Design Controls & Criteria

Instructor: Dr. Nedal Ratrout

Design Criteria

- DESIGN VEHICLE
  - Turning Radii
- DRIVER PERFORMANCE
  - Guidance Task
  - Information System
  - Driver Error
  - Speed and Design
  - Design assessment
- TRAFFIC CHARACTERISTICS
  - Volume
  - Speed

Driver Error

- A common characteristic of many high accident locations is that they place large or unusual demands on the information processing capabilities of drivers
- At locations when the design is deficient , the possibility of error and inappropriate driver performance increases

Error Due To Driver Deficiencies

- Driver's deficiencies in capabilities and/or temporary states in conjunction with inadequate design or difficult situation usually create failure (accidents) (such as recovering from skid, gap acceptance while passing, poor glare recovery)

- Psycho physiological states such as:
  - Alcohol & Drugs.
  - Fatigue due to sleep deprivation.
  - Long driving without rest.
  - Prolong exposure to mountains area.

How to Overcome Driver's Deficiencies

- Assess al stnd to determine the feasibility of designing for the 85th or 99th percentile driver
- Improve sight distance
- Assess sight triangles for adequacy
- Provide decision sight distances
- Simplify intersections and interchanges
- Consider alternate design to reduce conflicts
- Provide protected movements particularly left turns
- Eliminate yield situation.

Speed and Design

- Speed reduces the visual field, restricts peripheral vision, and limits the time available to receive and process information.
- High road standards gives the drivers clear path, obstruction free and clear roadside.
- On the other side driving at night on highways may lead to reduced forward vision because of glare which will lead to insufficient time for drivers respond and severe accidents.

Speed and Design

- Extended long high speed driving on highways with low demand for info processing may not always be proper since it may cause fatigue to driver.

- Therefore
  - Long, flat and tangent sections should be avoided.
  - Follow the natural contours of the terrain whenever possible and allow smooth curves and alignments.
  - Well space rest areas

Design assessment

- Study the interaction between the driver and the road design.
- Design should be assessed in the sense of
  - Is the drivers unfamiliar with the highway and visualize how the segment will appear to them and what effect it will have on their performance
  - Consideration should be given to the visual quality of the road
  - Locations of information, identify overloaded and under loaded segments
  - Unusual vehicle maneuvers is expected

TRAFFIC CHARACTERISTICS
Volume

- Traffic indicates the need for the improvements and directly affects the geometric features of design, such as width, alignments and grades.
- Traffic volume collected by state or local agencies includes the traffic volume for days of the year and times of the day, as well as the distribution of vehicles by types and weights. The info also includes the trend of the future growth which the designer has to consider
- Data such as
  - Average daily traffic (ADT)
  - Peak Hour Traffic
  - Directional distribution
  - Composition of traffic
  - Future projection of traffic demands
  - Speed (operating, design and running speeds)
  - Traffic flow relationship.

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Volume
Average daily traffic (ADT)

- Average daily traffic (ADT) is the total volume during a given time period (in whole days) grater than one day and less than one year divided by the number of the days in that time period.
- It affects the structure of the road
- It shouldn’t be used to design for geometric since it doesn't give the variations of traffic occurring during the various months of the year, days , hours
- The design should be done on the average daily traffic on a normal day (which could be exceeded on certain days in the year)

Volume
Peak Hour Traffic

- Traffic volumes should be represented in time shorter than one day (usually 1 hour interval) to reflect a better operating conditions that should be used for design.

- The hourly traffic volume shouldn't be exceeded very often or by very much, and shouldn't be so high that would rarely be great enough to make full use of the resulting facility.
- For Highway design, the variation in hourly traffic volumes should be measured and the % of ADT during the 30^{th} highest hour determined (Fig II-20).

- The 30^{th} highest hour (30 HV) is the common criteria in design with exception on rural or urban highway / roads with high traffic variations or seasonal traffic where other considerations have to be considered in the design.

Volume
Directional distribution

- For tow –lane rural highway , the DHV is the total traffic in both directions of travel.
- On highways with more than two lanes, knowledge of the hourly traffic volume in each direction of travel is essential for design.
- For the same ADT a multilane highway with a high % of traffic in one direction during the peak hours may require more lanes than a highway having the same ADT but with a lesser %. (see example page 58)
- The directional distribution of traffic DDHV = (30 HV %) * (DD of that hour) * (ADT)

Volume
Composition of traffic

- Trucks are slower and occupy more roadway space and consequently impose greater traffic effect on highway more than passenger vehicles do.
- Trucks is often equivalent to several passenger cars. The number of equivalent passenger cars is dependent on the gradient and the passing sight distance available.
- For design purposes the % of busses and trucks of the total traffic during the peak hour should be known.

