Section 1

DESIGN CONTROLS AND CRITERIA

Roadway Design Resources

MoDOT Resources for Roadway Design:

- Roadway Geometric Design Notes (For you to keep)
- Engineering Policy Guide (Searchable Electronic Document)

  http://epg.modot.org
- Design Standard Plans for Highway Construction (Std. Drawings)

MoDOT Standard Plans for Highway Construction

Standard Drawings show details on how to construct certain work items. Last hard copy of the standard plans issued was in July 2004. These Plans are also available electronically and are located in PW. Plans are in Microstation format and they're placed in folders according to effective date.

pwname://MoDOT/Documents/CADD_Standards/Standard Plans for Highway Construction/

Roadway Design Resources

OTHER NON-MODOT RESOURCES

- AASHTO's A Policy on Geometric Design of Highways and Streets (a.k.a The Green Book)
- AASHTO's Roadside Guide Design Manual
- Highway Capacity Manual
- The Manual on Uniform Traffic Control Devices
- Other AASHTO, and FHWA publications
- Other publications on specific topics.

Definitions: Traffic/Design Terms

Volume

AADT or Annual Average Daily Traffic is the number of cars that travel a road in a 24-hr consecutive period averaged over 365 days.

Peak-Hour Traffic **–** traffic volume collected in a time shorter than one day (e.g. rush hour volume). Peak-hour traffic is used to determine the design hourly volume (DHV), which is often expressed as a percentage of the AADT.

•New roadway projects should not be based on the current traffic volumes, instead a design volume of a distant future should be obtained.

•Future traffic volumes are hard to accurately be predicted. Through years of research, highway engineers have found that a maximum design period is in the range of 15-24 years.

•At MoDOT we use a 20-year design volume for new construction. According to AASHTO, for reconstruction/rehabilitation projects, a period of 5-10 years may be chosen. 3R projects use a 10-yr design volume. 3R stands for resurfacing, restoration, and rehabilitation.

Definitions: Traffic/Design Terms

Traffic Composition

Truck traffic volume is collected and determined in percentages to be used in the design.

For this purpose, trucks are normally defined as those vehicles having a gross vehicle weight (GVW) of 9,000 lbs and having dual tires on at least one rear axle

Speed

Design Speed – is used as a parameter in the design. This is the maximum safe speed that can be maintained on a section of roadway for specific design features.

Definitions: Traffic/Design Terms

Design Vehicle

The design vehicle characteristics are used to establish roadway design controls. This vehicle represents the weight, dimensions and operation characteristics for what the roadway is designed.

Classification of Design Vehicles

- Passenger cars – cars, suv's, mini-vans and vans, and pickup trucks
- Buses – inter-city (motor coaches), city transit, and school buses.
- Trucks – single unit trucks and tractor semi-trailer combinations.
- Recreational vehicles

AASHTO Green Book Exhibit 2-1 shows design vehicle dimensions and Exhibit 2-2 shows minimum turning radii. Exhibits 2-3 through 2-23 show the minimum turning path for the various different design vehicles.

Definitions: Traffic/Design Terms

Vehicle Performance and Pollution

Acceleration/deceleration rates are a measure of vehicle performance and are important factors for proper design of ramps, climbing/passing lanes, and turnout bays for buses.

Vehicular pollution refers to air pollution from car emissions as well as noise pollution.

Definitions: Traffic/Design Terms

How do drivers interact with the highway and information system presented to them?

The Driving Task

This consists of a series of actions required to complete the journey. The task is based on many inter-related activities, which are classified as follow:

- Control – steering, speed control, shifting, etc.
- Guidance – following road signs
- Navigation – trip planning in general, looking at a map, etc.

Designers should keep designs simple and provide continuity in their roadway design to make it easier on the driver to complete the driving task.

Definitions: Traffic/Design Terms

The Driver and the Information System

Drivers handle information through a short and complex process. This process happens in a short amount of time (reaction time) and includes three steps:

- Acknowledgment – recognize a situation exists
- Decision making – what should I do?
- Reaction – taking action

Definitions: Traffic/Design Terms

Reaction Time

Time it takes a driver to react to a situation, and it increases depending on the complexity of the situation and amount of information processed.

The longer the reaction time, the greater the chance for error.

For expected situation, average reaction times range from 0.6 sec up to 2 sec. However, for unexpected events, the reaction time increases up to 35%, taking 2.6 sec or more time for simple decision-making and action.

How do drivers react to different situations?

