Emergency Parking Areas Along Restriped Urban Freeways

JAMES H. BANKS

Research related to the design of emergency parking areas along restriped urban freeways is documented. Several issues involved in designing such facilities are discussed; performance of existing emergency parking areas on the Santa Ana Freeway in Los Angeles County is documented; and dimensions for emergency parking areas based on the use of normal freeway shoulders are recommended. Extensive videotaping of the existing emergency parking areas revealed that they are little used, probably because they are too small and inconspicuous. Meanwhile, an analysis of accident records provided no evidence of safety problems associated with them or with the lack of normal shoulders on the freeway section in question; however, because of the lack of use of the parking areas, this does not necessarily indicate that the existing dimensions are adequate. The amount of space involved in use of normal shoulders was found to be widely variable; however, emergency parking areas with total lengths of 190 to 240 m should accommodate a majority of the maneuvers observed.

Increasing traffic congestion on urban freeways has led to use of a number of low-cost measures intended to increase capacity. One such measure is to restripe the freeway to convert shoulder areas to traveled way. This concept has been addressed by McCasland (*1*) and Urbanik and Bonillo (*2*) and is the subject of ongoing research funded by NCHRP. This concept has yet to be accepted as desirable and is used only in extreme circumstances; nevertheless, its use is increasing.

Restriping raises important safety and operational issues. This is especially true when it involves use of the right shoulder because it leaves no room for disabled vehicles to pull off the road. One possible solution is to provide emergency parking areas at intervals along restriped freeways. These provide limited capability to remove disabled vehicles without the cost or other impacts of a full-scale widening project.

To date, emergency parking areas have been provided in only a few cases and there is no guidance as to their proper geometric design or optimum spacing. The purpose of the research described in this paper was to document the performance of six existing emergency parking areas located on the northbound Santa Ana Freeway (Interstate 5) in the La Mirada–Santa Fe Springs areas southeast of Los Angeles and to develop information that will provide a rational basis for the design of such facilities.

PERFORMANCE OF EXISTING EMERGENCY PARKING AREAS

Very few emergency parking areas have been constructed to date. In addition to those on the Santa Ana Freeway, several have been constructed alongside Interstate 66 in northern Virginia; however, no published information on the performance of the Virginia facilities could be found. Because the six parking areas on the Santa Ana Freeway could be studied conveniently, it was decided to confine the study of existing emergency parking areas to them.

At the outset it was expected that experience with these existing parking areas would provide considerable insight into the proper design of such facilities. Particular questions were how extensively they were used, whether drivers using them were experiencing obvious difficulties in entering or exiting them, and whether there was evidence of an unusual incidence of accidents involving them.

Answers to these questions were sought by means of extensive video surveillance of the parking areas, an analysis of accident records, and a survey of the professional opinions of California Department of Transportation (Caltrans) maintenance workers and California Highway Patrol (CHP) officers familiar with them.

Usage

Approximately 87 hr of videotaping was carried out over 44 days between June 29 and August 28, 1992, at three of the six existing emergency parking areas on the Santa Ana Freeway for which vantage points were available. These sites are located in a section for which the right shoulder has been restriped to provide an auxiliary lane between interchanges and are intended primarily to provide parking at emergency call boxes. Their dimensions are documented in Figure 1. In all cases, videotaping was carried out during the morning peak period, between 6:30 a.m. and 8:30 a.m. Only one case of use of an emergency parking area was observed. From this experience, it was concluded that usage of the parking areas is quite low, probably because they are rather inconspicuous.

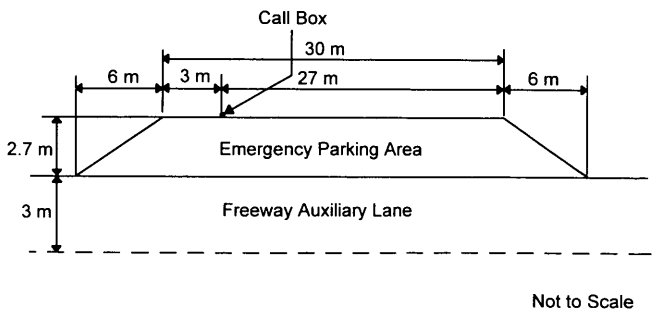

FIGURE 1 Dimensions of existing emergency parking areas on the Santa Ana Freeway.

