

THE JANUARY 17, 1994 NORTHRIDGE EARTHQUAKE IMPACTS ON THE INTERSTATE-5 AND THE STATE ROUTE-14 COMMUTE BEHAVIOR IN LOS ANGELES COUNTY

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Southern California was struck by a 6.8 magnitude earthquake (measured on the Richter scale) on January 17, 1994 (Northridge Earthquake) which caused extensive damage to some of the region's freeway system. The Golden State Freeway (Interstate 5), the Antelope Valley Freeway (State Route 14), and their Interchange in and around the City of Santa Clarita were significantly damaged.

Although the Northridge earthquake caused damage to several freeways in southern California, this report focuses only on the impact of the quake on the traffic on I-5 and SR-14.

Two of the four connector structures between I-5 and SR-14 collapsed (southbound SR-14 to northbound and southbound I-5), while there was considerable damage to the other two connectors (northbound I-5 to northbound SR-14 and southbound I-5 to northbound SR-14). I-5 collapsed on top of the Old Road at Gavin Canyon Undercrossing. I-5 was completely shut off between Roxford Street and Lyons Avenue. Detours were quickly established practically within hours of the earthquake. Work on the damaged (or destroyed) freeway segments was initiated within a few days. Traffic volumes, occupancy counts, and travel time runs were frequently conducted to capture the changes to pre-quake conditions as repair work progressed. Various surveys were also taken to ascertain commute behavioral changes. The results indicated that the majority of people were satisfied with the available detour routes. Those who utilized the established temporary High Occupancy Vehicle (HOV) lane on SR-14 (one lane each direction) saved as much as 9 minutes compared to those on the mixed flow lanes during the morning peak period (southbound) commute.

About seven percent of the I-5 pre-quake trips were discontinued through the two corridors (I-5 and SR-14 corridors) after the quake because of increased traffic congestion, inconvenience, telecommuting, and change in work location. Approximately nine percent of the SR-14 pre-quake trips were also discontinued through the damaged sections due to the same reasons.

Metrolink ridership on the Santa Clarita line increased significantly (from 1,000 boardings per weekday pre-earthquake to 22,000 per weekday in late

January, 1994). This, however, decreased to about 4,000 boardings per day in July.

INTRODUCTION

The purpose of this paper is to give the reader an overview of how commute characteristics and driver behaviors were impacted by the earthquake for I-5 and SR-14. The results of traffic data collection and various surveys performed will also be discussed.

Early Monday morning on January 17, 1994 Southern California was shaken by a 6.8 magnitude (Richter scale) earthquake. The EpiCenter of the earthquake was determined to be in Northridge in west San Fernando Valley. There were very few injuries and one fatality on the freeways resulting from the earthquake. This was due to the early morning hour of the quake as well as the fact that all local, state, and federal agencies were closed in observation of Martin Luther King Birthday. However, the quake caused substantial structural damage of varying magnitude to most of the region's freeways including the I-5 and the SR-14 (see Figure 1).

Caltrans estimated the total State Highway reconstruction cost at \$308 million. Actual expenditure on the major damaged facilities was about \$250 million, including approximately \$90 million for the I-5 and SR-14 corridors.

Caltrans, in concert with the following federal, state, and local agencies 1) initiated an accelerated rebuilding program using federal emergency funding and emergency contracting procedures; 2) established a multimodal action plan featuring primary and secondary detour routes, temporary HOV lane on SR-14, and additional transit services; and 3) created a coordinated program to provide the public with information about detour routes, road closures, and available services.

