Birth of a Transitway: Katy Freeway (I-10W), Houston, Texas

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ABSTRACT

The Texas State Department of Highways and Public Transportation and the Metropolitan Transit Authority of Harris County have jointly pledged to develop an extensive system of highway transit facilities to improve mobility in Houston, Texas. These facilities, or transitways, are exclusive, physically separated lanes that are located within freeway medians for use by such authorized high-occupancy vehicles as buses, vanpools, or carpools. The objective of these transitways is to maximize person throughput within a freeway corridor at an affordable cost and in a minimum time period of implementation. Phase 1 of the Katy Freeway (I-10W) Transitway, which was opened for operation on October 29, 1984, is described. Design, construction, and operational procedures relative to the facility are discussed; tables and figures show utilization trends; and subsequent improvements and modifications are outlined. After 9 months of operation, the transitway is being used for approximately 5,200 passenger trips a day. As the length of the transitway is extended, the current annualized 9-month passenger growth rate of 43 percent per year is anticipated to increase.

The Katy Freeway (I-10W) is a major interstate highway that serves the western part of the city of Houston and Harris County (Figure 1). Extensive commercial and residential development has occurred as far west as 35 mi from downtown Houston. Traffic congestion within sections of the Katy Freeway corridor inhibits peak-hour speeds to less than 20 mph. In some portions of the corridor, average daily traffic is 175,000 automobiles in a six-lane section. In the vicinity of State Highway (SH) 6, the volume of traffic has been increasing at an annual rate of 25 percent for the past several years and is now in the range of 90,000 vehicles per day. In 1983, a bus trip from SH 6 to downtown Houston would have taken 45 min over a distance of approximately 17 mi.

Present and projected future volumes, as well as the extent of traffic congestion, overwhelmingly justify the provision of an exclusive transitway on the Katy Freeway. Recognizing this need and the fact that there were no other plans at the time to expand capacity in the corridor, the Texas State Department of Highways and Public Transportation (SDHPT) and the Metropolitan Transit Authority (METRO) of Harris County entered into a cooperative agreement to develop a median transitway on the Katy Freeway. This transitway would be developed as part of an already scheduled major pavement rehabilitation project. SDHPT, in conjunction with FHWA, agreed to pay all freeway overlay improvement costs, to award all contracts, and to supervise construction. METRO, using primarily local funds, agreed to pay the additional transitway costs that would be incurred from the project. This concerted effort facilitated the construction and implementation of the Katy Freeway Transitway in a relatively short time period, and thus minimized traffic disruption and the combined cost of the project.

Details are provided in this paper of project development and implementation, and the first 9 months of operation of the Katy Freeway Transitway are documented. Subsequent facility improvements and vehicle authorization modifications that were made during the first year are also presented along with a summary discussion of growth trends.

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PROJECT DESCRIPTION

The Katy Freeway Transitway is being developed and operated in three phases. Phase 1 was constructed between I-610 and Gessner Drive, a distance of 4.75 mi. Completion of the first phase reduced peak-period travel time for users of the transitway by 5 to 9 min depending on freeway conditions. Phases 2 and 3 will subsequently extend the transitway another 6.75 mi to beyond SH 6. When fully completed, the transitway will extend a total of 11.5 mi (see Figure 1).

The Katy Freeway Transitway is being constructed in the median of the freeway, separated from general traffic lanes by concrete median barriers. The transitway is reversible (it is operated inbound in the morning and outbound in the evening); it includes an emergency breakdown shoulder along most sections; and it is designed to accommodate buses, vanpools, and other high-occupancy vehicles. As is shown in the typical "before-and-after" transitway construction cross-sections of Figure 2, the transitway has little impact on the freeway cross-section. The number of mixed-flow lanes and the availability of an outside shoulder remain intact. Only small adjustments to lane widths and the elimination of the inside shoulder are necessary to accommodate the placement of the 19.5-ft wide transitway within the freeway median.

Access to the transitway differs at each terminal location. At the western terminus, a series of concrete median barriers creates slip ramps to provide access and egress from the inside freeway lane (Figure 3). During inbound operation, the median shoulder upstream of the transitway entry serves as a concurrent flow lane. In the afternoon, the outbound vehicles exiting the transitway use the inside shoulder to merge into the mixed-flow lanes. At the eastern terminus near I-610, an elevated flyover ramp leaves the median and ties into an arterial street inter-

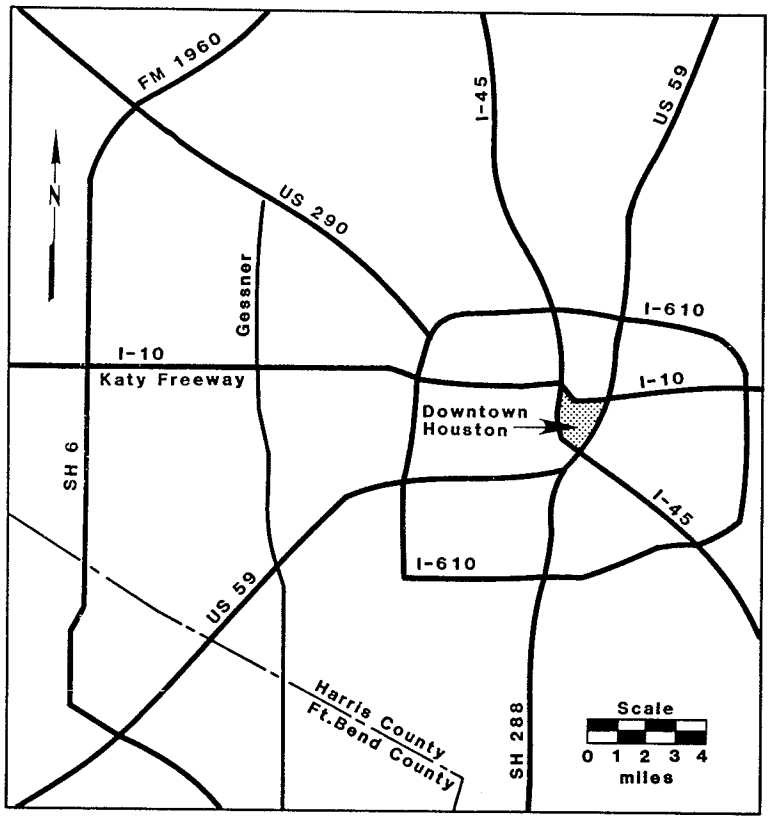

FIGURE 1 Katy Freeway (I-10W), Harris County, Texas.

