3. PANTURA JAVA NATIONAL ROAD, INDONESIA

Pantura (Pantai Utara) Java national road, in Indonesia is located along North Java Island and across five provinces i.e. Banten Province, DKI Jakarta, West Java Province, Centre Java Province, and East Java Province, in Indonesia. Pantura Java national road has 1,100 km long and carries 20,000 up tp 40,000 vehicles per day (Kirmanto, Djoko, **http://koran-jakarta.com/index.php/detail/view01/97465**, accessed 25 October 2012). Head of public relation of Indonesian Police said that from all of road crashes, 60.6 percent occurred on Pantura Java national road. Figure 1 describes map of Pantura Java national road, in Indonesia and Figure 2 shows an example of blackspot location in national road Pantura Java i.e. national road Sutomo, Pekalongan Kota, Centre Java, Indonesia (Jurnas.com, 2011).

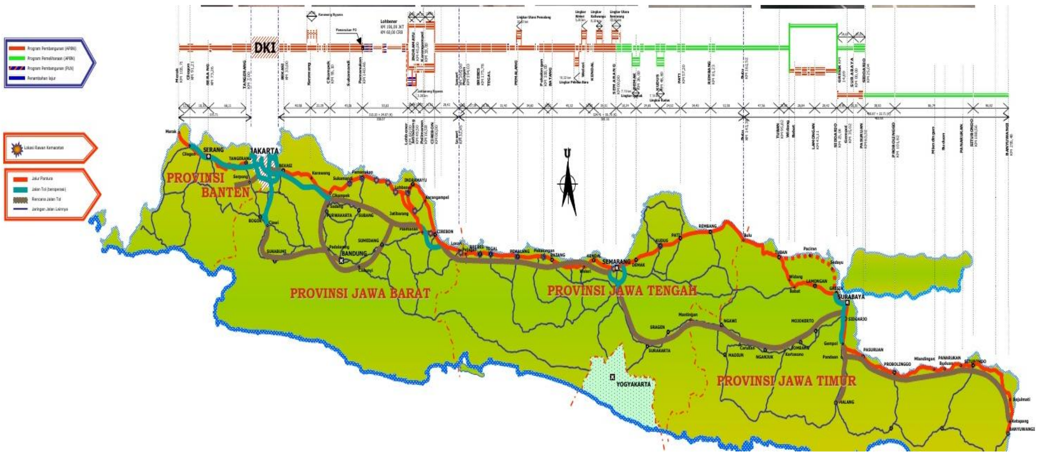

Figure 1. Map of national road, Pantura Java, Indonesia (**www.ardhosting.com**, 2012)

Figure 2. National road Sutomo, Pekalongan Kota, Centre Java, Indonesia.

4. DATA COLLECTION

Case study is carried out on "Centre Java Pantura" national road in Java Island, Indonesia, wherein accident data is well recorded. Centre Java Pantura national road has 383 km long. Survey method is used to collect primary data, include road geometric data, road pavement surface data, and road furniture data. Moreover, accident data as a secondary data is needed to determine locations of “blackspot”, and obtained from Police of Centre Java Province, Indonesia. Video camera, GPS MAP, laser distance meter, and digital water-pass are used as tools to collect the field data.

Table 1 shows detail accident data of sixteen road segment locations of Centre Java Pantura national road as locations with high number of accidents according to Police of Centre Java Province. Since detail of road geometric data, road pavement surface data, and road furniture data of every location presented in Table 1 are too many, therefore in this study location 6 is chosen as an example of location that has the most accidents happen (15 times) with fatal casualty. Road geometric data, road pavement surface data, and road furniture data of location 6 on Centre Java Pantura national road is presented in Table 5. Table 5 is also use in Section 5 Road Safety Analysis.

5. ROAD SAFETY ANALYSIS

Road safety analysis is done based on field data collected, i.e. road geometric data, road pavement surface data, and road furniture data of Centre Java Pantura national road presented in Table 5 and accident data in one year of Centre Java Pantura national road presented in Table 1. Based on the results of analysis, recommendations can be provided to reduce deficiency of road safety and then making road safer.