Civil Engineering Department, San Diego State University, San Diego, Calif. 92182-0189.

Accident Experience

Accident records contained in the Traffic Accident Surveillance and Analysis System (TASAS) data base were examined to determine whether there were obvious safety problems associated with the operation of the emergency parking areas or evidence of accidents involving disabled vehicles that were unable to reach a parking area. TASAS reports for the period January 1 through December 31, 1991, were examined for a 5.6-km section of the northbound Santa Ana Freeway containing the existing emergency parking areas.

All accidents within a distance of 0.08 km of the midpoint of an emergency parking area were examined in detail. In no case was there any indication that use of an emergency parking area was involved in an accident. This is not surprising, given the low level of usage, and certainly should not be interpreted as evidence that the design of the existing emergency parking areas is adequate.

In addition, TASAS reports were scanned to identify all accidents in the section involving stopped vehicles. It was found that 24.5 percent of the accidents did involve stopped vehicles. Comparison with the percentages of stopped-vehicle accidents occurring in the southbound lanes of the same section of the Santa Ana Freeway, which has a normal shoulder, indicated that this rate of stopped-vehicle accidents was not unusual. Once again, however, sample sizes are far too small to support general conclusions.

Experience of Maintenance and Law Enforcement Personnel

Expert opinion concerning the existing emergency parking areas was sought through a written survey of Caltrans maintenance personnel and CHP officers familiar with them. Respondents were asked whether the emergency parking areas were useful to them in their work, who else used them and for what purposes, whether there were any safety or operational problems associated with the current design of the parking areas, and how their design could be improved. It had originally been intended to survey 12 to 15 individuals from each organization; however, after contacts with supervisory personnel, it became apparent that very few people were familiar with the existing parking areas. In the end, questionnaires were distributed to six Caltrans maintenance employees and one CHP officer. Surveys were returned by the CHP officer and five of the six maintenance employees; however, only four of the questionnaires returned by maintenance employees were usable.

Respondents indicated that the emergency parking areas were useful to them in their work. The CHP uses them for traffic stops and to remove disabled vehicles and vehicles involved in accidents from the traffic lanes. Caltrans maintenance employees use them to set up signs, remove litter, repair water systems, prune and load landscape cuttings and debris, and set lane closures. Maintenance employees further reported that in restriped sections that lack emergency parking areas, they are required to set up lane closures for even such routine maintenance activities as litter removal. In addition, respondents reported that the emergency parking areas were used by motorists for emergency repairs and various types of discretionary stops.

Several maintenance personnel reported that the emergency parking areas were too short for them to reenter the freeway safely and that in some cases they were too short to accommodate both disabled vehicles and tow trucks. Also, the maintenance employees stressed that normal shoulders should be retained wherever possible, stating that emergency parking areas are not adequate replacements for normal shoulders for many of their activities.

DESIGN OF EMERGENCY PARKING AREAS

Issues

Major issues in the design of emergency parking areas are their spacing and dimensions (lengths, widths, and tapers). The cost of emergency parking areas and their impact on the restriped freeway depend on both their dimensions and spacing. Their safety and operational efficiency depend largely on their dimensions.

Emergency parking areas are intended to serve as partial substitutes for normal shoulders, many of whose functions can be performed by relatively small, widely-spaced parking areas. Maintenance activities, non-vehicle–related emergency stops, repair of nondisabled vehicles, and stops of traffic violators all involve some discretion on the part of the driver as to where they take place. Many such stops can be accomplished by exiting the freeway altogether. On the other hand, total disablement of vehicles and accidents occur at random locations and often involve considerable difficulties in moving vehicles. In these cases, emergency parking areas are of value only if they are in the immediate vicinity of the incident.

