14.1.5 Location of Recreational and Scenic Routes

The location process of recreational and scenic routes follows the same steps as discussed earlier, but the designer of these types of roads must be aware of their primary purpose. For example, although it is essential for freeways and arterial routes to be as direct as possible, a circuitous alignment may be desirable for recreational and scenic routes to provide access to recreational sites (such as lakes or campsites) or to provide special scenic views. The designer must realize, however, the importance of adopting adequate design standards, as given in Chapter 15. Three additional factors should be considered in the location of recreational and scenic routes:

1. Design speeds are usually low, and therefore special provisions should be made to discourage fast driving, for example, by providing a narrower lane width.
2. Location should be such that the conflict between the driver's attention on the road and the need to enjoy the scenic view is minimized. This can be achieved by providing turn-outs with wide shoulders and adequate turning space at regular intervals, or by providing only straight alignments when the view is spectacular.
3. Location should be such that minimum disruption is caused to the area.

Special guides are available for the location and design of recreational and scenic routes. The reader is referred to *A Policy on Geometric Design of Highways and Streets,* published by the American Association of State Highway and Transportation Officials, for more information on this topic.

14.1.6 Location of Highways in Urban Areas

Urban areas usually present complex conditions that must be considered in the highway location process. In addition to factors discussed under office study and reconnaissance survey, other factors that significantly influence the location of highways in urban areas include:

- Connection to local streets
- Right-of-way acquisition
- Coordination of the highway system with other transportation systems
- Adequate provisions for pedestrians

Connection to Local Streets

When the location of an expressway or urban freeway is being planned, it is important that adequate thought be given to which local streets should connect with on- and off-ramps to the expressway or freeway. The main factor to consider is the existing travel pattern in the area. The location should enhance the flow of traffic on the local streets. The techniques of traffic assignment, as discussed in Chapter 12, can be used to determine the effect of the proposed highway on the volume and traffic flow on the existing streets. The location should provide for adequate sight distances at all ramps. Ramps should not be placed at intervals that will cause confusion or increase the crash potential on the freeway or expressway.

Right-of-Way Acquisition

One factor that significantly affects the location of highways in urban areas is the cost of acquiring right of way. This cost is largely dependent on the predominant land use in the right of way of the proposed highway. Costs tend to be much higher in commercial areas, and landowners in these areas are often unwilling to give up their property for highway construction. Thus, freeways and expressways in urban areas have been placed on continuous elevated structures in order to avoid the acquisition of rights of way and the disruption of commercial and residential activities. This method of design has the advantage of minimal interference with existing land-use activities, but it is usually objected to by occupiers of adjacent land because of noise or for aesthetic reasons. The elevated structures are also very expensive to construct and therefore do not completely eliminate the problem of high costs.

Coordination of the Highway System with Other Transportation Systems

Urban planners understand the importance of a balanced transportation system and strive toward providing a fully integrated system of highways and public transportation. This integration should be taken into account during the location process of an urban highway. Several approaches have been considered, but the main objective is to provide new facilities that will increase the overall level of service of the transportation system in the urban area. In Washington, D.C., for example, park-and-ride facilities have been provided at transit stations to facilitate the use of the Metro system, and exclusive bus lanes have been used to reduce the travel time of express buses during the peak hour.

Another form of transportation system integration is the multiple use of rights of way by both highway and transit agencies. In this case, the right of way is shared between them, and bus or rail facilities are constructed either in the median or alongside the freeway. Examples include the WMATA rail system in the median of Interstate I-66 in Northern Virginia; the Congress Street and Dan Ryan Expressway in Chicago, Illinois; sections of the Bay Area Rapid Transit System in San Francisco, California; and freight rail lines in the medians of freeways, as illustrated in Figure 14.3 (page 700) for the CSX Railroad, on I-95 in Richmond, Virginia.

Adequate Provisions for Bicycles and Pedestrians

Providing adequate facilities for bicycles and pedestrians should be an important factor in deciding the location of highways, particularly for highways in urban areas. Pedestrians are an integral part of any highway system but are more numerous in urban areas than in rural areas. Bicycles are an alternate mode of transportation that can help to reduce energy use and traffic congestion.

