Transportation Engineering- II
Lecture 2

Phases of Highway Location Process

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

Office study of existing information

- **Data Examination (office study) -** 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 prior to any field or photogrammetric investigation.
- **Data Sources:** (National/Provincial departments - transportation, agriculture, geology, hydrology, and mining)
  - Existing engineering reports
  - Maps
  - Aerial photographs
  - Charts

Office study of existing information

- The type and amount of data collected and examined depend on the type of highway being considered
- **Area characteristics covered in data collection:**
  - 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

Office study of existing information

- **Preliminary analysis of the data**
  - 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.

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**
- Rural roads - 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

Reconnaissance Survey

- 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

Preliminary Location Survey

- During this phase of the study, the positions of the feasible routes are set as closely as possible by:
  1) Establishing all the control points
  2) 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

Preliminary Location Survey

- Factors considered in economic evaluation
  - Road user costs
  - Construction costs
  - Maintenance costs
  - Road user benefits
  - Road user dis-benefits - such as adverse impacts due to dislocation of families, businesses, and so forth.
- Results of economic evaluation of the feasible routes:
  - Provide information on the economic resources that will be gained or lost if a particular location is selected
  - Aid the policy maker in determining whether the highway should be built, and if so, what type of highway it should be

Preliminary Location Survey

- **Environmental Evaluation**
  - Highway construction at any location - significant impact on surroundings
  - A highway - an integral part of the local environment
  - **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.
  - Essential to evaluate environmental impact of alignment selected

Preliminary Location Survey

- In cases environmental impact study (EIS) is required, it is conducted at this stage to determine the environmental impact of each alternative route
- EIS will determine the negative and/or positive effects the highway facility will have on the environment
- **Example:**
  - At grade freeway construction, urban area - may result in an unacceptable noise level for the residents (negative impact)
  - 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 - provide an opportunity for constituents to give their views point
- Best alternative, based on all the factors considered, is then selected as the **preliminary alignment** of the highway.

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 of the straight portions of the highway and fit a suitable horizontal curve between these
- Best alignment is obtained using a trial-and-error process (designer's opinion) considering both engineering and aesthetic factors

