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Bulletin on:
Geometric Guideline for Exclusive Motorcycle Lane

Theme of the month:
MOTORCYCLE LANE

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INTRODUCTION

Malaysia, as part of an ASEAN countries has high percentage of motorcycles in the transport models. In normal road design practice, all vehicle types share the same carriageway travelling from one destination to another. With the high number of motorcycles, the likelihood for fatal accident to occur involving motorcyclists is greater. Separating motorcycles from other vehicles in traffic by providing motorcycle lanes is a good engineering measure to improve the safety of motorcyclists. There are non-exclusive motorcycles lanes (NEML) and exclusive motorcycles lanes (EML) provided at certain road stretches in Malaysia. However, there has been no established guideline for the design of motorcycle lanes. The lanes, either on Expressways or Non-expressways are constructed based on the respective authorities' own documents which differ from one to the other.

Geometric Guideline for Exclusive Motorcycle Lane (GGEML) is prepared to assist road designers on the design criteria and approach as to provide uniform and standard design for the exclusive motorcycle lane (EML). With the ever increasing numbers of motorcycles on the roads, it has become imperative that motorcycle being given special consideration and provision of exclusive lanes for the safety of the riders and pillions.

MOTORCYCLE CHARACTERISTICS

The geometric design of motorcycle lane is affected by the physical characteristics and the proportion of various sizes of motorcycle. For purposes of geometric design, the designed motorcycle should be one with dimensions and minimum turning radius larger than those of almost all motorcycle in its class. Therefore, motorcycles with capacity of 250cc and below only are considered to be used in this geometric guideline.

TABLE 1 : MOTORCYCLE DIMENSIONS AND CHARACTERISTICS

Motorcycle Description	Dimension in Metres (Maximum)			Turning Radius (Metres)
	Length	Width	Height	
Motorcycle ≤250 cc	**2.60**	**1.00**	**1.64** **(inclusive of rider)**	**3.00**

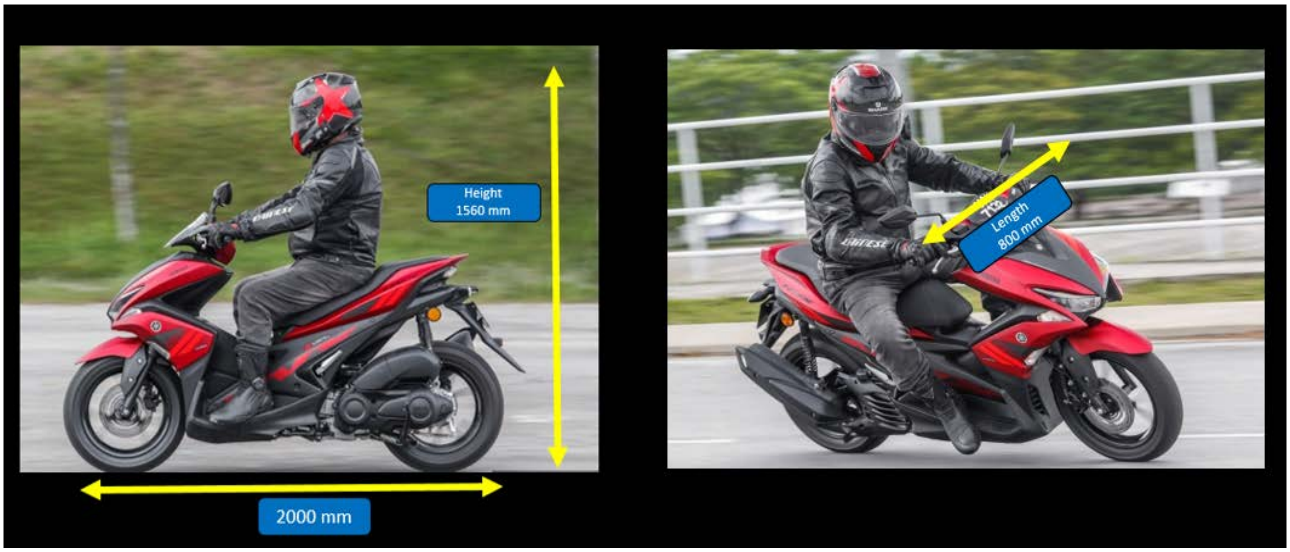

FIGURE 1: MOTORCYCLE DIMENSIONS

<u>Motorcycle Lane Classification/Hierarchy There are two (2) types of facilities for motorcycle lane:</u>

