IOP Conference Series: Materials
Science and Engineering

Traffic Characteristics of Two-WayTwo-Lane (TWTL) Highway in Iraq: Al-Mishkhab Road As A Case Study

To cite this article: Ahlam K. Al-Zerjawi *et al* 2020 *IOP Conf. Ser.: Mater. Sci. Eng.* **888** 012030

Traffic Characteristics of Two-WayTwo-Lane (TWTL) Highway in Iraq: Al-Mishkhab Road As A Case Study

Ahlam K. Al-Zerjawi[1,*], Hamid A. Al-Jameel[2], Sajad A. Zagroot[3]

[1,2 and 3] Civil Engineering Department, University of Kufa, Najaf, Iraq
*Corresponding author: Email: ahlam.alzerjawi@uokufa.edu.iq

Abstract. Two-Way Two-Lane (TWTL) highways have been developed rapidly throughout the world, and they represent a large percentage of the road network spread about the world. In Iraq, this type of road still has also been adopted widely. Therefore, this study tries to investigate the two-way, two-lane highway characteristics because very few studies have been devoted to studying this topic in Iraq. Three sections of this type of highway have been selected along Al-Mishkhab city as a case study. The data collected include flow, headway, number passing and speed. A speed gun was used to measured speed in the selected sections. The passing frequency was high and amounted to about 240passings/hr. Further, the speed distribution was normal. The results of this study indicate that the number of passing vehicles is up to 240 passes/hr/km at 1200 veh/hr. In addition, as flow increases more than 1200 veh/hr, the number of passing vehicles decreases because of absence the adequate gap for such passing.

Keywords: Two-lane, two-way highway, lane utilization, lane change, headway, passing behavior.

1. Introduction

Two-lane highways are mainly considered as basic element in the highway systems of most countries. For example, in China alone, the total mileage of Two-Lane Two-Way (TLTW) is about 1.4 million Kilometres [1]. Such types of these highways exist in rural areas and are generally characterized by high interaction between vehicles travelling in the same and opposite directions [2, 3]. As volume and geometric restrictions increase, the traffic operational such the ability of passing decreases and the long platoons form. These platoons are one signs of delay because vehicles are unable to pass others [4].
Due to specific interactions between vehicles in the same and opposite directions, TLTW highways have different traffic operations than other types of roads. In particular, lane changes and passing manoeuvres are mainly performed in restricted conditions using the opposing lane when sight distance and suitable gaps are available in the opposing traffic stream. This makes the TLTW highways have specific and unique challenges to traffic analysts [5].

Passing manoeuvres on two-lane two-way rural highways have significant effects on safety, capacity, and service quality; therefore the understanding drivers' passing behaviour can contribute significantly to accurately predicting risk and service quality [6]. The success of an overtaking manoeuver is affected by many factors, including the type of overtaking vehicle, driving style, volume of traffic flow in the opposing direction and the characteristics of the leading vehicle. Therefore, the overtaking manoeuver requires the driver to visualize in advance every detail of what might happen during the manoeuver [7]. Hashim [8] analysed the speed characteristics of rural TWTL highways under existing conditions using empirical data from several study sites on the intercity, rural TLTW roads in Minoufiya Governorate, Egypt. The author discovered that the speed took a constant value at a headway equal to 5 sec or more, confirming that the study sites' speed data had a normal distribution.

2. Passing process

To implement the passing process, the passing demand and supply should occur at the same time and location. The speed difference is the main factor for passing demand. A long enough gap in the opposing traffic and enough sight distance can create the suitable passing opportunity. Desired speed is the speed of a vehicle if unimpeded by other vehicles [9].

Overtaking is an important factor TLTW highway operations. When platooning results from a slow-moving vehicle, large gaps exist downstream of the slow vehicle. The effect of a passing manoeuver on a two-lane highway's operational performance is considered through adjustment factors considering average travel speeds and percent time spent following [2].

