FREEWAY INCIDENTS AND SPECIAL EVENTS: SCOPE OF THE PROBLEM

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ABSTRACT

This paper briefly discusses the scope of the traffic problem generated by incidents and special events and describes the nature of nonrecurrent congestion and traffic problems associated with special events. The frequency, characteristics, and effects of freeway incidents and the effects of roadwork on freeway capacity are discussed. Categories of solutions are also presented.

Introduction

Urban transportation, in the broadest sense, is the movement of persons, goods, and services into, within and out of an urban area. Any system that provides adequate mobility for the compact concentrations of persons and goods within a relatively small area will necessarily be extremely complex. Urban mobility to a large extent depends upon the effective utilization of urban streets and freeways.

There are many events, however, that result in operational problems which adversely affect mobility and thus require our attention in order to preserve mobility. These operational problems are manifested in the form of recurrent and nonrecurrent traffic congestion, and congestion due to special events.

Recurrent Problems

The most common form of recurrent problem is the so-called peak-period congestion where traffic demand exceeds capacity for relatively short time periods. Peak-period congestion occurs daily and is quite predictable in both effect and duration. This problem has received considerable attention during the past 25 years leading to the development of freeway ramp control systems which have proved their effectiveness in reducing recurrent peak-period congestion. Freeway corridor control systems under development are expected to further improve operations.

Nonrecurrent Problems

Nonrecurrent problems are caused by random or unpredictable incidents such as traffic accidents, temporary freeway blockages, maintenance operations, high truck loads, etc. Environmental problems such as rain, ice, snow, fog, etc., also fall into this category.

Accidents or other lane-blocking incidents on a freeway significantly reduce capacity. Freeway incidents occur randomly, are unpredictable, and result in congestion.

Although maintenance activities are planned by the operating agency, they are unexpected by motorists, and therefore the effects of maintenance lane closures can be as severe as accidents. Some maintenance activities require complete closure of a freeway section.

High truck load accidents at bridges not only damage the structures but also result in congested freeways. Maintenance on the damaged structures requires closure of freeway lanes.

When a major incident causes a bottleneck, significant freeway congestion results even though unused capacity may exist on parallel routes within the freeway corridor. Not all incidents result in significant delay; however, each creates queuing on the freeway, which can be a serious traffic hazard to uninformed motorists.

Adverse weather conditions reduce capacity as well as create safety hazards. Occasionally, conditions may warrant partial or total closure of highway facilities. Major storms oftentimes require the movement of large numbers of people within relatively short time periods.

Special Events

Special events, (e.g., ballgames, parades, etc.) often generate large volumes of traffic that are somewhat predictable in nature. Generally, congestion occurs on certain freeway segments at or near the generator. In many cases, alternate routes are available but are not used because drivers are either unaware of them or have no knowledge of the severity of congestion on their primary route to the special event.

Although the effects of many special events can be predicted from historical data by traffic planners and are expected by motorists who regularly attend the special event, the congestion that develons oftentimes is unexpected by the motorists who are not traveling to the special event. Irregular event dates and variable starting times contribute to the motorists' inability to predict traffic conditions.

Operational studies (1) (2) have shown that managing traffic during special events will result in extremely high payoffs in terms of reduced congestion and delay.

There are other types of special events that occur infrequently -- sometimes only once in a lifetime as far as having to be addressed by a specific group of transportation planners and engineers -- but have a profound impact on our transportation facilities. The Olympics or a world's fair are examples. Traffic control planning for these events is much more complex because no local historical data relative to these events are available to help the agencies involved with planning and traffic control.

FREQUENCY AND CHARACTERISTICS OF FREEWAY INCIDENTS

Information on the frequency and characteristics of freeway incidents is documented in several reports (3) (8). Studies of a 6-mile section of the Gulf Freeway in Houston (ADT = 120,000), for example, revealed that approximately 13 lane-blocking incidents occurred per week between 6 a.m. and 7 p.m. (3). On the average, at least one major incident occurred on the inbound lanes of the freeway every week between 6:00 to 8:30 a.m. Approximately 80 percent of the incidents reduced the directional capacity of the freeway by at least 50 percent.

The effects of a lane-blocking incident are significant. Goolsby (4) reported that a one-lane blockage on a three-lane section of freeway reduces the capacity by 50 percent, although the physical reduction in usable lanes is only 33 percent (Table 1). An accident that blocks two of three lanes (67 percent) reduces the capacity by 79 percent. The capacity reduction caused by a stalled car is as great as that due to a lane-blocking accident.

Table 1. Available capacity on inbound Gulf Freeway during different incident conditions.

