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## ABSTRACT

Since its inception in July 1991, the Los Angeles County Metro Freeway Service Patrol (FSP) with its 144 roving tow trucks has proved to be a valuable traffic management tool in reducing motorists' delay by early detection and clearance of minor incidents. During the recovery period after the January 17, 1994 Northridge earthquake, the FSP again made major contributions to relieve the non-recurrent congestion in Los Angeles.

The Northridge earthquake caused significant damages to some of the region's freeways in Los Angeles County, including the heavily traveled Santa Monica Freeway (I-10) and the Golden State Freeway (I-5)—the main corridor connecting southern and northern California. Miles of traffic backup and hours of traffic delay were experienced by the motorists. This is compounded by the post-earthquake restriping of freeways and detours to maximize the roadways capacity leaving little or no shoulder for disabled vehicles. Any incidents, however minor, could have magnified the already congested traffic delay.

This paper describes the efforts of the FSP in deploying the tow trucks to the earthquake-affected freeways and local detour areas in assisting the motorists during the earthquake recovery. The strategies of the deployment, the operations of the roving tow truck and the management are discussed. In addition, statistics of the post-earthquake assists are presented to show the effects of the FSP in the detection and response to the incidents in the earthquake-affected areas. Comparisons of the pre-earthquake and post-earthquake and afterreopening assists are performed to characterize the earthquake detour areas incidents. Conclusions of the efforts and effects are also presented.

This paper is useful to the incident and traffic management project managers and administrators. Keywords: Freeway Service Patrol, Incident Management, Northridge Earthquake.

## BACKGROUND

The January 17, 1994 Northridge earthquake caused many damages to the regional freeways in Los Angeles County. A 4-mile section of Santa Monica Freeway (Interstate 10), the world's busiest freeway, was closed after the earthquake due to the collapse of two bridges. An 8 mile section of the Golden State Freeway (Interstate 5), the main corridor connecting southern and northern California, was also closed due to the collapse of the Galvin Canyon bridge and the interchange of I-5 and State Route (SR) 14.

California Department of Transportation (Caltrans), with cooperation from other governmental agencies, quickly provided freeways, highways, and local surface streets detours for these closures. However, the closure of freeways had a significant effect on the commute traffic. Miles of traffic backup resulted and substantial traffic delay was experienced by the motorists in the early stage of earthquake recovery, especially when most of the detour roadways were restriped to maximize capacity leaving little or no shoulder for the disabled vehicles. Any incidents, however minor, could have magnified the already congested traffic and resulted in extended traffic delay to the motorists. These incidents, if not removed quickly, could have also resulted in more incidents-secondary accidents. Early detection and timely clearance of incidents have a significant effect on the delay reduction as well as accident reduction on the earthquake detour routes.

Since its inception in July 1991, the Los Angeles County Metro Freeway Service Patrol (FSP) with its 144 roving tow trucks has proved to be a valuable traffic management tool in reducing motorists' delay by early detection and clearance of minor incidents. During the recovery period after the January 17, 1994 earthquake, FSP again made major contributions to relieve the nonrecurrent congestion in earthquake detour areas.

This paper describes the efforts of the FSP during the Northridge earthquake recovery by providing roving tow trucks to the earthquake-affected freeways, highways and local streets detour areas to assist stranded motorists and provide tow service to the disabled vehicles. The strategies of the earthquake deployment, the operations of the roving tow truck and the management are discussed. In addition, the statistics of the post-earthquake incidents and their characteristics from January to May, 1994 are presented for the major damaged freeway detour areas (I-10, I-5, SR-14 and SR-118) to show the effects of the FSP during the Northridge earthquake recovery. Comparisons and analysis of incident characteristics for the pre- and postearthquake and after-reopening by the end of May 1994



FIGURE 1 Freeway service patrol area map.

are performed. Conclusions of the efforts and effects are also presented.

# THE LOS ANGELES COUNTY METRO FREEWAY SERVICE PATROL

The FSP was initiated in July 1991, the first such program in California. It is a joint venture of Caltrans, California Highway Patrol (CHP), and Los Angeles County Metropolitan Transportation Authority (MTA). The FSP program is intended to reduce the nonrecurrent congestion on freeways during the peak commute hours by quickly removing the disabled vehicles from freeways, or providing quick fixing items, such as refilling a gallon of gasoline, changing a flat tire, repairing a leaking hose and recharging a dead battery.