In a study on passing on two-lane, two-way rural roads in northern Iraq, Abdul-Mawjoud and Sofia [10] observed more than 28,000 vehicles, and passing manoeuvres were recorded on 10 TLTW highways in 2005. They found that the number of passing manoeuvres increased up to a 130 pass/hr/km as indicated in Figure 1. The passing manoeuvres decreased with the increase in flow rate. The increase in flow rate causes an increase in demand in terms of passing and a decrease in the passing supply [10].

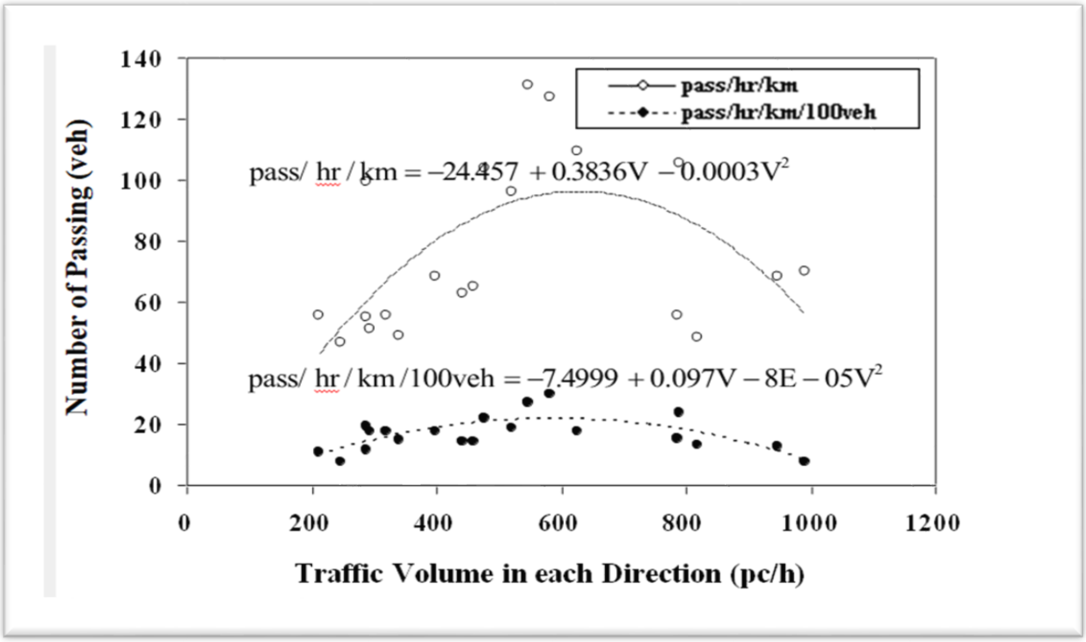

Figure 1. Frequency of passing with total flow [10].

The capacity of TLTW was about 2,650 passenger cars per hour per lane. This value was found to be close to the general (extended section) capacity provided in the Highway Capacity Manual (HCM) [11, 12]. The speeds at which capacity occurs, on the other hand, were lower than the HCM values: about 40 km/hr. versus about 70 km/hr, respectively [10]. Further research on the proper time interval for an analysis of highway capacity and on flow regimes and capacity values for various geometric, terrain, and traffic characteristics is suggested [13].

In the passing process, the speed of the vehicle taking the passing action must be faster than the vehicle being passed, and all vehicles that follow the slow vehicle are forced to keep the same speed as the slow vehicle. Accordingly, the speed of the slow vehicle (passed vehicle) is assumed to be 10 miles per hour lower than that of the passing vehicle. Under the capacity condition, the passing action is closed to zero [15].

3. Data collection

In the current study, data have been collected from all sections using video cameras (32GB). Additionally, a speed gun was used to measure vehicle speed. The selected sections were segments with high to moderate traffic volumes where the terrain was level. Figure 2 indicates the location of each section. Further, all the selected sections were free of road works and maintenance in order to avoid errors in the analysis of the results [16, 17]. In addition, all sections had no curves and no obstacles on the road, such as check points. It was challenging to select the best vantage point from which to monitor the traffic stream because there were no footbridges or any high buildings near the selected sections. Consequently, a wooden structure was mounted on a single unit truck stopped on broad shoulders of the selected roads to ensure the optimum possible coverage of the longest portion of each section. The coverage of 300m and 200m of road was obtained for Section No.1 and Section No. 2 and 3 respectively, which was adopted with consideration for the light columns distributed on the roadsides.