Final Location Survey

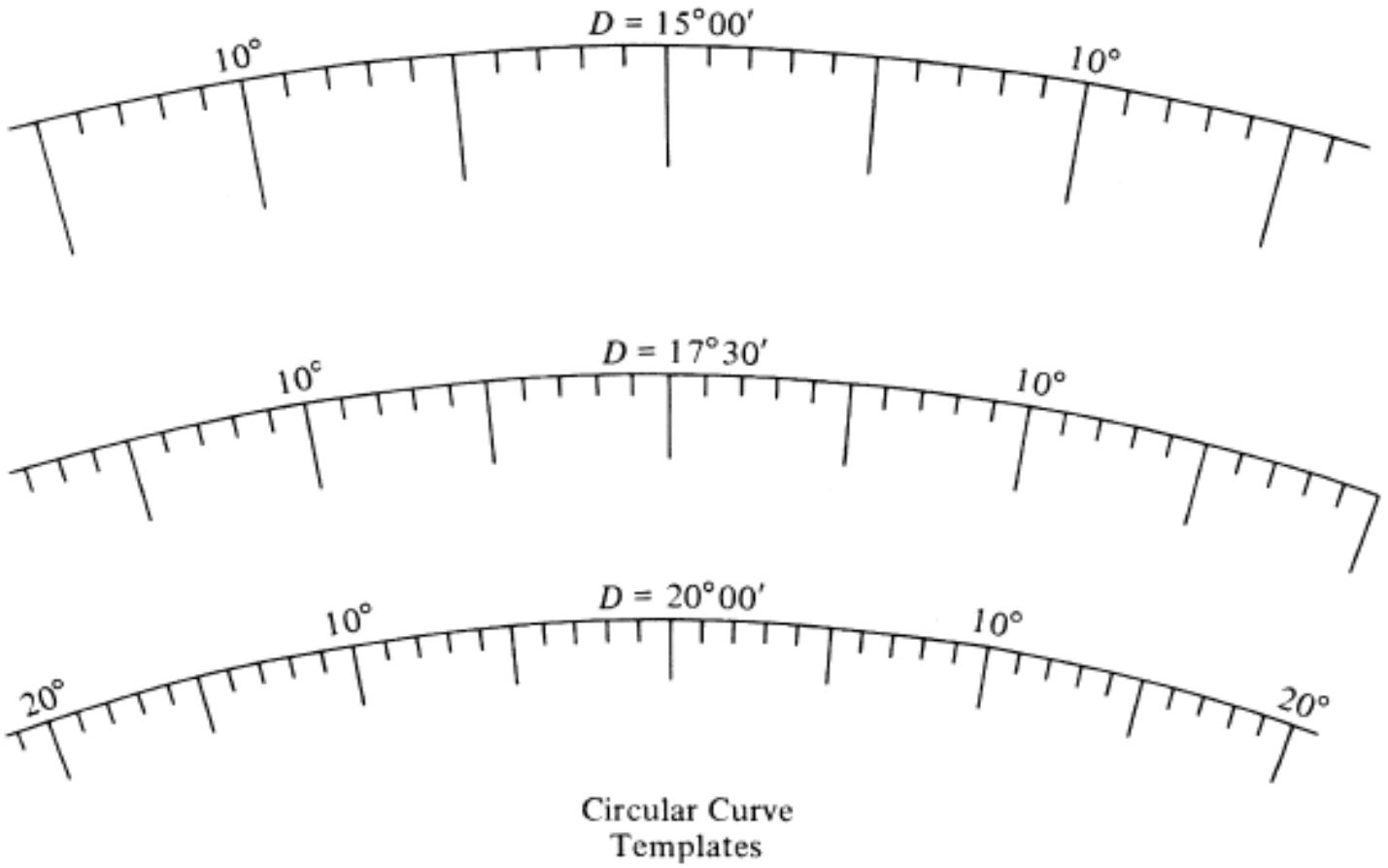

Figure 14.1 Circular Curve Templates

Final Location Survey

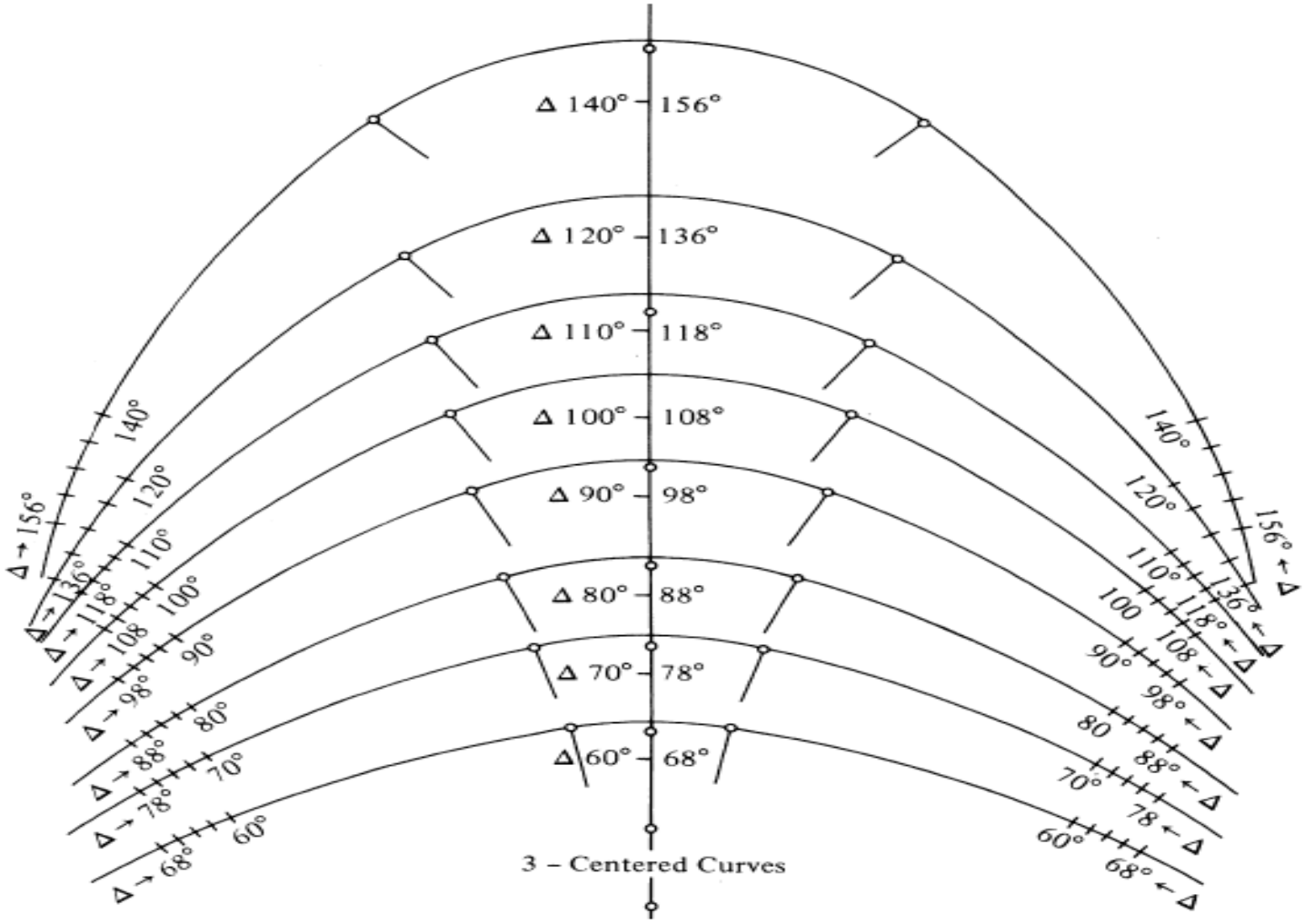

Figure 14.2 Centered Curve Templates

Highway Location in Urban Areas

- Additional factors that significantly influence the location of highways in urban areas include:

i. Connection to local streets

ii. Right-of-way acquisition

iii. Coordination of the highway system with other transportation systems

iv. Adequate provisions for pedestrians

Highway Location in Urban Areas

- **Connection to local streets-**
  - **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 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.

