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Vehicles safety-related impacts of various high beam headlights intensities

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ABSTRACT

Road accidents are one of the most important issues in today's society. Motorcycle fatalities represent more than 60% of total traffic accident fatalities and more than seven times more than passenger car fatalities. This shows that 29% were fatal, 56% needed hospitalization and 15% sustained minor injuries. There were 6674 road fatal in 2014, and its decrease about 3.5% compared to 2013. Among the use of a motorcycle compare other's road vehicle users, it has the possibility of disclosure in a road accident because of motorcycles performances and rider capabilities such as straightforwardly uncovered by effects of vehicles' high beam headlighting that create glare. Some of the most important obstacles to the wider use of high beam headlighting systems are the visibility duration of the headlighting beam regarding the stop distance of the vehicles. In addition, the need for existing restrictions on the luminous strength of high-beam headlights, which the driver deemed visible to complete the stop, could be examined. The method of Stopping Sight Distances (SSD) and site experiment of velocity – SSD were used. This first-stage study therefore summarized and investigated stopping sight distances (SSD) involving braking distances that allow the evaluation of vehicle performance to enhance the safety-related driver and vehicle capability. The ten (10) test of experiments have been done with cars of Perodua Myvi at the University road. The results showed that SSD could be used to evaluate the SSD graph by taking into account the velocity (V0), driver's perception reaction time (tR), breaking friction coefficient (fT), gravitational constant (g), deceleration rate (a) and grade of roadway (G). Research concluded that SSD could be used to evaluate the SSD graph by considering velocity (V0), driver perception reaction time (tR), breaking friction coefficient (fT), gravitational constant (g), deceleration rate (a) and grade (G) of the roadway. It thus showed that the timing for switching to Hi-beam (AHB) is at SSD distance (meters or seconds).

Key words : Braking distance, stopping distance, headlights beam, visual of motorcycle.

1. INTRODUCTION

Various beam headlights give the human eye a certain amount of visible light, distance of sight and it is expressed as lumens per square meter (lux). Previous experiments demonstrated the visual impact of high-beam headlights with oncoming and preceding vehicles[1]. The study also investigated the need for the current limits on the level of luminous intensity of high-beam headlights. Based on an in-depth investigation conducted by the Malaysian Institute of Road Safety Research (MIROS) Crash Reconstruction Unit, however, it was found that risky driving, speed and fatigue are the main causes of road accidents out of ten (10) other factors [2]. It does not indicate lights-related triggers-day or night time (headlights effect). Nevertheless, it reveals an 8.5 per cent number of injuries environmental factor (445 cases)[2]. While these factors contributed to many of these crashes, poor visibility probably also played a part [3]. Since 1969, Federal Motor Vehicle Safety Standard 108 has mandated that all vehicles sold in the United States must have separate switches for manually choosing low beams and high beam headlamps, with low beams needed to minimize glare for oncoming or leading vehicles, and high beams necessary to maximize forward illuminance in the absence of other traffic. The most important issue of using high beam headlights most frequently causes glare to the oncoming and preceding vehicle drivers.

Nonetheless, one can also find the high beam range for safety driving requiring safety headlighting for the glare. The range is an important aspect of the vehicle being able to stop with ample distance before reaching the obstacles in front. Details of the range are considered factors; speed, time of brake reaction, distance of braking and distance of stop [4,5]. Instead, studies were also consider the probabilistic approach to find the most relevant factors such as road geometric design and traffic performances [6-9]. Extensive technology approaches have been used for the better monitoring of vehicles movements to provide operational and safety measures of individual vehicle [10,11]. Furthermore, some approaches used can also monitoring the road accident status, which are important for better early crashes prediction and crashes data assessment [12]. Therefore, the following study objects are intend to identify factors related to auto high beam (AHB) headlights as part of vehicles tools and determine the rate of AHB headlights relate to SSD/ vehicles performances. The stopping distance is the distance the vehicle travels until a rest arrives. This depends on the car speed and the friction coefficient (μ) between the wheels and the ground. This formula for stopping distance does not involve the anti-lock brake effects or brake pumping. The SI Distance Stop Unit (SD) is metered,

$$SD = \frac{v^2}{2\mu g} \quad (1)$$

Where v is car velocity (m / s), μ as friction coefficient and g is gravity acceleration (9.80 m / s2).

The braking distance is the distance that a vehicle travels while slowing to a complete stop. The braking distance is a function of several variables. First, the slope (grade) of the roadway will affect the braking distance. If vehicles are going uphill, gravity assists in vehicles attempts to stop and reduces the braking distance. Similarly, gravity works against when vehicles are descending and will increase vehicles braking distance. The formula for the braking distance is given below

$$d = \frac{v^2}{254 f_T} \quad (2)$$

where f_T is coefficient of breaking friction between the tires and the pavement surface.