Optimum spacing of emergency parking areas, unless dictated by some other consideration such as emergency call box spacing policies (as might be the case in California urban areas) depends on the size of the parking area and the desired tradeoff between cost and the probability that the parking area is available in the case of a nondiscretionary stop. This probability is roughly the fraction of the roadside occupied by parking areas, which can easily be computed for any given set of parking area dimensions and spacings.

Appropriate dimensions for emergency parking areas depend on vehicle dimensions and the behavior of drivers exiting and entering them. Widths are primarily dependent on vehicle dimensions and should be adequate to accommodate all vehicles of legal width. The legal width of the largest trucks is 2.6 m. On the basis of this measurement, a minimum width of 3 m, similar to the existing California standard for normal freeway shoulders, is desirable for emergency parking areas.

Required lengths and taper angles are less obvious. The overall maneuver involved in pulling into an emergency parking area and subsequently returning to the freeway includes the following stages:

1. Deceleration in the right lane of the freeway;
2. Diverging onto the emergency parking area;
3. Deceleration within the parking area to a stop;
4. Acceleration within the parking area from a stop;
5. Merging into the right lane of the freeway; and
6. Acceleration in the right lane of the freeway.

Stages 2 through 5 correspond to the design elements of the parking area; Stages 2 and 5 correspond to the tapers at the upstream and downstream ends; and the total of Stages 3 and 4 correspond to the length of its full-width portion.

Use of Normal Freeway Shoulders

Distances required for each of these stages are best determined by observing actual driver behavior. Because the study of the existing emergency parking areas on the Santa Ana Freeway provided almost no insight into the use of these facilities, it was necessary to rely on a study of use of normal freeway shoulders. This involved analysis of videotapes from several previous freeway studies to determine the distances involved. As these videotapes were originally produced for other purposes, they were not always ideal for studying shoulder use; nevertheless, it was possible to identify about 20 cases for which the distances involved in stopping, starting, or both, could be determined.

Two methods were used to measure distances from these tapes. The first involved deriving a relationship between distances measured on the screen and those on the ground (*3*). As it turned out, this method could be used at only one site. The other method was to mark the beginning and end of the vehicle maneuver on the video screen and make measurements of the times it took several vehicles to cover this distance. If traffic was free flowing, average speeds were assumed to be in the range of 85 to 100 km/hr, and the distance was computed using an assumed average speed. Neither of these methods is very accurate. This was not very important, however, because the distances involved in shoulder-related vehicle maneuvers varied widely, and only an approximate idea of them was needed.

Where possible, four separate distances were measured. These included the diverge, defined as the distance covered between the times that the right front and left rear wheels left the traveled way; the deceleration distance on the shoulder; the acceleration distance on the shoulder; and the merge, defined as the distance covered between the times the left front and right rear wheels entered the traveled way. In some cases it was not possible to distinguish between diverging and deceleration on the shoulder or between acceleration on the shoulder and merging, and in these cases the total stopping or starting distance was measured. In other cases, it was possible to measure either the stopping distance or the starting distance, but not both.

Figures 2 through 6 present cumulative distribution curves for these measurements. From these one can see that the distributions of total stopping distance, total starting distance, and total distance used are relatively uniform. That is, there is in each case a break point indicating the tail region of the distribution, but below this break point the cumulative distribution curve is nearly a straight line, indicating that all distances are equally likely. Breakpoints are about 120 m for total stopping distance, 180 m for total starting distance, and 240 m for total shoulder distance used. The breakpoint for total distance used is not equal to the sum of those for total starting distance and total stopping distance because the longest starting and stopping distances did not necessarily occur for the same vehicles and because in some cases either starting or stopping distance was measured, but not both. Cumulative distribution curves for diverge and merge distances are more nearly S-shaped. In both cases, the bulk of the distribution falls between 30 and 45 m, although the distribution of merge distances is more spread out than that of diverge distances.