Drivers react to situations based on the concepts of primacy and expectancy. Primacy refers to “how important is to my safety to respond”, and expectancy refers to continuity or familiarity of the roadway.

Definitions: Traffic/Design Terms

Driver Error

There are two types of driver errors:

- Due to situation demands – careful planning and design can prevent these types of errors.
- Due to driver deficiencies – lack of driver experience, influence of alcohol and drugs, and advancing age.

Highway Capacity

Highway Capacity Manual (HCM)

The HCM is used to determine or assess roadway capacities. Highway capacity is the maximum hourly rate at which vehicles can reasonably travel a particular section of roadway during a given time under normal roadway and traffic conditions.

Always consult with district traffic studies engineers when assessing roadway capacities.

Levels of Service (LOS)

Levels of service is a subjective way to define the roadway capacity.

A – Free flow

B – Reasonable free flow

C – Stable flow

D – Approaching unstable flow

E – Unstable flow

F – Forced or breakdown flow

Facility Selection

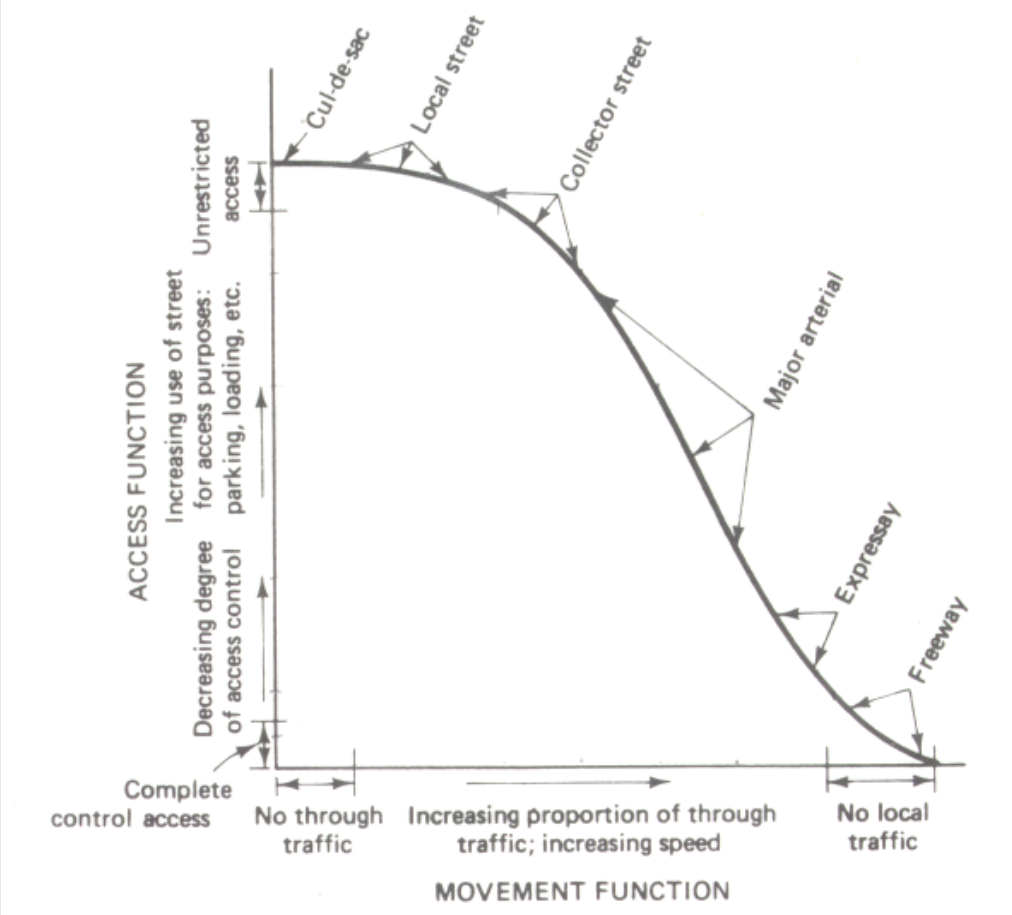
EPG Category: 232

Mobility vs. Access?

Roadways are classified based on travel mobility and access to property.

The faster traffic moves, the less access it has to adjacent property.

Roadway classification determines the type of criteria used for the design.



Facility Selection

EPG Category: 232

The Rural Roadway System consists of:

- Rural Principal Arterials – freeways and other principal arterials, which provide relatively high travel speed. These roads carry state and interstate traffic, and movements between urban areas. Examples: interstate highways, and some US routes.

- Rural Minor Arterials – provide linkage for cities or larger towns, integrated interstate and intercounty travel.