Figure 2. The locations of the sections chosen in Mishkhab-Al Manathira [14].

3.1. Site Description

The three sections selected for this study are on different normal sections of a primary TLTW rural highway in southern Najaf Province in Iraq, starting from the Al Manathira-Mishkhab intersection to the Al Debeneh bridge (at the entrance of Mishkhab city). The selected road is considered an important part of Najaf-Al Muthanna road because it connects cities such as Al-Muthanna, Basrah and Thi-Qar, with Najaf city. Such a connection is especially important during religious events, as people visit the holy shrines in Najaf and Karbala in addition to the commercial ventures on both sides of the road. Section No. 1 was in Silo region of the road under study. The traffic data required was collected for two directions, as indicated in Plate 1.

The next section, Section No. 2, was designated in the Rice research region. Section No.3 was near the entrance of the chosen road. These sections have been selected because they were free from any curvature and traffic disruption which may affect the investigated driver behaviour. These sections should be normal segments [15]. Plates 2 and 3 demonstrate the characteristics these last two sections. Data observations and recordings were conducted in March, April, May and August 2018, as shown in Table 1. The process was conducted during daylight and good weather conditions.

3.2 Geometric design

The geometric design characteristics of the three sections are indicated in Table 2. The total length of case study road is 9.64 km, and each section is 8m wide.

Plate 1. Section No.1 of Mishkhab-Al Manathira road (TLTW).

Table 1. Data collection dates and duration at the different sites.

Section	Dates of data collection	Recording time for two directions
Sec. No.1	21-3-2018	2hr (7:00-9:00)AM
	22-3-2018	2hr (04:35-06:35)PM
	24-8-2018	2hr and45Min(7:05-9:50)AM
Sec. No.2	4-4-2018	2hr (7:40-9:40)AM
	24-8-2018	2hrand 20Min(8:20-10:40)AM
Sec. No.3	5-5-2018	1hr (6:00-7:00)PM
	30-8-2018	2hr (5:00-7:00)PM

Plate 2. Section No.2 of Mishkhab-Al Manathira road (TLTW).

IOP Conf. Series: Materials Science and Engineering **888** (2020) 012030 doi:10.1088/1757-899X/888/1/012030

Plate 3. Section No.3 of Mishkhab-Al Manathira road (TLTW).

4. Data analysis

The collected data were analysed statistically using the SPSS version 19 and Microsoft Excel (2010) programs. According to HCM 2000, there are two types of vehicles to be considered, i.e., passenger cars (PCs) and heavy goods vehicles (HVs). Figure 2 indicates the flow rate for each lane in each direction for each segment case study