Definition of blackspot is different among countries. The definition is the basic to analyze road safety in order to determine blackspot location. In Victoria, Australia, definition of blackspot is three crashes happen that cause fatal casualty during five year (Direktorat Jenderal Bina Marga and IndII, 2010). In New Zealand, definition of blackspot is crash in urban area in radius of 30 meter or crash in open space in radius of 250 meter, and three or more accidents cause fatal casualty or heavy injured during three year (Ministry of Transport, 2009).

In Indonesia, analysis can be done using analysis by Direktorat Jenderal Bina Marga and IndII, (2010), Mulyono (2009) and Direktorat Jenderal Bina Marga (2007). Probability of crash happen because of road safety deficiency is presented in Table 2. Fatality impact of accident is presented in Table 3. Whereas risk value and recommendation to improve the road safety are presented in Table 4.

Table 2. Probability of crash happen because of road safety deficiency
(Direktorat Jenderal Bina Marga and IndII, 2010; Mulyono, Agus Taufik. et all, 2009; and Direktorat Jenderal Bina Marga, 2007)

Difference between measured dimension in field and technical standard	Qualitative Value	Quantitative Value
< 10%	Accident never happen	1
10% - 40%	5 accidents per year	2
40% - 70%	5-10 accidents per year	3
70% - 100%	10-15 accidents per year	4
> 100%	More than 15 accidents per year	5

Tabel 3. Fatality impact of accident
(Direktorat Jenderal Bina Marga and IndII, 2010; Mulyono, Agus Taufik. et all, 2009; and Direktorat Jenderal Bina Marga, 2007)

Evaluation result of casualty on the road	Qualitative Value	Quantitative Value
Property damage only	Very light	1
Light injured and property damage only	Light	10
Heavy injured, no potential of fatality with/without property damage only	Moderate	40
Heavy injured, potential of fatality with/without property damage only	Heavy	70
Fatality injured with/without property damage only	Very heavy	100

Table 4. Risk value and recommendation to improve the road safety
(Direktorat Jenderal Bina Marga and IndII, 2010; Mulyono, Agus Taufik. et all, 2009 and Direktorat Jenderal Bina Marga, 2007)

Risk Analysis		Action to reduce road deficiency and improve road safety
Risk Value	Risk Category	
< 125	Not Danger	Routine monitoring with scheduled road safety inspection of locations with high potential of occurred accident
125 – 250	Danger Enough	Need unscheduled technical arrangement based on results of road safety inspection at the location
250 – 375	Danger	Need technical arrangement at least 2 months after having results of road safety audit
>375	Very Danger	Need total technical arrangement with stakeholders at least 2 weeks after having results of road safety audit

Table 1. Detail accident data of Centre Java Pantura national road

Location	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Number of accident	8	6	8	7	4	15	5	5	4	4	3	3	5	6	6	3
Fatality	1	0	1	1	1	1	1	1	1	1	1	1	0	1	1	1
Heavy injury	0	1	1	1	1	1	0	1	0	0	1	2	1	0	0	1
Light injury	0	2	1	1	1	2	0	1	0	0	1	0	1	1	0	0
Weather	clear	clear	clear	clear	clear	clear	clear	clear	clear	clear	clear	clear	clear	clear	clear	clear
Road condition	good	good	good	good	good	good	good	good	good	good	good	good	good	good	good	good
Vehicle	motorcycle	motorcycle	bus	bus	bus	motorcycle	motorcycle	motorcycle	bus	motorcycle	truck	motorcycle	motorcycle	truck/bus	motorcycle	motorcycle
Type of accident	front-end	front-end	front-front	pedestrian	side	side	pedestrian	front-front	pedestrian	single	front-end	front-end	front-front	side	front-front	front-front
Traffic controller	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Form of road	straight	straight	straight	straight	straight	straight	straight	straight	straight	straight	straight	straight	straight	straight	straight	straight

Legend:

