



## Location, Geometrics, and Drainage

**H**ighway location involves the acquisition of data concerning the terrain upon which the road will traverse and the economical siting of an alignment. To be considered are factors of earthwork, geologic conditions, and land use. Geometric design principles are used to establish the horizontal and vertical alignment, including consideration of the driver, the vehicle, and roadway characteristics. Design of parking and terminal facilities must be considered as they form an integral part of the total system. Since the new highway will alter existing patterns of surface and subsurface flow—and be influenced by it—careful attention to the design of drainage facilities is required.

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## CHAPTER 14



# Highway Surveys and Location

Selecting the location of a proposed highway is an important initial step in its design. The decision to select a particular location is usually based on topography, soil characteristics, environmental factors such as noise and air pollution, and economic factors. The data required for the decision process are usually obtained from different types of surveys, depending on the factors being considered. Most engineering consultants and state agencies presently involved in highway locations use computerized techniques to process the vast amounts of data that are generally handled in the decision process. These techniques include remote sensing, which uses aerial photographs for the preparation of maps, and computer graphics, which is a combination of the analysis of computer-generated data with a display on a computer monitor. In this chapter, we present a brief description of the current techniques used in highway surveys to collect and analyze the required data, and the steps involved in the procedure for locating highways. We also cover earthwork computations and mass diagrams, since an estimate of the amount of earthwork associated with any given location is required for an economic evaluation of the highway at that location. The result of the economic evaluation aids in the decision to accept or reject that location.

### 14.1 PRINCIPLES OF HIGHWAY LOCATION

The basic principle for locating highways is that roadway elements such as curvature and grade must blend with each other to produce a system that provides for the easy flow of traffic at the design capacity, while meeting design criteria and safety standards. The highway should also cause a minimal disruption to historic and archeological sites and to other land-use activities. Environmental impact studies are therefore required in most cases before a highway location is finally agreed upon.

The highway location process involves four phases:

- Office study of existing information
- Reconnaissance survey
- Preliminary location survey
- Final location survey

### 14.1.1 Office Study of Existing Information

The first phase in any highway location study is the examination of all available data of the area in which the road is to be constructed. This phase is usually carried out in the office prior to any field or photogrammetric investigation. All of the available data are collected and examined. These data can be obtained from existing engineering reports, maps, aerial photographs, and charts, which are usually available at one or more of the state's departments of transportation, agriculture, geology, hydrology, and mining. The type and amount of data collected and examined depend on the type of highway being considered, but in general, data should be obtained on the following characteristics of the area:

- Engineering, including topography, geology, climate, and traffic volumes
- Social and demographic, including land use and zoning patterns
- Environmental, including types of wildlife; location of recreational, historic, and archeological sites; and the possible effects of air, noise, and water pollution
- Economic, including unit costs for construction and the trend of agricultural, commercial, and industrial activities

Preliminary analysis of the data obtained will indicate whether any of the specific sites should be excluded from further consideration because of one or more of the above characteristics. For example, if it is found that a site of historic and archeological importance is located within an area being considered for possible route location, it may be immediately decided that any route that traverses that site should be excluded from further consideration. At the completion of this phase of the study, the engineer will be able to select general areas through which the highway can traverse.

### 14.1.2 Reconnaissance Survey

The object of this phase of the study is to identify several feasible routes, each within a band of a limited width of a few hundred feet. When rural roads are being considered, there is often little information available on maps or photographs, and therefore aerial photography is widely used to obtain the required information. Feasible routes are identified by a stereoscopic examination of the aerial photographs, taking into consideration factors such as:

- Terrain and soil conditions
- Serviceability of route to industrial and population areas
- Crossing of other transportation facilities, such as rivers, railroads, and highways
- Directness of route

Control points between the two endpoints are determined for each feasible route. For example, a unique bridge site with no alternative may be taken as a primary control point. The feasible routes identified are then plotted on photographic base maps.

### 14.1.3 Preliminary Location Survey

During this phase of the study, the positions of the feasible routes are set as closely as possible by establishing all the control points and determining preliminary vertical and horizontal alignments for each. Preliminary alignments are used to evaluate the economic and environmental feasibility of the alternative routes.

#### Economic Evaluation

Economic evaluation of each alternative route is carried out to determine the future effect of investing the resources necessary to construct the highway.

The evaluation methods described in Chapter 13 are used for this decision process. Factors usually taken into consideration include road user costs, construction costs, maintenance costs, road user benefits, and any disbenefits, which may include adverse impacts due to dislocation of families, businesses, and so forth. The results obtained from the economic evaluation of the feasible routes provide valuable information to the decision maker. For example, these results will provide information on the economic resources that will be gained or lost if a particular location is selected. This information is also used to aid the policy maker in determining whether the highway should be built, and if so, what type of highway it should be.

#### Environmental Evaluation

Construction of a highway at any location will have a significant impact on its surroundings. A highway is therefore an integral part of the local environment and must be considered as such. This environment includes plant, animal, and human communities and encompasses social, physical, natural, and man-made variables. These variables are interrelated in a manner that maintains equilibrium and sustains the lifestyle of the different communities. The construction of a highway at a given location may result in significant changes in one or more variables, which in turn may offset the equilibrium and result in significant adverse effects on the environment. This may lead to a reduction of the quality of life of the animals and/or human communities. It is therefore essential that the environmental impact of any alignment selected be fully evaluated.