Median distances were 45 m for merging, 40 m for diverging, 60 m for total stop, 85 m for total start, and 190 m for total distance used. The median values of starting and stopping distances do not add up to that of total distance because in some cases either starting or stopping distance was measured, but not both.

CONCLUSIONS AND RECOMMENDATIONS

From the foregoing it may be concluded that emergency parking areas are useful in cases in which freeway shoulders are converted to traveled way and that they can substitute for some but not all functions of normal shoulders. In particular, they are not effective substitutes for the full range of maintenance activities.

The existing emergency parking areas on the Santa Ana Freeway appear to be too small. Not only are their usage rates very low, probably as a result of the fact that they are small and inconspicuous, but their dimensions are considerably less than the distances typically used in pull-off-pull-on maneuvers on normal

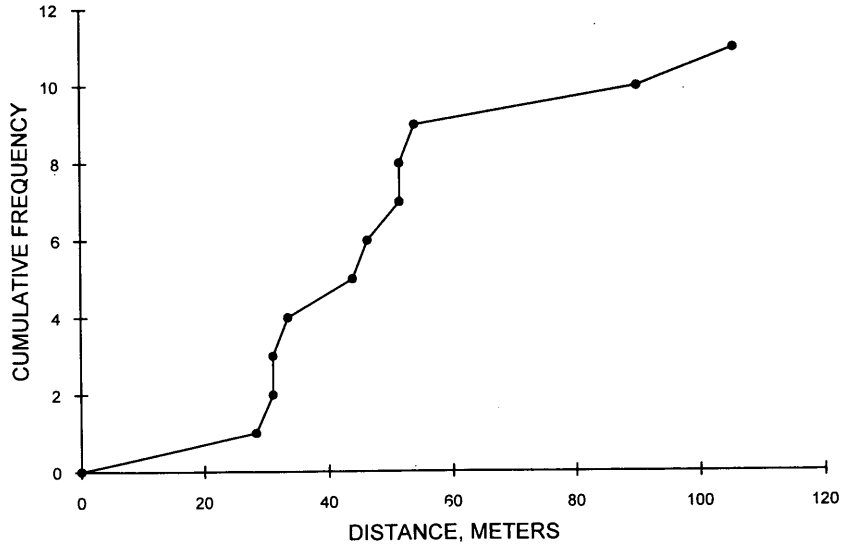

FIGURE 2 Cumulative distribution: diverge distances.

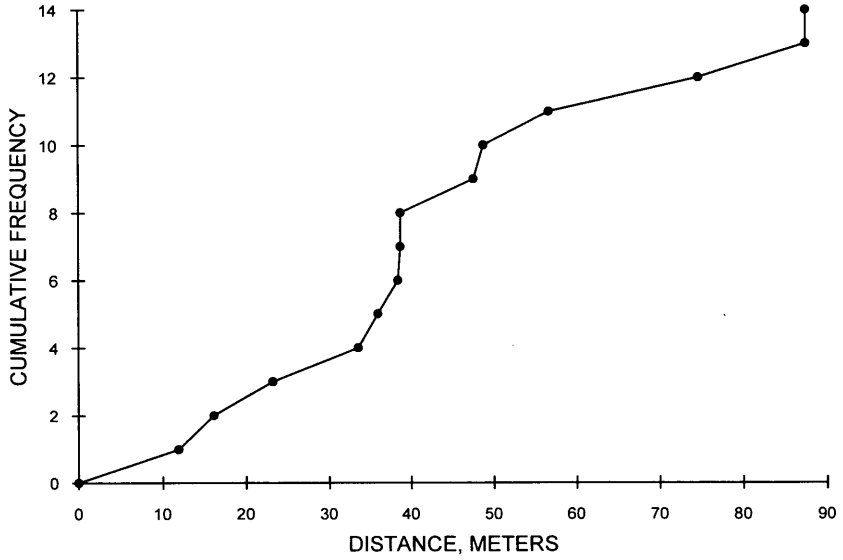

FIGURE 3 Cumulative distribution: merge distances.