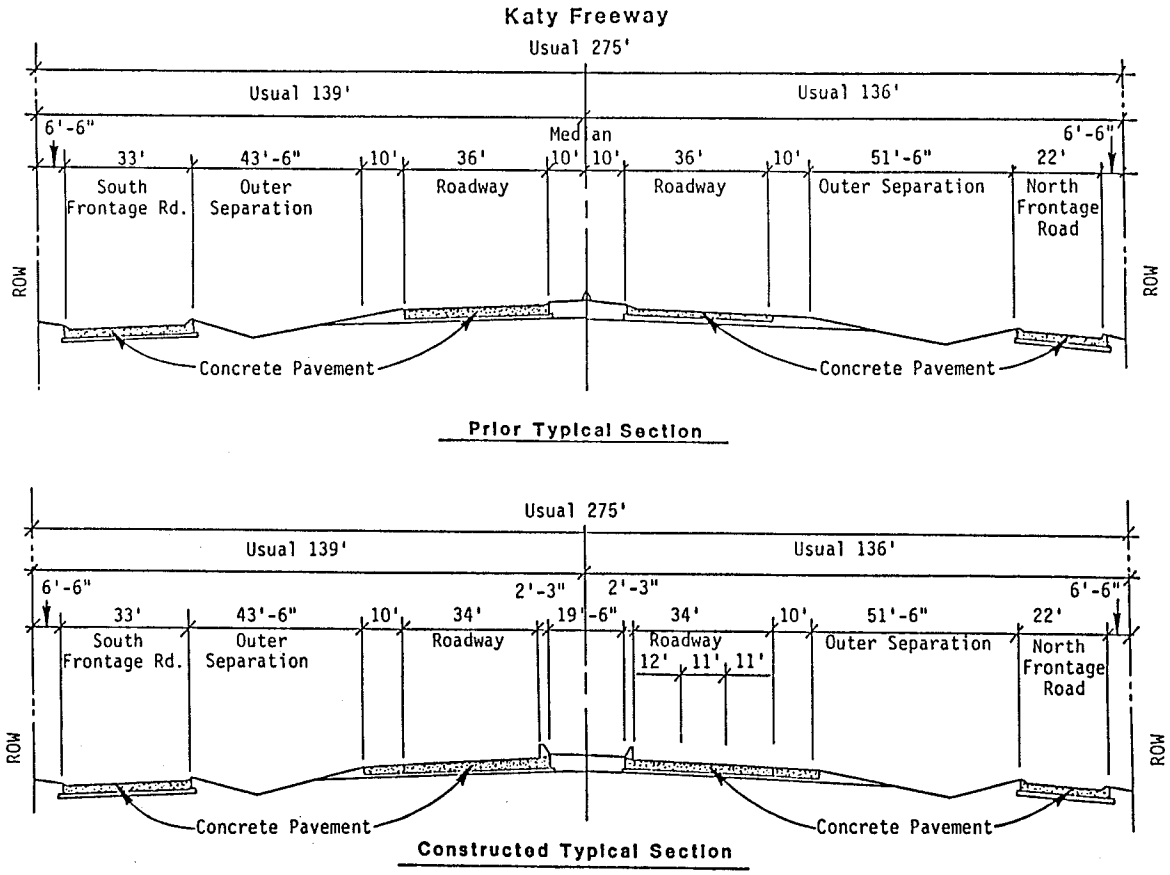

FIGURE 2 Before and after transitway freeway cross sections.

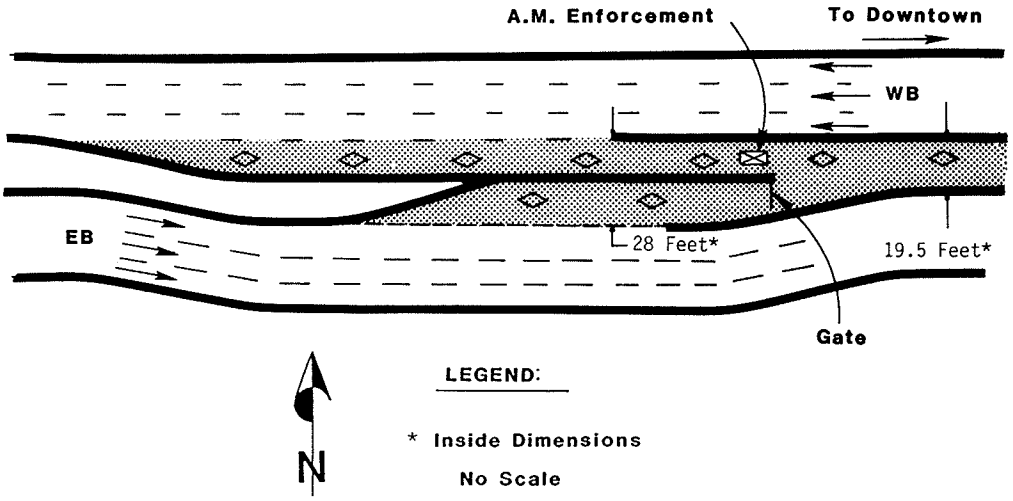

FIGURE 3 Western terminus, Katy Freeway Transitway.

section (Figure 4). At that intersection, authorized high-occupancy vehicles can either travel south to major employment centers or continue east to reenter the Katy Freeway in mixed-flow lanes to reach downtown Houston.