Before the January 17, 1994 Northridge earthquake, the FSP had 144 tow trucks patrolling 40 beats (a beat is sections of freeways) covering 381.3 centerline miles of freeways in Los Angeles County as shown in Figure 1. More than 550,000 incidents had been assisted by the FSP with an average annual assist of 220,000. The 144 tow trucks are from 20 private contractors, which can tow the vehicles with a gross weight up to 6,000 pounds. The FSP program has been very successful since its inception. More than 90 percent of returned survey letters rated the service as excellent and commended the program as a wise expenditure of the tax-payers' dollars. The 93/94 fiscal year budget is \$24 million. The



FIGURE 2 The Northridge Earthquake affected freeways and roadways.

program is the largest one in the nation in terms of the number of tow trucks according to a survey by *The Urban Transportation Monitor* (Ref: This Week's Survey Results: Freeway Service Patrols. *The Urban Transportation Monitor*, Vol. 6, Numbers 16 and 17, September, 1992).

# THE DAMAGED FREEWAYS BY THE NORTHRIDGE EARTHQUAKE

Figure 2 shows the locations of the major freeways which were damaged during the January 17, 1994 Northridge earthquake. They included I-5 (the Golden

BEAT	FWY	LIMITS	CENTERLINE MILES	# OF TRUCK		AM	PM
				HEAVY DUTY	REGULAR	SHIFT	SHIFT
41	5/14	Roxford St. to San Fernando Rd.	4.5		4	5:00 AM to 9:30 AM	2:30 PM to 7:30 PM
42	5	Lyons Ave. to Roxford St.	8.1	1	3	5:00 AM to 8:00 PM,	Monday-Friday
				1	2	8:00 AM to 8:00 PM,	Saturday
				1	2	10:00 AM to 8:00 PM,	Sunday

## TABLE 1 LIST OF NEW BEATS IN THE EARTHQUAKE DEPLOYMENT

TABLE 2 LIST OF EXISTING BEATS WITH EARTHQUAKE EXTENDED SERVICES

BEAT	FWY	LIMITS	CENTERLINE MILES	# OF TRUCKS	AM SHIFT	PM SHIFT
7	101	Reseda Boulevard to	9.6	5		
		Route 101/134 Interchange		(4)	(6:00 AM to 10:00 AM)	(3:00 PM to 7:00 PM)
10	405	Devonshire St. to Mulhulland Dr.	9.2	4	6:00 AM to 11:00 AM	3:00 PM to 7:30 PM
				(3)	(6:00 AM to 10:00 AM)	(3:00 PM to 7:00 PM)
17	10	Bundy Dr. to Vermont Ave.	9.3	5	6:00 AM to 11:00 AM	2:30 PM to 7:30 PM
				(4)	(6:30 AM to 10:00 AM)	(2:30 PM to 7:00 PM)
33	118	Rocky Peak Road to Route 210 at Maclay St.	16.8			3:00 PM to 7:30 PM
				(4)	(6:00 AM to 9:00 AM)	(3:30 PM to 6:30 PM)
34	5	Roxford St. to Hollywood Way	10.3	5	5:30 AM to 10:00 AM	3:00 PM to 7:30 PM
				(4)	(5:30 AM to 9:00 AM)	(3:00 PM to 7:00 PM)

Shaded areas are either trucks or hours modified to suit the needs of FSP extended service

( ) : Original trucks and shift hours before Northridge Earthquake

---- : No Deployment

State Freeway), I-10 (the Santa Monica Freeway), SR-14 (the Antelope Valley Freeway), and SR-118 (the Simi Valley Freeway). Three of the four damaged freeways are located in the north-western portion of Los Angeles County, about 20 miles away from Downtown Los Angeles. The Santa Monica freeway is west of Downtown Los Angeles.