The response time for the brake is the amount of time that elapses between detecting an obstacle or danger in the roadway and braking. The length of the reaction time for the brakes varies widely between drivers. An alert driver can respond in less than 1 second while other drivers can take up to 3.5 seconds to react. The reaction time for the brake depends on a wide number of variables including:

- Driver characteristics such as mood, fatigue level and experience.
- Environmental conditions such as air visibility and daylight time.
- The hazard properties, such as scale, colour and movement, or the object itself.

Therefore, Stopping Sight Distance (SSD) is further upgraded by considering brake reaction distance and braking distance. It represent driver performances (braking) and quality vehicles (brake) that can be simplify with

$$SSD = 0.278\, V_0\, t_R + \frac{V_0^{\,2}}{254\ f_T}$$

where

$$SSD \quad \{0.278\, V_0\, t_R\}_{BRAKE\ REACTION\ DISTANCE}$$

and

$$\left\{\frac{V_0^{\,2}}{254\ f_T}\right\}_{BRAKING\ DISTANCE}$$

where V_0 = intial speed, expressed by the design speed or 85th – percentile speed, ft/s (m/s), (km/h), t_R = driver perception reaction time, s and f_T = coefficient of breaking friction between the tires and the pavement surface.

Linked to this, an on-road calculation of the braking reaction time showed that the braking reaction time would vary from 1.0 to 2.0 seconds for average drivers [13, 14]. This time of brake reaction allows the drivers to perceive a danger, release the accelerator pedal and move the leg to the brake pedal. A total of 89 motorcycle riders (i.e. 56 males and 33 females) were recruited, of which 60 riders (i.e. 38 males and 22 females) were between the ages of 16 and 30 with a mean age of 25.4. Additionally, 29 riders (i.e. 18 males and 11 females) were between the ages of 50–60 with a mean age of 54.7. Reaction time ranged between 0.55s and 2.55s with a mean of 1.29 s [15].

As important results, the Japan New Car Assessment Program (NCAP), Toyota Central Driving School developed the relationship graph between velocity (cars), stop distance, and high beam range. The graph is used as the key reference for further analyses of this study. Nonetheless, the graph shows no involved parameters (driver efficiency, vehicle efficiency) and values for the correct braking reaction time. Since the specifics are considered confidential, the authors have, proportionally, re-drawn the graph. The graph can be shown in Figure 1 below:

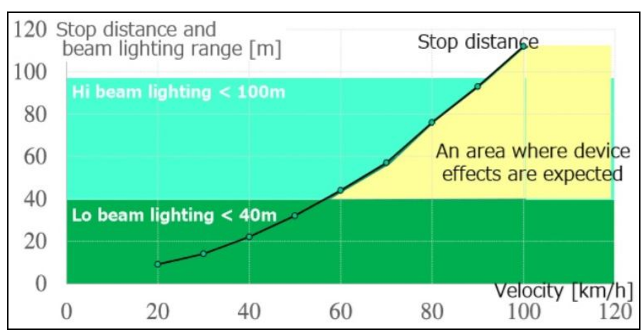

Figure 1 : Japan NCAP – Toyota SSD

The graph does not show an exact formula referred to with stop distance line (SSD)-velocity relation. The aims of this research are therefore: to identify the formula that produced Toyota Central Driving School's stop distance graph, to identify the formula that produced the stop distance graph, and to identify the difference (distance) between stop sight distance (SSD) for levelling surface and flat surface area. Consequently, the results are expected to allow assessment of the potential benefits of luminous intensity on forward visibility, and potential implications for driving safety such as visibility range safety and glare discomfort levels.

2. METHODOLOGY

The ten (10) field experiments were performed during optimal circumstances (i.e. daylight, good weather) at roads within the Universiti Tun Hussein Onn Malaysia campus. The roadways have standard geometric features of a two-lane-two-way with an average width of 7.5 m and flat with high accident levels of road [3]. At a performance, speed of 60 km/h the check conducted braking manoeuvres was measured.

2.1 Field of experiments

Within the Universiti Tun Hussein Onn Malaysia (UTHM) area, a short road track of about 300 meters was selected for experimental purposes, taking into account straight, flat and isolated traffic – safety reasons that were closed during all experimental sessions. The driver was briefed on the study description, and was permitted to practice as directed on driving. When randomly signalled by raising the flag, they were told to apply the brake quickly and their actions were filmed in slow motion so that the vehicle, the brake light, could be seen from the main station [16-18]. In addition, the time between light activation and the initial onset of car brake light activation (i.e. stop light) was registered. The situation can be defined below in Figure 2 and Figure 3.