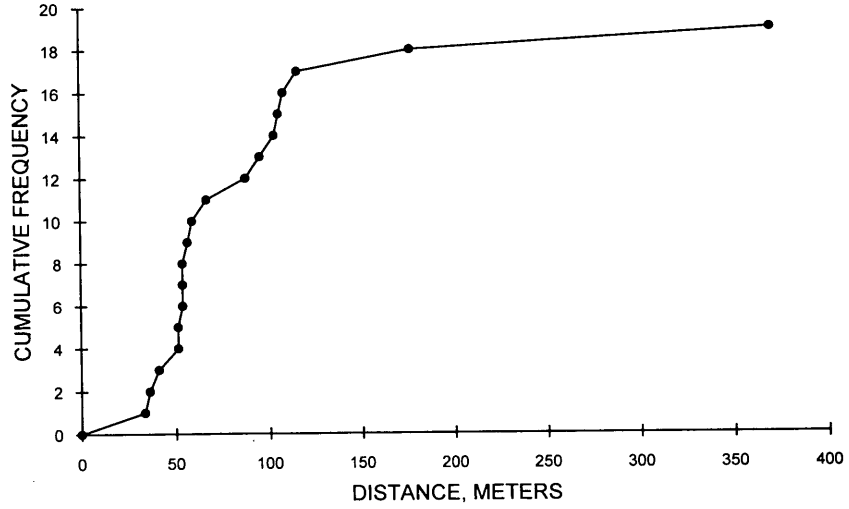

FIGURE 4 Cumulative distribution: stopping distances.

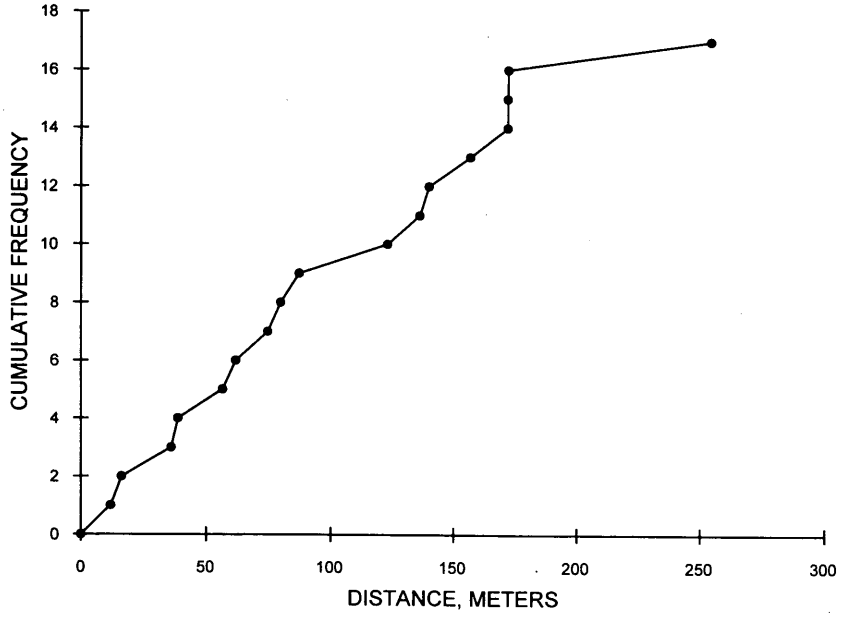

FIGURE 5 Cumulative distribution: starting distances.

