Mitigating Corridor Travel Impacts During Reconstruction: An Overview of Literature, Experiences, and Current Research

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The impacts of major urban transportation construction projects on existing traffic patterns and economic activity are undeniable and significant. Reducing the costs of delay to the local community of users and nonusers imposed by highway and bridge reconstruction projects requires that appropriate management actions be taken. To mitigate these external costs, strategically planned actions have been adopted or are being considered in the execution of several recent or planned projects to reduce construction-related impacts. Examples of such actions include (a) innovative project-scheduling strategies; (b) new construction techniques, including the use of special or prefabricated materials; (c) use of contract incentives to encourage more timely performance; (d) construction and use of temporary traffic lanes, (e) traffic improvements to alternative routes, (f) increased supply of public transportation services, (g) private and public promotion of ridesharing, and (h) public awareness campaigns via printed materials and the news media. A survey and review are given of state-of-the-art reconstruction techniques, traffic accommodation strategies, construction quality-control measures, and project development and evaluation processes as they have been applied to mitigate corridor travel impacts during reconstruction projects.

The impacts of major urban transportation construction projects on existing traffic patterns and economic activity are undeniable and significant. Reducing the costs of delay to the local community of users and nonusers imposed by highway reconstruction projects requires appropriate management actions. To mitigate external costs, strategically planned actions have been adopted or are being considered to reduce construction-related impacts. Examples of such actions include

- Innovative scheduling of construction activities to maintain traffic flow on the maximum possible number of lanes during peak periods;
- Introduction of new materials or placement techniques to speed construction (e.g., prefabricated elements, temporary load-bearing spans, quick-curing concretes);
- Contract incentives to encourage on-time performance with work conducted in a manner least disruptive to existing traffic patterns:
- Construction of temporary lanes or ramps, which can often become the shoulders or emergency pull-off areas of the completed project;
- Implementation of alternative transportation strategies in the affected corridor, such as ridesharing promotions, special parking arrangements, or additional transit services;
- Traffic flow improvements to alternative routes, such as parking restrictions along curb lanes, turning restrictions, intersection improvements, and the retiming of traffic signals; and
- Use of media advertising and public-private cooperation to inform the public of how to collectively make the best of a difficult situation.

The primary purpose of each of these efforts, whether it be an innovation in construction technology or a creative people-moving strategy, is to reduce the external costs of a reconstruction project. The objectives of the research described in this paper are

1. To investigate and document the critical interrelationships among state-of-the-art reconstruction techniques, traffic accommodation strategies, construction quality issues, and the project development and evaluation process, and
2. To formulate and document a Corridor Reconstruction Project Evaluation Process (CRPEP) based on the foregoing investigations.

Specialty conferences on traffic management strategies for special events were held before the 1985 and 1986 Transportation Research Board Annual Meetings at which pertinent experience was presented and discussed (*1-3*). Many articles in recent issues of the ASCE *Transportation Engineering Journal* and the *Transportation Research Record* focus on traffic management strategies in and around work zones (*4-6*). However, a great deal of additional documentation and project data is available from the agencies responsible for these projects.

There are several issues of particular concern in preparing for the construction phase impacts of a transportation

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project. One is the explicit trade-off between reducing direct project costs and mitigating the external or indirect costs to travelers and economic activity. The best action to minimize direct project costs would be to close off the work zone entirely so that construction crews can perform their work unaffected by passing traffic and travelers are not exposed to construction work-zone hazards. However, the complete shutdown of a facility during reconstruction is often not a reasonable alternative in heavily traveled corridors where an inadequate level of service is available from alternative routes or modes to accommodate the shift in travel volumes.