a) <u>Exclusive Motorcycle Lane (EML)</u>

The EML is the separating right of way from the main roads that is established to be solely used by motorcyclists. The motorcycle lanes are designed to separate motorcyclists from other class of motorists and avoid unintended occurring. The motorcycle lanes are not developed from the existing carriageway in the original width of main roads. The motorcycle lane helps by reducing the conflicts from the main road vehicles. The EML is:

- Roadway meant exclusively for use by motorcycles (motorcyclists are compelled by law to use it and other vehicles are prohibited by law from using it).
- Physically separated from main carriageway.
- Grade separated from the main carriageway at intersections/interchanges/points of conflicts.

b) <u>Non-exclusive Motorcycle Lane (NEML)</u>

- Extra lane/verge/marginal strip on the left hand side of the main road carriageway.

The NEML is to be provided in two (2) categories of roads which are Expressway and Non-expressway.

Expressway is characterized by high speed high volume road with full access control and grade separated interchanges all along the road. While Non-expressway defined as roads other than expressways and include Federal Roads, State Roads, Municipal Roads and other roads.

FIGURE 2 : NON-EXCLUSIVE MOTORCYCLE LANE

FIGURE 3 : EXCLUSIVE MOTORCYCLE LANE

TABLE 2 : SUMMARY OF WARRANT ANALYSIS FOR EXCLUSIVE MOTORCYCLE LANE

<table>
<tr><th colspan="2" rowspan="2">Numerical Warrants</th><th colspan="3">Type of Roads</th></tr>
<tr><th>Expressways</th><th>Non Expressways</th><th>Section of Expressways and Non Expressways</th></tr>
<tr><td>1.</td><td>Total Volume of Traffic</td><td>> 15,000 vehicle per day</td><td>> 15,000 vehicle per day along a 2-lane 2-way road
OR
> 10,000 vehicle per day per lane along a multi-lane road</td><td rowspan="5">• For Section with Expressway Road Conditions, Warrant for Expressways shall apply.
OR
• For Section with Non Expressway Road Conditions, Warrant for Non Expressways shall apply.
OR
• For combination of Expressway and Non Expressways along the road, the engineer's experience and engineering judgment is required to decide the most appropriate form of motorcycle facilities.</td></tr>
<tr><td>2.</td><td>Percentage of motorcycles</td><td>> 30% of main stream traffic</td><td>> 30% of main stream traffic</td></tr>
<tr><td>3.</td><td>Total number of Motorcycle Accidents</td><td>> 5 accidents per km per year</td><td>> 5 accidents per km per year</td></tr>
<tr><td>4.</td><td>Side Friction Scores</td><td>Not Applicable</td><td>< 30 friction scores</td></tr>
<tr><td>5.</td><td>Combination of 1,2,3 and/or 4</td><td colspan="2">• Can be provided even if not fulfilling criteria 1, 2, 3 or 4 if its absence would be detrimental to the safety of motorist/other road user.
• Warrants if there is a high likelihood of warrants 1, 2, 3 and/or 4 being met within 5 years of design life of the project.</td></tr>
</table>

(Source : NTJ 33/2015 Guidelines For Motorcycle Facilities)

SPEED

Speed is an important factor in all modes of transportation. Speed determines the travel duration and expected time of arrival at a particular destination. High capacity motorcycles (e.g. 250 cc and above) can easily accelerate from zero to 60 kph within a few seconds and capable of traveling at very high speed. At high speed, a motorcycle tends to be more vertically stable. However, its agility and maneuverability drops. In the event of an emergency, such as a sudden obstruction in its path due to some accident ahead, motorcyclists traveling at high speed may not be able to make a drastic change in direction or reduce their speed significantly without risking of losing their balance. There are very specific limits to how sharp or fast we can turn and how these are related to the size and design of the motorcyclist. Frequently, riders may lose control of their vehicles and usually end up falling off their motorcycles or crashes into the obstruction or ends up with serious consequences or even death.