The closed sections on I-5 and SR-14 are in mountainous terrains. There are few nearby alternate parallel arterial streets. Special detour plans for the closed sections of I-5 and SR-14 were implemented by Caltrans and other agencies to use the local streets, highways and undamaged freeways as detour routes. Traffic normally using the closed sections of the urbanized I-10 and SR-118 can use the parallel arterial streets as alternative.

The closed section of I-5 is a 4-lane facility in each direction with pre-earthquake daily traffic volume of about 136,000. I-10 and SR-118 are also a 4-lane facility in each direction with pre-earthquake daily traffic volume of 257,000 and 123,000, respectively. The damaged sections of I-5/SR-14 interchange are a two lane connector from the south-bound (S/B) I-5 to north-

bound (N/B) SR-14 and the three lane connector from S/B SR-14 to S/B I-5.

### THE FSP EARTHQUAKE DEPLOYMENT

#### Strategies

The FSP management realized the importance of early incident detection and clearance and the effectiveness of the FSP and decided to provide roving tow truck service to the earthquake affected areas as part of the transportation management strategies implemented in the Northridge Earthquake Traffic Management Plan. Thirteen additional FSP roving tow trucks from the existing FSP contractors were deployed to the earthquake affected freeways, highways, and Local streets detour routes to reduce the incident-related congestion. The deployment included adding extra tow trucks to the existing covered FSP areas and the preearthquake un-covered but earthquake-affected areas (I-5). The regular peak commute hour service schedules were extended and additional service hours were also provided based on the traffic conditions and construction activities.

## **Deployment and Service Hours**

Two new beats were initiated for the I-5 and SR-14 detour areas. They are Beat 41 and Beat 42. Table 1 shows the characteristics of these two beats. Beat 41 covered 4.5 centerline miles from Roxford Street on I-5 to San Fernando Road on SR-14. Four FSP tow trucks patrolled this beat from 5:00 to 9:30 a.m. in the morning shift, and from 2:30 to 7:30 p.m. in the afternoon shift, Monday to Friday. Beat 42 covered 8.1 centerline miles on I-5 from Roxford Street to Lyons Avenue. Three FSP tow trucks patrolled Beat 42 from 5:00 a.m. to 8:00 p.m., Monday to Friday; and two FSP tow trucks patrolled from 8:00 a.m. to 8:00 p.m. on Saturday and from 10:00 a.m. to 8:00 p.m. on Sunday.

Added number of tow trucks and extended service hours on other existing beats are shown in Table 2. One FSP tow truck was added to Beat 17 which includes the closed section of Santa Monica Freeway (I-10). The original patrolling route was modified to cover the traffic detour areas of local arterial streets. The service hours were also extended to cover from 6:00 to 11:00 a.m. in the morning shift and from 2:30 to 7:30 p.m. in the afternoon shift. Beat 33, which includes the closed section of Simi Valley Freeway (SR-118), extended its service hours to cover from 3:00 to 7:30 p.m. in the afternoon shift - half hour early for the starting time and one hour late for the ending time. The original patrolling routes were also modified to cover the detour traffic on the parallel arterial streets. One FSP tow truck was added to Beat 34 which is from Hollywood Way to Roxford Street on I-5. The service hours were extended from 5:30 to 10:00 a.m. and from 3:00 to 7:30 p.m. One additional FSP tow truck was added to each of Beats 7 and 10 together with extended service hours.

## **Heavy Duty Tow Truck**

Before the earthquake, all the FSP tow trucks would only tow a vehicle with a gross weight of up to 6,000 lbs. When the disabled vehicle is more than 6,000 lbs, a rotational tow truck is called out to tow the disabled vehicle. During the earthquake deployment, a new type of roving tow truck was deployed to Beat 42 on I-5, as listed in Table 1. This new type of roving tow truck is the heavy duty tow truck with the ability to tow up to 80,000 lbs. The purpose is to reduce the response time for calling a rotational tow truck in case of disabled heavy trucks. This is because of the high percentage of trucks using I-5, usually about 15 percent of traffic volume. The percentage of the disabled vehicles that are three or more axles (Big Rig) before the earthquake is more than 5 percent. The deployed heavy duty tow truck gave FSP the additional capability to clear almost all the disabled vehicles with improved response time. During the course of three and half months, the heavy duty tow truck had assisted in 641 incidents.

