A FEASIBILITY STUDY OF A REVERSIBLE-LANE FACILITY FOR A DENVER STREET CORRIDOR

James Hemphill, Federal Highway Administration; and
Vasant H. Surti, Center for Urban Transportation Studies,
University of Colorado at Denver

ABRIDGMENT

•TRAFFIC volumes and rush-hour congestion in and around many metropolitan areas are increasing yearly. Several years ago a national system of freeways was seen as the panacea for the congested streets and highways of the United States, but these wide-lane, limited-access facilities require space that is often not available in urban areas. Recently the emphasis has switched to grade-separated rapid transit systems for urban areas, but these systems are costly to develop and operate. Both of these systems have merit and could help in solving the chaotic transportation scene in urban areas if time and money were made available. Because of the high volumes of traffic on urban streets and the difficulty urban areas have in obtaining large amounts of capital funds, more economically attractive and easily implemented systems for increasing street capacities and traffic volumes need to be investigated. One such system that could help alleviate some of the congestion by increasing traffic volumes is a reversible-lane facility.

A street corridor southeast of the Denver central business district was selected as a study area. This area demonstrated directional flow characteristics on its boundary one-way arterial streets, Sixth and Eighth Avenues. Seventh Avenue, a little-used two-way residential street between the boundary one-way arterials, was believed to be capable of relieving some of the rush-hour congestion within the study corridor by the application of traffic engineering techniques.

The objective of this study is to determine the feasibility of the installation of a reversible-lane facility to reduce the congestion on a pair of one-way streets during rush hours. In this study it is hypothesized that, based on rush-period operation within the study corridor, a reversible-lane facility will increase capacity and reduce travel time with a minimum of disruption to the neighborhood.

Throughout the 1½-mile length of the study corridor Seventh Avenue changes from a 48-ft-wide street with business activity to a 30-ft-wide residential street and then to a 6-lane divided parkway through a residential area. By eliminating curb parking along the 30-ft-wide portion of Seventh Avenue, adequate width for a reversible center lane can be maintained. Transitions at both ends of the study corridor and for each of the changes in the street characteristics can also be provided.

The implementation of a reversible center lane and the resulting increase in capacity would be of little value if signal progression for the favored direction of flow could not be developed. Using a modification of the summation of offsets, new morning and afternoon rush-hour offsets were calculated that provide the favored directions with the same progression as the boundary arterials.

The signing, signaling, and pavement marking of a reversible center lane facility are perhaps the most important aspects for its safe and efficient operation. Without clear and legible lane-control devices a reversible-lane facility can be hazardous to drivers. Many different types of lane controls have been used in the past on reversible-lane systems. However, recently the Manual on Uniform Traffic Control Devices has defined standard lane controls to be used when implementing a reversible lane.

Publication of this paper sponsored by Committee on Operational Effects of Geometrics.

Before any system can be evaluated, some estimate of the number of people who will use the system must be made. There are several methods for determining traffic diverted to a new or improved traffic facility. A modification of the capacity restraint model, which determines the least travel time between two nodes, was developed for use in this study.

Travel times throughout the study corridor were established using the relationship between volumes, capacity, and speed. The relationships shown in Figure 1 are adaptations of Figure 10.3 of the Highway Capacity Manual. The figures illustrate that, as volume increases, average speed of the vehicles decreases. The v/c ratio is the actual volume divided by the capacity of the facility.

The two curves in Figure 1 are of the same family of curves but represent different types of streets. Curb I was calibrated for the 2 one-way boundary arterials. Curve II was developed for conditions on Seventh Avenue after the installation of a reversible center lane.

The traffic volumes were derived for Sixth and Eighth Avenues by projecting traffic counts obtained from the Colorado State Highway Department. There were no records of traffic volumes on Seventh Avenue but observations showed these volumes to be negligible.

If the capacity and volume of these streets are known, the travel time over these links can be calculated. By varying the volumes carried by the one-way arterials and the reversible center lane facility, optimum travel times throughout the study corridor can be determined. The speeds that can be maintained within the study corridor for various volumes were determined and plotted in Figure 2. This plot of speed versus volume can be used to determine the optimum speed a given total volume should maintain and the resulting volume on each street. Curve I represents the cumulative volume, curve II the volume on Sixth or Eighth Avenues, and curve III the volume on Seventh Avenue in the direction of favored flow.

Observations made during the peak period of the peak hour indicate that traffic volumes on Sixth Avenue are at or near its capacity of 2,200 vehicles per hour. Seventh Avenue runs approximately 10 percent of this volume during the same peak period. The total westbound volume of 2,420 vehicles per hour travels through the study corridor at an average speed of 13 mph under present conditions.

Assuming that, if a reversible center lane were installed on Seventh Avenue, drivers would choose the route providing the shortest travel time, the volumes and speeds of traffic using both Seventh Avenue and Sixth or Eighth Avenue can be determined by Figure 2. This figure indicates that the same volume of 2,420 vehicles per hour could travel through the study corridor at an average speed of 28 mph, with 1,710 vehicles using Sixth Avenue and 710 vehicles on Seventh Avenue.

To determine if the installation of a reversible center lane on Seventh Avenue is economically feasible, the total transportation costs with and without such a facility need to be determined. At present the transportation costs consist of vehicle and travel time costs. With the installation of a reversible center lane on Seventh Avenue the additional costs of installation and maintenance must be included.

Several factors need to be known in order to determine transportation costs within the study corridor. These factors include the hourly traffic volumes during rush hours, the average speed of these volumes, the cost of vehicle operation, the cost of travel time, and the vehicle occupancy rate.