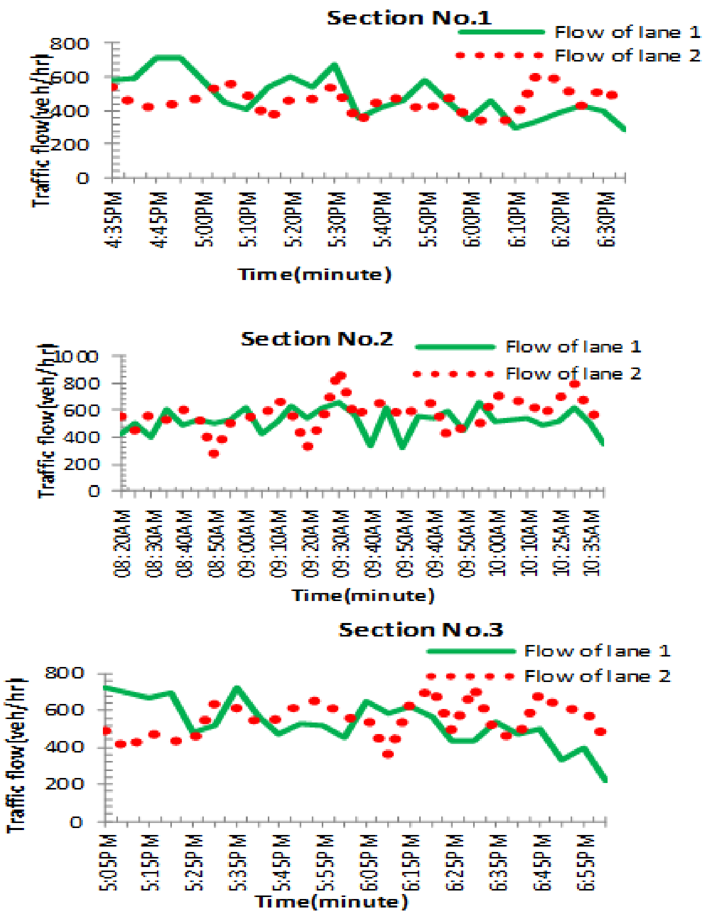

Figure 3. Flow rate for each lane for each section.

Table 2. Geometric design of the road case study.

Sec. No.	Right to AlManathira(m)	left shoulder to Mishkhab(m)	Lane width (m)
Sec. No.1	2.6	5.5	3.8
Sec. No.2	2.6	5.5	3.8
Sec. No.3	2.6	2.8	3.8

4.1 Desired speed

The speed gun (radar speed) (Bushnell Speedster III Radar Gun) was used to measure the desired speed of one vehicle with each key pressed. The speed data collected was recorded manually from the radar's screen.

On the evening of 30 August 2018 on Section No. 3, data were collected in order to calculate the speed of passing vehicles. Plate 4 demonstrates the gun's measuring process. After using the SPSS program, the frequencies of the speeds fit to the normal distribution as indicated in Figure 4.

Plate 4. Details of Site No.3 with the speed gun to measure the speed.

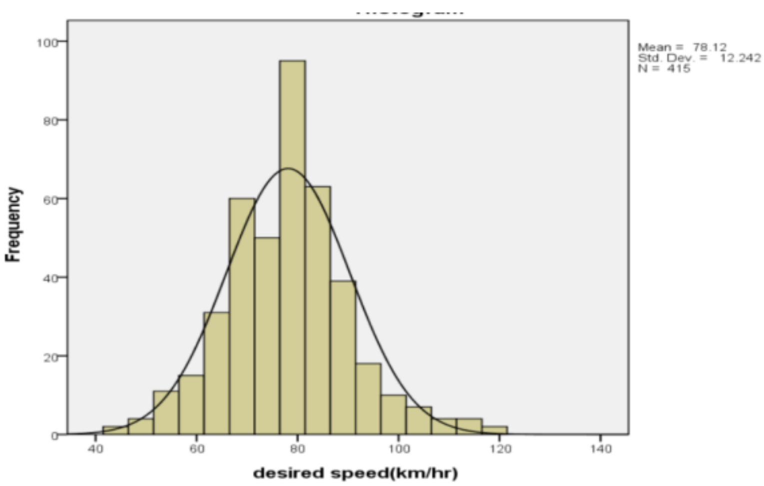

Figure 4. Histogram for the speeds in Section No. 3.

Information for the standardized speed distribution for the sections in this part of study is shown in Table 3. Free flow speed has been collected according to HCM 2010.

Table 3. Desired speed characteristics for Section No.3.

Properties	Lane 1	Lane 2
Standard deviation (km/hr)	12.70	12.2
Mean (km/hr)	79.37	78.12
Free flow speed (km/hr)	112	120

4.2 Frequency of passing

The start and end of each section was determined on the screen of the laptop used for the lane change analyses. At that point, the section under study was observed in order to count the number of vehicles passing from lane 1 to 2 and from lane 2 to 1. In this study, the time interval for analysis was 5 minutes.

