IOP Conf. Series: Materials Science and Engineering **732** (2020) 012034 doi:10.1088/1757-899X/732/1/012034

The solution of traffic congestion due to side frictions along the market area at national arterial road Tanjungsari Sumedang

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Abstract. Side frictions along the market area of Tanjungsari often cause traffic congestion during peak hours. The traffic congestions are caused by the high frequency of side frictions, which may decrease the effective road capacity. This paper to seek the influence of the dominant side frictions using the degree of saturation, as well as provide some effective alternative solutions to rural standard for 10 years. The two alternatives solutions, such as by widening road up to 2 meters and detouring with widening road up to 3.5 meters. Are the analysis results shows that, the most effective alternative solution is a detouring with widening road up to 3.5 meters because it can correspond with rural standards for next 10 years. The other reason considering the operation of Cisumdawu toll road may reduce traffic flow by 28% to 34% along market area using rural service standard. The predicted result, which relies on degree of saturation when Cisumdawu toll road has been operated is 0,51 for the direction of Bandung-Sumedang, otherwise is 0,74 of Sumedang-Bandung.

1. Introduction

Tanjungsari national arterial road section has a link between city of Bandung with city of Sumedang. Traffic congestion that often occurs is caused by the activity of side frictions in along market area which often disrupt the traffic flow. During the congestion at peak hours, the maximum space mean speed can be reached is 9 km/hour the Bandung-Sumedang direction, while at the Sumedang-Bandung direction is 18 km/hour. The space mean speed was obtained by the simulation results shows that it does not correspond at minimum operational speed for rural standard roads at 50 km/h [1]. Side frictions are defined as the level of interaction between traffic flow and road obstruction activities, such as traffic flow blockages at the shoulder as well as at side roads [2]. Traffic congestions are evaluated by calculating the events or road side activities to determine the class of side frictions [3]. Activities may cause blockage of flows such as public and private transport vehicles that parked on the road [4]. The side frictions are caused by any activities in the shoulders and roadside such as, pedestrians a crossed and a walked along roadway, then unmotorized such as rickshaw, bicycles and delman using along the roadway, stopping, crossing and walking along roadway, and then entering and leaving vehicle at secondary intersection and T-junction [5]. The characteristics of these side frictions, as a basis to determine the number of frequency of side frictions occurred along market area. Therefore, the purpose of this study is to provide the best solution that may increase the capacity of road sections, as well as

solutions that may reduce frequency of side friction dominant interference, in order to correspond for rural standards for 10 years along national arterial road in Tanjungsari at market area.

2. Research methodology

Four stages of research methodology to support the analysis process as follows:

- The formulation of the problem is to answer the two question namely,
  a. What alternative solutions are effective in order to achieve the performance of national roads in the market area fulfill the rural standards for 10 years?
  b. As a basis for consideration, what are the advantages and disadvantages of the effective solution to be applied?
- Conducting field observations to get primary data of geometric road, vehicle volumes, side frictions, the planning of frequency and space mean speed of vehicle. The secondary data, ie traffic flow trends and information on the Cisumdawu operation are collected from any resources.
- The effective solution chosen is to solve the most dominant side frictions and correspond at rural service standard for 10 years.
- Concept of analysis by reducing the frequency of side frictions for the cause of entering and leaving vehicles through a detour solution and increasing the capacity of roads by widening solutions.

3. Characteristic of alternative solution

Alternative simulation of solutions carried out in widening the road of 2 meters in every lane (simulation-I), and the diversion of traffic flow by detouring as and widening the road of 3.5 meters on the Sumedang-Bandung route (simulation-II). The characteristics of alternative solutions are carried out, evaluating based on strengths and weaknesses in order to provide the best solution, with several suggestions for the consideration of implementation.

3.1. Alternative solution-I

The widening of Sumedang-Bandung road in the simulation-I is done by increasing the width of the road sections of both side of the main road as shown in figure 1. The solution has the advantage that is the traffic flow remain constant, but the frequency of side frictions cannot be reduced.