## **Construction Activities**

Many Caltrans earthquake reconstruction projects were underway to reopen the damaged freeways as soon as possible. These projects involved closing some lanes and portions of the freeway, which could result in traffic congestion when traffic demand exceeds the reduced capacity. In order to prevent further potential congestion and delay, FSP tow trucks were deployed to these areas during the construction period. Two or more tow trucks were deployed on I-5 depending on the day, the time of constructions and the traffic conditions. The service hours were also varied to accommodate the construction activities. Hours were generally from 8:00 p.m. to 5:00 a.m.

## **Contract Award and Cost**

All the FSP tow trucks for the earthquake deployment were from the existing FSP tow truck contractors. The pre-earthquake FSP tow truck contract requires the contractor to have at least 1 backup tow truck and 2 backup drivers for each beat. Most backup trucks have adequate communication equipments to be operational. The backup drivers were also certified FSP drivers, trained by CHP and Caltrans staff. This enabled the tow truck contractors to provide the service immediately for the earthquake deployment. Twelve different tow truck contractors provided the earthquake tow service. During the earthquake deployment, the contract cost for a regular tow truck was from \$34.87 to \$50.00 per truck per hour. The heavy duty tow truck contract cost was from \$63.63 to \$70.00 per truck per hour.

#### **Operations**

The FSP tow trucks were equipped with radios and Mobile Data Terminal (MDT), which allowed FSP tow truck drivers to communicate with the dispatchers at Los Angeles Communication Center (LACC) and Caltrans. Dispatchers can talk to the FSP drivers through the radio system, and the MDT enables the driver to send the information about the incident immediately to the Computer Aided Dispatching System (CAD) and this information becomes a record in the CAD available for evaluation and other uses. For those tow trucks without the radio equipment, cellular phones were provided. This also enables the dispatcher to call the tow truck driver to respond to the incident immediately when the dispatcher receives any requests for help.

The FSP tow trucks patroled both directions of the beats of the freeways and detour routes. They were designed to have a uniform headway between the tow trucks. They could take a 15-minute break for each 4hour shift, but no two tow trucks could take breaks at the same time or at the same location. When the FSP driver encountered a disabled vehicle, the driver usually spent up to 15 minutes attempting to mobilize the disabled vehicle. This may have included changing a flat tire, adding a gallon of gasoline, providing "jump start", temporarily taping cooling system hose and refilling radiators. Otherwise, the driver was instructed to tow the disabled vehicle off the freeway to a designated drop-off location.

CHP and Caltrans FSP field supervisors jointly supervised the operations of FSP tow trucks in the earthquake detour areas. When an FSP tow truck driver was found in violation of the FSP operational policies, the driver or the contractor could have been subjected to penalty.

#### Management

Caltrans with CHP and MTA jointly managed the FSP program and monitored the tow trucks operations, and contractors' compliance with the contracts. Two committees, the Policy Committee and the Technical Committee, consisted of members from Caltrans, CHP, and MTA and contractors. The committee members made the policy changes, resolved issues arising in daily operations, and explained the contract related service by holding regular meeting. In addition, each agency had its assigned responsibilities. Caltrans was responsible for the fleet management, program evaluation, and required equipment order and supplies. CHP was responsible for the tow truck dispatching, safety and operational enforcement, complaint investigations, and tow truck inspections. MTA was responsible for the funding, contract administration, meeting coordination and billing. CHP and Caltrans are jointly responsible for the FSP tow truck driver training.

Caltrans fleet managers, with the aid of Automatic Vehicle Locator (AVL) and the MDT information in the CAD, monitored the locations of the trucks, the sign-on, sign-off and break time of the FSP tow truck drivers. Whenever it was needed, the Caltrans fleet managers dispatched the FSP tow truck driver to the incident scene as well. Good communications, careful planning, close coordination, and timely decision making from all three agencies' management contributed to the responsiveness and effectiveness of the earthquake deployment.