- U.S. Department of Transportation, Federal Highway Administration (FHWA);
- California Highway Patrol (CHP);
- City of Los Angeles, Department of Transportation (LADOT);

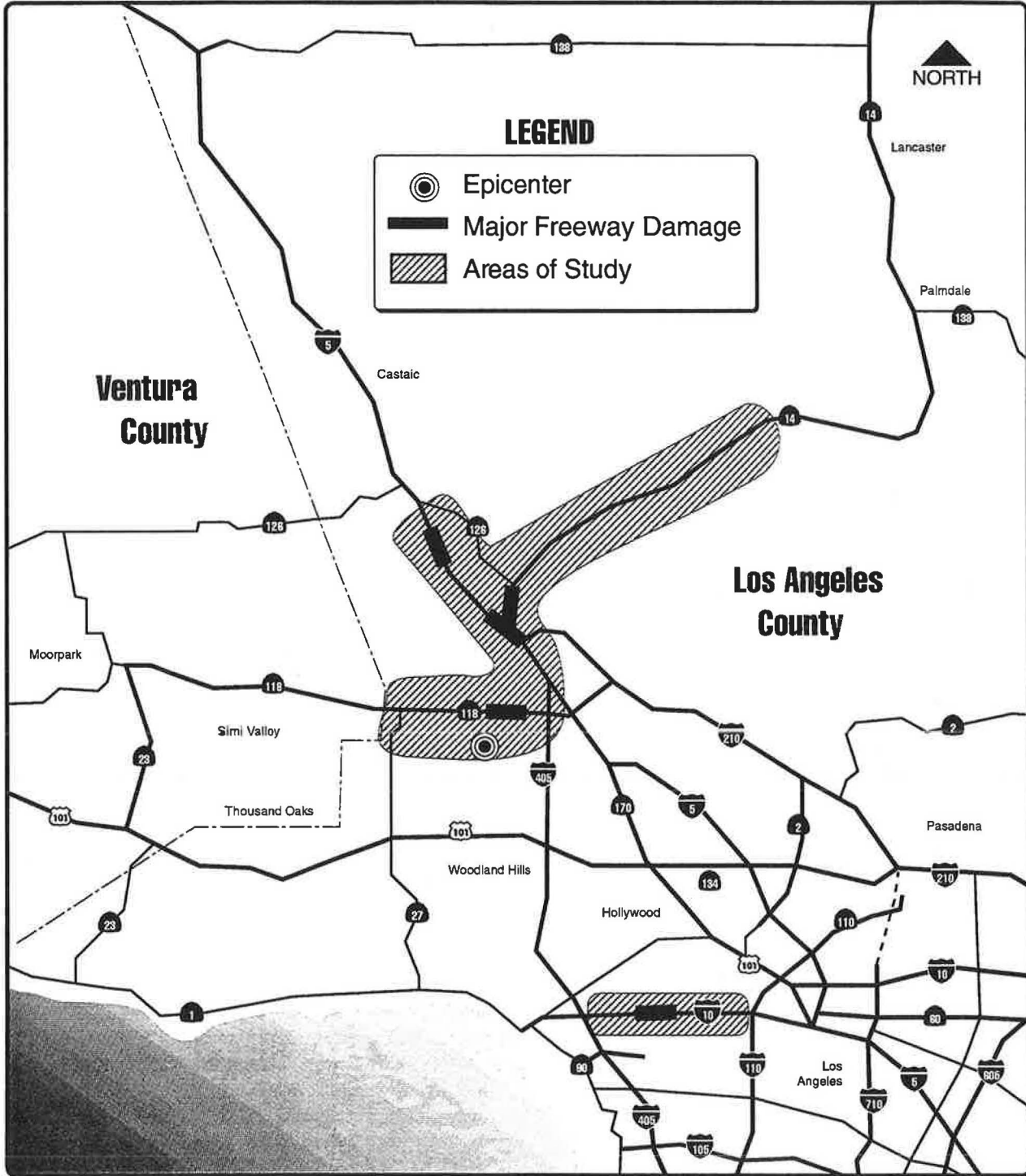


FIGURE 1 The Northridge Earthquake affected freeways and roadways in Western Los Angeles County.

- Los Angeles County Metropolitan Transportation Authority (LACMTA);
- Southern California Regional Rail Authority (SCRRA);

- Antelope Valley Transit Authority (AVTA);
- City of Simi Valley Transit (SVT); and
- City of Santa Clarita, Santa Clarita Transit (SCT).

