IN REAL LIFE: Building for Communities with Motorcycles

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World Bank: 
Vietnam Central Highlands Connectivity Improvement project

- To improve the connectivity, safety and climate-resilience of the National Highway 19.

GRSF MAIN ROLES

- Safety Assessments
  - Road safety assessments for NH19

- Mentoring and Capacity Building
  - Safe System approach and safe infrastructure
  - Safety at Road Works
  - Review and road safety improvement of 2-wheeler lanes standard
Road safety assessment of the whole National Highway 19. Road Safety Audits and Road Safety Inspections were carried out for a total length of about 255 km.

A speed management analysis included, with a focus on school zones along the NH19; treatments are proposed for sections where speed is a critical factor.

<table>
<thead>
<tr>
<th>Star Rating</th>
<th>Vehicle occupant Length (km)</th>
<th>Percent</th>
<th>Motorcycle Length (km)</th>
<th>Percent</th>
<th>Pedestrian Length (km)</th>
<th>Percent</th>
<th>Bicyclist Length (km)</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 Stars</td>
<td>0.00</td>
<td>0.00%</td>
<td>0.00</td>
<td>0.00%</td>
<td>0.00</td>
<td>0.00%</td>
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</tr>
<tr>
<td>4 Stars</td>
<td>31.40</td>
<td>0.00%</td>
<td>20.50</td>
<td>0.00%</td>
<td>0.00</td>
<td>0.00%</td>
<td>24.60</td>
<td>0.00%</td>
</tr>
<tr>
<td>3 Stars</td>
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<td>0.00%</td>
<td>38.92%</td>
<td>0.00%</td>
<td>0.00</td>
<td>0.00%</td>
<td>42.40</td>
<td>0.00%</td>
</tr>
<tr>
<td>2 Stars</td>
<td>35.30</td>
<td>0.00%</td>
<td>24.67%</td>
<td>0.00%</td>
<td>0.00</td>
<td>0.00%</td>
<td>0.00</td>
<td>0.00%</td>
</tr>
<tr>
<td>1 Star</td>
<td>20.70</td>
<td>0.00%</td>
<td>14.47%</td>
<td>0.00%</td>
<td>0.00</td>
<td>0.00%</td>
<td>28.20</td>
<td>0.00%</td>
</tr>
<tr>
<td>Not applicable</td>
<td>0.00</td>
<td>0.00%</td>
<td>0.00</td>
<td>0.00%</td>
<td>0.00</td>
<td>0.00%</td>
<td>0.00</td>
<td>0.00%</td>
</tr>
<tr>
<td>Totals</td>
<td>143.10</td>
<td>100.00%</td>
<td>143.10</td>
<td>100.00%</td>
<td>143.10</td>
<td>100.00%</td>
<td>143.10</td>
<td>100.00%</td>
</tr>
</tbody>
</table>

The baseline assessment shows that:
- For vehicle occupants 60.9% of the existing road is rated as 3-star or better
- For motorcyclists 44.2% of the existing road is rated as 3-star or better
- For pedestrians 42.6% of the existing road is rated as 3-star or better
- For bicyclists 50.2% of the existing road is rated as 3-star or better
Findings and Recommendations from Citizen Engagement Study in strategic locations along NH19
Due to sharp crabs, high out of sight. Many accidents have caused loss of life and property. It is recommended to widen the road, remove the corner, and launch the road

FGD, Community members
RECOMMENDATIONS

➢ Separate lanes for motorcycles

➢ Upgrade items to road sections, bends, slopes, road sections passing through densely populated areas, intersections

➢ The deployment of speed calming measures, and speed regulation (i.e., installing speed limit signs, rumble strips, and cameras)

➢ Modifications to non-motorized vulnerable road users’ attributes (i.e., adding sidewalks, pedestrian crossings, fencing, and parking areas), especially around school zones

➢ Add surveillance cameras

➢ Assess and maintain road infrastructure frequently
Outline of the ORIGINAL manual (2019) and SUMMARY OF COMMENTS

GENERAL INFORMATION
LEGAL PROVISIONS
- Legal regulations, policies at national level
- Legal regulations, policies at local level

TECHNICAL INSTRUCTIONS
- Classifications
- Data collection & investigation
- Design guide
  - geometric elements,
  - traffic organization,
  - road surface,
  - drainage facilities,
  - traffic safety system