IMPACT OF CONSTRUCTION

Construction on Phase 1 of the Katy Freeway Transitway began in April of 1983. The introduction of a transitway facility into the median required special retrofit construction processes that constrained adjacent freeway sections that were already serving high volumes of traffic. A primary concern was to minimize the adverse traffic impacts associated with this type of construction.

In order to accomplish the transitway construction, work was sequenced independently within each project segment. The work sites were developed in the median and to the north and the south sides of the freeway mainlane cross-section. Traffic was routed around the work sites through narrow lanes that varied from 10 to 11 ft in width, with no shoulders on either side of the lane. Temporary concrete median barriers protected and separated the work sites from freeway traffic.

Construction on Phase 1 of the Katy Transitway was completed in October of 1984, approximately 4 months ahead of the estimated construction time. An evaluation of the impacts of the transitway construction indicated that mainlane traffic volumes and speeds were minimally affected, and that after an initial 1-month adjustment period, accident rates were not significantly different during transitway construction than they were the year before (1).

INITIATION OF SERVICE

The Katy Freeway Transitway formally began service on October 29, 1984. High-occupancy vehicles authorized to use the transitway were restricted to buses and vanpools. Within the first few weeks of operation, a total of 78 buses per day (carrying 2,860 passengers) and 160 vanpools per day (carrying 1,303

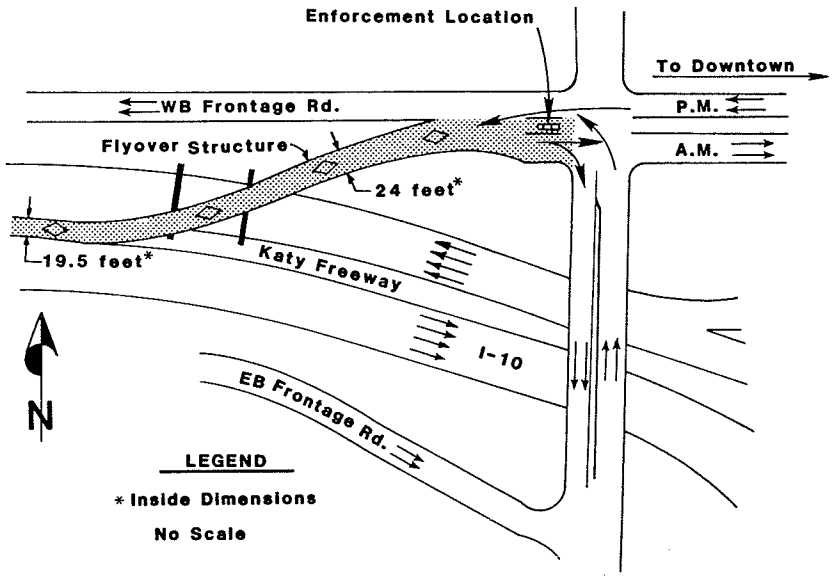

FIGURE 4 Eastern terminus, Katy Freeway Transitway.

passengers) were using the Phase 1 segment of the transitway, which represented average occupancy rates of 37 and 8 persons for buses and vanpools, respectively.

For the initial length of the Katy Transitway from Gessner Drive to near I-610 (a distance of 4.75 mi), a net travel-time savings of 5 to 9 min per trip can be realized during the peak period compared with adjacent freeway mainlane travel times. These travel-time savings are realized despite the 2 min that are lost traveling on the arterial street that connects the transitway's eastern terminus with the Katy Freeway mainlanes inside of I-610.

Current operation of the transitway is manually controlled by an on-site crew that consists of a transit police officer, a wrecker driver, and a traffic control worker. These persons open the inbound transitway by 5:45 a.m. and close the transitway by 9:15 a.m. until reversed operation begins. In the afternoon, the transitway is open for outbound traffic from 3:30 to 7:00 p.m.

The transit police officer is on duty at the eastern terminus to handle emergencies and to warn or ticket any unauthorized patrons using the transitway. The wrecker and driver are situated at the western transitway entrance to handle emergencies and to remove stranded vehicles. In order to improve its maneuverability within the transitway cross-section (in particular, to provide a tighter turning radius), the wrecker was specially designed with a shorter-than-normal wheel base.

A number of signs and lane control signals are used to direct traffic through the transitway. As shown in Figure 5, changeable message signs are used at each end of the transitway to inform vehicles and the public about the facility. Lane control signals that display a red X or a green or yellow arrow verify the direction and conditions of transitway operation. Finally, traffic signs direct vehicles from connecting arterials to the transitway entrance. Currently, all signs and lane control signals within the transitway are manually controlled when the facility opens and closes each day. Within the next 6 months, all transitway signs and signals will be remotely controlled by computer with operator intervention.

FIRST-YEAR OPERATIONS

Transitway Buses, Vanpools, and Carpools

The Katy Freeway Transitway was opened on October 29, 1984, as a median, barrier-separated, one-way, reversible, single-lane priority facility to be used by authorized buses and vanpools. Daily vehicle and passenger volumes initially totaled 78 buses and 160 vanpools that carried 2,860 and 1,303 passengers, respectively. Carpools were authorized to use the facility in April of 1985. Monthly transitway vehicle and passenger demand from the time it opened until August 1985 is presented in Tables 1 and 2. The cumulative increases in demand categories are also given. These values are shown in Figures 6 and 7.