Because the implementation of special work schedules and traffic accommodation strategies increases the project's costs in attempts to lower external costs, the evaluation of travel characteristics and transportation facilities in the area surrounding the work zone is the key to the proper assessment of the trade-off between direct and indirect project costs. Moreover, mitigation strategies can be as important to less heavily used facilities as to projects involving high traffic volumes. For example, preconstruction planning for a moderately traveled facility, with few alternative routes or modes of travel in the neighboring area, may reveal potentially greater travel impacts than the reconstruction of a major expressway for which there are several alternative routes that can each handle a portion of the diverted traffic volumes. This is just one illustration of how several interrelated factors must be taken into account when a reconstruction project is planned and managed. A prudent analysis of such factors, with input from local communities, can be used by engineers and planners to develop appropriate types and levels of innovative transportation and construction management strategies that a particular project warrants.

Traffic management strategies for one major reconstruction project (I-376) have been evaluated and documented in detail (*7*). Procedures for planning and implementing reconstruction traffic management schemes were suggested in that study and are being adopted by other projects around the country (*8*). However, steps by which alternative project strategies can be developed, assessed, and selected for implementation are not currently documented as a systematic procedure involving all of the cost and quality control aspects of corridor traffic management. Moreover, many different public and private organizations are involved in the construction planning and management process, and responsibilities are not always clearly defined for assessing the effectiveness of alternative plans and deciding on the best set of strategies to adopt. Several recent projects discussed next serve to characterize the types of innovative strategies and project-planning procedures that are of key relevance to these issues.

SOME RECENT EXPERIENCES

There are several Interstate reconstruction projects in various stages of planning and construction that serve as useful and pertinent examples because of the data and experiences that can be obtained from them. Reconstruction of Chicago's Edens Expressway (I-94), 1978-1980, and reconstruction of Pittsburgh's Parkway East (I-376), 1981-1982, are two examples of completed projects for which transportation management procedures were extensively planned, monitored, and documented. In addition, Leisch and Associates (*9*) compiled case studies of the planning and design features of several past or ongoing freeway reconstruction projects as of 1983.

The Edens Expressway project might be considered as an early example of a major reconstruction of a heavily traveled urban Interstate freeway. For this project, the Illinois Division of Highways developed six alternative traffic control plans and evaluated them on the basis of 12 primary considerations (*10*). The social and environmental impacts of that project, grouped into six basic categories, have also been documented (*11*). In part, experiences with the Edens project alerted federal, state, and local transportation officials that the impacts of Interstate reconstruction projects in urban areas would indeed be significant, but that these impacts could be mitigated by means of an effective transportation management plan and innovative construction scheduling (*12*).

To mitigate impacts of the Parkway East (I-376) reconstruction project, the Pennsylvania Department of Transportation (PennDOT) implemented an experimental plan of people-moving strategies that included a third-party vanpool program, new express bus service, high-occupancy-vehicle ramps for passage through the work zone, new park-and-ride lots, a new commuter rail service, and traffic flow improvements to many local arterials (*13, 14*). This experiment tested the concept of implementing alternative transportation strategies throughout a travel corridor in order to reduce the construction-related impacts of a single major project. A research team from GAI Consultants and Carnegie-Mellon University (CMU) conducted extensive data-gathering surveys before, during, and after this project in order to measure the relative effectiveness of these various strategies (*7, 15, 16*). As an immediate benefit of the GAI-CMU evaluation, some of the people-moving strategies and traffic operations plans were modified to be more cost-effective in the second year of reconstruction on the basis of data collected during the first year, and additional low-cost traffic control measures were implemented to reduce traffic delay (*17*).