3.2. Alternative solution-II

Diverting traffic flow as an alternative solution to solve the interference due to any side frictions, such as entering and leaving vehicles. Diverting the traffic flow is done by eliminating the access of vehicles that may cross from the primary to secondary road or vice versa, so that the traffic flow is directed towards the nearest U-turn [6]. It is to reduce any conflicts at the intersection and T-junction figure 1. The route of traffic flows going in and out is applied in one direction at the intersection and T-junction points. In addition, road widening is carried out on the Sumedang-Bandung route by increasing the width of the road to the side of the market area, as shown in figure 2. So that the alternative solutions have the advantage that is, the frequency of entering and leaving vehicle disruption can be reduced, but the impact of flow diversion causing traffic flow increased at the intersection (STA-13) and T-junction (STA-12).

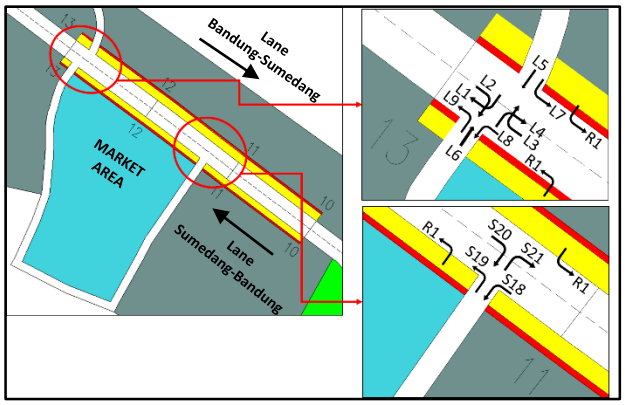


Figure 1. Route entering and leaving vehicle existing condition at secondary road along market area, with widening road using simulation-I

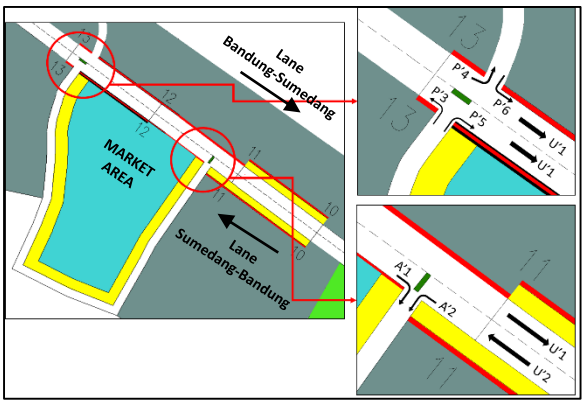


Figure 2. Route entering and leaving vehicle after making a detour solution at along market area, with widening road with simulation-II

4. Analysis solutions for traffic congestion influence side friction

The analysis of congestion solutions namely, 1) calculating the degree of saturation of each alternative solution, 2) looking for a dominant side frictions based on the highest degree of saturation, 3) finding the best alternative solution that correspond to rural standard during peak hour, 4) determining the best solution over a period of 10 years.

4.1. Analysis of simulations using traffic congestion parameters

The total traffic flow for existing simulation and simulation-I at peak hours is 1,512 pcu/hour on the Bandung-Sumedang line and 1,896 pcu/hour on the lane Sumedang-Bandung on all stations While the total traffic flow that increased due to diversion (simulation-II) on the Sumedang-Bandung route became 2,168 pcu/hour at STA-13 of 2,340 pcu/hour at STA-12 and at STA-11 remained unchanged. Then the basic capacity (Co) value is 1,550 pcu/hour for simulation-I, while simulation-II is 1,700 pcu/hour for 2 lanes. And then to determine the value of effective capacity at each STA, using the minimum value of the side frictions adjustment factor. Even though the traffic flow increases due to a detouring flow, the value of basic capacity by simulation-II can increase. So the value of the degree of saturation of simulation-II throughout the STA, can correspond of the rural standards, with the results shown in figure 3.