As can be seen, the growth in vehicle utilization of the transitway has increased from 238 to 304 vehicle trips per day, and passenger movement has increased from 4,163 to 5,433 passenger trips per day, which represents an approximate 28 percent increase in vehicle volumes, and a 31 percent increase in passenger volumes. Although the number of vehicles currently using the transitway in a peak hour of operation is typically less than 5 percent of the vehicle volume that may be observed on an adjacent freeway mainlane, the number of passengers served by these few vehicles is almost the equivalent of an

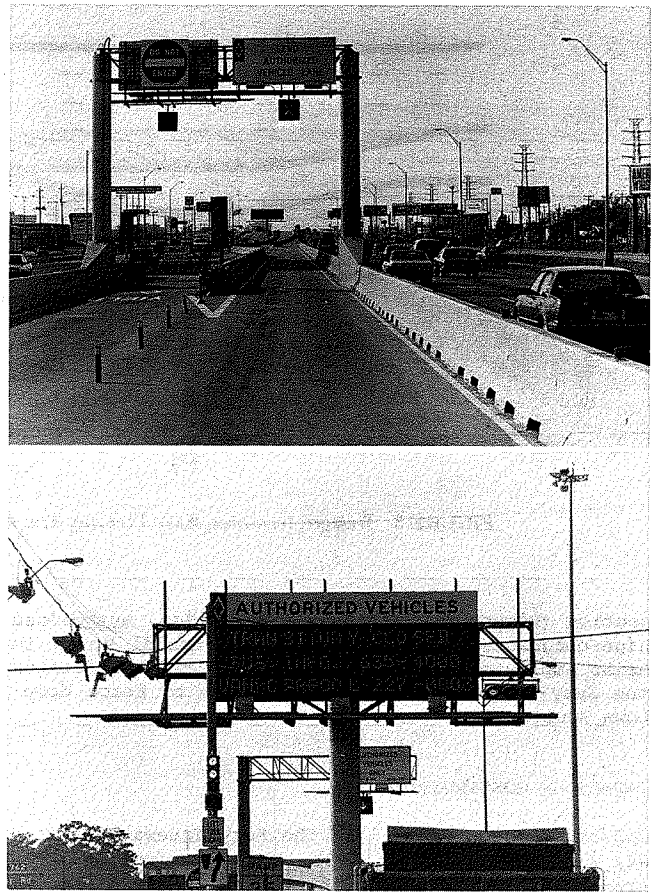

FIGURE 5 Transitway signs.

TABLE 1 Transitway Vehicle Demand, 1984-1985

Month	Daily Vehicles				Cumulative Percent Change
	Buses	Vanpools	Carpools	Total	
November	78	160	-	238	-
December	81	162	-	243	2
January	90	172	-	262	10
February	97	166	-	263	11
March	101	170	-	271	14
April	104	166	10	280	18
May	106	168	12	286	20
June	121	158	13	292	23
July	116	153	28	297	25
August	122	145	37	304	28

TABLE 2 Transitway Passenger Demand, 1984-1985

Month	Daily Passengers				Cumulative Percent Change
	Buses	Vanpools	Carpools	Total	
November	2,860	1,303	-	4,163	-
December	3,020	1,426	-	4,446	7
January	3,180	1,636	-	4,816	16
February	3,520	1,640	-	5,160	24
March	3,450	1,596	-	5,046	21
April	3,490	1,601	40	5,131	23
May	3,300	1,557	50	4,907	18
June	3,780	1,271	50	5,101	23
July	3,880	1,236	111	5,227	26
August	4,100	1,203	130	5,433	31

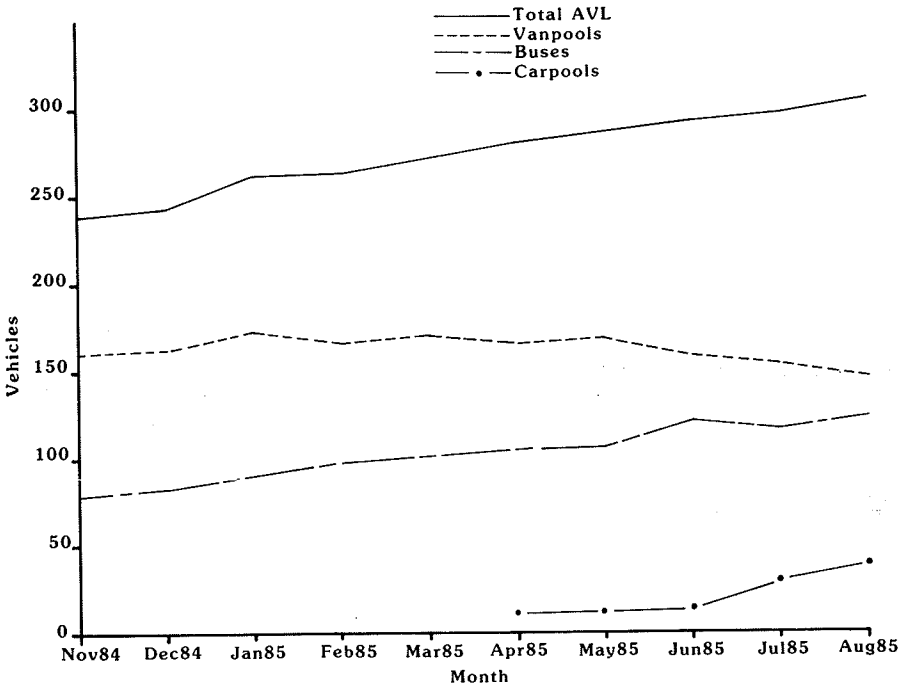

FIGURE 6 Katy Freeway Transitway demand: daily vehicle volumes.

adjacent freeway lane operating at peak capacity with normal automobile occupancies.

There have been corresponding increases in demand for transitway support facilities such as park-and-ride lots and vanpool staging areas. The geographic locations of these facilities within the Katy Freeway corridor and their current capacities are shown in Figure 8. Demand totals for each of these transitway support facilities are given in Table 3. Total corridor demand for park-and-ride facilities has increased by 82 percent over the 9-month period since the transitway began operating.

The typical distribution of vehicle demand during peak periods on the transitway is shown in Figures 9 and 10. Note the substantial and distinctly different peaking characteristics exhibited by buses and vanpools. Approximately 60 percent of total transitway demand is served on the transitway during a typical peak hour of operation.

