A STUDY OF LAND DEVELOPMENT AND TRAFFIC GENERATION ON CONTROLLED-ACCESS HIGHWAYS IN NORTH CAROLINA

Willard F. Babcock and Snehamay Khasnabis, Department of Civil Engineering, North Carolina State University

ABRIDGMENT

•A MAJOR problem in planning a controlled-access facility is the task of estimating the volume of traffic that will develop at interchanges. Land values around interchanges increase, and zoning changes to denser classifications cause land developments that were not originally foreseen. Such land developments frequently generate large traffic volumes that tend to overload the interchange. If a reliable method of prediction of land use changes were available, it would then be possible to purchase sufficient land at the outset, where necessary, for a properly designed and stage-constructed interchange. This study is a pilot analysis to investigate if it is possible to make realistic predictions of land development along controlled-access freeways in North Carolina. An attempt has also been made to evaluate the traffic-generating characteristics of these land developments. All controlled-access freeways (a total of 550 miles) in North Carolina have been included in this study.

METHODOLOGY

Base maps for all the routes to be studied were prepared showing land use data up to ½ mile on either side of interchanges. A limited number of origin-and-destination surveys were also made at selected interchanges having differing types of land development. The North Carolina State Highway Commission provided traffic data relative to several complicated interchanges.

The researchers held discussions with the planning officials of the five different cities having controlled-access freeways to aid in making objective judgments concerning which developments were highway-oriented and which were not. The study area was classified into three categories: rural, suburban, and urban. Land development along or near the interchange in a rural area was almost 100 percent highway-oriented. A majority of developments were considered as highway-oriented at suburban interchanges. In urban areas, where the freeway passed through a built-up area, very little development was attributable to the freeway.

FINDINGS

Land Developments by Routes

Generally, it was found that, in a tourist-oriented route similar to Interstate 95, the major type of development was in the form of motels, restaurants, and service stations that would cater to the needs of motorists. On the other hand, along the corridor on Interstate 40 and Interstate 85 connecting the major urban areas in the state, numerous industries and commercial establishments have developed, including a sizable number of service stations, motels, and restaurants.

Publication of this paper sponsored by Committee on Social, Economic and Environmental Factors of Transportation.

Land Developments by Freeway Characteristics

Rural—Approximately 310 miles of rural freeways were studied that included 105 interchanges. It was found that at 35 percent of the interchange quadrants there was some land development, with the remaining 65 percent vacant. The land developments consisted of 117 service stations, 8 motels, 8 truck stops, 9 restaurants, 12 industries, and 14 miscellaneous types, making a ratio of 1½ land developments per interchange or 1.2 developments per quadrant.

Suburban—A total of 171 miles of freeways and 76 interchanges were studied in suburban areas. It was found that some form of land development took place on 70 percent of the interchange quadrants. The developments consisted of 181 service stations, 52 motels, 17 truck terminals, 85 industries, 16 shopping centers, and 49 retail sales outlets, along with other miscellaneous developments, making a ratio of 5.50 developments per interchange or 2.00 developments per developed quadrant.

Urban—Urban interchanges have a much higher density of development. Only 21 percent of the interchange quadrants were vacant, of which approximately half were undevelopable because of the physical characteristics or were state-owned property. The remaining quadrants are either in the process of being developed or being held for development. Of the 71.5 miles and 40 interchanges, there were 70 service stations, 20 motels, 15 truck stops, 61 industries, 6 large shopping centers, 58 retail sales outlets, and 26 office and institutional properties, along with other miscellaneous developments. This made a ratio of 6.5 developments per interchange or 2.1 developments per developed quadrant.