## THE STATISTICS OF EARTHQUAKE DETOUR ASSISTS

Whenever the FSP tow truck driver made an assist, the driver recorded the assist conditions on a pre-formatted card, namely scantron card. The recorded conditions include the type of incidents (out of gas, flat tire, overheat, accident, etc.), locations of the incidents (freeway lanes, right or left shoulder, etc.), type of vehicles (automobile, van, Big Rig, etc.), whether tow was needed, how the incident was detected. The cards were then returned to Caltrans for evaluation. The statistics presented in this section are from these returned cards for the post-earthquake assists. The purpose is to show the effects of the FSP assists during the Northridge recovery. Statistics for Beats 17, 33, 34, 41 and 42, which are in the major freeway damaged areas and represent more than 90 percent of assists, are used for this study. For Beat 17, data was collected from after earthquake to the reopening of I-10 on April 12, 1994. For beats 33 and 41, data was collected from after earthquake to the end of May, 1994. For Beats 34 and 42, data was collected from after earthquake to the reopening of I-5 on May 18, 1994.

Figure 3 shows the total monthly and accumulative earthquake assists for Beats 17 (I-10), 33 (SR-118), 34 (I-5), 41 (I-5/SR-14) and 42 (I-5). Beat 42 had the highest number of incidents because of few parallel arterial streets available as alternate routes. Interestingly, Beat 17 (I-10), the most traveled freeway before the earthquake, had the lowest number of



incidents. Due to the urbanized setting, motorists were able to use the arterial streets parallel to the freeway as alternate routes. Similar low assist results were found on Beat 33 (SR-118). The total accumulative assists for these four beats by the end of May, 1994 was 14,898.

Figure 4 (a) shows the percentage of assists for each type of disabled vehicles. Fifty-three percent of assists are automobiles, 14 percent are vans, and 6 percent are Big Rigs-a three or more axles vehicle. Figure 4 (b) shows the percentage of assists for each type of vehicle problems. The mechanical problem led with the highest percentage (23), with accidents at 5 percent, flat tire 13 percent, overheat vehicles 12 percent, and out of gas 8 percent. Figure 4 (c) shows the percentage of assists for each type of locations of disabled vehicles. Twelve percent of assists were located on freeway lanes, and 74 percent on right-shoulders. Figure 4 (d) shows 95 percent of incidents were spotted by FSP drivers, and only 5 percent were dispatched by CHP and Caltrans. In addition, 19 percent of incidents (2830) involved towing, as shown in Figure 4 (e).

## COMPARISONS OF PRE- AND POST-EARTHQUAKE ASSISTS

The purpose of the comparisons is to examine the change of the incident characteristics for pre- and postearthquake. There are two types of detours. One of which is where parallel arterial streets are available, such as Beats 17 (I-10) and 33 (SR-118). The other type of detours is where a few parallel arterial streets are available, such as Beats 34 and 42 (I-5) and Beat 41 (SR-14/I-5). However, Beats 41 and 42 are new and do not have records of pre-earthquake assists, Beats 17 and 34 are selected for the comparisons of the pre- and postearthquake assists characteristics. A period of two months before and after the earthquake was considered in the comparisons.

#### **Daily Assists**

Figure 5 (a) shows the average daily assists for November and December 1993, pre-earthquake





FIGURE 4e Drop locations, January-May, 1994.

January, post-earthquake January 1994, February, and March 1994 for Beats 17 (I-10) and 34 (I-5). After the earthquake, the daily assists for Beat 17 (I-10) are lower than pre-earthquake. This is due to the fact that the motorists used the available parallel arterial streets as an alternate route. However, Beat 34 (I-5) shows an increase of average daily assists after the earthquake, probably because the motorists had fewer parallel streets as by-pass alternatives to the closed freeway section. Furthermore, Beat 34 (I-5) is south of the I-5 detour and congestion often backed up from this point which resulted in more incidents.

#### **Incident Detection**

FSP is an effective traffic management tool in early detection of incidents. This tool is very valuable during the earthquake recovery when the detours directed traffic away from freeways and the surveillance system was not available yet. As shown in Figure 5 (b), the percentage of incidents spotted by FSP drivers increases just after the earthquake for Beat 17 (I-10). The percentage for Beat 34 (I-5) also increases slightly in February and March of 1994. Overall, for pre- and post-earthquake, more than 90 percent of incidents were spotted by FSP drivers.