A-Section No. 1:

Data were collected during the morning interval on 22 March 2018 (Thursday). Figure 5 shows the relationship between the frequency of passing and total flow (veh/hr). As it is obvious from Figure 6, there were a large number of lane Changing (LC) (168 passing/hr) at a flow of 1152 veh/hr. This behaviour was the result of slow vehicles and trucks travelling on the road.

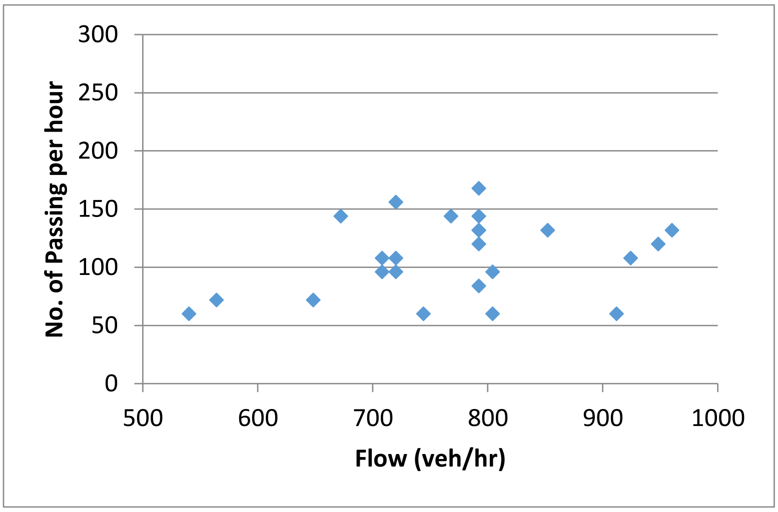

Figure 5. Frequency of passing with total flow for Section No.1.

B-Section No. 2:

The behaviour shown in Figure 6 differs from that observed in Section No. 1. It was clear that as flow increased, the LC (number passing) increased too. At a high flow rate of 1560 veh/hr, the FLC started to decrease because there were insufficient gaps in the opposing lane or there was no speed benefit from undertaking such lane changes. The maximum passing in this section was 204 passes/hr.

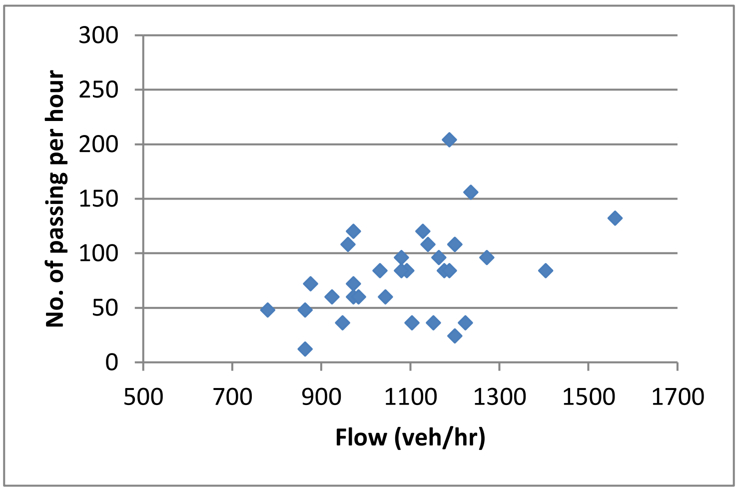

Figure 6. Frequency of passing with total flow for Section No.2.

IOP Conf. Series: Materials Science and Engineering **888** (2020) 012030 doi:10.1088/1757-899X/888/1/012030

C-Section No. 3:
In Section No. 3 the number of passing vehicles was concentrated from180-720 passes/hr/km, contrary to Sections No. 1 and 2. The relationship between flow and passing is still not clear because the maximum number of passing is about 240 passes/hr which corresponds to 1284 veh/hr, as indicated in Figure 7.
The purpose of the collections and analyses was to determine driver behaviour on the selected road in terms of changing speed in order to change lanes. As noted, this process depends on the flow in the opposing direction .Much passing was observed in this study, peaking at 1200 veh/hr due to the increase in the number of heavy trucks and agricultural vehicles travelling on these roads. Then, the number of LCs decreases because the opportunity to get a suitable gap for doing such lane changing or passing reduces due to high density or concentration of vehicles along the section case study.

