EFFECT OF WIND INDUCED ON ROAD ACCIDENT ALONG EAST COAST EXPRESSWAY (ECE)

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ABSTRACT

In becoming a develop country, Malaysia government had built infrastructure including new highway for easy commute. Hence of that, East Coast Expressway (ECE) was build from Kuala Lumpur to Kuantan. This expressway was built through roughness of Land Use and Land Cover (LULC), terrain and topography. From this situation will made cross wind phenomena occurred along that expressway. Consequently, road accident could be happen due to the phenomena of cross wind. Therefore, in this thesis terrain database along East Coast Expressway was establish and relationship slope topographic factor and wind speed was derived. Furthermore, access possibility of the accident prone location due to wind speed induced were identified. The GIS technique was used to establish database of study area and analysis information of topographic effect. The database demonstrates the system analyze in spatial analysis to obtain variation of slope along that area. Indirectly, this technique has enabled GIS database showing the system analysis for the effect of topographic variation in slope was established. In conclusion, the objective prove successful in the relation between data information and slope topographic effect of that area. Therefore, the results for this study can be made as a guideline for road construction and improvement in safety of the road users.

ABSTRAK

Dalam menjadi sebuah negara membangun, kerajaan Malaysia telah membina infrastruktur termasuk lebuh raya baru untuk kemudahan berulang alik. Oleh yang demikian, Lebuhraya Pantai Timur (LPT) telah di bina dari Kuala Lumpur ke Kuantan. Lebuhraya ini di bina melalui kekasaran guna tanah dan perlndungan tanah, bentuk muka bumi dan topografi. Keadaan ini akan mengakibatkan kejadian angin lintang berlaku di sepanjang lebuhraya itu. Oleh itu, kemalangan jalan raya boleh berlaku di sebabkan oleh fenomena angin lintang. Justeru, dalam kajian ini pangkalan data bentuk muka bumi di sepanjang lebuhraya ini di wujudkan dan hubungan antara topografi cerun dan kelajuan angin di peroleh. Tambahan pula, kemungkinan akses lokasi kemalangan yang terdedah di sebabkan oleh kelajuan angin teraruh telah di kenal pasti. Teknik GIS telah di gunakan untuk mewujudkan pangkalan data kawasan kajian dan maklumat analisis ruang untuk mendapatkan perubahan cerun di sepanjang kawasan itu. Secara tidak langsung, teknik GIS ini telah membolehkan pangkalan data yang menunjukkan analisis sistem untuk kesan perubahan topografi dalam cerun telah di tubuhkan. Kesimpulannya, objektif terbukti berjaya dalam hubungan antara data dan maklumat cerun kesan topografi kawasan itu. Oleh itu, keputusan ini boleh dijadikan sebagai garis panduan bagi pembinaan jalan raya dan peningkatan dalam keselamatan pengguna jalan raya.

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LIST OF SYMBOLS / SHORT FORMS

GIS	=	Geographical Information System
KM	=	Kilometer
JKR	=	Jabatan Kerja Raya
JUPEM	=	Jabatan Ukur dan Pemetaan Malaysia
ECE	=	East Coast Expressway
EMP	=	Environmental Management Program
MTD	=	Malaysia Traffic Development
FELDA	=	Federal Land Development Authority
PDRM	=	Polis Diraja Malaysia
Ø	=	Upwind Slope Of The Topographic Features
H	=	Height Oh Hill Or Escarpment Relative To Upwind Terrain
L_h	=	Distance Upwind Of Crest
U(z)	=	Wind Speed As S Function Of Height, M/S
U(zr)	=	Wind Speed At Reference Height, M/S
z	=	Height Above Ground, M
zr	=	Referenced Height, M
α'	=	Exponent Dependent Upon Roughness Of Terrain.

CHAPTER 1

INTRODUCTION

1.0 Introduction

Highway is one of the infrastructure which will catalyst the economic and growth to any country. For this reason, government take an effort to built highway for the country to give better commute. Since, highway had built between a part of place its inevitable there have variation of terrain which give effect of cross wind to vehicle.

Highway should give convenient and safely commute for community. Adversely, occurrence of the fatal accident give local authority concern regarding highway safety. There have much argument within different party regarding cause of accident. Eventually they found the lack of user altitude much contribute to the accident induced. Unfortunately, none party take account to the cross wind effect as one of the contributor to the accident.

The aim of this study is to analysis of cross wind effect spatially over LPT highway. Geographical Information System (GIS) technique were used in this study.