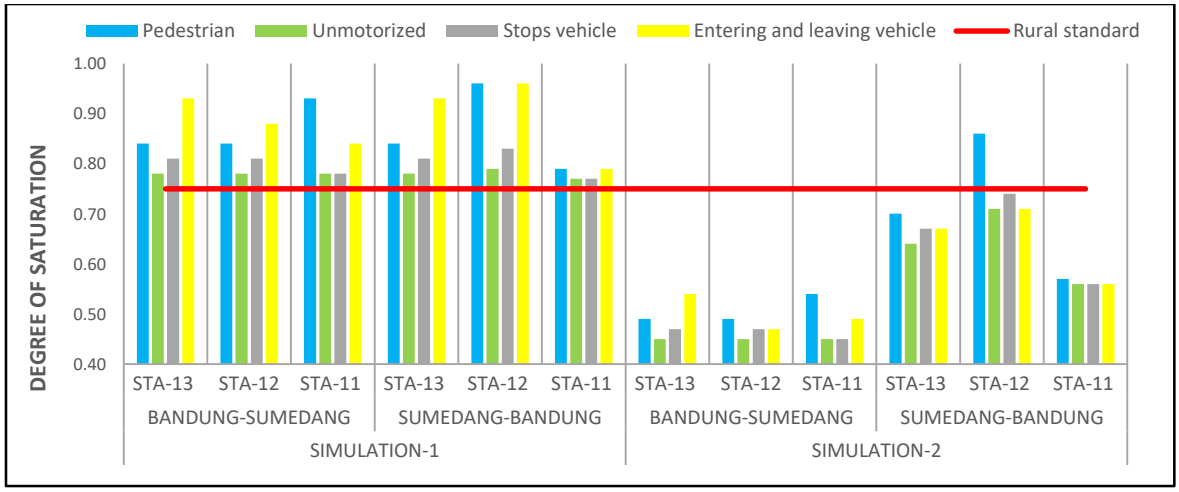


Figure 3. Value of degree saturation due to side frictions for all alternative solution every road points.

4.2. Analysis using the degree of saturations parameters

The percentage of side frictions, weighting is obtained by converting the value of the side frictions adjustment factor (FCHS), which is to find out how much the frequency of the side frictions can influence on capacity value, with the results shown in table 1 and table 2. So the equation for determining the percentage weighting of side frictions on each shoulder should be:

$$\mathbf{Csf = 100\% - FCHS}$$

Where :

Csf : Classification frequency of side friction an every witdh effective shoulder

FCHS : Side frictions adjustment factors based on Indonesian road capacity manual [7].

The frequency of side frictions, between existing conditions and the simulation-I did not change, so the influence of side frictions entering and leaving of vehicles remain more dominant than pedestrians, as the alternative solution scenario shown in table 2 [1]. Then after the traffic flows diversion is carried out, the pedestrian side frictions effect becomes more dominant than the entering and leaving vehicle, as shown by the alternative solution scenario in table 2 [1].

Table 1. Percentage weighting for side frictions factors.

Classification frequency of side friction (Csf)	0,5 meters	1 meters	1,5 meters
Very high	20%	17%	12%
High	17%	13%	9%
Medium	12%	9%	6%
Low	7%	5%	3%
Very Low	3%	1%	0%

Table 2. Existing conditions and simulations alternative solutions-I.

Side frictions variables	Bandung-Sumedang			Sumedang-Bandung		
	STA 13 (1m)	**STA 12 (1m)**	**STA 11 (1m)**	**STA 13 (1m)**	**STA 12 (0,5m)**	**STA 11 (1,5m)**
[1]Scenario of simulation: Existing conditons and simulation-I						
Pedestrian	Medium	Medium	Very high	Medium	Very high	Medium
Entering and leaving vehicle	Very high	High	Low	Very high	Very high	Low
[2]Scenario of simulation : Existing and simulation-II						
Pedestrian	Medium	Medium	Very high	Medium	Very high	Low
Entering and leaving vehicle	Very high	Low	Low	Low	Very low	Very low

