Designing for Bicyclist Safety
Module B

DESIGNING ON-ROAD BIKEWAYS
LEARNING OUTCOMES

- Describe features of on-road bikeways
- Select design criteria for on-road bikeways in various contexts
**BICYCLE CHARACTERISTICS**

- **Height**
  - Handlebar - 36-44 in
  - Eye - 60 in
  - Operating - 100 in

- **Width**
  - Physical – 30 in
  - Minimum operating – 48 in
  - Preferred operating – 60 in
OLDER BIKEWAY TYPES

- “Bike Route”
- “Bike Path”

Neither term is clear

They are all *bikeways*
BIKEWAY NETWORK

- Just like roads and sidewalks, bikeways need to be part of an connected network
- Combine various types, including on and off-street facilities
Designing On-Road Bikeways

SHARED ROADWAY
Most common—roads as they are
Appropriate on low-volume or low-speed
85% or more of a well-connected grid
**SHARED LANES**

- Unless prohibited, all roads have shared lanes
- No special features for:
  - Minor roads
  - Low volumes (< 1000 vpd)
  - Speeds vary (urban v. rural)
SHARED LANES

- Supplemental features
  - Pavement markings or “sharrows”
  - Detectors & signal timing
Lateral position
Connect gaps in bike lanes
Roadway too narrow for passing
Position in intersections & transitions
SHARED ROAD SIGNS

- Ride side-by-side?
- Chase bicyclist?
- Warning or regulation?
- Opposite forces?

...and who “shares”?

New Orleans, LA

Philadelphia, PA

California
Reminder for motorists
PASSING SIGNS

- TCD’s not meant to be educational
- Limit to areas with identified problem
Low speed/low volume
Up to 25 mph for LTS 1

Corvallis, Oregon
Increased speed or volume, increased LTS

LTS 4
Rural back roads
Designing On-Road Bikeways

PAVED SHOULDERS
PAVED SHOULDERS

- Useful for higher traffic volume and/or speed
- Frequently used for rural
- Uphill direction
- Not a travel lane – intersection conflicts
- Rumble strips
- Maintenance
SHOULDER BIKEWAY

Use AASHTO *shoulder* standards
For bicycles: 4 ft minimum, 6 ft desirable
No special markings

Min: 5' against curb, parking or barrier, 4' on open shoulder
Travel lane dimensions per relevant standards
## Shoulder Bikeway

<table>
<thead>
<tr>
<th>Functional classification</th>
<th>Volume (AADT)</th>
<th>Speed (Mi/h)</th>
<th>Recommended Minimum Paved Shoulder Width</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minor Collector</td>
<td>up to 1,100</td>
<td>35 (55 km/h)</td>
<td>5 ft (1.5 m)</td>
</tr>
<tr>
<td>Major Collector</td>
<td>up to 2,600</td>
<td>45 (70 km/h)</td>
<td>6.5 ft (2.0 m)</td>
</tr>
<tr>
<td>Minor Arterial</td>
<td>up to 6,000</td>
<td>55 (90 km/h)</td>
<td>7 ft (2.1 m)</td>
</tr>
<tr>
<td>Principal Arterial</td>
<td>up to 8,500</td>
<td>65 (100 km/h)</td>
<td>8 ft (2.4 m)</td>
</tr>
</tbody>
</table>
RUMBLE STRIPS

- Safety countermeasure for motor vehicle ROTR crashes
- Can render shoulder unrideable
RUMBLE STRIPS

- Minimum clear path
  - 4 feet
  - 5 feet adjacent to curb
- Periodic gaps
  - Minimum length 12 feet
  - Interval 40 – 60 feet
- Gaps at intersections
  - 10 – 20 feet prior to cross-street or driveway
- Bicycle tolerable (?) rumble strips
Designing On-Road Bikeways
BIKE LANE DEFINED

Portion of the roadway or shoulder designated for exclusive or preferential use by people riding bicycles
ADVANTAGES

- Low stress on wide/low speed streets
- Access to major destinations
- Mobility on arterials
- Guide bicyclist behavior
- Improve visibility
ADVANTAGES

- Travel at bicyclist’s pace
Advantages

- Guide cyclists behavior
  - Visible
  - Predictable
ADVANTAGES

- Reduce pedestrian conflicts
- Improve visibility at driveway conflicts
Riders at sites with sidewalks & no bike lanes

Effect on Rider Choice

- Riders on sidewalk against traffic: 34%
- Riders on sidewalk with traffic: 25%
- Riders on road with traffic: 39%
- Riders on road against traffic: 1%

Total sw riders: 64%
## Relative Danger Index

<table>
<thead>
<tr>
<th>Facility</th>
<th>Relative Danger Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major Streets w/out bike lanes</td>
<td>1.28</td>
</tr>
<tr>
<td>Minor Streets w/out bike lanes</td>
<td>1.04</td>
</tr>
<tr>
<td>Streets with bike lanes</td>
<td>0.5</td>
</tr>
<tr>
<td>Mixed-use paths</td>
<td>0.67</td>
</tr>
<tr>
<td>Sidewalks</td>
<td>5.32</td>
</tr>
</tbody>
</table>