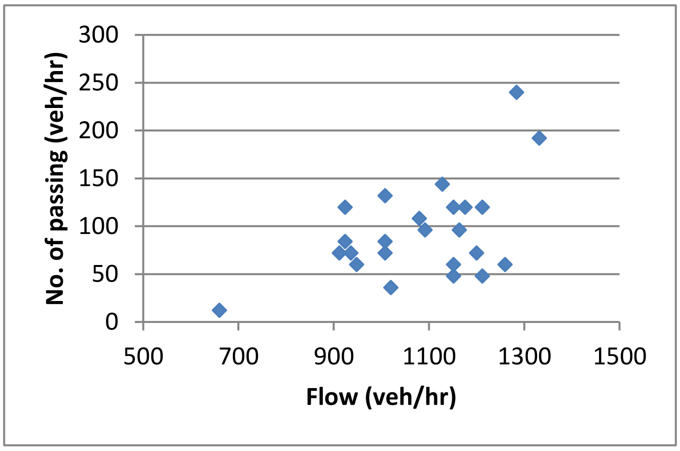

Figure 7. Frequency of passing with total flow for two lane from section No.3.

Generally, the number of passing observing in this study is higher than other studies as mentioned by Abdul-Mawjoud and Sofia [10] in the north of Iraq and as indicated in Figure 1.

4.3 Headway distribution
The vehicle headway is an important micro characteristic of traffic flow that affects the safety, level of service, driver behaviour, and capacity of the transportation system (Al-Jameel and Kadhim, 2017).
Headway time was measured for all sections since their segments each had video recordings. The procedure of counting headway could be summarized by putting a fixed line (such as a coloured tape) on the screen of Personal Computer (PC) and the time from each vehicle on the video cross this line to the next vehicle is the individual headway.
Therefore, at this stage, Section No. 2 was adopted for examination (TWTL). The collected data were recorded on the 24th of August 2018, during which time the flow rate ranges from 864 to 1560veh/hr/2lane. Data used for this section were collected over an one-hour span to test the negative exponential distribution and the shift negative exponential distribution in terms of the distribution of the data.
Plots of the percentage cumulative headway distributions obtained in this study are shown in Figure 8 for Section No.2's two lanes. Vehicle headways were grouped in one second intervals, with most of the headways falling in the 1-3 seconds interval group. From the total 138 observed headways in lane 1, the average headway was 5.13 seconds with a standard deviation of 4.66 seconds. In addition to lane 1, lane 2 is also represented in Figure 8.

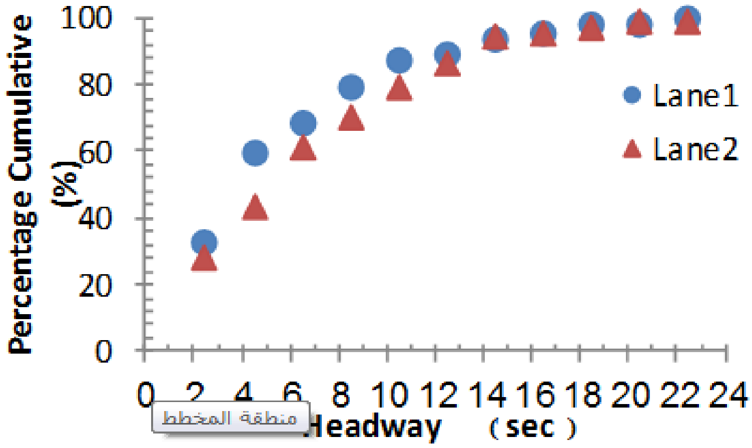

Figure 8. Cumulative headway distributions for lanes 1 and 2.

5. Conclusions

Based on the results, the study's achievements can be summarized as:

1. The number of passing vehicles increases as high as 240 passing/hr, then the number of passing vehicles decreases with increasing flow after 240 veh/hr due to the lack of suitable gap for passing.
2. The free flow speed is distributed as a normal distribution with standard deviation about 12 km/hr and mean about 78 km/hr.
3. The headway distribution on the road was concentrated around 0-3 seconds for lane 1, which represents 67% of the headways collected.