- Adjust and further improve the design manual/standards for considering important factors, such as road function, speed limit, traffic composition (% mode), while making decision on lane segregation between two-wheelers and four-wheelers
- Improve safety specifications for two-wheelers (including motorcycles and bicycles)
- Consider Safe System approach in design, construction, and operation of road infrastructure with consideration to the dominance of motorized two-wheelers (motorcycles)
PRINCIPLES FOR UPGRADING THE MANUAL

✓ Expert consultations
  ➢ (national and international)
✓ Literature review
  ➢ (taking stock of relevant design manuals and standards and studies in ASEAN and Asia)

❑ Focus on safety specifications for two-wheelers
  ▪ Lane design (width, # of lanes, lane separation)
  ▪ Speed (design speed, limits & signpost)
  ▪ Rumble strips to reduce speeding
  ▪ Road restraint technical standards
  ▪ Guideposts (made of flexible material)
  ▪ Roundabouts & intersections

❑ Improved readability
  ▪ Rewording explanatory texts
  ▪ Adding scientific evidences
SUMMARY OF KEY POINTS / IMPROVEMENTS

- Sustainable transport development
  - Current and future role of motorcycles
  - Inducive environment for motorcycle user safety

- Classification of roads/lanes for two-wheelers
  - (A, B) & speed, design features
  - (C, D) & speed, design features

- Geometric design
  - Horizontal alignment
  - Vertical alignment
  - Cross-section
  - Traffic separator
  - Night visibility

- Traffic organization
  - Principles for national HW and urban roads
  - Methods for two-wheelers in urban areas
  - Lane segregation at bus stops
  - Traffic organization at intersections

- Traffic safety system
  - Structures
  - Signs

- iRAP assessment (NH19)
  - iRAP limits in assessing motorcycle safety
  - Several examples & implications
SUSTAINABLE TRANSPORT & MOTORCYCLE SAFETY ISSUES

- Period 2010-2020: motorcycles doubled from 31.3 mil to 63.4 mil
- Year 2020: 670 MC/1000 pop vs 44 automobiles/1000 pop
- By 2030, about 70% people would still choose motorcycle for their daily travel
- Safe System for protecting MC users & VRUs

Four-Pillar Strategy for M-cycle Traffic Safety in Vietnam

- Creating a favorable environment for safely riding motorcycles

1. Policy & Regulation - Incorporating MC into Transport & Safety Policy
   - Road Safety policy should include motorcycles
   - Recognition of the economic and social contribution of motorcycling
   - Adapting Policies to Local Situations

2. Infrastructure - Committing to Safe Infrastructure
   - Safe system principles in all stages (planning, design, construction, operation) for motorcycle use
   - Contextual applications & guidance of the principles

3. Awareness, Education and Training for all Road Users
   - Awareness Raising for All Road Users
   - Lifelong Training of MC Riders
   - Preventing Impaired Riding
   - Protective Riding Gear
   - Regular maintenance of the vehicles

4. Technology Advances
   - Safety of the product is commited
   - Advances in preventive, primary, secondary safety

Source: VGTRC (2018)
CLASSIFICATION OF ROADS AND LANES FOR TWO-WHEELERS

❑ Dedicated roads/lanes – separated from 4W
  ▪ Category A: min 2 lanes (min 3 m totally)
  ▪ Category B: min 1 lane (min 2 m totally)
  ▪ National HW, Urban arterials Class I & II: Speed > 70 km/h

❑ Inclusive roads/lanes – sharing with 4W
  ▪ Category C: min 2 one-way lanes (min 3 m total)
  ▪ Category D: min 1 one-way lane (min 2 m totally)
  ▪ National HW, other roads below Class II: Speed < 70 km/h (hard median), < 50 km/h (no median)

Source: WB (2019)
GEOMETRIC DESIGN – Horizontal Alignment

- Min curve radius
- Min curve radius without super-elevation
- Max super-elevation rate
- Sight distance
- Roadway extension

Forces on a motorcycle moving in a curve

Design Speed (km/h) | Min Sight Distance (m) | Min Radius (m) |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>e=0%</td>
</tr>
<tr>
<td>90</td>
<td>145</td>
<td>490</td>
</tr>
<tr>
<td>80</td>
<td>120</td>
<td>360</td>
</tr>
<tr>
<td>70</td>
<td>95</td>
<td>275</td>
</tr>
<tr>
<td>60</td>
<td>75</td>
<td>190</td>
</tr>
<tr>
<td>50</td>
<td>60</td>
<td>120</td>
</tr>
</tbody>
</table>