Figure 2 : Test car drive on site

Figure 3 : Road path site with a common lane width

2.2 Field of experiments

For driven car with speed within the range of 20 km/h – 80 km/h, the road track with a width of 7.5 m was set up. The camera and camcorder stand was kept (static) at the back of the powered vehicles. The stand is 130 cm tall according to the raising template used. It occurred behind the driven car, and can be seen in Figure 4. The distances were among several suggested distances in the evaluation [10]. Recommended the longest distance as the minimum distance beyond which the stop distance range [19] is set.

Measuring brake reaction time and braking distance depended on captured video and camera data. When a vehicle went through an observation site, it recorded its brake light and recorded the camera; time, distance. The camera held a passing vehicle time signature, and this was used to assess moving sequence of vehicles. The field experiments inside UTHM at the local road were performed along 300 meter straight line. At 21.00 hours, all sessions began and the experiment was considered under clear and dry weather conditions. Rare brake system was fitted to the test cars (Myvi Perodua). Manually regulated device that conformed to the requirements. The cars will travel at approximately 20 km/h driving speed – 80 km/h [20-21].

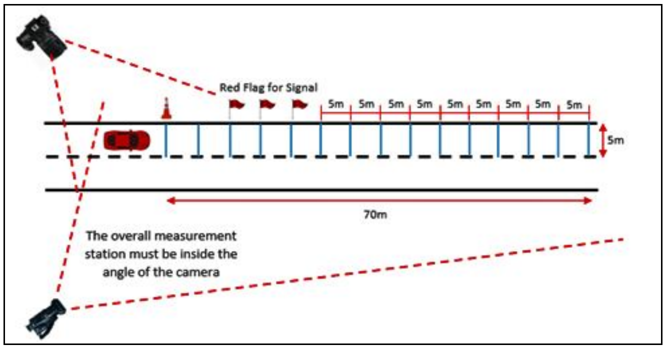

Figure 4 : Equipment set-up and measurement distances

2.3 Stopping Sight Distance (SSD) Experiments

All equipment was mounted on site by setting up the camera for all action recording and placing the cloth tape on the pavement surface of 5 m per side. The vehicle was tested and the driver was asked to familiarize himself with their vehicle, i.e. checking the seats, mirrors, safety belt, etc. as well as brake reaction. Once the car is completely stopped, the braking distance was determined when the flag was raised from the starting point. Repeated the check on braking time.

3. RESULTS AND DISCUSSION

3.1 Brake reaction time

The following tests on brake reaction time were performed using Perodua Myvi. The experiments were setup as shown in Figure 3. The car conducts experiments to find reaction time for the brake, braking distance and stop distance. The study found the overall brake reaction time in the range of 0.4s-1.0s based on an average of ten (10) test drive tests. This is shown in Table 1. Average brake reaction time was found to be 0.7 seconds in the test. The result were still within the range of standard practice used of 0.55s – 2.55s [15].

Table 1 : Brake reaction time

Test no.	Average (seconds)
1	0.90
2	0.70
3	0.60
4	1.00
5	0.60
6	0.60
7	0.90
8	0.70
9	0.60
10	0.40

3.2. Braking distance

The braking distance previously mentioned is the distance that the car moves from the point where you start braking until the car is still standing. Reliable braking distance measurements are very difficult to achieve, as road conditions and the grip of the tyres can differ greatly. For example, when ice is on the road the braking distance may be 10 times longer. The following research was performed with a speed range of 20 km/h-80 km/h finding the average distances of 4.3 m-45.2 m. Table 2 reveals findings of the average braking distances.

Table 2 : Average braking distance

Velocity (km/h)	Average Braking Distance (m)			Average (m)
	Test no.			
	1	2	3	
20.0	4.5	4.6	3.7	4.3
30.0	11.4	10.0	9.6	10.3
40.0	16.3	14.8	14.5	15.2
50.0	23.8	24.9	21.6	23.4
60.0	24.7	29.7	30.4	28.3
70.0	33.4	39.6	32.7	35.2
80.0	48.5	44.3	45.2	45.2

3.3. Stopping sight distance (theoretical and analysis)

The on-site reaction time is determined using the equation below, and the (theoretical) Stop Sight Distance graph is made. It shows the smooth curve of the line as shown in Figure 5 which is based on SSD formula. Figure 5 and Figure 6 further show SSD based on brake reaction time and braking distance.

