II. DESIGN

A. Introduction

With the "P" line plan, profile, and the groundline cross sections prepared, the designer is ready to begin the design process. As mentioned earlier, it is neither possible nor desirable to provide an all-inclusive design process in a step-by-step approach.

The procedures that will be outlined in this section will provide a skeleton structure. The designer must take the skeleton and flesh it out with his or her own expertise. The final design reflects the thinking and understanding of the designer. Triple crown winner Secretariat and a glue factory reject have the same skeletal structure.

Continuing the equine analogy, design is always a horse trading effort. The designer wants long tangents for visibility and to reduce the number of needed turnouts. At the same time, long tangents create more earthwork, do not have a minimum impact, create speed problems, etc. Steep grades gain elevation faster and can result in a shorter road and, therefore, less expense. Steep grades slow the travel speed and in some materials can create drainage and erosion problems. The designer's judgment is the only tool that can select the best design.

All of the rules, procedures, etc., that will be provided are, by necessity, generalizations. Mark Twain once wrote, "No generalization is worth a damn, including this one."

In short, using judgment as a guide, the designer must pick his or her pathway through a pasture full of rules, policies, procedures, standards, and specifications toward the best design for field situation. All of this must be done without stepping in anything.

B. Determine the Control Points*

Control points are those considerations, both natural and manmade, that put constraints or controls on the design. For example, a lake provides an obstacle that, for the forest road, forces the designer to go around rather than over. A high traffic count could force the use of two lanes.

When a point limits how much the designer can move the "P" line on the plan drawing, this is referred to as a horizontal control point. The location of a highly desirable landing would be an example.

Similarly, a point where the grade of the roadway cannot be altered is a vertical control point. The elevation at a stream crossing would be an example.

There are points that are constrained both horizontally and vertically, such as at the intersection of existing roads.

Control points result in the elimination of some of the alternatives open to the designer. This, in turn, usually forces the designer into options that increase the roadway cost. The decision making techniques to select the least cost design alternative are beyond the scope of this manual.

1. Natural control points usually involve geologic or soil materials related problems.

   a. Surface water; bogs, swamps, marshes, lakes, rivers.

   b. Subsurface; groundwater flow.

---

*Many engineers and surveyors have another definition of control points. This definition deals with precisely determined point on the surface of the earth. Such points are used to "control" other surveys.

c. Advantageous terrain; saddles, meadows or flatlands, desirable rock sources for paving materials, natural benches, ridges.

d. Soil materials; desirable stable materials, unstable materials.

2. Social or political control points are those often referred to as man-made.

a. Resource and land management; roadless area boundaries, campground or other proposed public use areas.

b. Existing facilities; roads, bridges, buildings, drainage structures.

c. Ownership; mining claims, private property, other agency public land boundaries.

d. Historical features; indian sites, logging railroad facilities, flumes.

3. Engineering considerations control the design to a large extent.

a. Traffic characteristics; type and volume.

b. Intersections with both existing and future roads.

c. Beginning and end points of the project.

d. Logging systems to be used.

The designer must spend the necessary time to identify the control points on the design. All of the available information on each control point should be collected, studied, and noted on the plans as needed.

If decisions by others need to be made concerning control point items, these decisions should also be obtained at this point in the design. The designer should stand ready to seek advice from the various specialists available as to how best handle the control points.

C. Isolate the Control Points

By carefully studying each of the control points the designer can determine a zone of the roadway over which each he or she is limited in design alternatives. These should be temporarily marked on the plan and profile. When this has been completed, the designer will find that the project has has been broken down into zones of difficult design connected by zones of comparatively easy design.

On an informal basis, the designer can determine which of the "controlled" zones is most difficult, which is next in difficulty, etc.

D. A Design Philosophy

The design philosophy that is recommended in this manual is to attack each of the difficult zones individually. Determine a workable design for that zone. The zones which contain no control points will be used to transition between the controlled zones.

In order to minimize earthwork and, therefore, excavation costs, the designer should attempt to create a "balanced section" wherever possible. A balanced section is not justified where it results in unacceptable grades or alignment.

(A balanced section is one where the amount of excavated material equals the fill embankment material plus the amount lost due to the various elements of the compaction factor.)

E. A Design Procedure

Refer to the design flow diagram as an overall guide to the following design procedure.

Taking one zone the designer is at the point in the flow chart where an assumption must be made as to whether to adjust grade or alignment. Once this assumption has been made, a more or less mechanical process follows.

ROAD DESIGN FLOW DIAGRAM