FIGURE 4 : AN EXAMPLE MEANDERING ALIGNMENT BEFORE ENTERING UNDERPASS

In deciding the appropriate design speed, one must understand some of the limits and constraints thereafter. Practically, existing terrain features, limited space and land use are some of the constraints that may limit the standard of road possible. Limitations of rider handling capability and vehicle operating capacity shall be considered accordingly. Notwithstanding the above, there are current facts and figures that need consideration of some guidance on the proposed design speed:

a. It was found that 99% of the motorcycles population in Malaysia comprises those of small and medium-sized type motorcycles with engine sizes 150 c.c. and below. Because of their small size, a rider does not require much space for maneuvering.
b. The proposed group of motorcyclists that is required to use the exclusive motorcycle lane are those riding motorcycles with a capacity of 250 cc or below. Based on the survey conducted by MIROS, the maximum speed of travel is not more than 140 kph. However, the appropriate design speed shall be lower than the maximum.

c. Motorcyclists, like pedestrians, are equally vulnerable in the case of road casualty. The poor protective nature of motorcyclists warrants serious considerations be given to the safety of the motorcycle rider/pillion. The risk of accident must be kept at the lowest level possible simply because, in the event of an accident, motorcyclists are very susceptible to serious injury or death. Hence there must be some limit to the maximum speed of travel along the motorcycle lane. At an impact of 60 kph, a pedestrian or motorcyclist, for that matter, has little chance of surviving a crash – at an impact speed of 40 kph the chance of survival for pedestrian is about 80 percent.
d. A spot speed study along the exclusive motorcycle lane along FT002 found that motorcyclists can reach up to a speed of more than 100 kph on certain section of the route even though the design speed for the facility was set at 60 kph then. This indicate that motorcyclists can confidently travel at higher speeds along the exclusive motorcycle lane but generally confined to a less meandering section of the alignment. Observations also showed that at high speed they would be travelling in a single file much due to safety reasons.

CROSS SECTION ELEMENTS

Pavement

Pavement surfaces should be smooth, and the pavement should be uniform in width. The smoothness of the riding surface affects the comfort, safety and speed of motorcyclist. The important pavement characteristics that are related to geometric design of motorcycle lanes are the ability of a surface to retain its shape and dimension, to drain, and to retain adequate skid resistance and the effect on driver's behaviour.

Proper selection of materials and an understanding of how they perform simultaneously within the composite pavement structure must be based on careful consideration of expected traffic loads, the environment, and proven evaluation and construction practices. Other considerations, including availability of materials and economics, will often influence which materials are ultimately selected.

1. Flexible Pavement

For pavement design purposes, mixed traffic (axle loads and axle groups) is converted into the number of ESAL repetitions by using load factors. The structural design of a pavement is then based on the total number of ESAL passes over the design period. Load factor can be determined from theoretically calculated or experimentally measured lorries and axle loads.

Considering minimal damaging effect of motorcycles to the pavement structure, it is recommended that pavement design for exclusive motorcycle lanes is to be as shown in **Figure 5**.

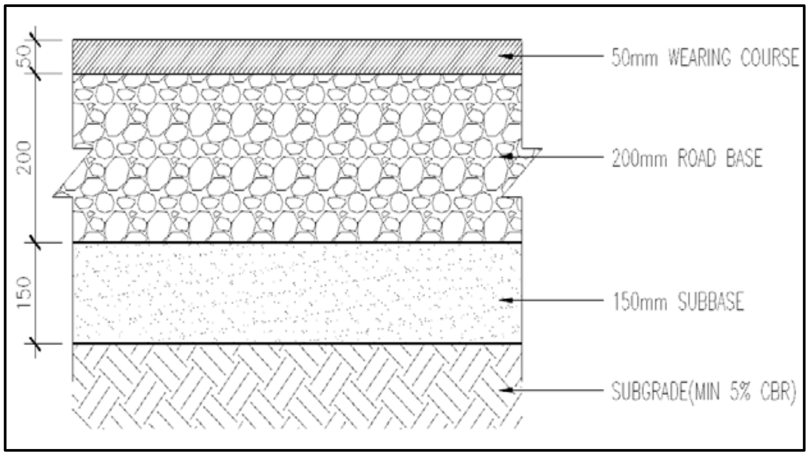

FIGURE 5: FLEXIBLE PAVEMENT STRUCTURE
Source : ATJ 5/85 (Pindaan 2013)