OTHER PLANNED OR CURRENT PROJECTS

Experiences with transportation management plans for the completed reconstruction projects cited in the previous section make up a small subset of those available for case studies. These projects are representative of significant innovative approaches to reconstruction, and the lessons learned from them are being applied to current projects elsewhere. The research described in this paper focuses on these and other major planned and current reconstruction projects, the most significant of which are as follows:

Seattle (I-5)	Syracuse (I-81)
Hartford (I-91)	Madison (I-90/94)
New Jersey (I-287)	Allentown (I-78)
Pittsburgh (I-376)	Philadelphia (I-76)
Ft. Lauderdale (I-95)	Minneapolis (I-394)
Boston (I-93 SE Expressway)	Atlanta Freeway System
Detroit (Lodge Freeway)	Los Angeles (Santa Ana Frwy)
Portland (Banfield Light Rail/Freeway Project)	Houston (North and Southwest Freeways)

Maryland (Woodrow Wilson and Cabin John bridges)	District of Columbia (George Mason Bridge)
Chicago (Edens, Eisenhower, and Dan Ryan expressways)	Dallas (North Central Project)
	San Antonio (I-35)

Several feature articles in both journals and trade magazines highlight the special aspects of several of the foregoing projects (*17-22*). A primary product of the initial research for this study was the compilation of an annotated bibliography containing abstracts or summaries of over 100 articles, reports, and other pertinent reference material (*23*). At the same time, a "short list" was developed of case study projects that were found to represent the greatest diversity of innovative experiences, of which there seemed to be ample documentation. The screening process began with the development of a "long list" of case study candidates, such as those shown earlier, that were found through the literature search and through discussions with FHWA officials. As candidate projects were identified, the criteria that were eventually used to select a smaller number of case study projects to be examined in further detail were refined. These selection criteria or project characteristics were grouped into the following five basic categories:

1. Reconstruction techniques and scheduling
   a. Pavements
      (1) Rigid
      (2) Flexible
      (3) Composite
   b. Bridge decks
      (1) Modular/precast
      (2) Cast-in-place
      (3) Metallic
   c. Project scheduling
      (1) Accelerated schedules
      (2) Night closure of lanes
      (3) Special staging areas
2. Traffic accommodation strategies
   a. Work-zone traffic control
   b. Lane-shift decisions
   c. Modal shifts
   d. High-occupancy-vehicle (HOV) measures
3. Travel impact forecasting procedures
   a. Sketch-planning techniques
   b. Computer simulation models
4. Construction quality issues
   a. Effects of rapid installation
   b. Performance of special materials
   c. Sampling and testing procedure
5. Project management and evaluation procedures
   a. Value engineering
   b. Use of incentive clauses
   c. Traffic management teams
   d. Contract administration

Reconstruction projects vary greatly in the extent to which special construction techniques or management strategies were employed. Certain projects, such as I-376, demonstrate a great variety of alternative travel strategies, whereas projects such as the Woodrow Wilson Bridge demonstrate uses of innovative construction methods or organizational control. Consequently, the experiences of many different projects must be taken as a cross section in order to document the relationships among the many diverse project attributes, not all of which are present or encountered on any one project. In the selection of projects to examine in depth as case studies, diversity was emphasized in the following areas:

1. Project location (geographical, rural, urban, suburban),
2. Facility type (road, bridge, tunnel, number of lanes),
3. Project type (reconstruction, redecking, major overlay),
4. Methods and materials (prefabricated slabs, segmental versus continuous pours, polymer concretes, steel decking),
5. Traffic handling requirements (high versus low volumes, critical peaks),
6. Project monitoring and evaluation procedures, and
7. Construction quality control measures.

CHARACTERISTICS OF ROAD RECONSTRUCTION PROJECTS

Reconstruction Techniques and Scheduling

A number of authors [e.g., Grimsley and Morris (*24*)] have documented the successful use of special methods and materials for highway and bridge rehabilitation and reconstruction projects. As one example, the use of precast or preconstructed bridge sections has reduced the time a bridge must remain out of service during reconstruction. A rather recent and very dramatic example of the degree to which innovative construction techniques and scheduling can be designed and used to reduce traffic disruptions is the Woodrow Wilson Bridge (I-95) redecking project (*25, 26*). The project incorporated innovations in traffic maintenance, design of the replacement sytems, applications of polymer concrete, and coordination of construction activities.