1.2 Problem Statement and Justification

East Coast Expressway were cross trough variation of topography and this situation, create cross wind phenomena. Therefore it is necessary identified the cross wind spot.

Figure 1.1 Accident at ECE involved by vehicle, suspect due to crosswind effect.

1.3 Objectives of the Study

The objectives of this study are:-

a) To establish terrain database along East Coast Expressway.
b) To identify relationship between slope factor and wind speed analysis.
c) To identified and access possibility of the accident prone location due to wind speed induced.

1.4 Scope and Limitation of Study

This study is limited to the following:

a. Study area was carried out along Bentong - Kuantan expressway from Bentong (KM 76.0) to Kuantan (KM 246.0) Pahang Darul Makmur which is known as exit Kuantan – Karak (E8).
b. Accidents record within 5 years collected from Lembaga Lebuhraya Malaysia (LLM) and Kuantan Police Traffic.
c. Analysis were perform using GIS technique.

1.5 Study Area

The study area of the East-Coast Expressway is 169 km (99mi) runs from Kuantan to Karak Expressway through Gambang, Sri Jaya, Maran, Chenor, Temerloh, Lanachang, and Karak interchange.

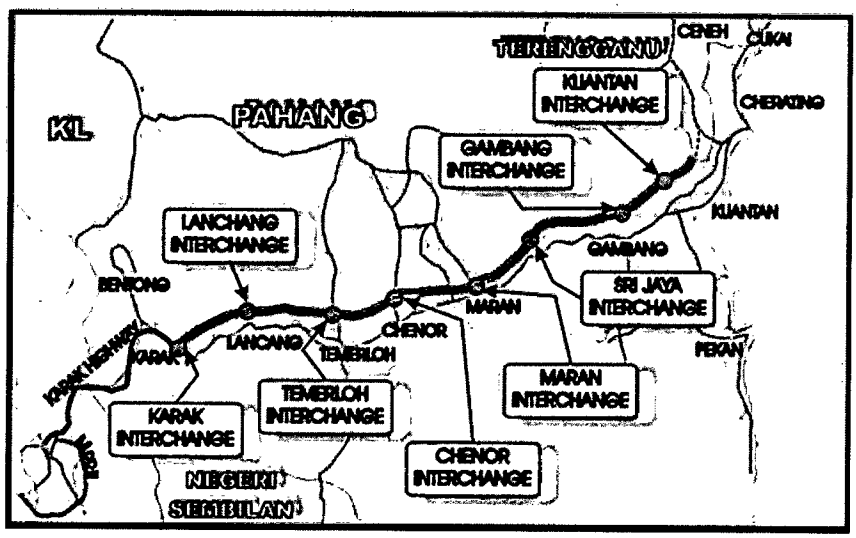


Figure 1.2 Location of study image

1.6 Significance of Study

The importance of this study is to determined in spatial the prone area of the cross wind effect.

1.7 Thesis Structure

The contents of each chapter are summarized under five chapter :

1. Introduction : this chapter is an overview of the problem statement, objective, scope of study and study area.
2. Literature review : this chapter related to the research objectives.
3. Methodology : includes methods from start to end of this project run and methods of using the GIS technique.
4. Discussion of the results obtained from the case study.
5. Conclusions of the discussion which is drawn from the works and provide the direction for the future.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter presents a review of the literature on Malaysia expressway development, wind effect and related previous study.

2.2 Malaysia Expressway Development.

In Malaysia, Road has played an important role in the trade and transportation system throughout the world, and it become rapid increase in the pavement infrastructure development in Malaysia. Gazette under Federal Roads Ordinance is usually roads linking the state capitals, airports, railway stations and ports. Currently, Malaysia has more than 80,300km roads. The road is divided into three main categories

namely toll expressway (1,700km), federal roads (17,500km) and state roads (61,100km) and the life spans are between 10 to 15 years (Zakaria and Hassan, 2005). Local authority road (city mall, municipal or local council) or kampong (district office) road is depending upon jurisdiction and normally maintained by the responsibility local authority (Haron, 2004)..

Expressways are defined as high-speed highways built under the JKR R6 rural highway standard, as dual-carriageways of at least 4 lanes (2 lanes per carriageway) with full access control, grade-separated interchanges and high design speed limit of 120 km/h, allowing the maximum speed limit of 110 km/h.

2.2.1 East Coast Expressway (Study Area)

East Coast Expressway (ECE) RM1.2 billion valuable is the latest sensation of the public transportation sector in Malaysia. ECE is open to the public on August 1, 2004 with the construction cost was RM1.3 billion or RM 7.9 million per kilometer. ECE is the only four-lane two-way highway linking the west and the east coast of Peninsular Malaysia.