2. Rigid Pavement

Rigid pavements are normally constructed of Portland cement concrete and may or may not have a base course between the subgrade and the concrete surface. Rigid pavements have some flexural strength that permits them to sustain a beamlike action across minor irregularities in the underlying materials. There are several types of rigid pavements. However, for the EML, plain concrete pavements is chosen due to its low loading criteria. In general, it is recommended to apply plain concrete pavement in areas where the natural subgrade condition is favorable and uniformity of support can be achieved. Joints are placed at relatively shorter distances (3 to 6 m) within concrete slab to reduce amount of cracking.

Figure 6 below shows the recommended pavement structures as one of alternatives for motorcycle lanes.

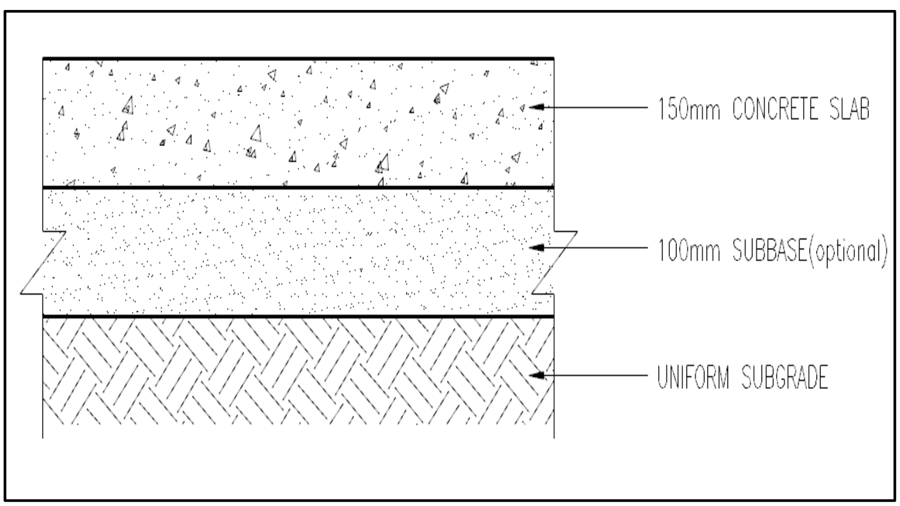

FIGURE 6: RIGID PAVEMENT STRUCTURE
Source : ATJ 5/85 (Pindaan 2013)

Traffic Barriers

1. General

A traffic barrier is an obstacle and a hazard in itself. The decision to install it should only be taken if other means of removing the obstacle it protects are impossible or prohibitively expensive, and that the barrier itself is not a greater danger than the obstacle it is intended to protect. If a traffic barrier does not fulfil its purpose of installation, then it should be changed to a different type of traffic barrier (i.e, traffic barrier with Additional Rub Rail or Special Impact Attenuators).

2. Traffic Barriers for Motorcycle Lane

Generally, Semi-Rigid Barriers minimum TL2 and with appropriate end treatment are recommended to be used and installed for motorcycle lane with some improvement to the traffic barrier performance for motorcyclists. Two methods are recommended, i.e. the first method is by covering the existing guardrail posts and opening under the guardrails beam with additional rub rail on the lower section of the guardrail system and the second method is by covering exposed posts with special impact attenuators. Attenuator absorbs energy and redirects the impacting motorcyclist by preventing the motorcyclist from impacting guardrail posts.