The technical and traffic management aspects of this project were keyed to the special conditions of the project. The entire redecking was accomplished through the use of prefabricated slabs lifted into place from a barge moored below the work site. Whereas traffic was restricted during all construction periods of the I-94 and I-376 projects, the contractor for the Woodrow Wilson Bridge project was able to keep all three lanes open in each direction across the bridge during all peak-period hours. This provision of peak-period capacity was made possible through the use of steel grid decks that temporarily spanned the current segment under construction each day. In addition, a rapid-curing polymer concrete was used for cast-in-place bearing pads that achieved their full load-bearing strength less than 24 hr after being poured. The entire project exemplified how the use of special construction materials, techniques, and scheduling can result in the reconstruction of a critical link without excessive disruptions to existing travel.

Other articles or reports dealing with the use of special materials and placement techniques on reconstruction projects include that by Meyer et al. (*27*). Conducting reconstruction and maintenance activities at night has become a common phenomenon in urban areas where daytime vehicle volumes mandate that facilities operate at normal capacity. Research suggests that nighttime work is not only feasible, but that it is also the most practical and cost-effective schedule in many cases (*28, 29*).

Traffic Accommodation Strategies

Although one part of this research is primarily an investigation of case study projects involving innovative reconstruction techniques, another major part is the investigation of cost-effective traffic accommodation strategies for implementation in either the work zone or the affected corridor. Traditional maintenance and protection-of-traffic plans focus primarily on the work zone itself. However, as travel accommodation strategies become more innovative, they often entail measures that fall both within and outside of the work zone. For example, HOV ramps that allow for priority passage of carpools, vanpools, and buses through a work zone can be implemented in conjunction with strategies outside the work zone, such as ridesharing incentives and special bus services that utilize these ramps.

A survey of recent publications revealed a manual prepared by the New York State Department of Transportation (*8*). The major emphasis of this manual is specific transportation system management (TSM) strategies that have been used or may be utilized in traffic management efforts. This manual draws heavily on the experiences of applying TSM strategies in Pittsburgh, Syracuse, and Boston in their respective reconstruction projects. TSM strategies that are discussed in this manual include HOV actions, additional bus transit, park-and-ride lots, vanpooling, commuter rail service, ferry service, expansion of alternative routes, and the use of public information (e.g., newspapers and public advertisement campaigns) as a way of handling traffic in reconstruction corridors. Each chapter of this manual gives information on a different TSM strategy and presents the following: (a) where the TSM action was implemented and (b) a description of the specific program and how it was incorporated in the overall TSM plan. Suggestions about the effectiveness of each particular TSM strategy are included.

Another document describing TSM strategies as they can be applied to travel impact mitigation is NCHRP Report 263 (*30*), which is written in the form of a user's manual and is supplemented by "training aids" consisting of audiovisual slide/tape modules and interactive computer-assisted instructions (*31*). This set of reports and aids is designed to assist project personnel in the planning, design, and implementation phases of all types of low-cost TSM improvements and will assist agencies in applying the approach to identify feasible, workable, and low-cost solutions to corridor transportation. They present the research findings in a form directly applicable by transportation professionals at municipal, regional, and state agencies.

The major emphasis of past and recent research in the area of traffic control during highway maintenance, rehabilitation, and reconstruction activities has been focused on work-zone traffic control rather than corridorwide travel impact mitigation. In particular, there are three key documents describing work-zone traffic control (*32-34*). Several recent papers have also been either presented or published on this topic (*2, 35-40*). Other papers and reports (*29, 41*) deal with the cost and safety aspects of work-zone traffic control. Finally, several researchers from both the United States and abroad have developed computer simulation models of work zones and temporary lane closures to predict the responses of traffic flows to changes in the supply characteristics of the roadway (*42-44*).