## **Type of Vehicle Problems**

Accidents due to traffic congestion and reduction in capacity are always our concerns in the sense that these accidents may prolong the delay and magnify the traffic backup. Figure 5 (c) shows the percentage of incidents that are involved in accident for the pre- and postearthquake. For Beat 17 (I-10), the accident percentage increases immediately after the earthquake. For Beat 34 (I-5), the accident percentage increases only in February by 50 percent comparing with November and December, 1993, but drops in March, 1994.

Figure 5 (d) shows the percentage of incidents for another type of vehicle problem: overheat, for pre- and post-earthquake. Long traffic delay often results in overheating problem for the vehicle. This is quite true for Beat 34 (I-5), which is south of and adjacent to the beginning of the detour and was often congested during peak commute hours. However less overheating problems were found for Beat 17 (I-10), which has less traffic volume because many motorists used surface streets as an alternate route.

#### **Type of Disabled Vehicles**

Figure 5 (e) shows the percentage of automobile incidents for the pre- and post-earthquake. There is no significant change in automobile incident percentage between pre- and post-earthquake for both Beats 17 (I-10) and 34 (I-5). It seems to suggest that most of the motorists still stay with their own means of commuting after earthquake. Private vehicles are still preferred by Los Angeles commuters.

Figure 5 (f) shows the percentage of Big Rig incidents—a three or more axle vehicle for pre-and postearthquake. For Beat 17 (I-10), the percentage of Big Rig incidents is zero before the earthquake, but increases to 1 percent in March after the earthquake. For Beat 34 (I-5), the Big Rig percentage increases from 6 percent to 9 percent in February but drops back to 4 percent in March. The increase in February may be resulted from the opening of Old Road detour with 2 lanes in each direction near the end of January. Trucks might then shift to use this Old Road detour and worsened the traffic conditions. After February the traffic volume became more stable.

## Locations of Incidents

Figures 5 (g) and (h) show the percentages of incidents located on freeway lanes and on right shoulders, respectively, for pre- and post-earthquake. Both Beats 17 (I-10) and 34 (I-5) have an increase in the percentage of incidents located on the freeway lanes after the earthquake, especially for Beat 34 (I-5), recording an increase of 50 percent. Consequently, both two beats have a decrease in the percentage of incidents located on the right shoulders after the earthquake. These changes may be the results of detours and restriping of roadways to maximize the roadway capacity, therefore eliminating some shoulders.



FIGURE 5a-d Comparisons of pre- and post-earthquake assists for Beat 17 (I-10) and Beat 34 (I-5).

#### Summary

In summary, after the earthquake, both Beats 17 (I-10) and 34 (I-5) have higher percentages in accidents, Big Rig incidents, and freeway in-lane incidents, but lower incident percentage on right shoulder. For Beat 17 (I-10) with the parallel arterial streets available for the motorists to by-pass the damaged freeway section, the average daily assists and the overheating incident percentage decreased after the earthquake. For Beat 34, the average daily assists and the overheat incident percentage increased after the earthquake. In addition, more than 90 percent of incidents were spotted by FSP drivers.

## COMPARISONS OF POST-EARTHQUAKE AND AFTER REOPENING ASSISTS

I-10 (Beat 17) was the first freeway to be reopened on April 12, 1994. I-5 (Beats 34 and 42) was reopened on May 18, 1994. However, the data for June is not available for Beat 34 at the time of this study and thus less than half month data for after reopening are available. Beats 42 was terminated after the reopening of I-5. SR-118 (Beat 33) and interchange of SR-14/I-5 (Beat 42) are still under construction. Therefore, Beat 17 is selected for the study of the effects of freeway reopening on the incident characteristics. Incidents assisted by the FSP in March and May are compared, and in the meantime, pre-earthquake incident characteristics are also compared.