- Rural Collectors – primarily carries intracounty traffic rather than statewide.

- Rural Local Roads – include all rural roads not classified as any of the above. These roads provide direct access to adjacent property.

Facility Selection

EPG Category: 232

The Urban Roadway System consists of:

- Urban Principal Arterials – freeways and other principal arterials, which provide relatively high travel speed. These roads carry movements entering and exiting urban areas or movements bypassing the central city.
- Urban Minor Arterials – arterials not classified as principal. This system provides intra-community travel and may include bus routes. This system does not enter neighborhoods.
- Urban Collectors – provide both land access and traffic circulation within neighborhoods, commercial and industrial areas, and it also carry local bus routes.
- Urban Local Roads – provide direct access to adjacent property and has the lowest level of mobility. These roads do not carry bus routes.

Facility Selection

EPG Category: 232

MoDOT Roadway Classification:

- Major Highways – Principal Arterials (and above) in the state, which include all NHS routes and Interstaste as well as some other routes which are not on the NHS.
- Non-Major Highways – All minor arterials (and below).

Facility Selection

EPG Category: 232

Primary Design Guidance:

Roadway design will be based on the following criteria:

1. Design Speed = Posted Speed
2. Level of Service
   - Rural – 20 yr peak hourly traffic at LOS D and off-peak at LOS C
   - Urban - 20 yr peak hourly traffic at LOS E and off-peak at LOS D
3. System Continuity
4. Access vs. Mobility
5. Expressway vs. Freeway
6. Two Way Left Turn Lanes
7. Passing Lanes

Section Elements for Roadway

EPG Category: 231

Lane Widths

- Major Roadways = 12 ft wide
- Minor Roadways = 10 –12 ft wide
- Auxiliary lanes are to be as wide as the through-traffic lanes.
- For very low volume local/collector roads and streets carrying < 400 veh/day, use guidance in the AASHTO Green Book section for Geometric Design of Very Low Volume Local Roads.

Section Elements for Roadway

EPG Category: 231

Shoulder Widths

- Never eliminate shoulders altogether. Motorists expect them.
- Shoulders on major roadways = 4-10 ft wide.
- Shoulders on rural minor roadways = 2-4 ft wide.
- Shoulders will not be provided on urban roads with no access control if ample turning opportunities exist for a vehicle to leave the roadway. (No U2 paved shoulders).
- An earthen shoulder will be provided behind a mountable curb.

Section Elements for Roadway

EPG Category: 231

Median Widths

- 60-ft depressed median is preferred for expressways and freeways.
- Narrower than 60-ft median may be used with a barrier on expressways and freeways.

Section Elements for Roadway

EPG Category: 231

Side Slopes

- In-slopes should be designed based on the geotechnical report recommendations as well as the AASHTO Roadside Design Guide to meet a safe clear zone.
- Backslope grade should be designed based on the geotechnical report recommendations including benching design. When good quality rock is present, you can use a 1:1 backslope from the back of the ditch to establish theoretical slope limits for determining R/W limits.

Section Elements for Roadway

EPG Category: 231

Roadside Ditches

- The purpose of a ditch is to provide adequate drainage for the design storm event and also to prevent seepage under the pavement through a permeable base.
- The geometry selected for ditches are based on hydraulic capacity. Keep the side slope requirements based on clear zone principles and/or soil conditions.
- When using pavement edge drains, make sure the ditch is of sufficient depth.
- Min. ditch grades are based on the drainage velocities needed to avoid sedimentation as max. ditch grades are based on a tolerable velocity for vegetation and shear on soil types.
- Use the appropriate erosion control methods to reduce or withstand the flow velocity.

Access Management

EPG Category: 940

Control Access vs. Access Management

Control access refers to simply regulating access while access management is the proper planning and design of access to the public roadway system that helps ensure traffic flow more smoothly and with fewer crashes.

Access Management

EPG Category: 940

Why should we control access

Roadways with full access control consistently experience much lower crash rates than those without any access control.

To achieve an acceptable access management design, one should:

- Limit direct access to roads with higher functional classifications.
- Locate traffic signals to emphasize through traffic movements.
- Locate driveways and major entrances to minimize interference with traffic operations.
- Use curbed medians and locate median openings to manage access movements and minimize conflicts.

Pedestrian Facilities

EPG Category: 642

Resources for design of pedestrian traffic:

- Engineering Policy Guide
- *The American with Disabilities Act Accessibility Guidelines (ADAAG)*
- *AASHTO Guide for the Planning, Design, and Operation of Pedestrian Facilities.*
- *FHWA Publications.*
- Technical assistance available on case-by-case from the MoDOT's Non-Motorized Transportation Engineer.