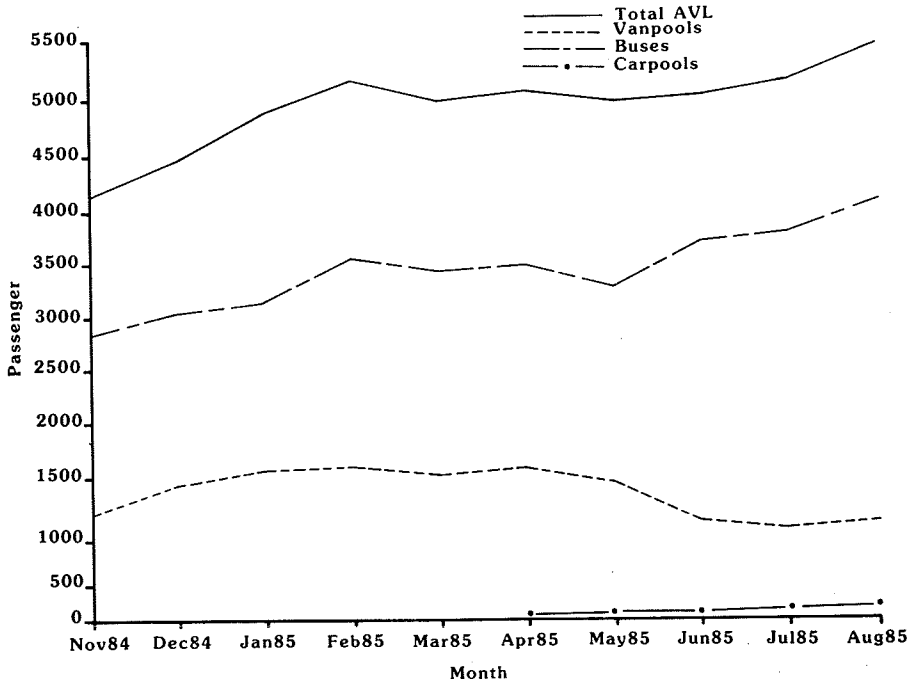

FIGURE 7 Katy Freeway Transitway demand: daily passenger volumes.

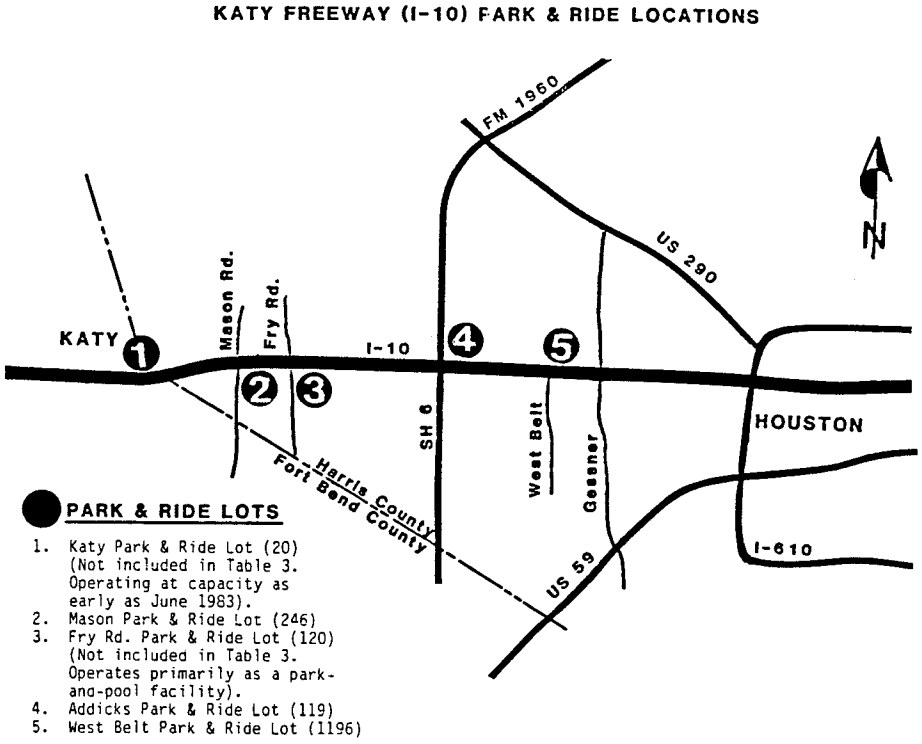

FIGURE 8 Katy Freeway Transitway support facilities.

TABLE 3 Katy Freeway Park-and-Ride Demand Totals, 1984-1985

Month	Demand (parked vehicles) by Park-and-Ride Lot				Percent Change
	Mason[a]	Addicks[a]	W. Belt[a,b]	Total	
November	147	378	-	525	-
December	162	335	-	497	-5
January	173	425	-	598	14
February	171	430	191	792	51
March	170	420	144	734	40
April	167	423	197	787	50
May	165	417	189	771	47
June	175	461	226	862	64
July	180	492	237	909	73
August	203	522	228	953	82

[a]See Figure 8 for location.
[b]Operational Jan. 28, 1985.

Freeway Mainlanes

Because of continued population and economic growth along the Katy Freeway corridor, the impact on traffic congestion has not been apparent. Freeway mainlanes adjacent to the Phase 1 segment of the transitway were operating at depressed levels of service during peak periods before the transitway was built and they continue to be highly congested. The speed profile from Gessner Drive to the I-610 interchange (Phase 1) during peak periods on the Katy Freeway both before and after construction of the transitway is shown in Figure 11. As can be seen, there has been no substantial change in travel time in this section. As shown in Figure 12, there is also no major change in service volumes. Any apparent aberrations in speed and capacity flow conditions are inconsequential and practically insignificant.

Corridor Totals

A quarterly summary of morning peak-period vehicle and passenger movement along the Katy Freeway corridor between Gessner Drive and I-610 is provided in Table 4. Because of the transitway, the corridor serves approximately 1,400 more vehicles (+13 percent) and approximately 3,000 more passengers (+23 percent) (see Figure 13). Although it composes only 1 percent of the corridor's peak-period vehicle volume, the transitway contributes more than 15 percent of the total passenger trips during that peak period.