Traffic accommodation strategies both within and outside the work zone have interrelated impacts on mode shifts, route shifts, and changes in travel demand. Mode shifts include changes from low-occupancy vehicles to high-occupancy vehicles (public or private). Route shifts constitute the largest change in travel patterns during a reconstruction project, as is evident from several studies (*7, 11, 45*). However, travel demand changes other than mode and route shifts may also take place to a limited extent. Examples of travel demand changes are reductions in trip making, trip chaining, changes in departure times, or changes in destination choice. In comparing departure times from home before and during the Parkway East project, it was found that the average commuter departed 19 min earlier during construction in anticipation of construction delays (*7*). Stores and restaurants in downtown Pittsburgh also reported a significant drop in sales, indicating a shift in destination choices or trip-making frequencies of discretionary trips. Another working paper from this research will describe the following characteristics of alternative traffic accommodation strategies:

1. Location of primary focus (work zone versus corridor);
2. Responsibility for implementation (state transportation department, municipal traffic department, state or municipal police, metropolitan planning organization, regional transit authority, contractor, or project manager);
3. Implementation requirements (costs, lead time, materials, personnel, organizational coordination, media advertising);
4. Impacts on mode shifts, route shifts, and travel demand; and
5. Flexibility, that is, its ability to be adjusted to project needs.

The last aspect of a travel accommodation strategy is particularly important to the minimization of project risk, as it is for all aspects of a project's management plan. Special people-moving strategies that require a large initial investment to put in place carry with them a high risk of not being cost-effective. On the other hand, adjustments to bus services or adding cars to an existing commuter train have a much lower initial cost and can be revised according to traveler responses. In either case, it is important to estimate the costs of traveler impacts so as to make the proper trade-off (*46*).

In addition to the description of traffic accommodation strategies, later research will document the experiences of projects in which some of these strategies were employed. The Parkway East project represents the greatest number of travel accommodation strategies used for any single project. Because strategies focused outside the work zone are now only in the design or early construction phase in other projects (e.g., Minneapolis, I-394; New Jersey, I-287: Chicago, Dan Ryan Expressway; Houston, Southwest Freeway), the extent to which actual construction experience with these strategies is documented is somewhat limited.

Construction Quality Control Issues

Another area being investigated is the construction quality control issues that arise as new materials, methods, and scheduling strategies are introduced to the construction process. Of specific concern to this investigation will be

1. Strength or curing characteristics of new materials, or both;
2. Differences in road surface characteristics and structural integrity of segmental versus continuous construction and between prefabricated versus pour-in-place construction effects of traffic vibrations on the curing of materials;
3. Effects of traffic vibrations on the curing of materials;
4. Effects of traffic accommodation strategies on the abilities of workers to operate machinery and perform different tasks;
5. Quality difference between daytime and nighttime work;
6. Changes in workmanship when staffing requirements place excessive demands on the available labor supply;
7. Changes in quality due to accelerated schedules; and
8. Effects on quality of less frequent inspections.

Rapid installation and the effects of traffic-induced vibrations are two topics for which reports of recent research are readily available (*47*). Several articles in *Quality in the Constructed Project* [the proceedings of an ASCE workshop (*48*)] make it apparent that measuring "quality" is often a very difficult charge (*49*). An inspector can examine material placement, check for apparent flaws, or observe that pour is performed properly, but in-service quality deficiencies may not be obvious until some time later. As projects become more organizationally complex, with both owners and contractors appointing supervisory personnel to a project site, the issues of quality control and accountability also become less clearly defined (*50*). This indicates that it may be difficult to find existing documentation on the degree to which quality control problems have arisen on particular projects. However, the extent to which quality control procedures and guidelines are prescribed for road and bridge projects of various types can be obtained from the responsible project agencies.

Two documents in particular have been published by FHWA on quality control during construction (*51, 52*). The first of these emphasizes statistical concepts and techniques as they can be applied to quality assurance in general and specifically to construction materials. The second document cited is a more management-oriented description of how to implement quality assurance programs at the local level for construction and maintenance activities. A third document goes a step further to examine the cost-effectiveness of alternative sampling and testing programs in paving construction (*53*).