Federal legislation has been enacted that sets forth the requirements of the environmental evaluation required for different types of projects. In general, the requirements call for the submission of environmental impact statements for many projects. These statements should include:

- A detailed description of alternatives
- The probable environmental impact, including the assessment of positive and negative effects
- An analysis of short-term impact as differentiated from long-term impact

- Any secondary effects, which may be in the form of changes in the patterns of social and economic activities
- Probable adverse environmental effects that cannot be avoided if the project is constructed
- Any irreversible and irretrievable resources that have been committed

In cases where an environmental impact study is required, it is conducted at this stage to determine the environmental impact of each alternative route. Such a study will determine the negative and/or positive effects the highway facility will have on the environment. For example, the construction of a freeway at grade through an urban area may result in an unacceptable noise level for the residents of the area (negative impact), or the highway facility may be located so that it provides better access to jobs and recreation centers (positive impact). Public hearings are also held at this stage to provide an opportunity for constituents to give their views on the positive and negative impacts of the proposed alternatives.

The best alternative, based on all the factors considered, is then selected as the preliminary alignment of the highway.

#### 14.1.4 Final Location Survey

The final location survey is a detailed layout of the selected route. The horizontal and vertical alignments are determined, and the positions of structures and drainage channels are located. The method used is to set out the points of intersections (PI) of the straight portions of the highway and fit a suitable horizontal curve between these. This is usually a trial-and-error process until, in the designer's opinion, the best alignment is obtained, taking both engineering and aesthetic factors into consideration. Splines and curve templates are available that can be used in this process. The *spline* is a flexible plastic guide that can be bent into different positions and is used to lay out different curvilinear alignments, from which the most suitable is selected. *Curve templates* are transparencies giving circular curves, three-center compound curves, and spiral curves of different radii and different standard scales. Figure 14.1 shows circular curve templates, and Figure 14.2 shows three-centered curve templates. The spline is used first to obtain a hand-fitted smooth curve that fits in with the requirements of grade, cross-sections, curvature, and drainage. The hand-fitted curve is then changed to a more defined curve by using the standard templates.

The availability of computer-based techniques has significantly enhanced this process since a proposed highway can be displayed on a monitor, enabling the designer to have a driver's eye view of both the horizontal and vertical alignments of the road. The designer can therefore change either or both alignments until the best alignment is achieved.

Detailed design of the vertical and horizontal alignments is then carried out to obtain both the deflection angles for horizontal curves and the cuts or fills for vertical curves and straight sections of the highway. The design of horizontal and vertical curves is presented in Chapter 15.

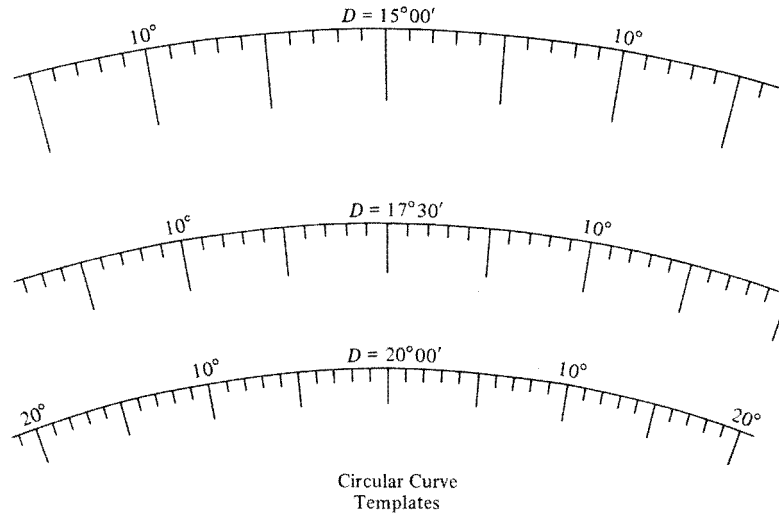


Figure 14.1 Circular Curve Templates

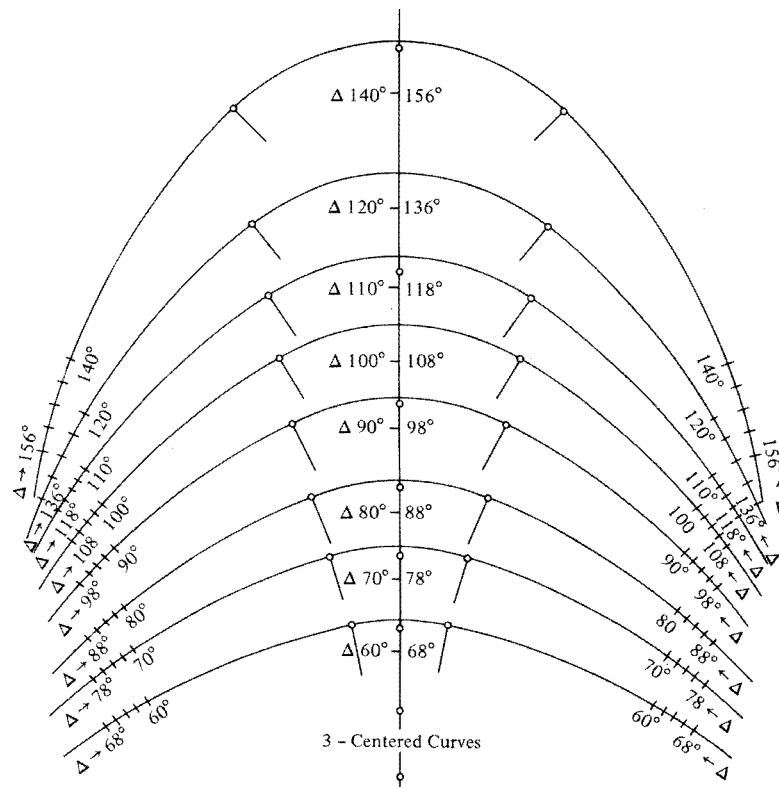


Figure 14.2 Centered Curve Templates