1.00 = median

* Typical shared roadway
DISADVANTAGES

- LTS 3 or 4 on arterials
- Often too narrow
- Removal of parking
BIKE LINES

- Urban thoroughfares
- Efficient cross-town travel
- Stop or signal control
- Little point on local streets
BIKE LANES

- Preferred in urban/suburban
- Rural for high demand for bicycle travel
- Preferential space for bicyclists delineated
- Bicyclists may leave lane
  + Passing
  + Turning
  + Avoid debris
  + Avoid buses
- Priority for uphill
BIKE LANE WIDTH

Desirable: 7 feet
AASHTO Guide minimum: 5 Feet
BIKE LANE WIDTH

Normal Solid White Line

5 ft\(^c\) (1.5 m) Bike Lane

Travel Lanes

4 ft min. (1.2 m) Bike Lane

Parking Prohibited
1. Desired width: 6 feet

2. Wherever possible, minimize parking lane width in favor of increased bike lane width.

6-8 inch solid white line

4 inch solid white line

11. Separation between bike lane striping and parking boundary reduces risk of door zone conflicts.

10. BIKE LANE

MUTCD R2-17
GUTTER PAN

- 4 ft preferred
- 3 ft minimum
Buffered Bike Lane

- Shy distance
- Bike passing
- Door zone
- Wider w/out confusing motorists
- More comfortable
BUFFERED BIKE LANE

1. The buffer shall be marked with 2 solid white lines. Minimum buffer width: 18 inches.

2. The combined width of the buffer(s) and bike lane should be considered "bicycle width" with respect to other guidance.

3. The buffer area shall have interior diagonal cross hatchings or chevron markings if 3 feet in width or wider.

4. Desired minimum next to on street parking: 5 feet.

5. Separation may also be provided between bike lane striping and the parking boundary to reduce door zone conflicts.
WIDE BIKE LANE/LOW SPEED

LTS 1
BUFFERED BIKE LANE

LTS 1
5 FT BIKE LANE/30 MPH

LTS 2
5 FT BIKE LANE/35 MPH

LTS 3
5 FT BIKE LANE/40 MPH

LTS 4
PAVEMENT MARKING & SIGNING

- Longitudinal marking required
  - Solid white line between bikes & motor vehicles
  - Line recommended between bikes & parking
- Symbols at beginning & interval
- Signs
Both sides preferred
Avoid premature wear
SIGNING

- Beginning, end, & interval
- Optional
SIGNING

BIKE LANE
AHEAD

BIKE LANE
ENDS

R3-17aP

R3-17bP
NO PARKING
BIKE LANE
R7-9

BIKE LANE
R7-9a
CONTRA-FLOW BIKE LANE

Reasons for:
- Continuity on one-way
- Avoid conflicts
- Maximize space

Considerations:
- Markings
- Signing
- Intersections
Sign on intersecting alleys & streets so motorists expect 2-way bike traffic

Retrofit signals (where applicable)

Cyclists can reenter traffic at each end

Direct access to destinations

Out-of-direction savings
Double yellow line creates 2-way street
With-flow cyclists ride in “normal” bike lane...
...or in a shared travel lane without bike lane
BIKE LANE PLACEMENT

- Both sides of two-way streets
BIKE LANE PLACEMENT

- Exception – may omit on downhill
BIKE LANE PLACEMENT

- Add shared-lane for uphill
  - discourage wrong-way
BIKE LANE PLACEMENT

- Between parking and travel lane
BIKE LANE PLACEMENT

- Right side of one-way
BIKE LANE PLACEMENT

- Exception—left side to avoid conflicts
BIKE LANE PLACEMENT

- Exception—left side to avoid conflicts
BIKE LANES & ON-STREET PARKING

- Use wider bike lane with
  - High turnover parking
  - Narrow parking lane
Is diagonal parking compatible with bicycling?
BACK-IN DIAGONAL PARKING

- Back-in diagonal parking
  - Improve sight distance
  - No door conflicts
  - Easier trunk access
  - Passengers channeled to curb
Designing On-Road Bikeways

SEPARATED BIKE LANES
SEPARATED BIKE LANES

- Exclusive bike facility
- Adjacent to or on roadway
- One-way or contra-flow
- Separated from traffic by vertical element
SEPARATED BIKE LANES

Mid-block (LTS 1)
SEPARETED BIKE LANES

Mid-block (LTS 1)
SEPARATED BIKE LANES

Mid-block (LTS 1 – except at intersection)
SEPARATED BIKE LANES

Mid-block (LTS 1 – except at driveways)
Advantages

- Very low stress **midblock**
- Encourages bike riding
- More conspicuous
- Crash rate reductions
Disadvantages

- Special intersection treatments
- Special driveway treatments
- Additional space needed
- More costly than bike lanes
- More to learn
SEPARATED BIKE LAKES

- Exclusive bike facility
- Adjacent to or on roadway
- One-way or contra-flow
- Separated from traffic by vertical element
  - Delineators
  - Bollards
  - Barrier
  - Median
  - Raised bike lane
  - Planters
  - Wheel stops
  - Parked cars
DESIGN GUIDANCE