1. Diponegoro street, Wanasari Brebes Subdistrict - Centre Java
2. DR. Ciptomangunkusumo street, Kel. Kaliangsa, Margadana Subdistrict, Tegal - Centre Java
3. Raya Pantura street Ds. Kedungkelor, Demangharjo Subdistrict, Warurejo Regency, Tegal - Centre Java
4. Petarukan street, Petarukan Subdistrict, Pemalang km - 128 Semarang - Cirebon - Centre Java
5. Raya A. Yani street, km 109 Wiradesa Subdistrict, Pekalongan Regency - Centre Java
6. Sutomo street, Pekalongan City - Centre Java
7. Raya Jatisari street, Suban Batang Subdistrict km - 71 Semarang Cirebon - Centre Java
8. Raya Tulis street, Tulis Batang Subdistrict km - 82 Semarang Cirebon - Centre Java
9. Raya Kandeman street, Kandeman Subdistrict, Batang Regency, km - 88 Semarang Cirebon - Centre Java
10. Raya Soekarno Hatta street, 80 Kendal - Centre Java
11. Raya Kaligawe street, Depan CPU Pakan Ternak Kali Babon Semarang - Centre Java
12. Perintis Kemerdekaan street, Watugong Semarang - Centre Java
13. Raya Karangtowo street, Karangtengah Subdistrict, Demak km - 18.700 Semarang - Cirebon - Centre Java
14. Kudus -Pati street, Ds. Gondoharum Jekulo Subdistrict, Kudus Regency - Centre Java
15. Pati - Kudus street, Ds. Sukoharjo Margorejo Subdistrict, Pati Regency - Centre Java
16. Raya Pati Juwana street, Desa Widoro Kandang Depan SPBU Cangkring , Pati Regency - Centre Java

Using Table 2, Table 3, and Table 4, analysis to determine blackspot location is done. For example, road safety deficiency analysis based on field data of location 6 is provided in Table 5a, Table 5b, and Table 5c. The same analysis is done to other locations. Action program to decrease road safety deficiency and making road safer for all locations is presented in Table 6. Furthermore, Figure 3 presents example of detail recommended solutions in increasing road safety deficiency in order to make safer road of Location 6 i.e. implementation of speed limit sign and road lighting along the road.

Table 5.a. Analysis of road safety deficiency based on geometric road condition and accident data of Location 6

Field Data		Technical	Measured	Difference	Probability	Fatality impact (person)			Impact	Risk	Risk	Action Recommended
Aspect	Dimension	Standard	dimension	(%)	Value	FI	HI	LI	Value	Value	Category	
Stopping sight distance	m	120	100	17	2	0	0	0	1	2	ND	Routine monitoring
Passing sight distance	m	550	300	45	3	0	0	0	1	3	ND	Routine monitoring
Turning radius	m	210	200	5	1	0	0	0	1	1	ND	Routine monitoring
Lane width	m	3,5	3,41	3	1	0	0	0	1	1	ND	Routine monitoring
Shoulder width	m	2	0,8	60	3	0	0	0	1	3	ND	Routine monitoring
Elevation difference shoulder vs traveled way	cm	< 1	2	200	5	0	0	0	1	5	ND	Routine monitoring

Legend:
FI = Fatal Injured; HI = Heavy Injured; LI = Light Injured
ND = Not Danger; DE = Danger Enough; D = Danger; VD = Very Danger

Table 5.b. Analysis of road safety deficiency based on road pavement surface condition and accident data of Location 6

Field Data		Technical	Measured	Difference	Probability	Fatality impact (person)			Impact	Risk	Risk	Action Recommended
Aspect	Dimension	Standard	dimension	(%)	Value	FI	HI	LI	Value	Value	Category	
Pothole (ϕ 25 cm d > 10 cm)	m^2/km	< 100	0	0	1	0	0	0	1	1	ND	Routine monitoring
Rutting	m^2/km	< 100	0	0	1	0	0	0	1	1	ND	Routine monitoring
Deformation d > 10 cm	m^2/km	< 100	0	0	1	0	0	0	1	1	ND	Routine monitoring
Bleeding (slipery)	m^2/km	< 200	200	1	1	0	0	0	1	1	ND	Routine monitoring