After the reopening of I-10, the daily traffic volume has increased by more than 50 percent (Northridge Earthquake Recovery, Weekly Transportation Report, Numbers 9 and 13, Caltrans District 7, April and May, 1994, *unpublished*). However, the average daily number of incidents after reopening has no significant change comparing March with May, as seen from Figure 6 (a), but is lower than pe-earthquake [Figure 5 (a)]. The percentage of incidents spotted by the FSP drivers decreased after the reopening as seen from Figure 6 (b), probably because the freeway was closely monitored by Caltrans and CHP, and the other effective communi-



cation tools were available for the motorists, such as call boxes. The percentage after reopening is also lower than pre-earthquake [Figure 5 (b)]. The percentage of incidents involved in accident drops by 50 percent in May compared to March, as seen from Figure 6 (c), but is still slightly higher than pre-earthquake [Figure 5 (c)]. Overheating incident percentage decreases in May as seen from Figure 6 (d), which is also lower than preearthquake [Figure 5 (d)]. The percentage of automobile incidents is slightly higher in May as shown in Figure 6 (e), but is within the range of pre-earthquake [Figure 5 (e)]. The percentage of Big Rig incidents increases from 1 percent to 2 percent, as shown in Figure 6 (f), which is also higher than pre-earthquake [Figure 5 (f)]. The percentage of incidents located on freeway lanes is the same for March and May as shown in Figure 6 (g), which is also about the same as preearthquake [Figure 6 (g)]; however, the percentage of incidents located on right shoulder after reopening increases from 75 percent to 82 percent as shown in Figure 6 (h), which is about the same as pre-earthquake [Figure 5 (h)].

Overall, the comparisons show that the reopening of I-10 has no effect on the average daily number of

incidents, although the daily traffic volume has increased by 50 percent, but has reduced the accident percentage. More incidents were found on right shoulders due to the shoulder availability on the freeway. This might have indirectly reduced the accident rate. However, the Big Rig incident percentage has increased. After the reopening, all the incidents characteristics are back to pre-earthquake levels, except the average daily assists and the overheating incident percentage are lower than pre-earthquake.

## CONCLUSIONS

The Los Angeles County Metro Freeway Service Patrol (FSP) has responded quickly to the need of assisting motorists after the Northridge earthquake by timely deploying the roving tow trucks to the earthquake affected freeways, highways and local detour streets to reduce the non-recurrent congestion. FSP also deployed a new type of tow truck - heavy duty tow truck - to the I-5 where a high percentage of truck incidents was recorded.





FIGURES 6a-d Comparisons of post-earthquake and after reopening assists for Beat 17 (I-10).





FSP has provided an additional 13 tow trucks (including the heavy duty tow truck) to the earthquake affected areas and covered an additional 12.6 centerlinemiles of freeways in addition to the pre-earthquake existing FSP service areas. The FSP service hours for the earthquake affected areas were extended to accommodate the long commute hours for the motorists. Special arrangements to provide tow truck and special service hours were made for the construction activities to reduce the potential of traffic congestion.

During the earthquake recovery period, FSP has detected the incidents earlier with 95 percent of the incidents spotted by the FSP drivers. FSP has assisted in 14,898 incidents for Beats 17, 33, 34, 41 and 42 during the earthquake recovery period from January 18, to the end of May, 1994. FSP also provided tow service to 2830 disabled vehicles (19 percent of assists) for the five beats (17, 33, 34, 41 and 42).

The comparisons of pre- and post-earthquake and reopening incidents show that when there are parallel arterial streets available for motorists, the number of the incidents was lower after the earthquake. This may be due to the fact that the motorists use the arterial streets as alternative routes to avoid potential traffic congestion. But when there are few parallel arterial streets, such as I-5 (Beat 34), the number of incidents and the accident percentage have increased after the earthquake, because the roadway capacity was reduced in the detour areas. In addition, the reopening of the freeway seems to have positive effects in the sense that the percentage of accident incidents was reduced.

The comparisons also reveal that most of the incidents were located on the right shoulder, but the percentage decreased after the earthquake due to the restriping of the roadways to maximize the roadway capacity, but went back to pre-earthquake level after the reopening. In addition, there was an increase of percentage of in-lane incidents after the earthquake. These results provide clear evidence of the need for deploying the roving tow trucks to the earthquake affected areas to quickly clear the incidents in order to reduce the non-recurrent congestion.

In summary, the Los Angeles County Metro Freeway Service Patrol has proved to be an effective traffic management tool in reducing the non-recurrent traffic congestion as well as aiding the motorists during the Northridge earthquake recovery.