ECE project implemented in two phases. Phase 1 linking Karak to Kuantan, Pahang. Phase 2 connecting Kuantan to Kuala Terengganu, Terengganu.Phase 1 along the 169 km begins in Karak, Pahang (cross Karak) and ends on the borders of Pahang/Terengganu (cross) Kuantan. It is connection from the Kuala Lumpur to Karak present. The main concept of this highway construction was built in environmental friendly atmosphere and " Environmental Management Program (EMP) " was used as a

guide by the MTD Construction Sdn. Bhd which is the main contractor of this project. This highway provides the facilities of a modern, fast and good transportation.

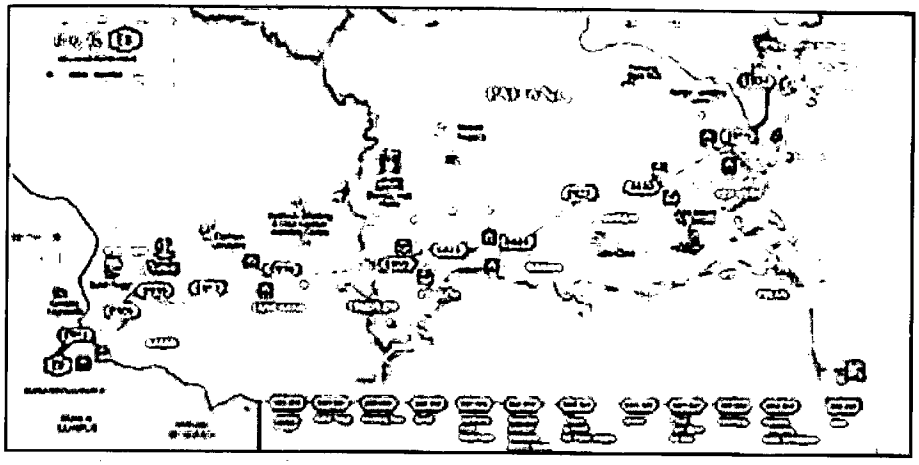


Figure 2.1 Kuantan-Karak East Coast Expressway

2.2.2 Characteristic of Study Area

2.2.2.1 Agriculture and Plantation Area

In the 5 mile radius of this highway, the largest land use is agriculture which covers 90& of land use activities in the area. Most of the rubber and oil palm plantations are under Federal land Development Authority (FELDA). Others agriculture activities is the vegetable garden. In the Maran district, there are three FELDA area which is Bukit Tajau, Kampung Berja and Kampung New Zealand. Dairy farms are within 5km from the Gambang and is located 1km north-ranged highway.

2.2.2.2 Urban and Village Area

There are two major cities are located near this ECE, there are Bandar Maran and Bandar Sri Jaya. Location of the two cities is the margin ranges from 2 to 5 km from the highway. The villages are located along this route and have been estimated 15 to 250 people in each village.

2.2.2.3 Forest and swamps area

Only a small portion of forest is traversed by the highway which is Hutan Simpan Bukit Tajau and Hutan Simpan Berkelah. This route passes through the edge of the Wetland. The largest area of the swampy lake area are Tasik Ulu Lepar, Tasik Beringin, and Tasik Bungor.

Table 2.1 Rivers that crossed by the East Coast Expressway Phase 1 (Maran to Kuantan)

Rivers	**Uses**	**Direction location in map 2.0**	**Remarks**
Sg. Kenak	Domestic	W12	
Sg. Chedong 1	Domestic	W12A	
Sg. Chedong 2	Domestic	W12B	
Sg. Luit / Kg. New Zealand	Domestic/ Agriculture	W13	Water Intake point Location : 103 05 00E 03 03 00N
Sg. Bakapor	Domestic	W13A	
Sg. Lepar	Domestic	W14	
Sg. Kebantan	Domestic	W14A	
Sg. Berkelah	Domestic	W15	Water Intake Point Location: 102 58 00E 03 43 00N
Sg. Pohoi	Domestic	W16	
Sg. Belat	Domestic	W17	
Sg. Pandan	Domestic	W18	
Sg. Kuantan / Kg. Padang & Kg. Kobat	Domestic	W19	Water Intake Point Location : 103 15 00E 03 49 00N
Sg. Mabuk	Domestic	W20	

Table 2.2 Main rivers and the catchment area and crossed by the East Coast Expressway phase 1 (Maran to Kuantan)