Legend:
FI = Fatal Injured; HI = Heavy Injured; LI = Light Injured
ND = Not Danger; DE = Danger Enough; D = Danger; VD = Very Danger

Table 5.c. Analysis of road safety deficiency based on road furniture condition and accident data of Location 6

Field Data Aspect	Technical Standard	Measured dimension	Difference (%)	Probability Value	Fatality impact (person) FI	HI	LI	Impact Value	Risk Value	Risk Category	Action Recommended
Speed limit sign											
· number of signs	2	0	100	5	1	1	2	100	500	VD	Total technical arrangement
· Number of sign locations	4	0	100	5	0	0	0	1	5	ND	Routine monitoring
· Condition (%)	100	0	100	5	0	0	0	1	5	ND	Routine monitoring
Guide sign											
· number of signs	6	0	100	5	0	0	0	1	5	ND	Routine monitoring
· Number of sign locations	6	0	100	5	0	0	0	1	5	ND	Routine monitoring
· Condition (%)	100	0	100	5	0	0	0	1	5	ND	Routine monitoring
Marking											
· Availability	available	available	0	5	0	0	0	1	5	ND	Routine monitoring
· Condition (%)	100	50	50	3	0	0	0	1	3	ND	Routine monitoring
Road lighting											
· Availability	available	n/a	100	5	0	0	0	1	5	ND	Routine monitoring
· Distance between road lighting	60	0	-100	1	0	0	0	1	1	ND	Routine monitoring
· Position to the roadside (m)	4	0	0	1	0	0	0	1	1	ND	Routine monitoring
Signal	available	available	0	1	0	0	0	1	1	ND	Routine monitoring
Median											
· Width (m)	2	0	100	5	0	0	0	1	5	ND	Routine monitoring
· Height (m)	0.4	0	100	5	0	0	0	1	5	ND	Routine monitoring
Guardrail											
· Long (m)	10	0	100	5	0	0	0	1	5	ND	Routine monitoring
· Height (m)	1	0	100	5	0	0	0	1	5	ND	Routine monitoring

Legend:
FI = Fatal Injured; HI = Heavy Injured; LI = Light Injured
ND = Not Danger; DE = Danger Enough; D = Danger; VD = Very Danger

Table 6. Action program to decrease road safety deficiency and increase road safety

LOCATION	ROAD GEOMETRIC CONDITION		ROAD SURFACE CONDITION		ROAD FURNITURE CONDITION		ACTION PROGRAM
	Risk Value	Risk Category	Risk Value	Risk Category	Risk Value	Risk Category	
1	300	D	1	ND	5	ND	Technical arrangement of road geometric condition at least 2 months after having results of road safety audit. Routine monitoring with scheduled road safety inspection of road pavement surface condition and road furniture condition.
2	5	ND	1	ND	350	D	Technical arrangement of road furniture at least 2 months after having results of road safety audit. Routine monitoring with scheduled road safety inspection of road geometric condition and road pavement surface condition.
3	300	D	2	ND	5	ND	Technical arrangement of road geometric condition at least 2 months after having results of road safety audit. Routine monitoring with scheduled road safety inspection of road surface condition and road pavement furniture condition.
4	5	ND	1	ND	500	VD	Technical arrangement of road furniture at least 2 weeks after having results of road safety audit. Routine monitoring with scheduled road safety inspection of road geometric condition and road pavement surface condition.
5	3	ND	1	ND	500	VD	Technical arrangement of road furniture at least 2 weeks after having results of road safety audit. Routine monitoring with scheduled road safety inspection of road geometric condition and road pavement surface condition.
6	5	ND	1	ND	500	VD	Technical arrangement of road furniture at least 2 weeks after having results of road safety audit. Routine monitoring with scheduled road safety inspection of road geometric condition and road pavement surface condition.
7	3	ND	2	ND	500	VD	Technical arrangement of road furniture at least 2 weeks after having results of road safety audit. Routine monitoring with scheduled road safety inspection of road geometric condition and road pavement surface condition.
8	300	D	2	ND	5	ND	Technical arrangement of road geometric condition at least 2 months after having results of road safety audit. Routine monitoring with scheduled road safety inspection of road pavement surface condition and road furniture condition.
9	3	ND	1	ND	500	VD	Technical arrangement of road furniture at least 2 weeks after having results of road safety audit. Routine monitoring with scheduled road safety inspection of road geometric condition and road pavement surface condition.
10	5	ND	1	ND	500	VD	Technical arrangement of road furniture at least 2 weeks after having results of road safety audit. Routine monitoring with scheduled road safety inspection of road geometric condition and road pavement surface condition.
11	5	ND	1	ND	500	VD	Technical arrangement of road furniture at least 2 weeks after having results of road safety audit. Routine monitoring with scheduled road safety inspection of road geometric condition and road pavement surface condition.