After determining these factors, transportation costs were computed within the study corridor for the years 1973 through 1975. For the purpose of comparison, the costs were derived for the weekday rush periods because a reversible center lane would operate only during these times.

All transportation costs were computed on a yearly cost basis. The yearly transportation costs with and without the installation of a reversible center lane on Seventh Avenue and the yearly savings and present worth of that savings were calculated for 3 years. Over a 3-year period a savings of $697,400, in 1973 dollars at 6 percent interest, in transportation costs will be recognized by the installation of a reversible center lane on Seventh Avenue. Each year the savings in total transportation cost is greater than that of the preceding year. Since the expected life of a reversible center

Figure 1.

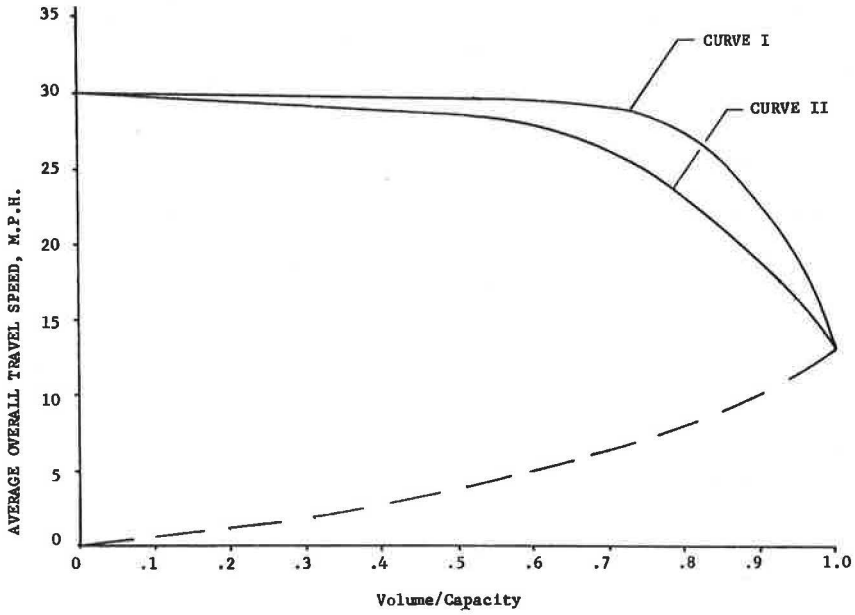
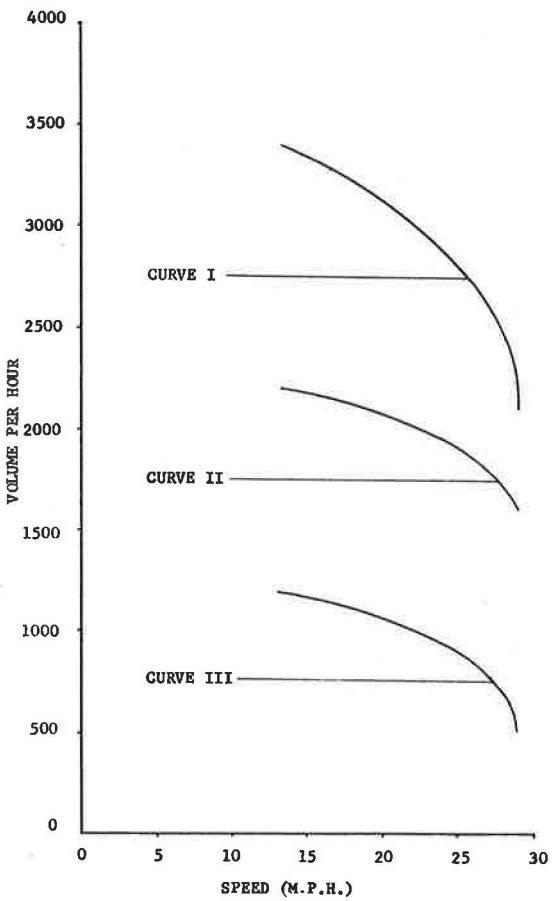


Figure 2.



lane facility should be at least 15 years, the actual transportation costs savings over the life of the project should far exceed the average present worth yearly gain of $233,000.

Before completing any study of a proposed traffic facility improvement, there are environmental aspects that should be considered. When crowded street conditions force traffic to start and stop often during rush hours, automobile emissions are increased. By increasing traffic progression, reducing congestion, and shortening the length of the rush period, air pollution and noise pollution can be reduced. Another environmental aspect, the aesthetics, may also be disrupted by the use of overhead lane signals and other devices used to implement a reversible lane system, but, when compared to widening projects or other alternatives for increasing street capacities, these devices seem less disruptive.

The results of this study show that a small initial investment for the installation of a reversible center lane facility could have a significant effect in reducing transportation costs over a short period of time within the study corridor.

Therefore, after an engineering analysis, the recommendation of this study is that a reversible center lane be installed on Seventh Avenue. This economically attractive and easily implemented system provides a simple solution for decreasing traffic congestion on the overburdened arterial streets.

As in any study of this kind, the results and recommendations are only a tool to be used by the decision-makers. Other aspects, such as citizen participation and reaction, would be vital inputs into the decision process before implementation could be considered.

Although this study concerns the feasibility of installing a reversible-lane facility for a Denver street corridor, the method of analysis is applicable in other areas of other cities. The probability of these same conditions existing elsewhere is very small, but the existence of overburdened arterial streets is a common problem for many urbanized areas. A properly engineered reversible-lane facility could be a boon in relieving some of the ever-increasing rush-hour congestion.

The research presented in this paper is part of a project sponsored by the Urban Mass Transportation Administration. The results and views expressed are those of the authors and not necessarily those of the sponsoring agency.