Symbols

Yellow : The first influence of side frictions dominant

Green : The second influence of side frictions dominant

(m) : The width shoulders effective

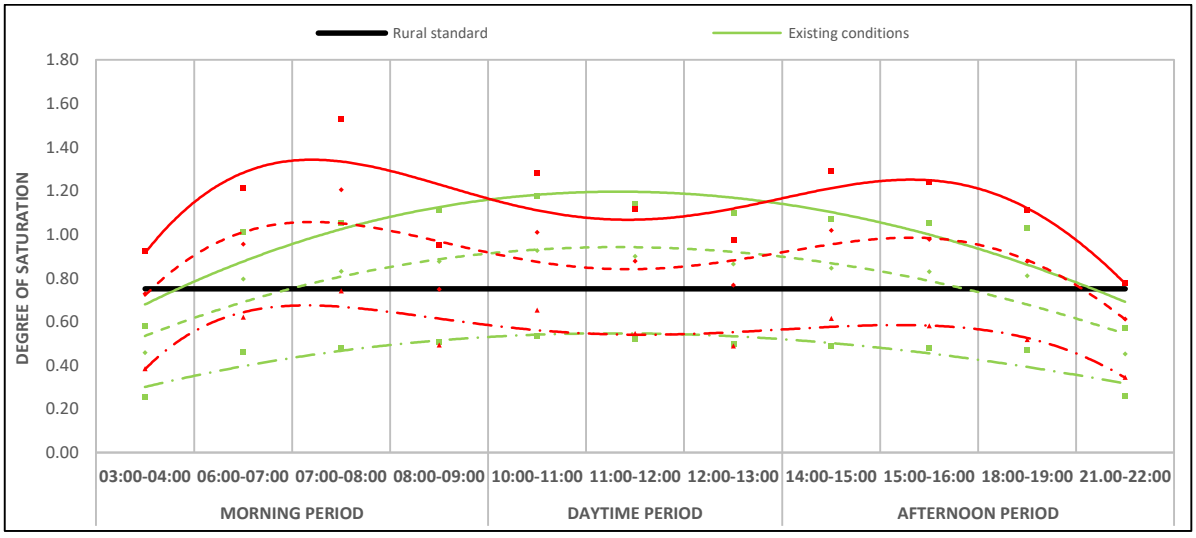
4.3. Analysis of peak hours parameters

Alternative solutions with simulation-I can only reduce the time of congestion compared to existing conditions. An effective alternative solution to reduce congestion at all peak hours is by the detouring solution by widening road of 3.5 meter (simulation-II) because it may correspond to rural standard, as shown in figure 4.

4.4. Analysis for traffic predictions during 10 years period

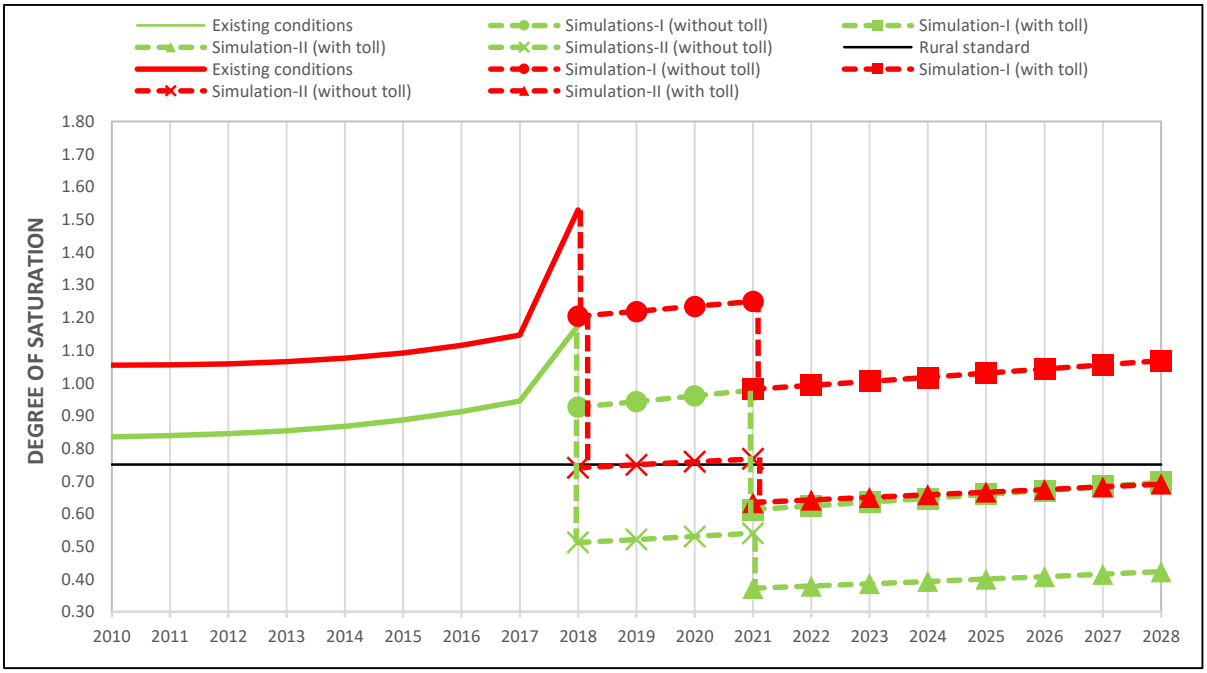
The scenario analysis of congestion predicted evaluation is divided into 2 stages, has follows, (1) the scenario when the Cisumdawu toll road has not going to be operated, (2) the scenario when the Cisumdawu toll road has been operated. The purpose of the scenario when the Cisumdawu toll road has not been operated is, to ascertain whether alternative solutions still meet or not, against of rural standards until 2028. The calculation of the degree of saturation when the Cisumdawu toll road operated in 2021,