The \$14.8 million contract (which included a \$150,000 per day bonus/penalty) to rebuild the Gavin Canyon bridges on I-5 was awarded on January 29. The contract was scheduled to be completed within 130 calendar days. The freeway opened four months after the earthquake struck, 33 days ahead of schedule. Southbound lanes were opened on May 17, and the northbound lanes on May 18.

A \$19.6 million contract was awarded on March 18 to rebuild two of the four bridges, (S/B to S/B and N/B to N/B), in the I-5/SR-14 interchange. Work began on March 19 on reconstruction of the southbound SR-14 ramp to the southbound I-5, and northbound I-5 ramp to northbound SR-14. This project was scheduled to be completed within 132 calendar days (on July 28) and had a bonus/penalty of \$100,000 per day. These two connectors were restored to their original (pre-quake) configurations and were opened to traffic on July 8, 1994 after the morning peak period.

The project to reconstruct the other two southbound to northbound connectors (S/B I-5 to N/B SR-14, and S/B SR-14 to N/B I-5) was awarded on July 8, 1994. This project was scheduled to be completed in 120 calendar days, and had an Incentive/Disincentive figure of \$20,000 per day. These two connectors were opened to traffic on November 4, 1994.

BACKGROUND

Interstate 5 is the only primary north-south regional route that connects the Los Angeles Basin and the San Fernando Valley with points north of the San Gabriel Mountains. State Route 14 connects the cities of Lancaster and Palmdale with the San Fernando Valley and the rest of the Los Angeles Basin (see Figure 1). These two freeways converge at the I-5/SR-14 interchange, where they were mostly destroyed or damaged by the earthquake. Pre-earthquake traffic volume on I-5 south of the interchange (Sylmar, Roxford Street Interchange) was about 220,000 vehicles on an average weekday, while it was about 127,000 vehicles for SR-14 at San Fernando Road interchange (Junction of Route 126).

DETOUR INSTALLATION

Surface Streets

Since the I-5 was closed between Lyons Avenue and Roxford Street, Caltrans with cooperation from Los

Angeles County and the City of Los Angeles established detour routes in a matter of hours. The southbound I-5 traffic was forced off at Lyons Avenue, to San Fernando Road, to Sierra Highway, to San Fernando Road, to Sepulveda Boulevard, and got back on at Roxford Avenue on-ramp. Foothill Boulevard was used as the main detour route for the northbound traffic.

San Fernando Road carried about 3,500 vehicles between 7:00 to 8:00 a.m. in the southbound direction, while the northbound volume was insignificant. Foothill Boulevard carried about 1,100 vehicles between 7:00 to 8:00 a.m. in the southbound direction, while the afternoon volume was 1,600 vehicles from 4:00 to 5:00 p.m.

The Old Road

The Old Road detour around the damaged bridges of I-5 at Gavin Canyon opened to traffic on January 29, eleven days after the earthquake. Caltrans crews and the contractor worked together to create the 4.8-km (3-mile) detour from Calgrove Boulevard to the I-5 truck stop just north of the I-5/SR-14 interchange. The construction cost was \$3.2 million; another \$3 million was spent removing the damaged structures at two locations and shoring up another structure.

This detour provided two mixed flow lanes in each direction which turned out to alleviate considerable amount of congestion. Data collected on the I-5 detour south of SR-14 revealed that the northbound volume was about 3500 vehicle on the mainline detour. The total detour corridor volume (including the SOV and HOV truck lanes, Foothill Blvd, and San Fernando Road) for the northbound direction was about 10,500 vehicle (from 3:00 to 4:00 p.m.). This was 102 percent of the pre-earthquake volume for the same location. The southbound I-5 mainline detour volume was counted to be about 3200 vehicle (from 7:00 to 8:00 a.m.). The total detour corridor volume for the southbound direction was about 12,000 vehicle between 7:00 to 8:00 a.m. This was about 88 percent of the pre-earthquake volume.

Truck Lane

On January 28, ten days after the earthquake, two lanes of the SR-14 opened for southbound traffic connecting to the southbound I-5. Caltrans restriped the southbound truck bypass to provide one mixed flow lane and one HOV lane. Later it was restriped for two mixed flow lanes.