Therefore, special attention must be given to the provision of adequate bicycle and pedestrian facilities in planning and designing urban highways. Facilities for pedestrians should include sidewalks, crosswalks, traffic-control features, curb cuts, and ramps for the handicapped. Facilities for bicycles should include wide-curb lanes, bicycle paths and shared-use paths. Design considerations for bicycles are discussed in Chapter 15. In heavily congested urban areas, the need for grade-separated facilities, such as overhead bridges and/or tunnels, may have a significant effect on the final location of the highway. Although vehicular traffic demands in urban areas are of

Figure 14.3 CSX Railroad in the median of I-195, Richmond, Virginia

SOURCE: Office of Public Affairs, Virginia Department of Transportation. Used with permission.

primary concern in deciding the location of highways in these areas, the provision of adequate bicycle and pedestrian facilities must also be of concern because they are an indispensable and vital component of the urban area.

14.1.7 Principles of Bridge Location

The basic principle for locating highway bridges is that the highway location should determine the bridge location, not the reverse. When the bridge is located first, in most cases the resulting highway alignment is not the best. The general procedure for most highways, therefore, is to first determine the best highway location and then determine the bridge site. In some cases, this will result in skewed bridges, which are more expensive to construct, or in locations where foundation problems exist. When serious problems of this nature occur, all factors such as highway alignments, construction costs of the bridge deck and its foundation, and construction costs of bridge approaches should be considered in order to determine a compromise route alignment that will give a suitable bridge site. This will include completing the transportation planning process and the economic evaluation of the benefits and costs, as discussed in Chapters 11 and 13.

A detailed report should be prepared for the bridge site selected to determine whether there are any factors that make the site unacceptable. This report should include accurate data on soil stratification, the engineering properties of each soil stratum at the location, the crushing strength of bedrock, and water levels in the channel or waterway.

When the waterway to be crossed requires a major bridge structure, however, it is necessary to first identify a narrow section of the waterway with suitable foundation conditions for the location of the bridge and then determine acceptable highway alignments that cross the waterway at that section. This will significantly reduce the cost of bridge construction in many situations.

14.2 HIGHWAY SURVEY METHODS

Highway surveys usually involve measuring and computing horizontal and vertical angles, vertical heights (elevations), and horizontal distances. The surveys are then used to prepare base maps with contour lines (that is, lines on a map connecting points that have the same elevation) and longitudinal cross-sections. Highway surveying techniques have been revolutionized due to the rapid development of electronic equipment and computers. Surveying techniques can be grouped into three general categories:

- Ground surveys
- Remote sensing
- Computer graphics

14.2.1 Ground Surveys

Ground surveys are the basic location technique for highways. The *total station* is used for measuring angles in both vertical and horizontal planes, distances, and changes in elevation through the use of trigonometric levels; the *level* is used for measuring changes in elevation only. A summary of survey equipment follows. For greater detail, refer to the surveying texts cited at the end of this chapter.

The Total Station

A total station is both an electronic theodolite and electronic distance-measuring device (EDM). The total station enables one to determine angles and distances from the instrument to other points. Angles and distances may be used to calculate the actual positions (coordinates and elevations). An example of a total station is shown in Figure 14.4a on page 702.

The standard theodolite consists of a telescope with vertical and horizontal cross hairs, a graduated arc or vernier for reading vertical angles, and a graduated circular plate for reading horizontal angles, whereas the electronic theodolite provides a digital readout of those angles. These readouts are continuous, so angles can be checked at any time. The telescope on both instruments is mounted so that it can rotate vertically about a horizontal axis. With the standard theodolite, two vertical arms support the telescope on its horizontal axis, with the graduated arc attached to one of the arms. The arms are attached to a circular plate, which can rotate horizontally with reference to the graduated circular plate, thereby providing a means for measuring horizontal angles.

Electronic Distance-Measuring Devices (EDM)

An EDM device consists mainly of a transmitter located at one end of the distance to be measured and a reflector at the other end. The transmitter sends a light beam or a