Traffic-Generating Characteristics

The following general conclusions can be made relative to the traffic-generation characteristics:

1. Service stations generate a minimum of 4 to a maximum of 13 trips (one-way) in an average hour leaving the freeway, with 80 to 90 percent of the vehicles returning.
2. Truck stops average 12 to 20 vehicles per hour, including passenger vehicles.
3. Truck terminals, except at certain night hours, average from 5 to 10 trips from the freeway to the terminal.
4. Industrial developments vary from 5 to 50 percent of vehicles at a shift change making use of the Interstate, depending on the location as to whether the major movements are perpendicular to the freeway or make use of the freeway for an urban destination.
5. Motels generate approximately one vehicle moving from the freeway for every 6 rooms in the motel per average daytime hour.
6. Apartment complexes are variable, depending on whether the movement is mainly radial or to the freeway. In one instance during the peak hour there was approximately one vehicle for every 5 housing units making use of the freeway. This was, however, a beltline characteristic.
7. Shopping centers are variable, with up to 50 percent of the traffic coming from the freeway in one case and in others approximately 25 percent of the traffic using the shopping center.
8. Where service roads exist, connecting the freeway interchanges, between one-third and one-half of all of the service-road traffic comes from or goes to the freeway, congesting the intersection.

Predictability of Land Use Changes

Rural—It was found that generally 50 percent of the quadrants in rural areas would remain vacant for a long time and on an average there would be one service station for each remaining quadrant. The question of the exact location of the service station was not pursued to any great extent since it was found that service stations generate very little traffic for the freeway.

Suburban—In suburban areas, the techniques of multiple linear regression were applied to obtain a mathematical expression for estimating land use changes by different

type of land use. The predictors were the average daily traffic on the freeway and on the crossroad, population of the nearest city, and distance of the interchange from the city. In order to make the analysis more sensitive, the total sample size for each category of land use was divided into a few subsamples according to the size of the nearest population center.

It was found that generally the location of service stations can be predicted with a high degree of accuracy (maximum $R^2 = 0.99$)[1]. The location of motels can also be predicted with a reasonable degree of accuracy (maximum $R^2 = 0.72$). If realistic judgment decisions may be made regarding availability of land for industrial development, their location can be predicted with a fair amount of accuracy (maximum $R^2 = 0.94$). In most cases, the level of significance was less than 0.25, which signifies that 75 percent of the time the predictions will not be in error. There were not a sufficient number of shopping centers to develop any predictive equations. It was found that shopping centers tend to locate around moderate to large urban areas, depending on the characteristics and availability of land and economic demand.

Urban—The problem of precise predictability of land development in and around urban areas has so many variables that a much more detailed analysis is required to provide specific answers. This study showed, however, that it is possible to make some general conclusions regarding the location of urban activities in and around freeway interchanges. The analysis indicates that some form of land development will take place in all quadrants of interchanges if such land is available for development. The question of exact location of these developments is subject to further research.

Predictability of Specific Types of Developments Near Urban Freeways

The following observations may be made in terms of specific developments near urban freeways.

If land is available at the interchanges and is predominantly residential, the increased value of land near the interchange may give rise to the construction of a large number of townhouses and apartments.

The construction of a freeway of the bypass type, rather than the radial type, with vacant land or with partially built-up land is very susceptible for the development of office and institutional-type activities.

It is realistic to assume that some form of a shopping center will develop on all types of bypasses and beltlines where land is available or where large parcels of land can be put together. Particularly when residential development has taken place beyond the bypass and there is still available land, the chances are high that some form of shopping center will develop between the residential area and the central business area near a major radial interchange with the freeway.

Service roads play a very significant role in the development of industries on freeways. Even if service roads are not available there is an apparent trend to build private roads away from the interchange connecting other radial roads, with the vacant land being developed into prestige location industrial parks. These industrial parks make for major generators at the intersection of the radial routes and the freeway interchange.

CONCLUSIONS

In this pilot study, an analysis was made of changes in land developments that have taken place on controlled-access freeways in North Carolina. It was found that developments in rural areas were predominantly service stations and so scattered that there was no predictability as to the location. In suburban areas developments were denser and location of service stations, motels, and industries could be reasonably predicted.

[1] The value of R^2 denotes the percentage variation of the dependent variable that can be explained by its relationship with the independent variables.

In urban areas, developments could be qualitatively predicted, although the factors involved were so numerous as to prohibit the use of statistical analysis on the moderate number of samples.

Major traffic generators for the freeway were the industrial plants and shopping centers, while the other developments (motels, restaurants, service stations, and apartment complexes) have very little effect on the operation of the interchange if these are located by themselves.