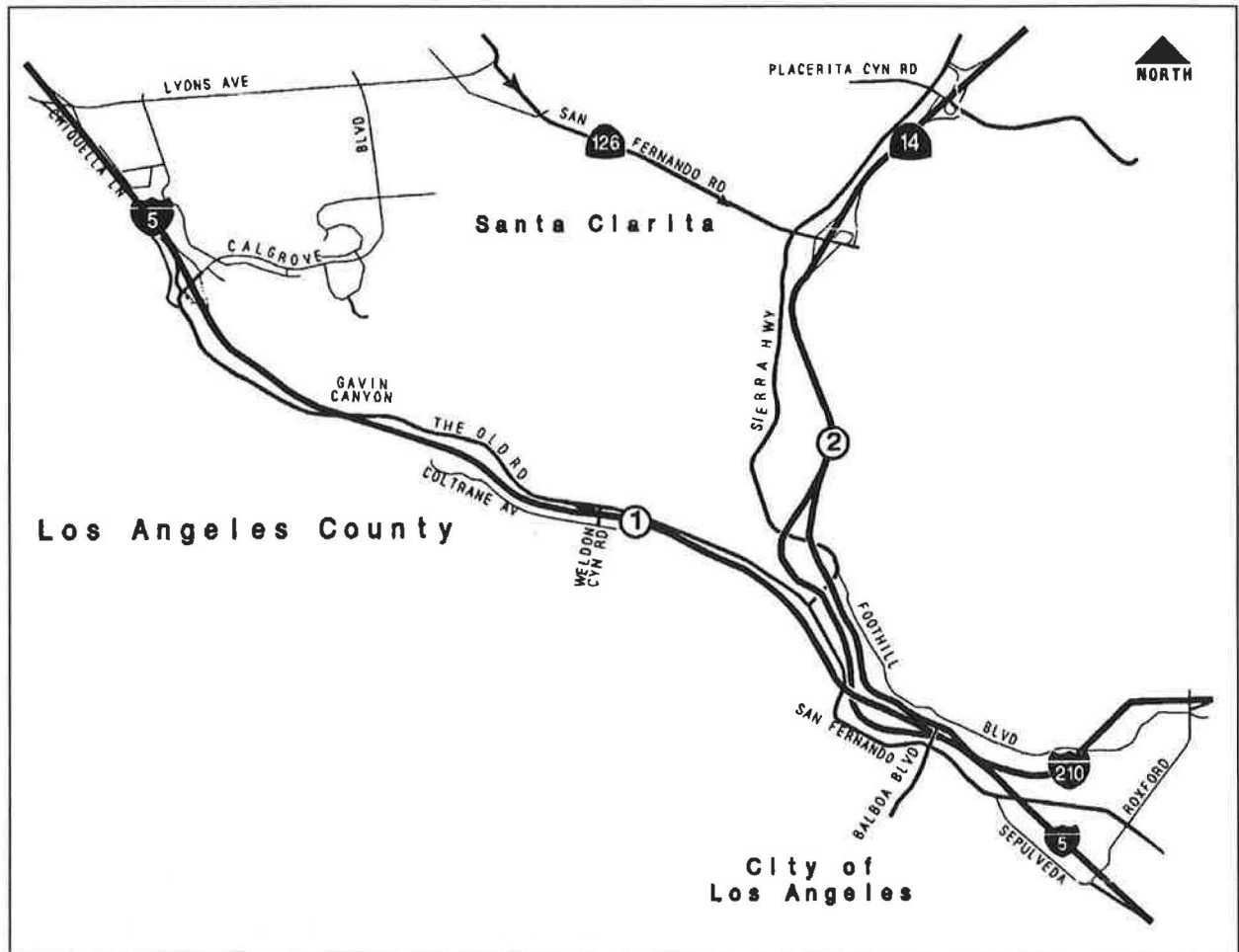


FIGURE 2 Count locations on I-5 and SR-14 freeway detours.

HOV Lane

A temporary HOV lane was installed on southbound SR-14. The northbound I-5 truck lanes were used as the connector to the northbound SR-14 freeway. Consequently, a northbound HOV lane was established using the right shoulder area of the truck lanes.