Roadway extension in a curve

<table>
<thead>
<tr>
<th>Curve Radius (m)</th>
<th>30</th>
<th>25</th>
<th>20</th>
<th>15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roadway Extension (m)</td>
<td>-</td>
<td>0.1</td>
<td>0.2</td>
<td>0.3</td>
</tr>
</tbody>
</table>

Source: WB (2019)
GEOMETRIC DESIGN – Vertical Alignment

- Max longitudinal grade, max slope length
- Vertical curve
- Clearance: min 2.5 m

**Max longitudinal grade, max slope length**

<table>
<thead>
<tr>
<th></th>
<th>Category A, B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max longitudinal grade (%)</td>
<td>11</td>
</tr>
<tr>
<td>Max length of the slope for 2W at max grade (11%) (m)</td>
<td>60</td>
</tr>
</tbody>
</table>

**Minimum radius of crest and sag vertical curve**

<table>
<thead>
<tr>
<th></th>
<th>Category A</th>
<th>Category B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radius of crest vertical curve (m)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Limited minimum</td>
<td>400</td>
<td>200</td>
</tr>
<tr>
<td>Normal minimum</td>
<td>600</td>
<td>200</td>
</tr>
<tr>
<td>Radius of sag vertical curve (m)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Limited minimum</td>
<td>2500</td>
<td>100</td>
</tr>
<tr>
<td>Normal minimum</td>
<td>400</td>
<td>200</td>
</tr>
<tr>
<td>Minimum length of vertical curve (m)</td>
<td>25</td>
<td>20</td>
</tr>
</tbody>
</table>

Source: WB (2019)
GEOMETRIC DESIGN – Cross-section

- Operating spaces required
- Optimum roadway width (ASEAN studies)
  - Dedicated: 3.0 – 4.0 m (divided into 2 sub-lanes)
  - Inclusive: 2.0 – 3.0 m (not allow cars to enter)
- Min roadway width
- Traffic volume and the number of lanes

Min spaces required for motorized 2W operation

### Minimum roadway, roadbed by 2W road category

<table>
<thead>
<tr>
<th>Category</th>
<th>Min # of lanes</th>
<th>Min width of roadway (m)</th>
<th>Min width of road shoulder (m)</th>
<th>Width of side ditch (m)</th>
<th>Min width of roadbed (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>2</td>
<td>3.0</td>
<td>0.5 – 1.0</td>
<td>0 – 1.0</td>
<td>3.5 – 4.5</td>
</tr>
<tr>
<td>B</td>
<td>1 – 2</td>
<td>2.0</td>
<td>0.5 – 1.0</td>
<td>0 – 1.0</td>
<td>2.5 – 4.0</td>
</tr>
<tr>
<td>C</td>
<td>2</td>
<td>3.0</td>
<td>0 – 0.5</td>
<td>0 – 0.5</td>
<td>3.5 – 4.0</td>
</tr>
<tr>
<td>D</td>
<td>1</td>
<td>2.0</td>
<td>0.5 – 1.0</td>
<td>0 – 0.5</td>
<td>2.5 – 3.5</td>
</tr>
</tbody>
</table>

### Design volume, # of lanes, and min roadway width (2W)

<table>
<thead>
<tr>
<th>Design volume (MC/h)</th>
<th>1000 - 1500</th>
<th>1500 - 3200</th>
<th>3200 - 4500</th>
</tr>
</thead>
<tbody>
<tr>
<td># of lanes</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Min width of roadway (m)</th>
<th>Non-urban</th>
<th>Urban</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.5</td>
<td>2.0</td>
</tr>
<tr>
<td></td>
<td>2.5</td>
<td>3.0</td>
</tr>
<tr>
<td></td>
<td>4.0</td>
<td>5.0</td>
</tr>
</tbody>
</table>

Source: Hussain et al. (2005)
GEOMETRIC DESIGN – Traffic Separator

- TCVN 4054: 2005 Standard
- TCXDVN 104: 2007 Standard
- Soft separator (painting & reflective stud)
- Hard separator (w-beam guardrail, concrete pillar, reinforced concrete, curb, island, tree,...)
- Flexible delineator post

Delineator

Soft separator

Hard separator
GEOMETRIC DESIGN – Night Visibility

- Single-vehicle crashes often occur at night when visibility is low
- Night visibility must be ensured

Clearance btw the lighting column and 2W carriageway

Source: Kerajaan Malaysia (2016)
Specific objectives:

- Ensure traffic safety
- Increase traffic capacity
- Reduce delays at intersections
- Improve traffic efficiency for a route/network