An issue related to quality assurance that is of vital public concern in nearly all professional fields today is that of liability, both with regard to personal injuries and contract disputes. The safety of workers, travelers, and pedestrians in and around the construction zone as well as the effect of diverted traffic volumes on the safety of travelers and pedestrians along more heavily traveled alternative routes are issues that local officials will be confronted with when planning for reconstruction projects (*54-56*). In addition, contract claims over work-order changes, delays, pay schedules, and unexpected conditions are project risks that require prudent administration and planning on the part of all the public and private officials involved (*57, 58*). On the Woodrow Wilson Bridge project, the Maryland Department of Transportation entered into an agreement with the contractor that every change of work request would be acted on within a 24-hr period so as not to delay the project.

Project Management and Evaluation Procedures

Project evaluation procedures can be effectively applied both before and during a reconstruction project in order to increase the cost-effectiveness of organizational management schemes being planned or implemented or in place. Many of the tools that can be used to achieve greater effectiveness can be found in the literature on value engineering (*59*). Two reports give examples of value engineering concepts applied specifically to highway reconstruction projects (*60, 61*).

Another important approach being successfully employed in the management of local transportation systems, both on a continual basis and during times of special need such as major reconstruction, is the development of traffic management teams, regularly scheduled meetings of planners, engineers, consultants, police officers, and transportation agency and local government officials, each of whom has a different perspective and primary concern with regard to the manner in which a project and its impacts are handled. Documentation of this approach, its advantages, and its disadvantages can be found elsewhere (*62-65*).

As another example of the corridor management team concept in practice, the Parkway East project (*7*) was quite more than an experiment with innovative transportation strategies. One experience that occurred on this project (*66*) was the manner in which travel impact mitigation strategies were modified to be more cost-effective for the second year of reconstruction. This indicates a significant amount of communication and cooperation between those monitoring the strategies and those in charge of their implementation. Public acceptance and utilization of these strategies and respect for the massive coordination effort at hand were due in large part to the cooperation between public agencies and private firms involved.

Other examples of actions that played an important role in the success of the Parkway East project are the following. A public media campaign staged by local radio and TV stations effectively diverted many travelers to alternative routes and modes even before the project began. The Southwestern Pennsylvania Regional Planning Commission (SPRPC) continued to encourage ridesharing as it had been doing for several years, and it also worked closely with Van Pool Services, Inc., to promote vanpooling in the affected corridor. Carpools and vanpools were allowed to enter the work zone via HOV ramps that were monitored 14 hr each weekday by Pittsburgh police. SPRPC provided data that assisted the project monitoring team to establish screenline count locations.

Also for that project, the Port Authority Transit of Allegheny County provided route, run, patronage, and cost data for the special express bus services. SPRPC and Van Pool Services also provided data to researchers at Carnegie-Mellon University that were used in subsequent modeling studies to forecast vanpool formations and alternative route volumes (*42, 67, 68*). The reconstruction contract also provided for traffic police to be stationed at 21 locations in the affected corridor, most of which were outside of the actual work zone. In short, the spirit of public-private cooperation exhibited during the Parkway East project was itself a key element to its success.

Contract administration plays an important role in the on-time performance of a construction project. Recent experiences have shown, in fact, that reasonable incentives can create such significant productivity improvements that the total cost of the project (i.e., public tax dollars plus the public cost of traffic disruptions) is lowered. The most comprehensive coverage of recent experiences and research concerning the impact of incentive-disincentive clauses on contract performance was produced by Viljoen as a Ph.D. thesis (*69*). Other brief articles include those by Officer (*70*) and by Weed (*71*).