These preferential (HOV) lanes proved to be very useful. The Average Hourly Volume for the southbound HOV lane (counted between 6:00 a.m. to 9:00 a.m.) was about 1800 vehicle, while it was about 1450 vehicle for the northbound HOV lane (counted between 3:00 to 6:00 p.m.). The peak-hour volume was approximately from 7:00 a.m. to 8:00 a.m. for the southbound direction, while it was from 3:00 to 4:00 p.m. for the northbound direction. The count locations were north of I-5, at merge/diverge point for the detours on the truck lanes.

I-5 AND SR-14 TRAVEL CHARACTERISTICS

Traffic pattern changed, after the earthquake, not only on I-5 and SR-14, but also on the other freeways in the area such as SR-170, I-210, and I-405. Hence, the changes in the traffic characteristics were periodically (weekly at first and then biweekly) monitored by reviewing the peak-period traffic data collected on the detour route. Peak-period data included traffic volume counts (for mixed-flow and HOV detour lanes), types of vehicles, and travel times on the detour route.

I-5 Peak-Period Traffic Volumes

Traffic volumes on the I-5 detour route were counted during the morning (6:00 a.m. to 9:00 a.m.) and evening

(3:00 to 6:00 p.m.) peak periods at the Weldon Canyon Road overcrossing (see Figure 2). Vehicle mix surveys were also conducted to determine the percentage of trucks and buses on the I-5 detour route.

Peak period traffic volume steadily rose after the earthquake. In the last two weeks of January, some commuters may have avoided making the peak-period trips on the detour route by utilizing transit. Others may have switched to carpools and therefore produced fewer vehicle trips for the same number of travelling persons in the corridor. On the other hand, traffic volumes during peak-periods may have increased in the following weeks in February and March as commuters became more and more familiar with the detour route and stabilized later in April and May before I-5 was re-opened on May 17 and 18. The increasing familiarity included accepting the operating conditions on the detour route, or switching to alternate routes or modes.

SR-14 Peak-Period Traffic Volumes

Traffic volumes on the SR-14 detour route were collected during the morning (6:00 to 9:00 a.m.) and evening (3:00 to 6:00 p.m.) peak periods (see Figure 2). Vehicle mix surveys (used to calculate the percentage of the trucks and buses in all lanes and the categories of vehicle in the HOV lanes) were conducted to ascertain the post-earthquake peak-period traffic characteristics.

Peak-hour traffic volumes steadily rose in the weeks after the earthquake on the SR-14 detour route. The average morning peak-period hourly volume (southbound) was approximately 1,000 to 3,000 vehicles in the mixed-flow detour; while between 1,000 to 2,200 vehicles traveled in the HOV detour. In the afternoon peak direction (northbound), about 2,500 to 4,500 vehicles were traveling in the mixed-flow detour; while 900 to 1,500 vehicles traveled in the HOV detour.

I-5 Truck Travel

The earthquake-damaged section of the I-5 was used by a high volume of trucks making long-haul trips in the region. Pre-earthquake truck traffic was about 13 percent of the total traffic volume on I-5 south of the SR-14 interchange. After the earthquake, some truck traffic was diverted from the damaged area of I-5 to other inter-regional routes such as I-15 and US-101. Trucks travelling from SR-99 in the Central Valley were diverted on SR-58 through Tehachapi to I-15 and then to I-10. Truck counts revealed that some truck drivers

used SR-138 as a detour route across the Antelope Valley to I-15.

After the earthquake and before the opening of the Old Road detour, truck traffic on I-5 had decreased by approximately 30 percent of the pre-earthquake levels. The establishment of the Old Road detour at the end of January provided two mixed flow lanes in each direction, (where there had been four lanes per direction prior to the earthquake on I-5 freeway). By late February, truck volumes on the I-5 detour route returned to their pre-earthquake levels.

SR-14 Truck Travel

Truck travel on SR-14 was not as significant as on I-5. While the trucks traveling on I-5 north of San Fernando Valley were making primarily long-distance (interregional or interstate) trips, this was not the case on SR-14. Trucks could travel on I-5 through southern California, as well as north through California and on to Canada or could connect to other east-west interstate routes. SR-14, on the other hand, provides a roadway connection only between the Antelope Valley and the San Fernando Valley.