Volume

Future projection of traffic demands

- New highways or improvement should not be based on current traffic volume alone, but consideration should be given to the future traffic expected.
- It is difficult to define the life of a highway since major segments have different length of physical life, depending on the land use, traffic, ROW etc.
- For example ROW and grading if considered may have a physical life expectancy of 10 years. Minor drainage and base courses 50 years. Bridges 25 to 100 years and surfacing 10 to 30 years. (all assuming frequent maintenance).

Volume
Future projection of traffic demands

- It is a critical question whether design should be based on life expectancy where economics is greatly involved. A highway might be designed for traffic 50 years with surfacing restoration in 25 years. However most highways can accommodate higher traffic volume than the design volumes with some inconvenience such as reduction is speed.

- In practical sense, Many highway engineers believe the max period is in the range of 20 to 24 years. A period of 25 years is widely used as a basis for the design

Volume

Speed (operating, design and running speeds)

- Speed (mirror to economy of the road) depends on:
  - Capabilities of the driver and vehicle
  - Physical characteristics of the highway and road sides
  - Weather
  - Presence of other vehicle
  - Speed limitations due o legal issues or control devices.

Volume

Operating Speed

- Operating speed is the highest overall speed at which driver can travel on a given highway under favorable weather condition and under prevailing traffic conditions without at any time exceeding the safe speed as determined by the design speed on a section-by-section basis.

Volume

Design Speed

- Design speed is the maximum safe speed that can be maintained over a specified section of highway when conditions are so favorable that the design features of the highway govern.

- A logical design speed should be assumed with respect to adjacent land use, topography and the functional classification of the highway.

Volume

Design Speed

- Every effort should be made to select the highest design speed as possible to attain a desired degree of safety, mobility and efficiency while being under constrains such as environmental quality, economics, aesthetics and social and political impacts.

- A highway with a higher functional classification may justify a higher design speed than a less important facility in a similar topography.

Volume

Design Speed

- Once selected all the pertinent features of the highway should be related to the design speed. Above-minimum design values should be used where feasible.

- Features such as curvature, super elevation and sight distance are directly related to speed while width of lanes, shoulders walls and rails clearance are not directly related to speed. but they affect vehicle speed.

Volume

Design Speed

- The speed distribution fit an S curve (fig II-21) The design speed chosen should be a high percentile value in this speed curve. 110 – 120 km/h is a desirable design speed on freeways, expressways and other major highways. Since larger percent of the vehicles traveling at the faster speeds will be safely accommodated.

- 80 km/h speed limit has proven it satisfactory on certain highways while the speed limit is enforced during off-peak hours.

Volume

Design Speed

- Changes in terrain and other physical controls may dictate a change in design speed on certain sections. The introduction of a lower speed should be done abruptly but should be effected over sufficient distance to permit drivers to change speed gradually.
- On arterial streets, design speed controls applies to a lesser degree than on higher-type highway since the speed on arterial streets is governed by the presence of other vehicles traveling in and across lanes and by traffic controls devices rather than the geometric of the street.. Speed is governed on arterial streets by speed limit, mid block turns, intersectional turns, traffic signal etc.
- horizontal alignment on arterial streets is not the governing factor in restricting the design speed. Minor changes to the horizontal alignment is commonly done at intersections.
- Super elevation may be provided at curves on arterial streets but in different manner than for open roads.

Volume

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Volume

Design Speed

- Super elevation is affected by cross slope, cross streets, drainage adjacent development.
- Topography affects the selection of the design speed on arterial streets.
- Arterial streets should be designed and control device regulated, where feasible, to permit running speed of 30 to 70 km/h. Lower speeds in this range are applicable for local and collector streets through residential areas and for the arterial streets through more crowded business areas, while higher speed supply to the high type arterials in the outlying suburban areas.
- With a running speeds of 30 to 70 km/h, it follows that pertinent design speeds for arterial streets and highways would range from 50 to 100 km/h

Volume

Running Speed

- The running speed is the speed of a vehicle over a specified section of a highway. Being the distance traveled divided by the running time (the time the vehicle is in motion).

- The average spot speed is the arithmetic mean of the speeds of all traffic at a specified point. (Spot speed can be used as the average running speed).

Volume

Running Speed

- From years of observations it is concluded that the observed average running speed is 90-95 % of the design speed. (under low volume conditions)
- A design that satisfies the requirements for the average running speed at a low volume is adequate for traffic using the highway when the volumes are higher and the speeds are lower.

Thank You