	Number of Incidents	Sample Size	Average Flow Rate (vph)	Capacity Reduction (percent)
Normal flow		312	5,560	-
Stall (one lane blocked)	4	43	2,880	48
Noninjury accident (one lane blocked)	17	167	2,750	50
Accident (two lanes blocked)	6	53	1,150	79
Accident on shoulder	23	254	4,030	26

The time of day an incident occurs is also important. For example, an incident occurring at the beginning of the peak period will cause more delay than one occurring at the end of the peak period. Figure 1 shows the periods of the day that a typical six-lane urban freeway is susceptible of congestion due to an incident.

Another factor that influences the amount of congestion and delay is the duration of the incident. The longer the duration, the more severe are the resulting congestion and delay for a given level of traffic demand.

The consequences of incidents are congestion, delay, shock waves in the traffic stream that lead to induced accidents, and other adverse effects. The following hypothetical incident on the inbound Gulf Freeway illustrates some of the relationships involved. It is assumed in Figure 2 that a stalled vehicle requiring police assistance occurs on a lane of the inbound Gulf Freeway at 7 a.m., the beginning of the peak period. The total delay that results is the area between the normal traffic demand curve and the capacity curve. When the stall occurs, the slope of the capacity curve drops, reflecting a reduction in freeway capacity from approximately 5,600 to 2,880 vph. The slope of the capacity curve returns to normal when the disabled vehicle is removed 18 minutes later (the average duration for a stalled vehicle on the Gulf Freeway). This hypothetical incident would result in 800 vehicle-hours of delay and an average delay per vehicle of approximately 8 minutes.

These results show that the frequency and duration of incidents are primary factors in determining the operating conditions of the freeway. The more frequently incidents occur, the more frequently congestion will result. The longer the duration of the incident, the more likely severe delay is to occur.

Accidents and stalled-vehicle incidents that require police assistance oftentimes block traffic for considerable time periods. Studies conducted by TTI (4) indicated that an average accident requiring police assistance takes 19 minutes from the moment the accident occurs until it is removed from the freeway. An additional 25 minutes, on the average, is required to complete the accident investigation. Figure 3 shows the duration of incidents observed on

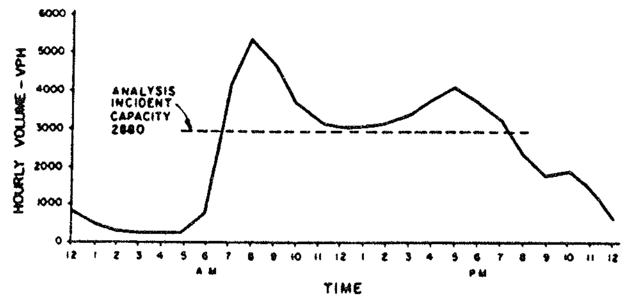

Figure 1. Traffic volumes of inbound Gulf Freeway at Griggs Overpass.

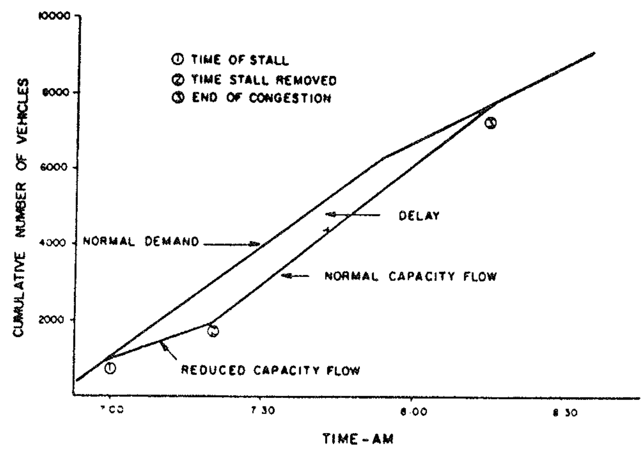

Figure 2. Example of delay caused by a stalled vehicle blocking one lane of inbound Gulf Freeway at 7 a.m.

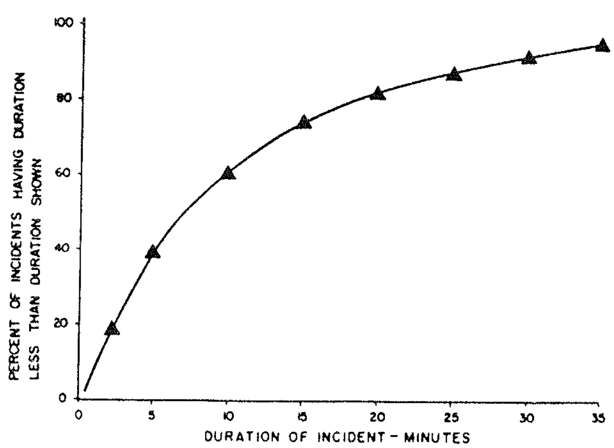

Figure 3. Cumulative distribution of the duration of incidents on Gulf Freeway.

the Gulf Freeway. In earlier studies, Lynch and Keese (9) observed that an average of 45 minutes was required to remove damaged vehicles from the freeway when emergency vehicles were required.

