

Planning and Operation of Urban Highway Work Zones

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ABSTRACT

Three problems are encountered in the planning and operation of work-zone activities: the optimum time to perform the work, the measures to take to warn the public, and the alternative means to protect the highway workers from errant motorists. These three problems become extremely critical in a rapidly growing urban environment such as Houston, Texas. The Houston District Office of the State Department of Highways and Public Transportation has embarked on a threefold campaign to handle these problems better. This consists of developing innovative work-oriented measures and public-oriented measures and the establishment of a special traffic-handling crew to aid in the planning and operation of urban highway work zones. The success of these programs is imperative in light of the increased maintenance problems created as existing freeways deteriorate further.

You are traveling on the freeway toward the airport for a long holiday weekend. It is 3:00 p.m. and your flight departs at 5:00 p.m. You have left yourself plenty of time. A few miles from the airport, however, you reach a traffic jam that reaches as far as you can see. At 4:30 p.m. you finally reach the cause of the jam. A crew of highway workers has blocked a lane to make pavement repairs. You are now in danger of missing your flight, and you are furious.

There is another side to the problem. In the Houston, Texas, area alone, 12 highway workers were killed and 34 injured during 1980 and 1981 while they were working on freeways. That is more than the combined losses of the Houston police and fire departments during that same 2-year period. Most of the casualties were caused by drunk drivers and speeding motorists. Because of these statistics, many highway workers believe that they are far safer when a queue of vehicles moves slowly past a freeway lane-closure work zone because there is less chance for an errant vehicle to kill or maim them.

Consequently, highway officials in the Houston area have had to reach a compromise between the two sides. They have severely limited the times when freeway work requiring lane closures can be done, and they have instituted several measures to improve worker safety. But the phenomenal population growth in the Houston metropolitan area has resulted in overcrowding of all of Houston's freeways, accelerating the need for remedial work while curtailing the time available to do such work without serious impediment to the flow of traffic. The steps taken thus far to deal with this situation by the Houston District Office of the Texas State Department of Highways and Public Transportation (SDHPT) are discussed.

THE PROBLEM

Between 1979 and 1981, the problem just described

reached critical proportions. The need for remedial work on Houston area freeways (particularly those more than 20 years old or carrying traffic volumes near or more than 200,000 vehicles per day) increased markedly. But complaints from the traveling public about traffic jams caused by such work led to one legislative suggestion (not passed) that all freeway work in the Houston area be limited to night operations. Yet highway workers were suffering the casualties described earlier, many during night operations. This led to restricting most scheduled work-zone operations to weekends, primarily Sunday mornings.

There are three basic questions in the planning and operation of work-zone activities:

1. When, barring emergencies, is the optimum time to perform short-term maintenance or construction operations that will block one or more lanes on urban freeways in a manner that is safe for workers yet impedes traffic only minimally?
2. On any specific freeway section, how many lanes can be closed at any one time without causing an unacceptable level of service?
3. What additional means besides conventional signing and warning devices can be employed to provide highway workers with better protection from errant vehicles?

MEASURES EMPLOYED

In response to these questions, several steps were taken to minimize motorist delay while improving worker safety. These measures can be categorized as follows: public-oriented measures, worker-oriented safety measures, and deployment of a special traffic-handling crew.

Public-Oriented Measures

To determine the optimum time when a temporary maintenance or construction operation could be performed, it was necessary to categorize the varying road types within the district. They were classified as follows:

1. Highways where there were certain time and lane-closure restrictions; work would preferably be performed during weekday off-peak hours;
2. Highways where, barring emergencies, work should be considered at night and on weekends unless special safety precautions were to be taken; and
3. Highways where there were no lane-closure or time restrictions.

This classification was presented on the district traffic control map, which is shown in Figure 1. Because this figure represents only the part of the district within the city limits of Houston, it does not include highway sections where there were no lane-closure or time restrictions.