Data collection and analysis

Scope and targets for study

- Intersections
- Road network
- Traffic control facilities

<table>
<thead>
<tr>
<th>Data collected for traffic organization plan</th>
<th>Data type</th>
<th>Data description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic conditions</td>
<td>- Traffic volume on routes (distribution by time and vehicle composition)</td>
<td>Traffic volume at off-peak and rush hour; Traffic flow composition; pedestrian and bicycle.</td>
</tr>
<tr>
<td></td>
<td>- Vehicle speed; vehicular queue length; Other factors such as parking lots, etc.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Data on road crash</td>
<td>Collect data on road crashes within the last 3 years.</td>
</tr>
<tr>
<td></td>
<td>- Current traffic control</td>
<td>Traffic control status of local road system.</td>
</tr>
<tr>
<td>Road conditions</td>
<td>- Local road network</td>
<td>Road system: arterial roads, connectors, access or frontage roads, etc.</td>
</tr>
<tr>
<td></td>
<td>- Local topographic and natural conditions</td>
<td>Local topographic and population conditions</td>
</tr>
<tr>
<td></td>
<td>- Current road conditions (if repairing or upgrading)</td>
<td>Current road conditions: surface type, width, etc.</td>
</tr>
<tr>
<td>Auxiliary structures conditions</td>
<td>- Drainage conditions</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Type and position of safety signs</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Lighting condition</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Landscape and clearance on road sides</td>
<td></td>
</tr>
</tbody>
</table>
TRAFFIC ORGANIZATION – Methods for Urban Roads

- Arterial roads
- Urban freeways
- Distance between intersections (depending on traffic capacity and intersection delay impact)

$X_1$: lane changing distance

$X_2$: distance in which vehicles travel in a specified lane

$X_3 + X_4$: length of left-turn bay
TRAFFIC ORGANIZATION – Methods for National Highways

- Lane separation for two 2W lanes
- Lane separation for three 2W lanes
TRAFFIC ORGANIZATION – Methods for Bus Stops

- Option 1
- Option 2

60% bus stops only require reallocation without expansion.
TRAFFIC ORGANIZATION – Methods for Intersections

- Ensuring **safety** and improving **capacity**
- Building bridge or tunnel (expensive)
- Signalization (3 phase control)
  - Phase 1: Allow cars in both directions of the primary road to go.
  - Phase 2: Allow motorcycles in both directions of the primary road to go.
  - Phase 3: Allow cars and motorcycles on the secondary roads to go.
- Motorcycle box
- Left-turn box

- Motorcycle box to increase MC visibility (Taiwan)
- Two-stage left turn box for MC (HCMC)
TRAFFIC SAFETY SYSTEM – Structures

- Help solve conflicts at intersection
- Overpass/Bridge
- Underpass/Tunnel

- Overpass
  ![Overpass Image]

- Tunnel
  ![Tunnel Image]
TRAFFIC SAFETY SYSTEM – Signs

- Traffic Signs and Signals QCVN 41: 2016/BGTVT
- Sign signs
- Signs on road surface
- Signs for lane segregation
- Cantilever signs/signposts
iRAP ASSESSMENT (NH19)
Limits of iRAP methodology in assessing 2W safety

- iRAP Star Rating is a simple and objective measure of the level of safety, which is ‘built-in’ to the road for vehicle occupants, motorcyclists, bicyclists and pedestrians
- It offers a useful framework for validating the safety features highlighted in this manual
- Only some of the topics addressed in the manuals can be coded using iRAP’s methodology
- However, many of the topics, when assessed individually, have a little impact on the Star Rating (i.e., no difference if included or not compared to the base case)

<table>
<thead>
<tr>
<th>Topic/Measure</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topographic, geotechnical, and hydrological aspects</td>
<td>Not considered in the iRAP methodology</td>
</tr>
<tr>
<td>Geometric design</td>
<td>Some aspects are not considered in the iRAP methodology (e.g. superelevation or radius of crests and sags); Other features are not significant for coding (e.g. min radius of horizontal curve, since it does not distinguish radii less than 200 m)</td>
</tr>
<tr>
<td>Traffic organisation and intersections</td>
<td>Mostly not considered in the iRAP methodology, e.g. the iRAP Coding Manual classifies the intersections in a generic way (it only distinguish the type and whether there is a channelization or not), so the detailed solutions proposed in the manual cannot be assessed</td>
</tr>
<tr>
<td>Small drainage structure</td>
<td>Not considered in the iRAP methodology</td>
</tr>
<tr>
<td>Road surface</td>
<td>iRAP methodology only takes into account whether road surface is paved or unpaved and its skid resistance</td>
</tr>
</tbody>
</table>
iRAP ASSESSMENT (NH19) – Examples