Table 6. Action program to decrease road safety deficiency and increase road safety (continue)

LOCATION	ROAD GEOMETRIC CONDITION		ROAD SURFACE CONDITION		ROAD FURNITURE CONDITION		ACTION PROGRAM
	Risk Value	Risk Category	Risk Value	Risk Category	Risk Value	Risk Category	
12	300	D	1	ND	5	ND	Technical arrangement of road geometric condition at least 2 months after having results of road safety audit. Routine monitoring with scheduled road safety inspection of road pavement surface condition and road furniture condition.
13	5	ND	1	ND	350	D	Technical arrangement of road furniture at least 2 months after having results of road safety audit. Routine monitoring with scheduled road safety inspection of road geometric condition and road pavement surface condition.
14	5	ND	1	ND	500	VD	Technical arrangement of road furniture at least 2 weeks after having results of road safety audit. Routine monitoring with scheduled road safety inspection of road geometric condition and road pavement surface condition.
15	5	ND	1	ND	500	VD	Technical arrangement of road furniture at least 2 weeks after having results of road safety audit. Routine monitoring with scheduled road safety inspection of road geometric condition and road pavement surface condition.
16	3	ND	1	ND	500	VD	Technical arrangement of road furniture at least 2 weeks after having results of road safety audit. Routine monitoring with scheduled road safety inspection of road geometric condition and road pavement surface condition.

Figure 3. Detail recommended solutions in increasing road safety deficiency and making road safer at Location 6 Centre Java, Indonesia.

In conclusion, it can be analyzed that based on action program to decrease road safety deficiency and making road safer presented in Table 6, all of 16 locations can be indicated as blackspot locations. Moreover, in general road geometric condition and road pavement surface condition is in a good condition because the case study is national road that has straight road and has also to fulfill the requirement condition. Nevertheless, based on data in Table 1, motorcycle as a large part of vehicles in Indonesia is the highest cause of accident on Pantura national road. And all accident happened in clear weather.

Furthermore, based on previous analysis, recommended solution that can be applied in the field in order to reduce road safety deficiency and making the road safer are as follow:

- Identification of road safety deficiency should be done regularly with schedule in order to have up to date, complete, and accurate database of road condition;
- Based on available database including road geometric data, road pavement surface data, road furniture data, and accident data, blackspot locations can be determine;
- Action program to reduce road safety deficiency and making the road safer especially at blackspot locations can be done;
- Road safety audit by road authority should be done regularly and any result reported from the road safety audit should be followed in order to reduce not only number but also rate of accident.
- All stakeholders including government, police department, society, and academic expert have responsibility to make safer road.

6. CONCLUSIONS

This study focuses on road safety problem in Indonesia. Using survey method, road geometric data, road pavement surface data, and road furniture data are collected to identify the road safety deficiency, whereas well recorded accident data are obtained from Police of Centre Java Province. Based on availability of accurate data of road safety deficiency, "blackspot" locations can be determine and furthermore specific recommended solution can be provided to reduce the road safety deficiency and making road safer. The detail results of the study are not only beneficial for Indonesian government in order to make policy in increasing safer road in Indonesia but also beneficial to increase safer road in other developing countries that have similar road conditions like Indonesia.

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