Certain guidelines were used in making the foregoing classification. They were as follows:

1. It was determined that the delay to the traveling public should not exceed 30 min.

To: DISTRICT MAINTENANCE ENGINEER
 DISTRICT CONSTRUCTION ENGINEER

REQUEST FOR APPROVAL OF TRAFFIC CONTROL PLAN

COUNTY: _____ HIGHWAY _____ DIRECTION _____ CONT. _____ SEC. _____ MP OR JOB _____

LIMITS: _____

1. Date scheduled: _____ Time: _____ AM,PM thru _____ AM,PM.

2. Nature of work: _____

3. Has work been coordinated with any other work in the area? Yes No None
 Individual contacted: _____

4. Individual in responsible charge of this work who will be present _____

5. Number of lanes 1 2 3 4 5 (Circle) { #1 Lane Always

6. Lane/s closed 1 2 3 4 5 (Circle) { Left Lane

7. Describe Traffic Management Procedures to be used: _____

(Use back of form for additional information and sketch)

8. If freeway, will any ramps require closure? Yes No. If so, identify:
 Entrances _____ Exits _____

9. Portable message signs recommended? Yes No

10. Is police assistance requested? Yes No How Many? Where and how will police be used? _____

11. Submitted by _____ Date _____

Carbon Copy Chairman, District Safety Review Team

DISTRICT OFFICE USE ONLY

TRAFFIC CONTROL PLAN APPROVED

_____ Date _____
 Dist. Const./Maint. Engineer

Freeway Traffic Management Check (Optional)

Recommend approval

Recommend modification (See reverse)

By _____ Date _____

Copy to:

Public Affairs Officer _____ Date _____

Traffic Management for Police Assistance

FIGURE 2 Traffic control plan request form.

Worker-Oriented Safety Measures

Once it has been decided that a particular state-maintained road requires construction or maintenance, it is up to the appropriate field personnel to deploy a traffic control plan in conformance with the Texas Manual on Uniform Traffic Control Devices. However, in light of Houston's accident statistics, it was apparent that additional and innovative devices or information were also needed to better protect highway workers from errant motorists. There have been two main approaches to the safety problem.

Protection Devices

The district office, through a traffic safety program of NHTSA, acquired three fiberglass truck-mounted impact attenuators. The attenuators are attached to dump trucks and protect workers from motorists approaching the work zone. Initially, one of the systems was deployed during ramp gore repairs. In the past at such sites, vehicles have entered the work areas, endangering the lives of the workers. The existing traffic control strategy usually requires the closure of two middle

There are a number of activities planned throughout this area that will affect traffic. The most predominant ones are listed below in one of three categories.

1. HIGH TRAFFIC AREAS:

<u>Activity & Location</u>	<u>Dates</u>	<u>Primary Highway Affected</u>
American Federation of Information Processing Societies - National Conference - Astrohall	6 - 11	IH 610 (South Loop)
Budweiser Superfest Astrodome	12	IH 610 (South Loop)
American Society for Medical Technology - Hyatt Regency/Albert Thomas Convention & Exhibit Center	20 - 25	IH 10 (Katy Freeway)
Concerts - Summit	11, 19, 20, 23	US 59 (Southwest Freeway)
Games - Astrodome	4-6, 14-16, 18-21, 22-27	IH 610 (South Loop)

2. HOLIDAYS:

Emancipation Day	19	
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3. OTHER:

<u>Activity & Location</u>	<u>Dates</u>	<u>Primary Highway Affected</u>
Main Street Festival Arts & Crafts Show - Conroe	12	IH 45 (North Freeway)
Blues Festival - Hermann Park	16 - 19	US 90A
Golf-Darrell Royal Tournament Woodlands	17 - 20	IH 45 (North Freeway)
14th Annual KCOH Street Festival - Clinton Park	20	IH 610 (East Loop)
Country Fair - Old Town Spring	26	IH 45 (North Freeway)

FIGURE 3 Special Events Calendar for June 1983.

lanes approaching an exit ramp or interchange. A sample traffic control plan is shown in Figure 4. All of the crew's operations were on freeways within Harris County.

The crew has used this system more than 90 times since its first use in February 1982. In the opinion of the crew, motorist visibility of the work area is greatly improved with the presence of the truck-mounted vehicle impact attenuator system. Although before-and-after analysis was not appropriate for such a project, it is worthwhile to mention that no injuries resulted nor did any errant vehicles enter the work area when the system was deployed.

The successful use of this first system prompted the modification of another vehicle for attachment of another unit. This second system is currently being used as the trail vehicle of a three-vehicle platoon in striping operations. Some of the accidents mentioned earlier have occurred while a striping operation was in progress. Since the system has been deployed, no accidents have taken place during the course of such operations.

Enforcement Measures

Most of the accidents resulting in the injury or death of highway workers involved drunken drivers, and nearly all of the accidents involved excessive speed within the work zone. It was obvious that many motorists ignored both regulatory and advisory signs associated with work zones. It therefore became imperative to secure better motorist compliance with

traffic laws in general as well as with signs placed in conjunction with work zones.