Highway Location in Urban Areas

- **Right-of-way acquisition**
- **Cost of acquiring right of way - significant affect on the location of highways in urban areas**
- Cost is largely dependent on the predominant land use in the right of way of the proposed highway
- Costs much higher in commercial areas
- **Elevated structures in urban areas**
  - No acquisition of rights of way
  - Minimum disruption of commercial and residential activities
  - Minimal interference with existing land-use activities
  - Noise or for aesthetic
  - Very expensive to construct - problem of high costs not eliminated completely

Highway Location in Urban Areas

- **Coordination of the Highway System with Other Transportation Systems**
- ***Urban planners strive toward providing a fully integrated system of highways and public transportation***
- ***Integration should be taken into account during the location process of an urban highway***
- Main objective is to provide new facilities that will increase the overall level of service of the transportation system in the urban area.
- Example: Park-and-ride facilities provided at transit stations to facilitate the use of the Metro system
- Multiple use of rights of way – (transportation system integration)
  - bus or rail facilities are constructed either in the median or alongside the freeway

Highway Location in Urban Areas

- **Adequate Provisions for Bicycles and Pedestrians**
  - ***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
  - Pedestrians facilities - include sidewalks, crosswalks, traffic-control features, curb cuts, and ramps for the handicapped
  - Facilities for bicycles - wide-curb lanes, bicycle paths and shared-use paths
  - ***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***

Highway Survey Methods

- ***Highway surveys - involve measuring and computing horizontal and vertical angles, vertical heights (elevations), and horizontal distances***
- Surveys are 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.
- Surveying techniques can be grouped into three general categories:
  - Ground surveys
  - Remote sensing
  - Computer graphics

Highway Survey Methods

❖ **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***
- Level is used for measuring changes in elevation only
- Major survey equipment
  - The Total Station
  - Electronic Distance-Measuring Devices (EDM)
  - Theodolite
  - Levels
  - Measuring Tapes
  - Survey Data Collectors
  - Global Positioning System Surveys

Highway Survey Methods

❖ **Remote sensing**

- Remote sensing is the measurement of distances and elevations by using devices located above the earth, such as airplanes or orbiting satellites *using GPS*
- The most commonly used remote-sensing method is photogrammetry, which utilizes *aerial photography*
- Photogrammetry is the science of obtaining accurate and reliable information through measurements and interpretation of photographs, displaying this information in digital form and/or map form
- Fast and economical process for large projects but can be very expensive for small projects

Highway Survey Methods

❖ **Remote sensing**

- The successful use of the method depends on the type of terrain. Difficulties will arise when it is used for terrain with the following characteristics
  - Areas of thick forest, such as tropical rain forests, that completely cover the ground surface
  - Areas that contain deep canyons or tall buildings, which may conceal the ground surface on the photographs
  - Areas that photograph as uniform shades, such as plains and some deserts
- Common uses of photogrammetry in highway engineering :
  - Identification of suitable locations for highways corridor study
  - Preparation of base maps for design mapping, showing all physical and man-made features plus contours of 2- or 5-ft intervals

Grand Canyon National Park - USA

Highway Earthwork and Final Plan

- The final element in the location process - to establish the horizontal and vertical alignments of the highway project and to prepare highway plans and specifications for estimating project costs and preparation of bids by contractors
- *Terrain significantly influences the cost to transport earthen materials that will be used to construct the roadbed*
- The final result of the location process is a highway plan used in estimating quantities and computing the overall project cost

Highway Grades and Terrain

- One factor that significantly influences the selection of a highway location is the terrain of the land, which in turn affects the laying of the grade line
- The primary factor that the designer considers on laying the grade line is the amount of earthwork that will be necessary for the selected grade line
- ***One method to reduce the amount of earthwork is to set the grade line as closely as possible to the natural ground level***
- *This is not always possible, especially in undulating or hilly terrain*
- *The least overall cost also may be obtained if the grade line is set such that there is a balance between the excavated volume and the volume of embankment*

Highway Grades and Terrain

- Another factor that should be considered in laying the grade line is the existence of fixed points, such as railway crossings, intersections with other highways, and in some cases existing bridges, which require that the grade be set to meet them.
- When the route traverses flat or swampy areas, the *grade line must be set high enough above the water level* to facilitate proper drainage and to provide adequate cover to the natural soil
- The height of the grade line is usually dictated by the expected floodwater level
- Grade lines should also be set such that the minimum sight distance requirements are obtained
- ***Highway grade should be established that minimizes earth moving and maximizes the use of native soil***


Q
A
Answer