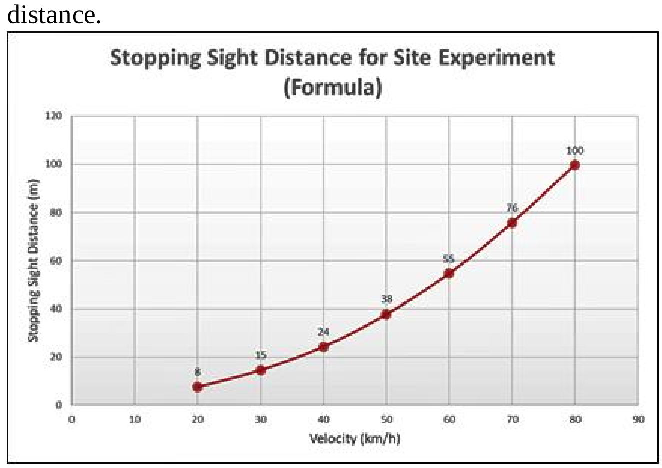

Figure 5 : Stopping sight distance (theoretical)

The two graphs indicate a difference of significance in SSD which can cause the brake reaction time to be measured inaccurately. Additional study can randomly apply location of objects seen by the drivers. Finding time bigger is planned. Figure 7 below shows the contrast of the Stopping Sight Distance (SSD) observed in the United States (levelling), Japan (levelling) [22], Japan NCAP – Toyota and the experiments. It shows a difference in significance between the NCAP study and Japan. Study in the US and Japan found higher SSD levels due to the required levelling road condition. Nonetheless, further research is required to find the reasons for the discrepancy between Japan's NCAP and the analysis.

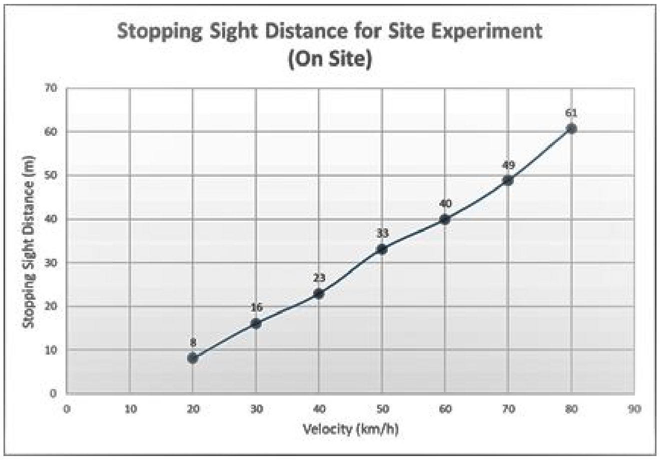

Figure 6 : Stopping sight distance (theoretical)

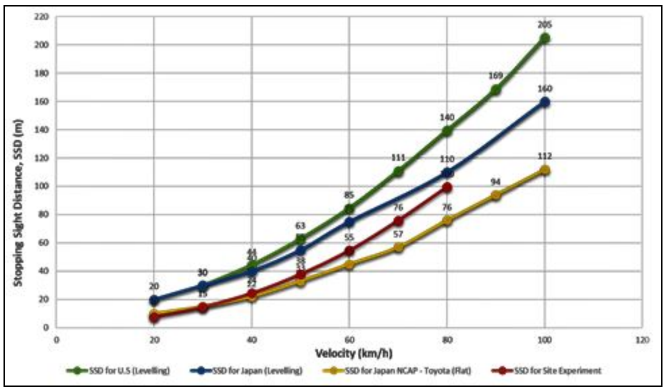

Fig. 7 : Stopping Sight Distance (theoretical)

4. CONCLUSION

The results from the tests and test measurements summarized in this study indicate that stopping distance systems give significant promise to investigate the significance of three major factors in brake reaction time, braking speed, and stopping sight distances, rather than headlight beaming discomfort vehicles that may produce glare. Therefore, while driving at night, the study will come up with significant results for safety improvements of high beam lights efficiency. This in turn contributes to the assumption of braking requirements systems and headlights output systems. Further tests are considered using higher car quality and camera recording for reliable and repeatable performance.