Pedestrian Facilities

EPG Category: 642

When do we provide sidewalks?

- The local jurisdiction has a comprehensive pedestrian policy in the area of proposed improvement.
- There is public support through local planning organizations.
- There is evidence of pedestrian traffic along proposed improvement.
- Pedestrian traffic generators are located near the proposed project.
- The route provides access across a natural or man-made barrier.
- Existing sidewalks are disturbed by construction.

Pedestrian Facilities

EPG Category: 642

MoDOT Sidewalk Design Criteria:

- In developed areas, separate the sidewalks from the traveled way (barrier curb).
- No sidewalks on paved shoulders behind mountable curbs.
- Provide paved shoulders in rural areas to accommodate pedestrian movements.
- Designated sidewalks or pedestrian paths must accessible according to ADA guidelines.
- Min. width = 5ft and min. depth = 4 in thick. (Okay to reduce min. width = 4 ft, which is the min. allowed by ADA guidelines).

Pedestrian Facilities

EPG Category: 642

Walking Speeds

Average speeds for pedestrians range from 2.5-6 ft/sec. The MUTCD uses an average of 4 ft/sec as a design control.

Some intersection guidelines include:

- Design should provide adequate storage area for those waiting to cross intersection.
- Crosswalks should be wide enough to accommodate pedestrian flow in both directions within the duration of the pedestrian signal phase.
- Avoid designing extremely wide streets as this provides too long of a pedestrian crosswalk.
- If wide street intersection is unavoidable, provide islands or medians at which the pedestrians can safely await to continue crossing the intersection.

Pedestrian Facilities

EPG Category: 642

Some intersection guidelines include:

- Eliminate left and/or right turns
- Prohibit right turn on red
- Convert from two-way to one-way street operation
- Provide separate signal phases for pedestrians
- Provide for pedestrian separations

Bicycle Facilities

EPG Category: 641

When do we provide bicycle facilities?

- Design and installation of bicycle facilities is at the sole discretion of the director or the district engineer.
- All decisions regarding bicycle facilities must be properly documented.
- Dedicated Bicycle facilities WILL NOT be provided on interstate roadways.
- If local jurisdiction is willing to assume the cost of the bicycle facility and R/W associated with it, the design should consider inclusion of bicycle lanes.
- Existing bicycle facilities disturbed by any MoDOT improvement will be replaced at MoDOT's expense.

Right-of-Way

EPG Category: 236

R/W Considerations

R/W is classified according to the type of access given to a roadway. The R/W type related to access control and the limits of such control is indicated on the plans and on the title sheet by proper legend.

Minimum R/W width

- Acquire only the minimum R/W width needed to build and maintain the facility.
- Attempt to minimize breaks in R/W line.
- Take into account utilities corridors, easements, future improvements, and maintenance of the facility.

Right-of-Way

EPG Category: 236

Types of R/W

Normal – Allows entrances to the road wherever necessary to access a property.

Controlled access – (limited access) Limits the points of access to specific locations, types and dimensions.

Fully controlled access – Allows access only at interchanges thru extensive outer or service roadways.

Partial controlled access – Controls access at intersections at all state roads and side roads which intersect a state route carrying an ADT>1700

No R/W access – Prohibits access to side roads near the interchanges.

Right-of-Way

EPG Category: 236

R/W Takings

R/W takings are based on the survey baseline. This survey centerline or baseline may not necessarily be in the "center" of the roadway pavement.

NEVER move a survey baseline that surveyors pick up.

EPG Category 235: Preliminary Plans

235.2 The district prepares preliminary plans. The preliminary plan is prepared once horizontal and vertical alignment and tentative right of way limits have been established. Where the horizontal alignment is to tie into existing roadways or alignments, the tie location is be based on field survey measures and verifications.

EPG Category 238: Surveying Activities

238.3.1 A survey is made to physically establish a location in the field. It includes the location of all man-made features in relation to the established roadway centerline in such a manner that these features can be accurately indicated on the plans. The survey also includes elevations based on National Geodetic Survey (NGS) or United States Geodetic Survey (USGS) datum necessary to locate grades, culverts, bridges, and to compute excavation quantities.

238.3.6 Before beginning a survey, the district survey party chief is furnished a copy of the location study. They are become familiar with the type of proposed improvement, the plan for improving or relocating intersections, the location and type of interchanges, and all other information necessary to complete the survey.