2.1 Method 1: Additional Rub Rail

The addition of rub rail to the lower section W-beam barrier systems is recommended to be used. **Figure 7** illustrates the example of rub rail fitted to an existing W-beam. The photograph of additional rub rail is shown in **Figure 8.**

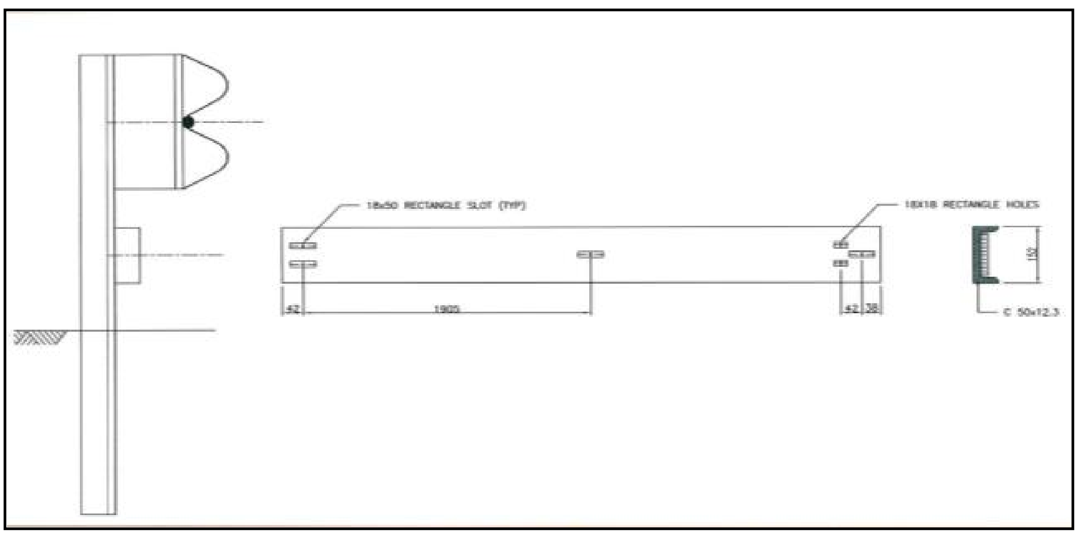

FIGURE 7 : SCHEMATIC DRAWING OF RUB RAIL FITTED TO AN EXISTING W-BEAM
Source : REAM GL 11/2011

FIGURE 8: PHOTOGRAPH OF RUB RAIL FITTED TO AN EXISTING W-BEAM
Source : Safe Direction

2.2 Method 2: Special Impact Attenuators

This method focuses on the ways to reduce consequences of a crash against a metal barrier. Impact attenuators, or dampers, that are fitted to existing guardrail posts, also serve to increase the impact surface and, due to their deformation properties, increases energy absorption on impact.

a) Plastirail

The device consists of a soft plastic fence covering barrier posts that can be fitted to existing barrier systems. It aims to combine both energy absorption properties and impact spreading properties. The photograph of plastirail fitted to existing barrier is shown in **Figure 9.**