.

6. References

[1] Cheng,G.; Zhang, S.; Wu, L. and Qin, L., "Spacing and geometric design indexes of auxiliary lanes on two-lane highway in China", *Advances in Mechanical Engineering*, Vol. 9(9), (2017),1-9.

[2] Moreno, A., Llorca, C., Washburn, S., Bessa, J., Hale, D., and Garcia, A. (2016), "Modification of the highway capacity manual's two-lane highway analysis procedure for spanish conditions", *Journal of Advanced Transportation*, Vol.50 (8), 1650-1665.

[3] Al-Kaisy, A.; Jafari, A.; Washburn, S.; Lutinnen, T. and Dowling, R., "Performance measures on two-lane highways: survey of practice", *Research in Transportation Economics*, Vol.71, (2015), 61-67.

[4] Jrew, B., and Msallam, M., "Analysis, evaluation and improvement of the level of service of two-lane highways in Jordan", See(Access on 20-10-2018) (https://scholar.google.com/scholar?hl=ar&as_sdt=0%2C5&q=Jrew%2C+B.%2C+and+Msallam%2C+M.+%282016%29.+Analyis%2C+evaluation+and+improvement++of+the+level+of+service+of++two-lane+highways+in+Jordan.+&btnG=)

[5] Durbin, C.,"Traffic performance on two-lane, two-way highways: examination of new analytical approaches", MSc Thesis. Montana State University. Bozeman, Montana (2006).

[6] Dixon, M.; Dyre, B.; Grover, A.; Meyer, M.; Rember, J. and Abdel-Rahim, A., "Modeling passing behavior on two-lane rural highways: evaluating crash risk under different geometric configurations", University of Idaho, U.S, (2013).

[7] Cirianni, F.; Leonardi, G. and Palamara, R., "Overtaking sight distance on two-lane highways: considerations and experimental verifications", *International Journal of Applied Engineering Research*, Vol.11 (18), (2016), 9320-9326.

IOP Conf. Series: Materials Science and Engineering **888** (2020) 012030 doi:10.1088/1757-899X/888/1/012030

[8] Hashim, I., "Analysis of speed characteristics for rural two-lane roads: a field study from Minoufiya governorate", *Ain Shams Engineering Journal*, Vol. 2, (2011), 43–52.

[9] Luttinen, T., "Traffic flow on two-lane highways: an overview", Lahti: Tl Consulting Engineers, Ltd, Finland, (2001).

[10] Abdul-Mawjoud, A.; Sofia, G., "Passing behavior on rural two-lane highways", *Al-Rafidain Engineering Journal*, Baghdad, Iraq, (2014).

[11] Highway Capacity Manual, "Transportation Research Board", Washington, DC, (2000).

[12] Highway Capacity Manual, "Transportation Research Board", Washington, U.S, (2010).

[13] Polus, A.; Craus, J. and Lrvneh, A., "Flow and capacity characteristics for two-lane rural highways", *Transportation Research Record*, Vol. 1320, (1988), 128-134.

[14] Google Earth, https://www.google.com/intl/ar/earth/ (accessed on 25-7-2018).

[15] Zhang, Y., "Scalability of car-following and lane-changing models in microscopic traffic simulation systems", MSc Thesis. Louisiana State University and Agricultural and Mechanical College, (2004).

[16] Al-Jameel, H.,"Developing a Simulation Model for a Three Normal Section Calibrated With Iraqi Field Data", *Babylon First International Engineering Conference, 22-23 December, the Iraqi Journal for Mechanical and Materials Engineering*, University of Babylon, Iraq, (2015).

[17] Al-Jameel, H., and Kadhim, A., "Modeling driver behavior for two and three lane sections of Iraqi rural roads", *Journal of Al-Qadisiya for Engineering Science*, Vol.10 (4), (2017), 431-450.