IMPROVEMENTS AND MODIFICATIONS

West Belt Extension

Phase 1 of the Katy Transitway was originally designed to be operated from I-610 to Gessner Drive. However, since the opening of the transitway in October of 1984, the interim operation of a western extension of the lane became both desirable and feasible. Consequently, a 1.45-mi extension from Gessner Drive to West Belt was implemented on May 2, 1985. Approximately 86 percent of the vanpools, 89 percent of the carpools, and 44 percent of the buses are currently taking advantage of this extension to save an additional 2 to 6 min in travel time over mainlane vehicles.

Carpool Authorization

Based on contraflow experience on the North Freeway, only authorized buses and vanpools were initially permitted to operate on the Katy Freeway Transitway. During the first 5 months of its operation and

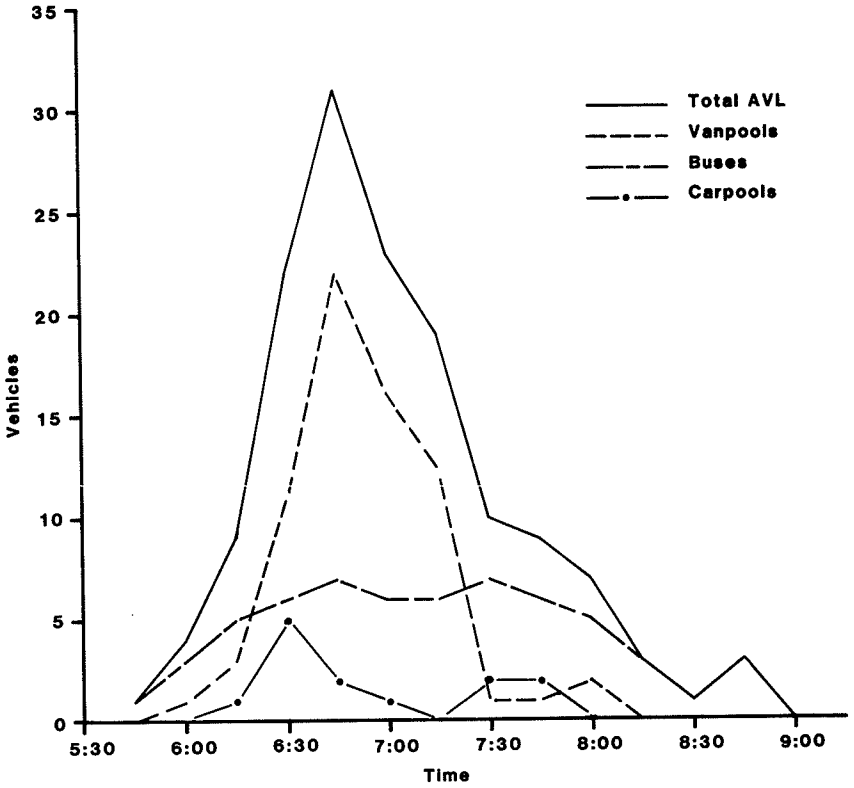

FIGURE 9 Katy Freeway Transitway demand distribution by time: morning, July 1985.

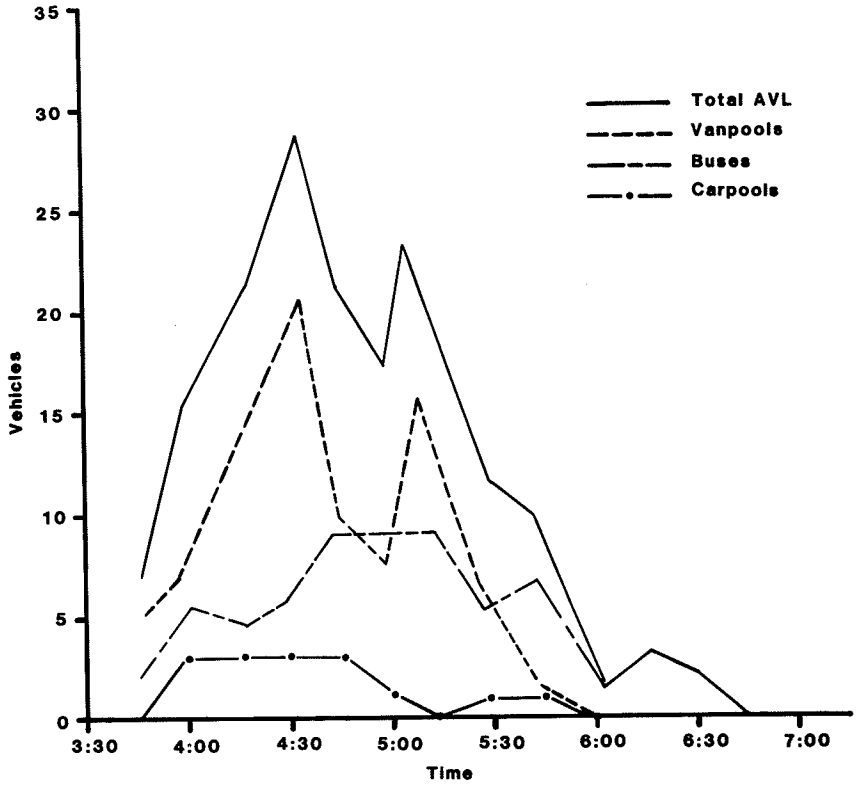

FIGURE 10 Katy Freeway Transitway demand distribution by time: afternoon, July 1985.