CORRIDOR RECONSTRUCTION PROJECT EVALUATION PROCESS

Anderson and Hendrickson describe a reconstruction traffic mitigation planning procedure developed by GAI Consultants, Inc., and Carnegie-Mellon University in 1982 during reconstruction of the Parkway East (*7*). Procedures employed in other traffic management plans that have been examined can be categorized according to the following attributes:

1. Current practice,
2. Recent developments,
3. Value engineering approaches,
4. Use of contract incentives and disincentives,
5. Use of computer models or sketch-planning techniques,
6. Use of management information systems or database software for project monitoring and control, and
7. Contract administration procedures for shop drawing reviews, material approvals, field change approvals, or contract time calculations.

GAI Consultants, Inc., prepared the traffic management plan and a maintenance and traffic protection plan for the reconstruction to Interstate standards (I-78) of 13 mi of PA-309 in Lehigh County, Pennsylvania. Preconstruction uses of origin-destination surveys, traffic counts, and a public information program were undertaken. Traffic impacts were identified for each of the six construction sections. Construction methods for maximizing on-system traffic movement were identified and coordinated with section design consultants. Alternative routing and detours were identified and improvements were recommended (*14*). In addition to these traffic management techniques, GAI, PennDOT, and FHWA are also investigating construction section scheduling and the limiting of work-order changes by section in an effort to reduce travel impacts and the costs involved.

Alternative CRPEPs must allow for the wide diversity of project types and conditions that exist throughout the national highway network. The different approaches that ought to be considered in this planning and evaluation process should include the use of value engineering, quick estimation techniques, management information systems, computer-based forecasting models, and special contract administration procedures, of which several are currently being put to test in the field. The criteria for formulating alternative CRPEPs should include, among other factors,

- Levels of project complexity;
- Expected project duration;
- Estimated project costs for construction, management, inspection, and contract administration;
- Facility type (road, bridge, tunnel, number of lanes);
- Project type (reconstruction, redecking, major overlay);
- Methods and materials (prefabricated slabs, segmental versus continuous pours, polymer concretes, steel decking);
- Criticality of the link (high versus low volumes, excessive peak-period volumes, availability of alternative routes, capacity reduction required during construction);
- Estimated external costs to users, nonusers, and business;
- Direct project costs versus mitigation and external costs; and
- Totals cost versus project quality trade-offs.

SUMMARY AND CONCLUSION

The impacts of major urban transportation construction projects on existing traffic patterns and economic activity have become a major issue confronting the expedient execution of reconstruction projects. Reducing the costs of delay to the local community of users and nonusers imposed by highway and bridge reconstruction projects has become a major focus of discussion and research, as indicated by the numerous studies cited in this paper, most of which have been published within the last 5 years. That serious efforts are being taken to understand and tackle this problem at all levels of government and industry is encouraging to prospects that future reconstruction projects will be executed at far less cost to the general public than has been done in the past.

The overall condition of the highway infrastructure in most every state of the Union is seriously beyond the budget allocations available to correct it within this century. The trade-offs that exist between higher direct project costs and local travel disruptions require careful analyses so that the available funds can be expended in the most cost-effective way possible. Thus, although upward pressure should not be placed on the direct costs of reconstruction projects, strategies must be found that can be employed to successfully mitigate the external costs associated with these projects.

As described in this paper, strategically planned actions have been adopted or are being considered in the execution of several recent or planned projects to reduce construction-related impacts. Examples of such actions include (a) innovative project-scheduling strategies; (b) new construction techniques, including the use of special or prefabricated materials; (c) use of contract incentives to encourage more timely performance; (d) construction and use of temporary traffic lanes; (e) traffic improvements to alternative routes; (f) increased supply of public transportation services, (g) private and public promotion of ridesharing, and (h) public awareness campaigns via printed materials and the news media. This paper stands as an initial overview of state-of-the-art reconstruction techniques, traffic accommodation strategies, construction quality-control measures, and project development and evaluation processes as they have been applied to mitigate corridor travel impacts during reconstruction projects.

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