Unfortunately, personnel limitations prevented the Houston Police Department from providing sufficient officers to monitor work zones at an adequate (and predictable) level. Moreover, some of the work zones, although in the metropolitan Houston area, actually fell outside the Houston city limits. Accordingly, an existing traffic safety program entitled the Selective Traffic Enforcement Program (STEP) within the Harris County Sheriff's Office was modified to include such enforcement activity. This program uses Harris County police working overtime to patrol the work areas.

In the initial approach the enforcement personnel traveled with the traffic flow through the work sites. However, this maneuver resulted in a lack of enforcement for periods up to 30 min, the time required for the enforcement unit to circle back to the point where the officers could reenter the traffic flow ahead of the work site. Therefore, both the officers and work-zone personnel believed that the program would be more effective if the officers were stationary within the work site. The high visibility of the officer, his vehicle, and its flashing lights continuously was more effective than the original plan with the gap of nonvisibility.

The officers were deployed when one or more lanes were closed, either for construction or for maintenance activities. Examples of the type of activity for which enforcement personnel were used are overlay work, guardrail repair, replacement of impact attenuators, and replacement of overhead signs and

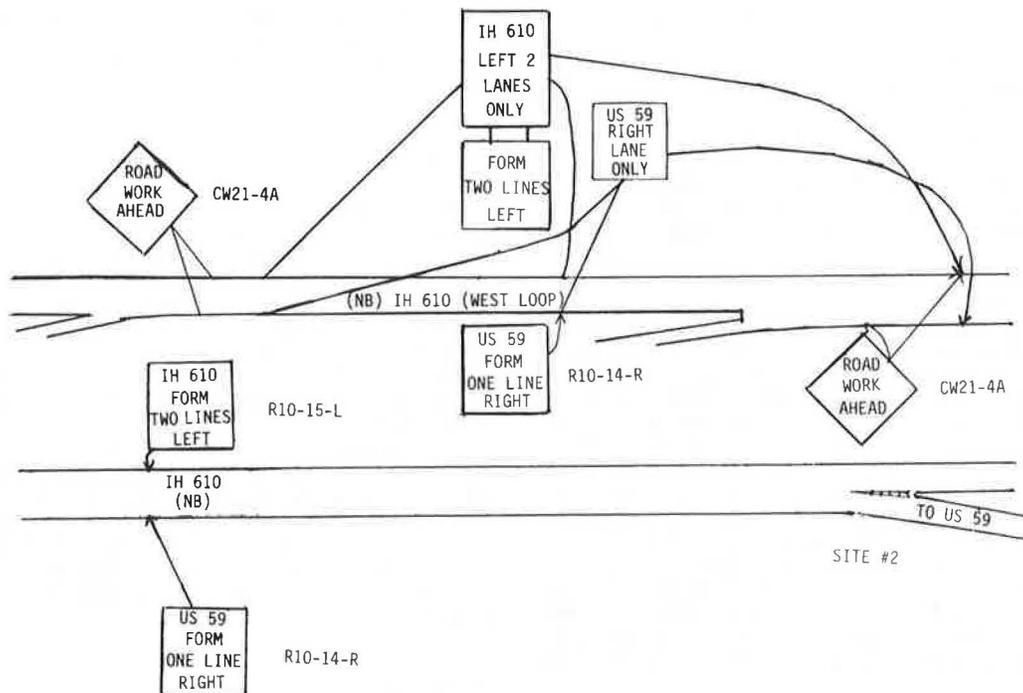


FIGURE 4 Typical traffic control plan for repair using vehicle impact attenuator system.

lights. The traffic management section supervisor of District 12 serves as liaison with the Sheriff's Office for this program and oversees the coordination of its activities.

Both maintenance foremen and construction superintendents believe that the active presence of the officers in the work zones has noticeably reduced speeds, thereby reducing the hazards for the road workers. Although the majority of the maintenance operations have taken place on Sunday mornings, speed enforcement studies indicate that a time halo may exist at a particular work location; that is, there is a beneficial effect from speed enforcement on one day on succeeding days when no enforcement is present.

Overall, the reaction to the selective traffic enforcement application to construction and maintenance zones has been favorable. Personnel from both groups have observed an increase in the level of compliance with the posted warning signs by the motoring public. Since the initiation of the modified STEP effort in April 1981, no one involved at work sites where officers were present has been injured or killed.