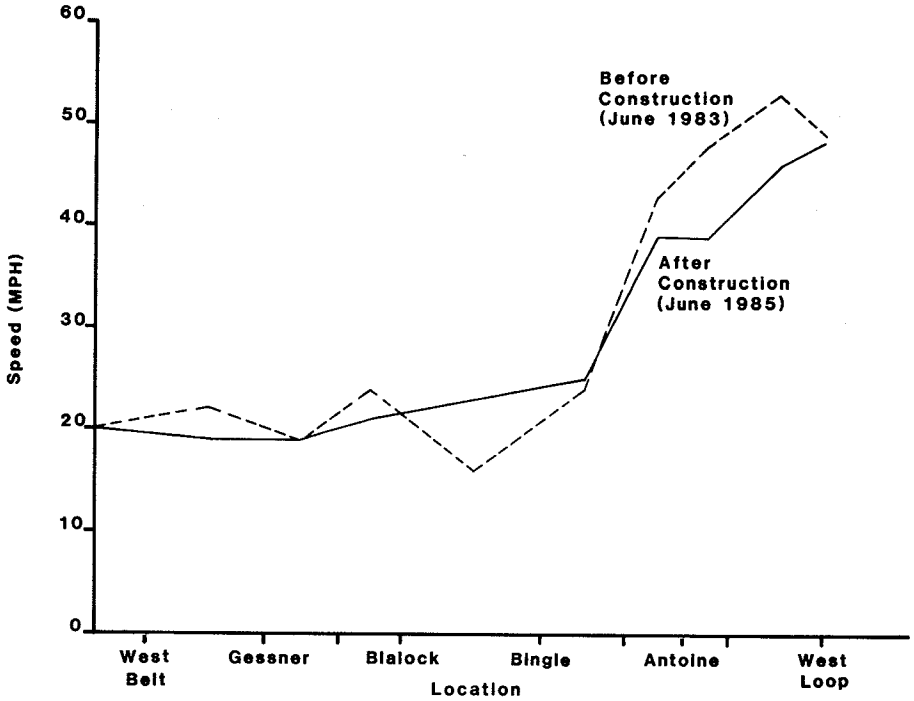

FIGURE 11 Katy Freeway peak-period mainlane speed profile.

despite its sustained growth, combined bus and vanpool volumes on the transitway were relatively low compared with its capacity, which resulted in a perception that the transitway was underutilized (2). As a means of overcoming this perception and following the examples set by most other HOV freeway projects elsewhere in the United States, METRO and SDHPT decided to approve a carpool experiment on the Katy Freeway Transitway beginning April 1, 1985 (3,4).

The use of carpools on the transitway was originally restricted to duly authorized automobiles that carried four or more passengers. If an authorized carpool had fewer than four persons on any day because of a carpool member's work schedule, travel, illness, or vacation, it was not permitted to use the transitway. This carpool designation was structured to ensure maximum passenger occupancy of vehicles traveling within the Katy Transitway and also

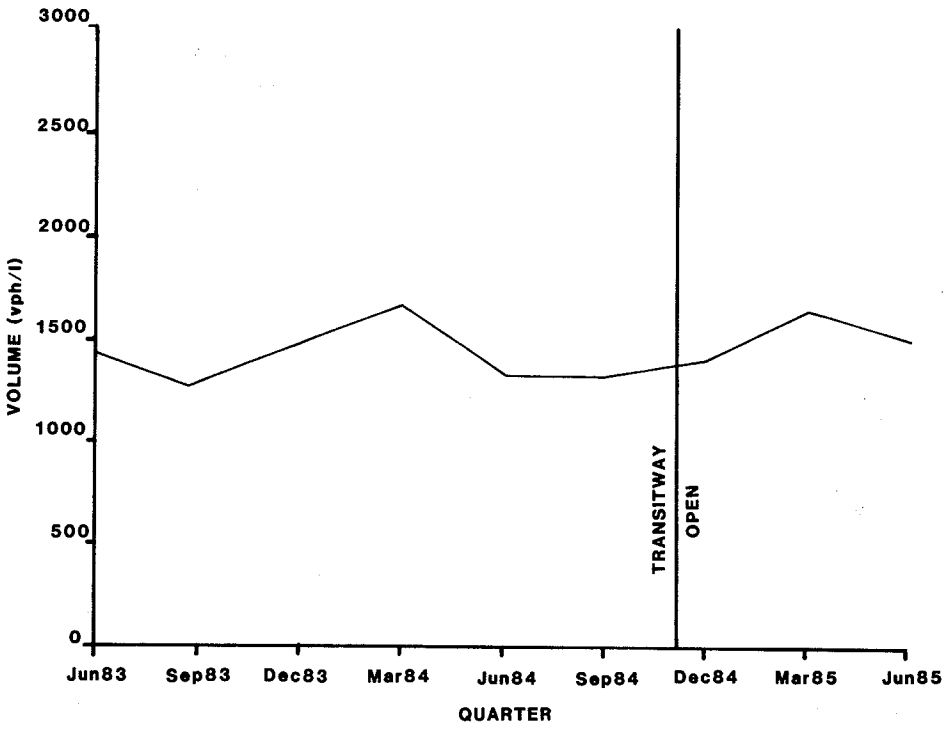

FIGURE 12 Katy Freeway peak-period mainlane service volumes.

TABLE 4 Quarterly Katy Freeway Corridor Volumes, Morning Peak Periods (6:30-9:30 a.m.), 1984-1985

Month	Freeway		Transitway		Total		Cumulative Percent Change	
	Vehicles	Passengers	Vehicles	Passengers	Vehicles	Passengers	Vehicles	Passengers
September	10,729	12,874	-	-	10,729	12,874	-	-
December	11,352	12,884	112	2,093	11,464	14,977	7	16
March	12,012	13,920	131	2,483	12,143	16,403	13	27
June	11,055	13,253	142	2,615	12,097	15,868	13	23

