the designer and the contractor working as a team, constructability is a key issue and their close collaboration often leads to more efficient implementation. In addition, design and construction activities can proceed concurrently and involve a single procurement. This typically results in significant time savings and has the potential to reduce overall costs, particularly when user costs are taken into account. Design-build also reduces a DOT's administrative burdens by eliminating the need to coordinate or arbitrate between separate design and construction entities.

Design-build can also promote innovation by encouraging constructors to utilize new materials and develop new design and construction techniques. For the successful design-builders, innovations that cut costs and speed implementation also bring greater profits. Because of these factors, several DOTs are choosing design-build delivery for complex projects or when fast track implementation is a priority. Design-build contracts are also awarded on a fixed-price basis, which sharply reduces the owner's exposure to cost overruns risks, making it the predominant delivery system when innovative funding approaches and particularly public-private partnerships are used to finance improvement projects.

DOTs often include provisions in their design-build procurements specifying performance requirements to minimize construction disruptions. It is common for design-build contracts to offer financial incentives to constructors for meeting such requirements, as well as penalties when they are not met. Design-build procurements for transportation projects can also include warrantee clauses to ensure that they are designed and constructed to meet specified performance standards, including pavement or structural durability. The use of warrantees further encourages the design-builder to utilize designs and materials that will minimize the frequency and duration of future maintenance and repairs.

Modified design-build procurement. Some agencies may be reluctant to use design-build procurement due to loss of control over the design and implementation processes. As a result, a modified design-build approach has been developed combining best attributes of the design-bid-build and design-build procurement models. With this approach the owner retains a designer and

develops a preliminary set of contract documents with a good set of quantities. The package is put out to bid and the selected contractor then becomes part of the design team and participates in the completion of the design and provides ongoing constructability reviews. Modified design-build procurement accelerates construction and allows owners to retain control over projects. It also eliminates or reduces change orders and construction claims.

Other procurement incentives. There is a variety of other procurement tools that DOTs have used with standard design-bid-build procurements to motivate contractors to complete construction projects more quickly and with fewer impacts on local communities. They include:

A + B Contracting: Most construction contracts are awarded to the qualified contractor providing the lowest bid price. The A + B procurement model uses two criteria to award construction contracts; one for lowest price and one for the duration of the construction. The A portion of the bid consists of the total of all quantities multiplied by the associated unit price quoted by each contractor. The B portion consists of a pre-established dollar value for each contract day multiplied by the number of contract days quoted by each contractor. The combined A+B amounts are used to determine the low bid even though the contract may then be written for the A amount only. The number of contract days is provided by the contractor as part of the bid. The cost-plus-time method requires contractors to commit to a construction schedule and encourages them to be proactive in identifying ways to consolidate construction schedules.

Incentive/Disincentive Contracting: Incentive/disincentive contracting uses financial incentives paid to the contractor for early completion of project milestones, as specified in the contract. Disincentive amounts are also subtracted from the contractor's fees if milestones are completed later than time allowed by the contract. The Incentive/Disincentive technique may be a stand-alone method, or may be used together with other alternative contracting techniques.

Lane Rental: The lane rental contracting technique requires contractors to determine the number of days that highway lanes will need to be closed during the construction period. This information is included in their bids and may be used as a factor in awarding the contract. Once construction is underway, contractors are charged lane rental fees for lane closures that exceed the timeframe specified in their bids. The lane rental fee is based on the estimated cost of delay or inconvenience to the road user during the rental period.

Calendar Date Versus Calendar Day Contracts: Calendar date contracts specify a completion date rather than provide the number of calendar days available for construction. Calendar date contracts tend to encourage shorter construction durations and less generous awarding by owners of additional construction days.

No Excuse Completion Dates: No excuse completion contracts use substantial bonuses to incentivize contractors to meet aggressive completion dates regardless of any problems or unforeseen condition that might arise, with the possible exception of "force majeure" events.

Bundling procurements. In many cases large projects are procured in smaller components. This is often due to funding constraints or the desire to encourage bidding by smaller local contractors. Breaking projects up in this way is often inefficient, and can delay their final project completion, escalate costs, and require more staff involvement within DOTs. A number of states are delivering large statewide construction programs as packages managed by dedicated teams working in concert with the transportation agency. This is particularly effective with larger and more complex projects and even entire capital programs. In addition to coordinating procurement

and construction activities, they often involve a combination of financial management and the development of strategies to bridge information gaps. Program management efforts of this nature involve the application of project cost and schedule controls as well as project, program and financial management systems not always readily available to public sector owners. This type of programmatic approach can significantly expedite the delivery of large construction programs, as is the case in South Carolina, Louisiana, Idaho, Arizona, Oregon, and Washington.