ROADWORK

Our highways require continuous maintenance in order to provide acceptable levels of service to the motoring public. Many urban freeways are being reconstructed. Roadwork generally requires that one or more lanes be closed, sometimes for long durations.

Normal capacity on an urban freeway would be expected to be between 1800-2000 vphpl. The capacity of an urban freeway undergoing reconstruction will be reduced slightly (10). Maintenance reduces the freeway capacity to between 1200-1500 vphpl depending on the type of closure (11).

SOLUTION APPROACH

From a traffic management viewpoint, when an incident occurs on the freeway the vehicles must be removed as quickly as possible, freeway demand must be intercepted before it reaches the reduced capacity caused by the incident, and the demand must be redirected to areas of available capacity in the freeway corridor. In addition, from a safety standpoint, motorists approaching the queue area should be warned of the slowed traffic.

Freeway incident management refers to a coordinated and preplanned approach used to restore freeway traffic to normal operation after an incident has occurred by using human and electronic/mechanical resources. The approach involves a systematic process for 1) detecting any incident, 2) identifying the scope (i.e., number of vehicles involved, number of lanes affected, severity of the accident, anticipated time of the lane closures, etc.) and needs (e.g., police, fire department, wrecker, maintenance equipment and personnel, etc.) relative to the incident, and 3) providing appropriate response to aid the motorists involved and to minimize the adverse effects of the incident by clearing the incident as quickly as possible. Corridor surveillance, control, and motorist information are required to accomplish these objectives.

The surveillance function is required to 1) detect and evaluate the nature of the freeway corridor operating characteristics, 2) detect any unusual conditions, and 3) determine the appropriate operational control strategy. The control function provides the response in terms of incident removal, motorist aid, and adjustment to the traffic controllers located at freeway ramps and intersections along alternate routes that will accommodate the short-term changes in traffic patterns. Motorist information systems perform a critical role in the successful operation of real-time freeway traffic control systems. They provide information that will enable motorists to intelligently select and follow the best alternate course of action, from rerouting through the corridor to diverting to another major facility.

Incident Detection

Vehicular incidents can be detected through

1. Electronic surveillance,
2. Closed-circuit television,
3. Aerial surveillance,
4. Emergency call boxes,
5. Emergency telephones,
6. Cooperative motorist aid systems,
7. CB radio, and
8. Patrol vehicles (police, mechanical service, maintenance).

Advantages and disadvantages of each method are discussed by Everall (12) and Mammano (13) and will not be elaborated on here. It is apparent that some methods provide better detection capabilities; others allow more detailed analysis of the scope and the required assistance. Cost-effectiveness analyses pursuant to the objectives of any proposed system would be necessary to determine the best approach or combination of approaches for a particular city.

Incident Response

Response time

How quickly do we need to respond to incidents? The answer lies in the relationship between required response time and system design. The speed of response is dictated in part by the objectives of the system. If the system is designed to warn approaching motorists of stopped vehicles on the freeway, then the response time must be short.

Response time includes the time required to detect the incident; it also includes the time required to dispatch assistance and remove the involved vehicles. Response time is dictated by the requirements of the system and consequently will affect the cost. A system objective to remove all incidents from freeways during the peak period within ten minutes after they occur will cost more than a system permitting a 20-minute response time. The relationship between response time and cost for alternative designs must be determined.

Type of response

Incidents may be serviced by police and highway patrol vehicles, tow trucks, or state-operated maintenance vans. Normally, more than one department of any agency or more than one agency is involved. Successful incident management cannot be accomplished in isolation. It requires the full cooperation of several government groups.

Incident response also involves balancing traffic demands to the available reduced capacity due to the incident. Approaches to demand balancing include entrance ramp controls and motorist information. Real-time motorist information displays, which give motorists on-the-spot accurate and timely information, play an important role in achieving effective urban traffic management (14).

ADVANCE PLANNING

Advance planning for handling traffic when emergency lane closures or freeway closures occur, when emergency environmental conditions dictate, or during special events, is essential to the orderly movement of traffic. Adequate advance planning minimizes the effects of incidents or special events on highway traffic.

SUMMARY

The scope of the problems relative to incidents, roadwork and special events has been briefly discussed. The following are a few challenges that need to be addressed so that effective traffic management systems can be implemented and operated.

1. What are the optimal system configurations for incident detection and response?
2. What are the trade-offs between response time and cost?
3. What are the total benefits of freeway patrols, call boxes, closed-circuit television, etc., and how do we evaluate these on a common basis so that alternatives can be considered from a cost-effectiveness standpoint?
4. What level of reliability can be expected from the various alternatives, and what maintenance problems and costs are involved?
5. How can government agencies and others establish priorities, plan, and coordinate activities for effective incident management?

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