- Primarily a geometric design feature
- Follow combination of shared use path & bike lane guidance
  - Dimensions
  - Horizontal
  - Signal timing
  - Design controls (speed, braking)
Follow combination of shared use path & bike lane guidance (chapter 9)

+ Bike lane signs
+ Bike lane and path markings
+ Bike lane extensions
+ Signal placement
+ Contra-flow

Look beyond current MUTCD
DESIGN GUIDANCE

- Not addressed in AASHTO
- Emerging need for design guidance
- Evolving knowledge with increasing experience
DESIGN GUIDANCE

- Conflicting definitions
- Basic dimensions
- Intersection considerations
- Goes beyond MUTCD
- Some contradictions
DESIGN GUIDANCE

MassDOT

SEPARATED BIKE LANE
PLANNING & DESIGN GUIDE
2015
MASSACHUSETTS DEPARTMENT
OF TRANSPORTATION
CONSIDERATIONS

- Are cyclists already using corridor?
- Would potential cyclists use the corridor if a separated facility existed?
- Could a SBL connect origins and destinations?
- How can a SBL help build a low stress bicycle network?
- Could a separated bike lane improve connections for disadvantaged populations?
SEPARATED BIKE LANE ZONES
## Bike Lane Elevation

- **Considerations**
  - Ped/bike encroachment
  - Usable bike lane width
  - Accessibility

- **Frequency of transition ramps**
- **Drainage**
- **Maintenance**

### Levels

- **Sidewalk level**
- **Intermediate level**
- **Street level**
- **Raised bike lane**
SIDEWALK LEVEL

- Motor vehicle separation
- Reduces debris
- Passing
- Ped/bike encroachment
STREET LEVEL

- Sidewalk delineation
- Accessible parking
- Existing drainage
- Retrofits
- Beveled curbs
INTERMEDIATE LEVEL

- Curb & drainage flexibility
- Smaller transitions
- Curb reveal:
  + 2-3" on bike lane
  + 6" on street
RAISED BIKE LANE

- One-way
- No parking for two-way
- No protected intersection
- Curb reveal
  - 2” on bike lane
  - 4” on street

bike lane + buffer < 7 ft
BIKE LANE WIDTH

- One-way

Widths vary by peak hour volume

+ 6.5-10 ft recommended
+ 5-8 ft minimum
+ 4’ allowable at bus stops or accessible parking

6.5’ min. for comfortable passing
BIKE LANE WIDTH

- Two-way

Widths vary by peak hour volume

+ 10-14 ft recommended
+ 8-11 ft minimum

≥ 10’ min. for comfortable passing
BIKE LANE WIDTH

- Maintenance
  - Sweeping
  - Snow removal
Curb angle & height influence:

- Wheel & pedal strike hazard
- Bicycle access to sidewalk
- Motor vehicle encroachment
- Cross section width
VERTICAL ELEMENTS

- Painted median
- Parking
- Lower cost
- Considerations
  - Shy distance
  - Spacing
  - Durability
  - Clear zone
VERTICAL ELEMENTS

- Raised median
  - Any bike lane elevation
  - Higher cost
  - Considerations
    - Streetscape
    - Landscaping
    - Drainage

6' rec. (2' min.)
Grates
Stormwater management
- Bike lane elevation
- Roadway crown
- Existing catch basins
- Existing utilities
- Median openings
**CURBSIDE ACTIVITY**

- Motor vehicle parking
- Loading zones
- Bike parking
- Bus stops
LOADING ZONES

Acceptable sidewalk width (context dependent) must be maintained

Dependent on offset and design speeds

Dependent on loading space requirement

8 ft Minimum

20 ft minimum
ACCESSIBLE LOADING ZONE

Diagram of accessible loading zone with markings and signage indicating directions and restrictions.
ACCESSIBLE LOADING ZONE
Considerations
- Opposite side of street
- Guide passengers
- Two crossings
- Communicate to bicyclists
- Floating bus stop
- In-lane bus operation
The term daylighting refers to the removal of on-street parking near intersections or adjacent to curb cuts in order to improve sightlines for motorists, cyclists, and pedestrians.

- 30 - 50 ft Typical
- Curb length dependent on vehicle length
- 20 ft Dependent on offset and design speed
- Ramp deployment area: Minimum 5 ft x 8 ft
- 4 ft Minimum
- 05
- 06
- 04
- 07
- 6 ft pedestrian crossing
- 1:10 - 1:25 slope
- Acceptable sidewalk width (context dependent) must be maintained
TRANSIT STOPS

- Railings or planters
- Intersection crossing
- Stop or yield markings
TRANSIT STOPs

Only consider where island not feasible

- Align crosswalks with doors
- Green pavement
- Do not pass when bus is stopped
TRANSIT STOP

[Images of transit stops and bike lanes]

[Images showing a pedestrian in a shopping area and a bike lane with markings]

[Images showing a road with bike lane and pedestrian crossing]

[Images of a sidewalk and a bus stop]

[Images of a street with bike lane and pedestrian crossing]