Innovative Finance. Often the greatest constraint to implementing projects quickly is the availability of funding. In response USDOT and FHWA have developed a number of innovative finance tools that allow DOTs to leverage and supplement their traditional funding sources and build projects faster. Tools such as TIFIA credit enhancements, grants anticipation bonds, state infrastructure banks, private activity bonds, and the expanded use of toll-based financing are helping DOTs around the country to expedite the delivery of needed transportation improvements, accelerate project completion dates, and utilize existing funds more effectively. Private investors have collaborated with DOTs in a variety of partnership arrangements to develop and rehabilitate toll road projects. The use of innovative finance tools and public-private partnerships are addressed in greater detail in other issue papers.

3. Implementation challenges

The many challenges to the use of innovative materials, techniques, and technologies in the maintenance and expansion of the surface transportation network, with reduced impacts to local communities, are summarized in this section.

Institutional issues. Among the more significant challenges is the need to modify standard business practices followed by Federal, State and local governments around the country. Historically, transportation procurements have focused on identifying the lowest initial investment cost rather than minimizing the ongoing lifecycle costs of building and maintaining transportation infrastructure over time, including the time and costs of disruptions to users. With limited resources and pressure to implement as many projects as possible, the motivations behind the focus on lowest implementation cost is understandable, as the initial investment of projects designed to minimize long-term life cycle costs is likely to be higher. The challenge is to encourage today's decision makers to make funding as well as investment decisions that will achieve long-term lifecycle savings, including reducing the costs of delays to users, maximizing the overall benefit to the public for each dollar invested in the transportation system.

Legal and regulatory issues. Most budgetary and procurement procedures for transportation improvements at the federal, state, and local levels encourage the development of construction projects on the basis of the lowest up front investment cost or award the construction contract on the basis of the lowest bid rather than the lowest life-cycle costs. These practices need to be modified to encourage the development of projects that minimize life cycle costs over time, making greater use of the innovative procurement measures discussed above.

Restrictions remain on the use of some innovative procurement methods. The use of design-build delivery is regulated by State law, and at present only 37 of the 50 States have legislation that permits this procurement method (and sometimes only for demonstration projects). SAFETEA-LU removed significant hurdles to use of design-build procurement on projects funded with Federal monies.

Knowledge gaps. One of the challenges associated with the development of new materials is understanding how they will perform over the long haul. Laboratory testing techniques are well developed. However, there are still significant challenges involved in projecting the performance of a new two-year-old material over an extended period measured in decades. We need to improve our ability to characterize, manufacture, and control these materials and understand how they are likely to react to wear and tear from severe weather conditions, oxidization and the stresses associated with day-to-day use. This type of information will allow us to weigh the initial implementation costs of using these new materials against the savings in construction and maintenance costs over time in order to optimize life cycle costs of our surface transportation assets.

Funding for research. At the Federal level, funding for research on new materials and construction technologies is channeled through a number of programs, following policy recommendations made within US DOT and outside organizations such as the Transportation Research Board (TRB), and the American Association of State Highway and Transportation Officials (AASHTO). The value of research under these programs is critically dependent on adequate funding that has the flexibility to be directed to areas of greatest need or promise. Currently under SAFETEA-LU there is very little flexibility to devote research monies to new ideas or suggestions as they arise. Many of these programs are now totally directed in the authorizing legislation, eliminating the opportunity to explore other innovations.

Industry conservatism. Engineers by their nature are conservative and resistant to change. It is essential to disseminate information on the successful implementation of new materials, construction technologies and practices, and procurement advances in order to encourage transportation practitioners around the country to consider implementing, or at the least, experimenting with both proven and promising advances. It is therefore critical to fund and promote the ACTT, Highways for LIFE, and other programs needed to educate and demonstrate advanced construction techniques and materials to States and local agencies.

Limited focus on acceleration among contractors. In many cases contractors follow established norms as they implement projects and are not motivated to seek new ways to implement projects more quickly and with fewer impacts. Outreach and educational opportunities in acceleration techniques are often limited for contractors. In situations where the availability of new work is slow, contractors may actually be motivated to make existing jobs last longer than necessary in order to keep their workers busy.

CONSOLIDATED COMMENTS FROM MEMBERS OF THE BLUE RIBBON PANEL OF TRANSPORTATION EXPERTS - PAPER 4I-01

One reviewer commented as follows:

Construction works that require part or full closure of roadways can result in considerable user costs due to increase in congestion and reduced safety. Disruptive effects on users and community can be reduced either by using long-lasting materials and/or expediting construction. With this respect, the paper presents a summary of benefits of recent and anticipated advances in construction materials, techniques, and technologies. First, the paper provides a state-of-the-practice of advanced construction materials. These materials usually entail greater initial cost

but have benefits in terms of service life, durability, strength, weight reduction, and so forth. Also, advanced construction technologies, such as prefabrication and precasting, which can save time and manpower significantly, are discussed. The paper also suggests importance of constructability reviews by experienced contractors or engineers throughout the pre-engineering/construction period, of effective construction management and scheduling, and of proactive coordination. Several procurement tools and contracting techniques are also discussed. Overall, the paper presents a discussion on possible options and related issues.

The future emphasis in the area of construction management should be on performance, and warranty based contracting procedures can be expected to replace traditional contracts based on least initial cost.