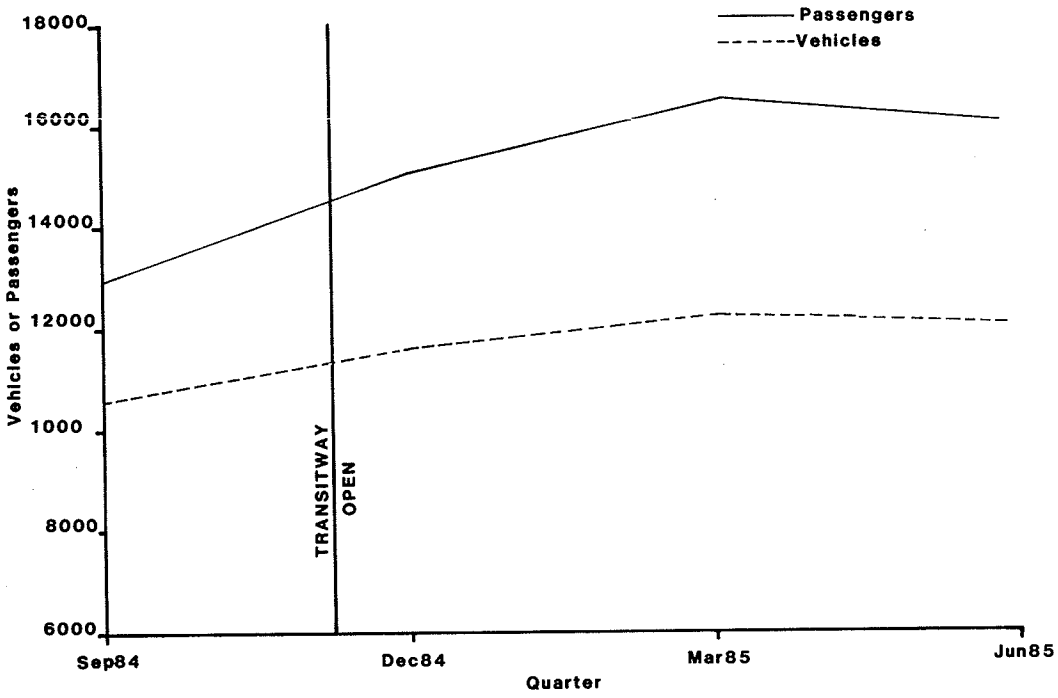

FIGURE 13 Katy Freeway corridor vehicle and passenger volumes.

out of concern that a designation of three or more passengers in a carpool could possibly cause the capacity of the transitway to be exceeded and create unacceptable operating conditions.

Approximately 30 carpools were authorized to use the transitway in April of 1985. However, as shown in Table 5, of these 30 carpools, an average of only 5 carpools actually chose to use the lane during a typical peak period. Since then, the number of carpools observed using the transitway has doubled, but absolute demand levels remain low. Consequently, effective July 29, 1985, carpools were permitted to enter the transitway with at least three passengers, although four or more registered passengers were still required to obtain authorization.

West Belt Park-and-Ride Lot

A major park-and-ride lot was opened by METRO near the West Belt cross street to I-10W in late January of 1985 to support the Katy Transitway. This facility has a capacity of 1,111 parked vehicles. After 7 months of operation, approximately 230 vehicles were using the lot with an average of 12 buses per peak period accessing the transitway. This represents a

TABLE 5 Carpool Demand on Katy Freeway Transitway, 1985

Month	Morning		Afternoon		Daily	
	Vehicles	Passengers	Vehicles	Passengers	Vehicles	Passengers
April	6	24	4	16	10	40
May	6	26	6	24	12	50
June	8	32	5	18	13	50
July	13	52	15	59	28	111
August	20	67	17	63	37	130

growth of approximately 20 percent in the first 7 months of operation.

Benefit-Cost Analysis

Based on August 1985 transitway volumes, persons traveling by authorized bus, vanpool, or carpool on the transitway are realizing a time savings over parallel freeway mainlane travel of approximately 551 person-hours per day. This estimate assumes a conservative travel-time savings of 5 min for each of the 2,478 people using the transitway as far as Gessner Drive (56 percent of bus volumes, 14 percent of vanpool volumes, and 11 percent of carpool volumes) and a savings of 7 min for each of the 2,955 people using the transitway all the way to West Belt (see Table 2). By placing a value of $7.50 on each person-hour of delay saved, the travel-time savings obtained in August 1985 translates into an annual benefit of $1,078,000 (5).

A postimplementation assessment of the benefits and costs of Phase 1 of the Katy Transitway affirms the transitway's long-term cost-effectiveness. By using a 20-year analysis period and a 10 percent discount rate, a benefit-cost ratio of 1.69 is obtained. The major costs and benefits that are included in this analysis are summarized in Table 6.

TABLE 6 Estimated Benefits and Costs, Katy Transitway, Phase 1

Benefit or Cost Component	Present Value ($ 1985 millions)
Benefits	
Travel time savings	22.020
Reduced bus operating cost	3.440
Subtotal	25.460
Costs[a]	
Transitway construction (including associated arterial street improvements)	10.693
Transitway operation	2.986
West Belt park-and-ride lot	1.400
Subtotal	15.079
Benefit-cost ratio	1.69

[a]Source: Metropolitan Transit Authority of Harris County, Texas.

CONCLUSIONS

The Katy Freeway Transitway was completed 4 months ahead of schedule with minimal operational and safety impacts to mainlane traffic during construction of the facility. After 9 months of operation, the transitway is carrying more than 5,400 persons per day. An 82 percent increase in park-and-ride demand has accompanied this rise in transitway utilization. The corridor as a whole is carrying more than 20 percent more people in the peak direction during a 3-hr peak period than it did before the transitway was introduced.

According to annual projections for the first year of operation, the Katy Freeway Transitway should accommodate demand by high-occupancy vehicles for an increase of approximately 39 percent per year for vehicles and 43 percent per year for passengers. If these rates are sustained through 1986, by the end of that year the transitway will serve an average of approximately 4,541 peak-period passenger trips, which is about 30 percent of the daily directional peak-period, mainlane freeway passenger movement.

This overall HOV growth trend is below that experienced on similar facilities nationwide (6) or on the North Freeway (I-45) contraflow lane in Houston (7). The location and short length of the transitway associated with Phase 1 implementation could be responsible for this limited growth in high-occupancy-vehicle volumes. The congestion and depressed level of service on the freeway extends far beyond the transitway terminus of Phase 1. As the Katy Freeway Transitway is extended westward, the reduction in travel time will become more substantial and will therefore offer more of an incentive for modal shifts to occur. It is anticipated that the growth rate of transitway utilization will be markedly greater as succeeding phases of the project become operational.

ACKNOWLEDGMENT

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