is obtained based on the percentage of rural vehicles going to for the Cisumdawu toll, with a percentage of 34% in the lane of Bandung-Sumedang and 28% in the lane Sumedang-Bandung. The analysis results show that simulation-II on the lane Sumedang-Bandung cannot correspond of the rural standards if the Cisumdawu toll road has not been operated, as shown in figure 5. Therefore, it is necessary to divert traffic flow to the Cisumdawu toll road by 28% to remain correspond of the rural standards until 2028.



(Green line : Bandung-Sumedang) ; (Red line : Sumedang-Bandung)

Figure 4. Peak hours characteristic conditions for simulations alternative solutions.



(Green line : Bandung-Sumedang) ; (Red line : Sumedang- Bandung)

Figure 5. Predictions of traffic congestion during 10 year period for scenario at Cisumdawu toll road not operate and operating

5. Results and discussions

The considerations of alternative solutions by widening road upto 2 meters (simulation-I): If an alternative simulation-I is to be used over a period of 10 years, a special attention is needed on the lane Sumedang-Bandung, because the increase of traffic flow by 2.35% on the Sumedang-Bandung is higher than the Bandung-Sumedang, so that can be done in order to suitable with the to rural standard. The percentage rural traffic flow into Tanjungsari market can be diverted to the Cisumdawu toll road by greater than 28%.

Consideration of alternative solutions with detouring and widening up to 3.5 meters (simulation-II): If there are no changes of the width of the road until 2028 or the Cisumdawu toll road has not been operated, the traffic congestion will decrease by 48% on the Bandung-Sumedang and 45% on the Sumedang-Bandung compared existing conditions. If the simulation-II is used for the period of 10 years, then percentage rural traffic flows to Tanjungsari market area can be diverted to the Cisumdawu toll road by 28%, so that it will fulfill the rural standards until 2028.

Other considerations according to alternative solutions are as follows :

- By increasing the width of the road by 3.5 meters in every lane on the detour roadway, or the increased road as wide as of the main road. It can also reduce the traffic congestion and reduce the frequency of side frictions caused by entering and leaving vehicles. However it is necessary to diverted rural traffic flow into the Tanjungsari market area. It may reduce the traffic to Cisumdawu toll road by 28%.
- Increasing the width roadway by 3.5 meters without diversion, the traffic flow remains congestion, due to entering and leaving vehicles the intersection and the T-junction of the secondary roads at the Tanjungsari along market area.

6. Conclusions

The best alternative solution can reduce the traffic congestion for a period of 10 years. Using detour solutions and road widening as 3.5 meters, the degree of saturation result 0.51 on lane Bandung-Sumedang, whreas Sumedang-Bandung lane is 0.74. It can reduce the traffic congestion and the frequency of dominant side frictions. Advantages and disadvantages are as follows :

The Advantages :

- The frequency of side frictions entering and leaving of vehicles can be reduce by detour solutions, because disruption due to vehicles flows can be eliminated.
- The lane Bandung-Sumedang have been imposed in one direction at the intersection and T-junction corresponds to the rural standard.

The Disadvantages :

- The traffic flow increases at the now existing conditions on lane the Sumedang-Bandung, because the impact of detouring solutions. The degree of saturation is 0.85 in 2028, which does not fulfill rural standard. However, it will fulfill when the Cisumdawu toll road has been operated.
- It is necessary to widen the road in equal measurement at all station to reduce the queue at intersection and T-junction along the market area.

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