Post-earthquake truck volume on SR-14 showed a similar pattern to that on I-5. By late February, volumes had largely returned to pre-earthquake levels. Data collected indicated that trucks traveling on SR-14 mixed-flow lanes during the peak travel periods in February and March represented between 2 percent and 8 percent of all vehicles.

ALTERNATE MODES OF TRANSPORTATION

Transit

Post-quake traffic capacity was significantly reduced (due to damaged structures) on I-5 and SR-14. This reduced capacity resulted in longer-than-usual delays for persons traveling on those freeways and their detour routes. Consequently, many persons sought other modes of travel (e.g., carpooling, buses transit, and Metrolink commuter trains).

The following transit operators in Southern California modified their services and expanded their people-carrying capacities to respond to changes in demand in the I-5 and SR-14 corridors: Los Angeles County Transportation Authority (LACMTA), the City of Los Angeles Department of Transportation (LADOT), the Southern California Regional Rail Authority (SCRRA), the Antelope Valley Transit

SURVEYS

Household

Home telephone interviews were conducted in May, and again in October 1994. There were two main areas targeted for the surveys; the Santa Clarita area (I-5), and the Palmdale/ Lancaster area (SR-14). The survey sample for each of the areas was 300. Approximately 300 respondents were using the I-5 and SR-14 prior to the earthquake, and were affected by the established detour routes. The survey results indicated the only significant travel mode shift was to Metrolink. The most significant finding from the first survey was that about 13 percent of the work trips and 28 percent of the non-work trips made on I-5 were discontinued due to the quake. The corresponding figures for the SR-14 were 9 percent and 10 percent, respectively.

These figures were significantly lower during the second survey. Namely, 4 percent of the work trips and 12 percent of the non-work trips made on I-5 were discontinued due to the quake. The corresponding numbers for the SR-14 were 5 percent and 13 percent, respectively.

The surveys also revealed that the majority of the trips were work trips which generally took place in the morning. During the time that I-5 was closed, more respondents started their trips between 4:00 a.m. and 6:00 a.m., while fewer made trips between 6:00 a.m. and 7:00 a.m.

I-5 Home-Interview Survey

The May survey results indicated that 68 percent (75 percent for the October survey) of those responded were making work related trips, while the rest were non-work related. The number for persons driving alone before the earthquake went down by 2 percent after the earthquake. The two, the three, and the four-and-more persons occupancy did not change. One percent reported using transit buses before and after the quake. One percent reported using the Metrolink prior to the earthquake, while 3 percent reported riding the trains post-earthquake.

The average duration of trips increased substantially after the earthquake. The post-quake work trip duration was 74 minutes, 26 minutes longer than that of pre-quake. The increase in non-work trip time was greater than that of work trips. The post-quake non-work trip time was 81 minutes, 32 minutes longer than pre-quake level.

Seventeen percent of the respondents (during the May survey) eliminated their trips (work and non-work

trips) due to the earthquake, while 4 percent eliminated their trips for other reasons. These figures dropped to 6 percent and 2 percent during the second survey. Figure 4 shows the breakdown of the survey result for I-5.

Of the 232 respondents that continued their trips after the earthquake, 155 (67 percent) changed their trip start time, and started their trip 44 minutes (average) earlier.

SR-14 Home-Interview Survey

The May survey result indicated that 77 percent (79 percent for the October survey) of those responded were making work related trips, while the rest were non-work related. The number for those driving alone decreased by 2 percent, while the two and the three vehicle occupancy increased by 1 percent. The four-and-more vehicle occupancy did not change. Two percent of respondents rode the transit buses before and after the earthquake. The survey showed that no one used the Metrolink trains prior to the earthquake, while 2 percent reported riding the trains post-earthquake.

Ten percent of those surveyed in May eliminated their trips due to the earthquake, while 4 percent eliminated their trips due to other reasons. These figures dropped to 7 percent and 3 percent during the October survey. Figure 4 shows the breakdown of the survey results for SR-14.