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REFERENCES

1. J.D Bullough, E.T, Donnell, M.S. Rea. **To illuminate or not to illuminate: roadway lighting as it affects traffic safety at intersections**. *Accident Analysis and Prevention*, Vol. 53, pp. 65-77, 2013.
2. Malaysian Institute of Road Safety Research (MIROS) & Road Safety Department Malaysia (JKJR). **Road Safety Plan of Malaysia 2014-2020**, 2014.
3. Insurance Institute for Highway Safety (IIHS). **Effectiveness of Forward Collision Warning Systems with and without Autonomous Emergency Braking in Reducing Police-Reported Crash Rates**, 2016.
4. J. Prasetijo, and W. Z. Zainal, **Development of Continuous Speed Profile Using GPS at Johor Federal Roads F0050.** *MATEC Web of Conferences*, Vol. 47 (03001), 2016. https://doi.org/10.1051/matecconf/20164703024
5. J. Prasetijo, G. Zang, N.A.A. Guntor, B. D. Daniel, M.E. Sanik, **Change of road integrated design consistency due to antiskid transverse rumble strips on high-speed Federal Road FT050.** *Advances in Civil Engineering Materials*, ASTM, Vol. 7 (3), pp. 460-472, 2018.
6. J. Prasetijo, and W. Z. Musa, **Modelling Zero-Inflated Regression of Road Accidents at Johor Federal Road F001**, *MATEC Web of Conferences*, Vol. 47 (03001), 2016.
7. J. Prasetijo, W. Z. Musa, and W. Z. Zainal, **Road Fatality Model Based on Over-Dispersion Data Along Federal Route F0050,** *MATEC Web of Conferences*, Vol. 103 (08012), 2017.
8. M. Hosseinpour, A.S. Yahaya, S.M. Ghadiri, J. Prasetijo, **Application of Adaptive Neuro-fuzzy Inference System for Road Accident Prediction,** *KSCE Journal of Civil Engineering*, Vol. 17, pp. 1761–1772, 2013.
9. J. Prasetijo, M. Hosseinpour, S. M. Ghadiri, **Capacity of Unsignalized Intersections under Mixed Traffic Conditions,** *Procedia Social and Behavioral Sciences*, Vol. 16, pp. 676-685, 2011.
10. M. Africa A.D., Asuncion F.X., Tiberio J.L., A. Munchua R.M.F., **Sensor-based traffic control network with neural network based on control system**, *International Journal of Advanced Trend s in Computer Science and Engineering*, Vol. 8(4), pp. 983-989, 2019. https://doi.org/10.30534/ijatcse/2019/01842019
11. Kulkarni S.R., Agrawal S., S. Manoj, Bhuvanagiri U.B., Priyadarsini M.J.P, **Automated toll booth using optical character recognition and RFID system**, *International Journal of Advanced Trend s in Computer Science and Engineering*, Vol. 8(4), pp. 1056-1061, 2019. https://doi.org/10.30534/ijatcse/2019/11842019
12. Mapa J.S., Sison A.M., Medina R.P., **Road traffic accident case status prediction integrating a modified C4.5 algorithm**, *International Journal of Advanced*

Trend s in Computer Science and Engineering, Vol. 8(5), pp. 2622-2625, 2019. https://doi.org/10.30534/ijatcse/2019/114852019

13. M. Green, **How long does it take to stop? Methodological analysis of driver perception-brake times**. *Transportation Human Factors*, Vol 2, pp. 195–216, 2000.
14. S. Y. Sohn, and R. Stepleman, **Meta-analysis on total braking time,** *Ergonomics*, Vol. 41, pp. 1129– 1140, 1998.
15. S. R. Davoodi, H. Hamid, M. Pazhouhanfar, J. W. Muttart, **Motorcyclist perception response time in stopping sight distance situations,** *Safety Science* Vol. 50(3), pp. 371–377, 2012.
16. J.D. Bullough, **Adaptive high beam systems: Visual performance and safety effects,** *SAE Technical Paper* 2014-01-0431, 2104. https://doi.org/10.4271/2014-01-0431
17. J.D. Bullough, **Vehicle forward lighting: A new look at intelligent adaptive headlamps, safety and performance,** in *Proc. of the VISION 2014 Congress, October 14-15*, 2014.
18. J.D. Bullough, N.P. Skinner, T.T. Plummer, **Adaptive driving beam headlights: visibility, glare and measurement considerations,** *A Transportation Lighting Alliance Report TLA*, 2016-01, 2016.
19. M. J. Flannagan, J. M. Sullivan, **Feasibility of new approaches for regulation of motor vehicle lighting performance,** *MI*: *University of Michigan, Ann Arbor*, 2011.
20. K. Rumar, **Relative merits of the U.S. and ECE high-beam maximum intensities and of two-and four-headlamp systems**, *UMTRI-2000-41*, Ann Arbor, MI: Michigan University, 2000.
21. J.D. Boer, **Public lighting,** *Philips Technical Library*, Eindhoven, Netherlands, 1967.
22. F.L. Mannering, S.S. Washburn, W.P. Kilareski, **Principles of Highway Engineering and Traffic Analysis**, John Wiley, 2009.