Deployment of Special Traffic-Handling Crew

The measures discussed so far have been instrumental in minimizing motorist delay and improving work-zone safety. However, with almost 600 miles of state-maintained roads in Harris County alone and work predominantly restricted to weekends, the rate of maintenance activity had fallen far behind the needed rate. This situation became increasingly critical in light of funding limitations and extensive red tape facing the initiation of major roadway rehabilitation. Consequently, it was decided that a means for performing maintenance operations on even the highest-volume roadways during the week must be found.

Several research studies have been conducted (1-3) on traffic management type capacity improve-

ments for work-zone operations. These have included temporarily using shoulders as a travel lane, modifying intersection signal timing, encouraging traffic to divert to alternative routes, and closing entrance ramps within the work zone. Some of these measures have been successfully implemented on major rehabilitation projects such as the Edens Expressway in Chicago or the Gulf Freeway in Houston. However, these techniques have been used only on a limited basis for shorter-term operations. Some earlier efforts to apply such techniques to maintenance work in the Houston area showed promise.

Accordingly, it was decided that a specially trained crew should be formed and specifically assigned the task of handling traffic during maintenance operations on high-volume roadways, thereby increasing the hours available for maintenance activity. The crew would have the authority and capability of implementing proven work-zone traffic management techniques (in a manner consistent with the Manual of Uniform Traffic Control Devices). A major advantage of the special crew would be its ability to actively manage traffic during the maintenance operation. Typically, a traffic control plan would be prepared based on traffic flow rates through a proposed work zone. The traffic data would indicate the number of lanes needed to minimize motorist delay or whether the work zone resulted in inadequate capacity to handle anticipated flow rates past the work. Then, for example, shoulder signing could be deployed at the outset of the operation and remain until the operation was complete. This would occur despite changing traffic patterns.

The special crew would react to changing traffic conditions. For example, one of the objectives is to ensure worker safety, and excessive speed adjacent to the work zone is a contributing factor to accidents. The use of the shoulder to provide additional capacity at work sites may actually contribute to speeds higher than desirable during lulls in traffic flow. The crew could react to this situation and in fact turn off the shoulder-use signing. This method

of handling traffic has been termed active traffic management.

It was decided that the special-crew concept should be tried on an experimental basis. An urban freeway in Houston carrying 175,000 to 200,000 vehicles per day was badly in need of pavement repair and rehabilitation; however, a contract to do so could not be carried out for several months. Some of the needed repairs were critical, but high traffic volumes precluded use of normal techniques used by maintenance personnel. Interim repair was needed, and this site provided the first test for the special traffic-handling crew.

A group of individuals not usually involved in field activities but who were experienced in traffic management techniques was asked to handle traffic while the interim maintenance was performed. Workload analysis indicated that working Monday through Thursday for 7 to 8 hr daily for two consecutive weeks would be enough time to make the interim repairs. Such a schedule required that three roadwork crews be available to work simultaneously. Work on one weekend would also be required. A job of this magnitude would normally have required at least 2 months or more of Sunday mornings. Therefore, if motorist delay could be kept to an acceptable level of under 20 min (4), the project would be successful.

Specifically, the crew was responsible for the following:

1. Coordination daily of the scheduled hours and areas of work-zone activity with the Public Affairs Section, which would disseminate the information to the public through press releases and radio broadcasts;
2. Because traffic signals on parallel frontage roads along the project are operated by the city of Houston, coordination of their activities with the city's Traffic and Transportation Department for their aid in modifying affected intersection signal timings;
3. Arrangement for the use of STEP officers for the project; and
4. Active management of traffic by using the shoulder as a travel lane, closing entrance ramps as required, and using other active traffic management techniques.

The project was successful. On only one day did a long queue develop. It was speedily dissipated when members of the special crew adjusted work-site traffic control. The ultimate measure of success was applied to this project: not one phone call of complaint from the public.

A regular crew was formed as a result of this

operation. This crew had been successfully deployed on three maintenance projects by the time this paper was written. Its potential for future projects looks promising.

CONCLUSIONS

Several conclusions can be drawn from the measures employed in Houston to minimize motorist delay while improving worker safety. They are as follows:

1. Advance public information of impending lane closures can minimize public complaints and erratic behavior by motorists.
2. The active presence of law enforcement officers in urban highway work zones can minimize erratic behavior by motorists.
3. Carefully planned active traffic management techniques can allow maintenance work to be done on high-volume urban highways during daylight without severely inconveniencing the traveling public.
4. Cooperation with law enforcement agencies and other affected governmental agencies is a necessary part of the active traffic management strategies employed.

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