CONCLUSIONS

Although the Northridge earthquake caused considerable damage to the Southern California Freeway System, and cataclysmic travel conditions were widely anticipated, with the exception of the first few days after the earthquake, excessive delays were not experienced and the system operated throughout the reconstruction period.

The Old Road detour for I-5 and the HOV and the mixed-flow detours on the SR-14 truck bypass lanes provided approximately 60 percent of the I-5 and SR-14 pre-quake capacity. These detours were efficiently designed, established in record time, and were well advertised by Caltrans and other local agencies.

Shortly after the earthquake, Caltrans initiated emergency measures to suspend normal contacting procedures. This allowed Caltrans to bid, award, approve and execute contracts the same day. In order to ensure the continuing and expeditious traffic data collection, and to prepare and publish various reports, Caltrans brought on board Barton-Aschman and Associates, Inc.

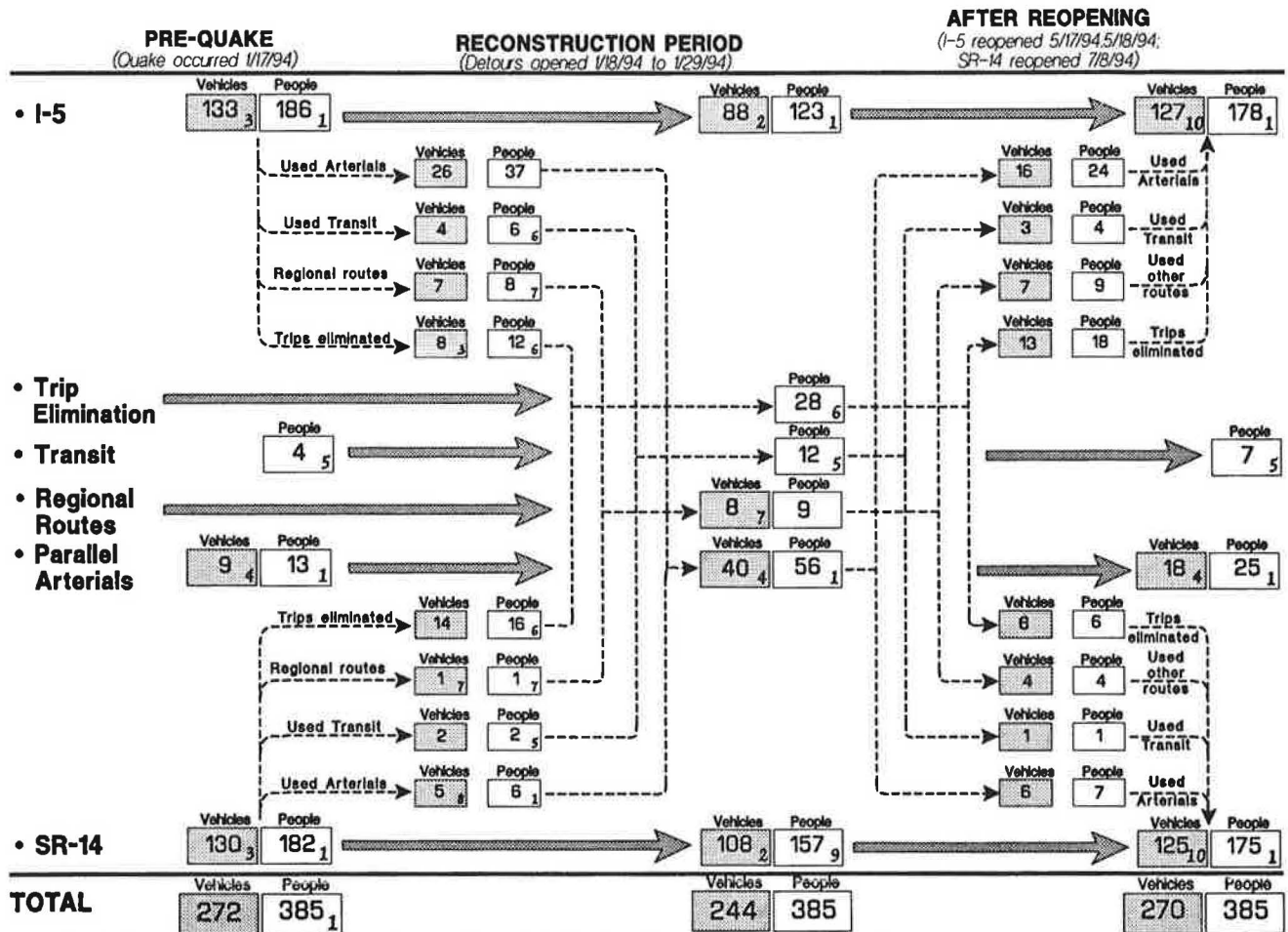


FIGURE 4a I-5 and SR-14 corridors: Travel behavior flowchart (daily trips in thousands).

The expansion of Metrolink service was well received by the local community; especially, the period of time immediately following the earthquake. The fast reconstruction of the mainline I-5 and the main connectors at the I-5/SR-14 interchange resulted in prompt return back to pre-quake travel patterns for the single drivers who had shifted to Metrolink.

The majority of the travelers were pleased with the implementation of the detours in the I-5 and SR-14 corridors.

Findings

Because few alternate detour routes were available in the damaged area of I-5, SR-14 and their interchange

(compared to other damaged freeways), Metrolink ridership increased significantly.

A considerable number of people using the established detours shifted their trip hours by starting earlier in the morning.

Some trips (mostly non-work trips) were eliminated due to the quake.

Need for Future Papers

There are different types of surveys, which fall outside the scope of this paper, that could be studied. One suggested topic would be to capture the effects of the Northridge earthquake on retail businesses.

Sources of Information for Travel Behavior Trends in the I-5 and SR-14 Corridors