**Base case: no facilities for two-wheelers**

Bicycles and motorcycles share the roadway with four-wheeled vehicles

![Image of a road with bicycles and motorcycles](image1)

**Description**

Type of facility: no specific provisions for bicycles or motorcycles.
Road type: undivided standard national highway (Vietnam) with two lanes (one in each direction).
Traffic separator: no separation between two-wheelers and other traffic.

**Motorcycle lane: Class 1 – Grade A**

Classification of dedicated roads and lanes for two-wheeled vehicles

![Image of a dedicated motorcycle lane](image2)

**Description**

Type of facility: exclusive motorcycle road, designed and constructed separately from the road surface used by cars.
Cross section: two lanes (one way, or two ways with a raised surface/median curb dividing opposing directions).
Traffic separator: separated from the four-wheeled vehicle lanes by a safety barrier (metal or concrete), fence, or wide (>1m) raised island/curb.
**Motorcycle lane: Class 2 – Grade C / soft separators**

Classification of dedicated roads and lanes for two-wheeled vehicles

![Image of motorcycle lane with soft separators]

**Description**
Type of facility: dedicated lane for two-wheeled vehicles lying on the same surface as the cars.
Cross section: two lanes (one way).
Traffic separator: separated from the four-wheeled vehicle lanes by soft separators (line markings and/or reflective nails), or <1m wide raised island/curb cast in place or precast.

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**Motorcycle lane: Class 2 – Grade C / hard separators**

Classification of dedicated roads and lanes for two-wheeled vehicles

![Image of motorcycle lane with hard separators]

**Description**
Type of facility: dedicated lane for two-wheeled vehicles lying on the same surface as the cars.
Cross section: two lanes (one way).
Traffic separator: separated from the four-wheeled vehicle lanes by a safety barrier (metal or concrete), fence, or wide (>1m) raised island/curb.
### Grade separated intersection / Overpass and underpass

**Intersections on National Highway grade I, II or main urban roads**

![Grade separated intersection image]

**Description**

Overpass or underpass for two-wheeled vehicles.

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### At-grade intersection

**Intersections on National Highway grade III, IV, V or VI**

![At-grade intersection image]

**Description**

Well-designed 4-leg intersection signalised with traffic lights and equipped with protected turn lanes. The motorcycle lane is interrupted at the intersection (not present). The dedicated red light waiting area cannot be coded as it is not considered among the attributes of iRAP.
CONCLUSIONS & WAYS FORWARD

- The upgraded manual is useful to study, plan, design and audit exclusive roads and lanes for 2W in order to ensure road safety for motorcyclists, bicyclists and pedestrians.

- Solutions recommended in the manual should be piloted, assessed and adjusted as the rollout is progressive.

- It is important to study and adapt the iRAP methodology into the context of dominant motorcycle traffic in Vietnam and elsewhere.

- The Upgraded Manual for Exclusive Roads and Lanes for Two-wheel Vehicles is now in EN and VN and is being revised in detail by the corresponding authorities, who may approve it, publish it and transform it (or part of it) into standard(s).
Discussion

Upcoming opportunities for Vietnam
- Activities and Indicators within MeRRCoP (3NHs new project)
- Joint actions with provinces involved
Activities and opportunities

Within the project and along with Provinces' support/joint actions

• Guard rails/barriers and infrastructure design with special consideration for motorcyclists.

• Minimize risks due to roadside hazards, creating “forgiving roads” (i.e., clear zones, shoulders, bridge and barrier ends have appropriate attenuators to absorb impacts, eliminate/relocate side hazards, etc.).

• Speed management (regulation, infrastructure/design, signs, enforcement and associated communication).

• Motorcyclists and pedestrian facilities (specially around social infrastructure i.e., schools, hospitals, markets) – considering persons with disabilities and elderly needs.

• Safe Intersections designs (ex. roundabouts preferred for crossroads and ‘Y’ intersections, raised platforms for intersections or pedestrian crossings, protected turns for signalized intersections, etc.)

• Capacity development and hands-on trainings on required themes (ex. detailed engineering designs, plus based on stakeholders and provinces inputs).
THANKS FOR LISTENING

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http://roadsafetyfacility.org

@WBG_Transport