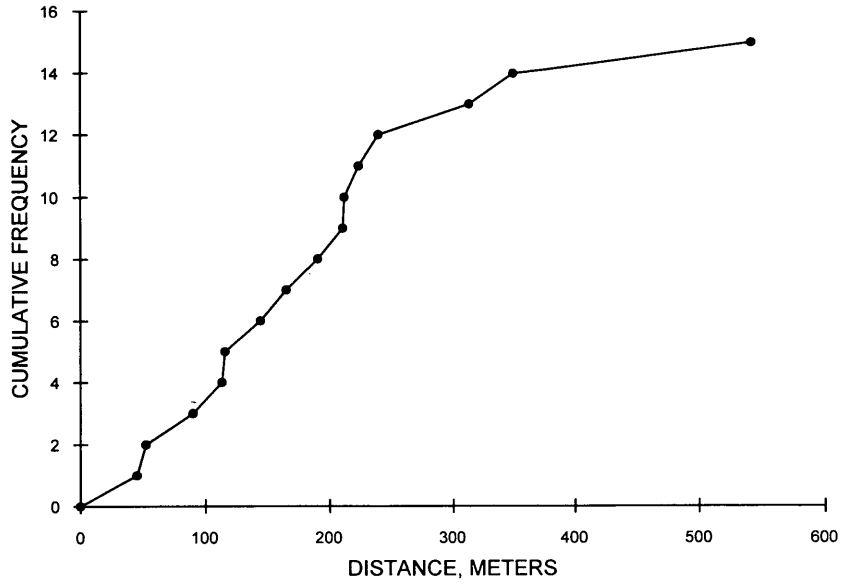

FIGURE 6 Cumulative distribution: total shoulder distance used.

shoulders. Observations of the use of normal freeway shoulders indicate that parking areas with overall lengths of 190 to 240 m should be adequate. Figures 7 and 8 give recommended dimensions of 190- and 240-m emergency parking areas incorporating emergency call boxes. The 190-m design is based on median distances observed on normal shoulders, and the 240-m design is based on upper break-point distances.

Where call boxes are installed, as in most urban areas of southern California, it is recommended that an emergency parking area be established at each box. This will result in a spacing of approximately 0.4 to 0.8 km. For the range of emergency parking area dimensions recommended here, a spacing of 0.8 km will result in 25 to 30 percent of the roadside being occupied by some part of an emergency parking area and 10 to 20 percent by the full-width parking area. For the 0.4-km spacing, these percentages will double.

Finally, there is no evidence that the existing emergency parking areas are involved in an unusual number of accidents. In fact, no accidents involving them were identified. The most likely explanation for this lack of accident experience is their low usage rates; however, it should not be concluded that the dimensions of the existing emergency parking areas are necessarily adequate to provide safe operation.

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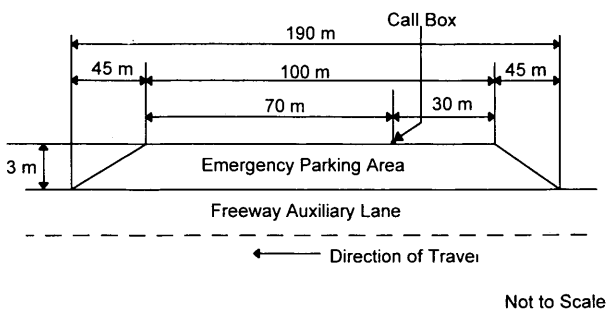

FIGURE 7 Recommended dimensions for 190-m emergency parking areas.

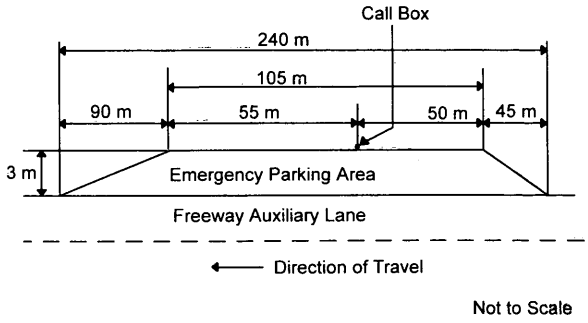

FIGURE 8 Recommended dimensions for 240-m emergency parking areas.

Highway Patrol; research assistant John Pham; and video crew members Bob Danila and Carl Segura.

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