Footnotes

1. Daily average vehicle occupancy for all trip purposes combined is 1.4 persons per vehicle for Los Angeles County based on the *1991 Regional Home Interview Survey*, Southern California Association of Governments.
2. Average weekday vehicle counts for I-5 and SR-14 detours from Caltrans and Wiltec field counts.
3. Source: Derived from the 1993 Traffic Volumes Count Book, Caltrans; for the I-5 between Calgrove Boulevard and the junction with SR-14. For the SR-14, between SR-126/San Fernando Road and the junction with I-5.
4. Pre-quake arterial counts from LADOT, Traffic Surveys. Post-quake data from Caltrans District 07.
5. Pre-quake, post-quake, and recovery transit patronage from Transit Operators: Los Angeles County Metropolitan Transportation Authority, Southern California Regional Rail Authority, City of Los Angeles (LADOT), Antelope Valley Transit Authority, and Santa Clarita Transit.
6. Source: Based on the *Home Interview Surveys for the I-5 and SR-14 Corridors*. For the I-5, approximately 7 percent of pre-quake trips were not made through the damaged portion of I-5 due to trip elimination or changes in trip origins or destinations. For the SR-14, approximately 9 percent of pre-quake trips were not made through the damaged I-5/SR-14 Interchange after the earthquake. Approximately 3 percent of all I-5 and SR-14 trips shifted to transit.
7. A combination of approximately 3,000 vehicles that formerly transitioned between I-5 and SR-14 using interchange ramps before the earthquake and interregional trips such as truck traffic utilizing other regional routes to enter the Los Angeles Basin. Source: 1994 Truck Intercept Survey and Caltrans' ramp count data.
8. Assumes that the growth in arterial volumes after the earthquake is split between trips attracted from I-5 and SR-14. In addition, some shift of trips from I-5 to SR-14 occurred including carpools from Santa Clarita being attracted to the SR-14 carpool lanes.
9. Based on field observations, the SR-14 mixed-flow and HOV detours had a composite vehicle occupancy of 1.45 persons per vehicle during March 1994.
10. Based on post-recovery traffic counts from Caltrans for August and September 1994.

FIGURE 4b Sources of information for travel behavior trends in the I-5 and SR-14 corridors.