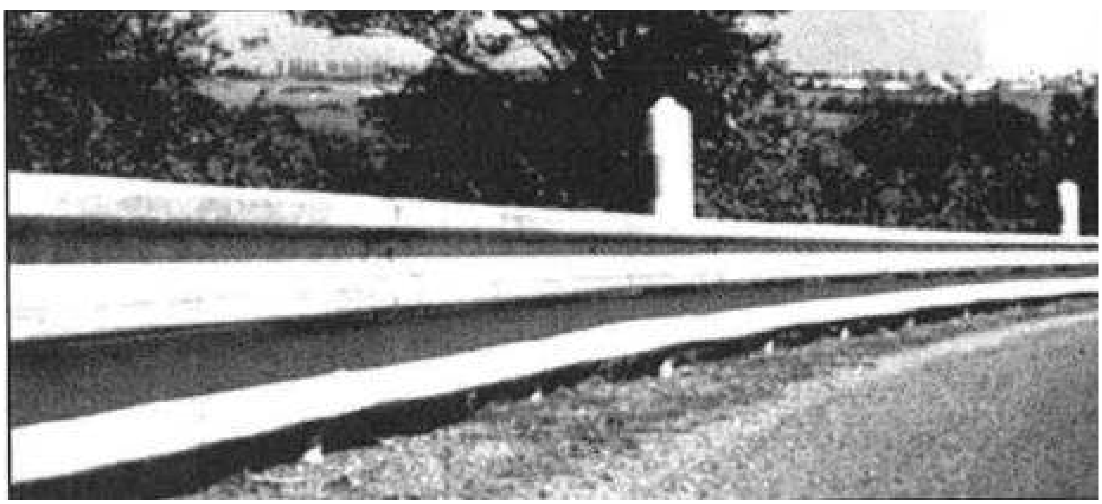

FIGURE 9 : PHOTOGRAPH OF THE "PLASTIRAIL" FITTED TO EXISTING BARRIER SYSTEM
Source : REAM GL 11/2011

b) Mototub

The “Mototub” is similar to the Plastirail except that it is made from 70% recycled material. It is currently used in a number of European countries. The photograph of “Mototub” fitted to existing barrier is shown in **Figure 10.**

FIGURE 10 : PHOTOGRAPH OF "MOTOTUB " FITTED TO EXISTING BARRIER SYSTEM
Source : Sodirel

c) The Basic Motorcyclist Protection System (MPS)

The Basic MPS is a unique concept which controls and absorbs bodily impact against safety barriers, thereby affording motorcyclist greater protection. This innovative high-tensile mesh guardrail protection system reduces motorcyclist injuries and fatalities. The Motorcyclist Protection System (MPS) fitted to existing barrier is shown in **Figure 11.**

FIGURE 11 : MOTORCYCLIST PROTECTION SYSTEM (MPS) FITTED TO THE EXISTING BARRIER SYSTEM
Source : Cegasa Internacional

REFERENCES

1. AASHTO, 2006. Roadside design guide, American Association of State Highway and Transportation Officials, Washington

2. AASHTO, 2011. A policy on geometric design of highways and streets. Washington D.C.

3. Fambro, D.B., Fitzpatrick, K., Koppa, R.J., 1997. Determination of stopping sight distance, Report 400, Texas Transportation Institute, Washington D.C.

4. www.highwaycare.co.uk

5. Hussain H., Radin Umar R.S., Ahmad Farhan M.S., Dadang M.M., 2005. Key Components of a Motorcycle-Traffic System: A Study along the Motorcycle Path in Malaysia, Journal of International Association of Traffic and Safety Sciences, Japan, Vol. 29, No.1, May 2005, pp. 50-56

6. Hussain H., Radin Umar R.S., Ahmad Farhan M.S., 2011. Establishing Speed-Flow-Density Relationships for Exclusive Motorcycle Lanes, Journal of Transportation Planning & Technology, Taylor & Francis,Vol. 34, No.3, April 2011, pp. 245-257

7. Hussain H. 2006. Development of Capacity and Level-Of-Service for Uninterrupted Exclusive Motorcycle Lanes in Malaysia, PhD Thesis, Faculty of Engineering, Universiti Putra Malaysia. (unpublished)

8. JKR, Arahan Teknik Jalan 8/86. A guide on geometric design of roads. Road Branch: Public Works Department Malaysia, Kuala Lumpur, Malaysia. (Revision 2015)

9. JKR, Arahan Teknik Jalan 5/85. Manual for the Structural Design of Flexible Pavement. Road Branch: Public Works Department Malaysia, Kuala Lumpur, Malaysia. (Revision 2013)

10. Lenkeit, J.F., Hagoski, B.K., Bakker, A.I., 2011. A study of motorcycle rider braking control behavior, DOT HS 811 448, National Highway Traffic Administration (NHTSA).

11. MS 825 Part 1 : 2007. Code Of Practice For The Design Of Road Lighting - Part 1: Lighting Of Roads And Public Amenity Areas (First Revision)

12. REAM GL 2/2002. A Guide On Geometric Design Of Roads. Road Engineering Association of Malaysia, Shah Alam, Selangor, Malaysia.

13. REAM GL 11/2011. Guidelines for Motorcycle Facilities. Road Engineering Association of Malaysia, Shah Alam, Selangor, Malaysia.

14. REAM GL 7/2004. Guidelines to the Design of Plain Concrete Pavement. Road Engineering Association of Malaysia, Shah Alam, Selangor, Malaysia.

15. Safedirection.com