SCOPE OF THE TRAFFIC PROBLEM GENERATED BY INCIDENTS AND SPECIAL EVENTS

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Introduction

Urban transportation is the movement of persons, goods, and services into, within and out of the 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 that 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

Recurrent problems occur routinely during peak-periods when traffic demand exceeds capacity, even 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 20 years, leading to the development of freeway ramp control systems that have proved their effectiveness in reducing recurrent peak-period congestion. Freeway corridor control systems under development are expected to further improve conditions.

Nonrecurrent Problems

Nonrecurrent problems are caused by random, unpredictable incidents such as traffic accidents, temporary freeway blockages, maintenance operations, overweight trucks, etc. Environmental problems such as rain, ice, snow, fog, etc., might 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 the driver, and therefore the effects of maintenance lane closures can be as severe as accidents. Some maintenance activities require complete closure of a freeway section.

Overweight-truck accidents at underpasses not only damage the structures but also result in congested freeways, when 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 queueing on the freeway, which can be a serious traffic hazard to uninformed motorists and may even lead to accidents.

Adverse weather conditions reduce capacity as well as create safety hazards. Occasionally, conditions may warrant partial or total closure of highway facilities. Major storms often 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 unused because drivers either are 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 by traffic planners from historical data and are expected by drivers who regularly attend the event, the congestion that develops is unexpected by drivers traveling to other destinations. Irregular event dates and variable starting times contribute to the driver's 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 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 numerous reports (3-8). Studies of a 6-mile section of the Gulf Freeway in Houston (ADT = 120,000) 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 per week from 6:00 to 8:30 a.m. on the inbound lanes of the freeway. Approximately 80 percent of the incidents reduced the directional capacity of the freeway by at least 50 percent. High rates of freeway incidents also have been reported by other authors.

The effects of a lane-blocking incident are significant. Goolsby (4) reported a one-lane blockage on a three-lane section of freeway reduced the capacity by 50 percent, although the physical reduction in usable lanes was 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 was found to be as great as that due to a lane-blocking accident.

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 a peak period. Figure 1 shows the periods of the day a typical six-lane (3 lanes inbound) urban freeway is susceptible to congestion due to an incident.

Another factor that influences the amount of congestion and delay that develops is the duration

of the incident. The longer the duration, the more severe are the resulting congestion and delay for a given level of 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 18.3 min. 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 min.

These results show that the frequency and duration of incidents occurring on a freeway 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 is, 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) indicate that an average accident requiring police assistance takes 19 min. from the moment the accident occurs until it is removed from the freeway. An additional 25 min., on the average, is required to complete the accident investigation. [Figure 3 shows the duration of incidents observed on the Gulf Freeway. In earlier studies,] Lynch and Keese (9) observed that an average of 45 min. 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. Maintenance occasionally requires the closing of one or more lanes of the primary facility for long periods of time. Thus, while normal capacity on an urban freeway would be expected to be between 1,800-2,000 vphpl, roadwork reduces it to 1,200-1,500 vphpl depending on the type of closure (10).

Solution Approach

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. Additionally, from a safety standpoint, drivers approaching the queue area should be warned of the slow traffic.

Incident management 1) consists of the method to detect the incident, 2) offers a means by which the scope and needs are identified, and 3) provides the appropriate response to minimize the adverse effects of the incident. Corridor surveillance, control, and information is required to accomplish these objectives.

The surveillance function is required to 1) detect and evaluate the nature of the 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. Driver information systems perform a critical role in the successful operation of real-time freeway traffic control systems. They provide information that will enable drivers to select and follow the best alternative 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 (11) 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 analysis pursuant to the objectives of any proposed system would be necessary to determine the best approach or combination of approaches.

Incident Response

Response time. How quickly do we need to respond to an accident? The answer lies in the relationship between required response time and system designs. 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 dispatching assistance and removing 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 10 min. after they occur will cost more than a system permitting a 20-min. 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 an 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 (12).

Advance Planning

Advance planning for handling traffic when emergency lane closures or freeway closures occur, when emergency environmental conditions dictate, or when special events occur is essential to the orderly movement of traffic. Adequate advance planning minimizes incident effects on highway traffic, and reduces the normal congestion that develops because of these incidents.

Summary

The scope of the problems relative to incidents, roadwork and special events has been briefly discussed. The following are a few challenges that, if considered, help ensure traffic management systems are implemented and operated with effectiveness.

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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FILM: TRAFFIC MANAGEMENT FOR FREEWAY INCIDENTS

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As a further introduction to both the problem and solutions in traffic management a new film produced by the Federal Highway Administration was shown. This 17-minute film promotes the rapid removal of freeway incidents, and describes lower-cost solutions that highway, police, fire, and other local agencies can use to improve traffic management, safety, and control at incident sites.

While freeways account for only 2 percent of the total miles of highways, they carry about 26 percent of the total travel. In urban areas, freeway incidents are highly visible disruptions, and they typically account for one-half of all freeway congestion.

This 16mm film, which is also available in a videotape format, illustrates how a pre-planned, coordinated interagency approach between traffic engineers, police, fire, media, and other local agencies can be implemented quickly when the need arises. Traffic management approaches are illustrated for both simple and complex incidents. The film incorporates footage from Chicago, Minnesota, Los Angeles, San Antonio, and other locations. The film is of interest to Federal, State, city, and local traffic engineers.

INCIDENT DETECTION AND RESPONSE

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The occurrence of traffic incidents on urban freeways presents a most challenging problem to operating agencies. Such incidents vary in severity and nature, and occur on a random basis at any time and any place. Lane-blocking accidents should be detected as soon as possible to effect vehicle removal and restoration of traffic service. Other incidents, such as the motorist with a disabled vehicle, are more subtle. Depending on when, where, and under what circumstances they occur, they may or may not be hazardous situations for other motorists.