Catchment area	Catchment area (km^2)
1. Takungan Sg. Luit	
- Sg. Chedong	23.5
- Sg. Luit	125
2. Takungan Sg. Lepar	
- Sg Berkapor	39.7
- Sg.Lepar	547.5
- Sg. Kebentan	12.64
- Sg. Berkelah	22.85
- Sg. Pohoi	66.92
3. Takungan Sg. Kuantan	
- Sg. Belat	43.27
- Sg. Pandan	42
- Sg. Kuantan	1138
- Sg. Riau	130

(Sources from Jabatan Bekalan Air, Pahang)

2.3 Wind Effect

Wind is a phenomenon of great complexity because of the many flow situations arising from the interaction of wind with structures. Wind is composed of a multitude of eddies of varying sizes and rotational characteristics carried along in a general stream of air moving relative to the earth's surface. These eddies give wind its gusty or turbulent character. The gustiness of strong winds in the lower levels of the atmosphere largely

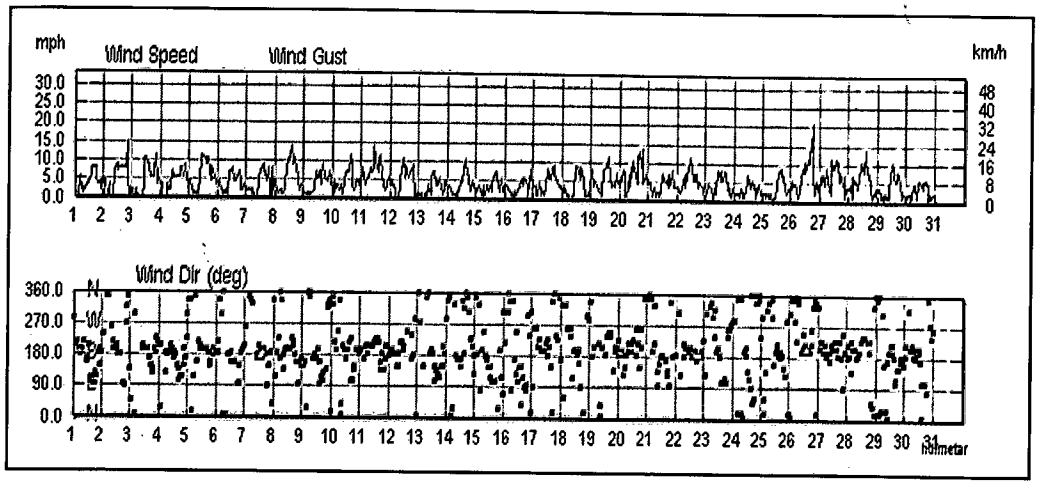
arises from interaction with surface features. The average wind speed over a time period of the order of ten minutes or more tends to increase with height, while the gustiness tends to decrease with height. (S.K Najid 2008)

The wind is defined in terms of a vector of its direction and speed. The continuous wind measurements are taken, as per international agreement (World Meteorological Organization, 1983), at fixed, least disturbed stations at a height of 10 m above the ground.

The wind is said to have a crosswind component; that is it can be separated into two components, a crosswind component and a headwind or tailwind component. A crosswind is defined as any wind that has a perpendicular component to the line or direction of travel. When winds are not parallel to or directly with against the line of travel. (Bruce Miller 2006)

2.3.1 Wind Speed

The aerodynamic and stability issues, wind also blows obstacles (debris, sand etc) onto the road, and the presence of precipitation with significant wind speed will make the situation more disorienting for drivers. Located at the east coast area of Malaysia, the data sets of this study consist of daily wind speed measured in meter per second. These are hourly wind speed and direction, sheltering obstacles, surface roughness changes, and orographic data (terrain height). Obstacles have an impact on the wind speed and alter the wind direction, particularly for lower level of height. If there are obstacles around the measurement station, wind speeds must be reconsidered again by taking the effect of these parameters into account (Bilgili et al. 2004).



(Souces from Weather by Wunderground.com)

Date : 27 September 2011 (Accident at Temerloh LPT KM 214.9)

2.3.2 Terrain Affect

Local terrain at the site can caused the wind speed which is will vary seasonally because of differences in large scale weather patterns who. Wind from one direction may experience an increase in speed because of the hills nearby and may experience a decrease from another direction. Since wind is also the cause of copious rain in the country, terrain users will highly likely to experience rain and high wind at the same time (e.g storm). The topography of Malaysian land is largely mountainous and therefore some of the road networks are inevitability being built across the hilly areas. The gust of air can be further amplified by the mountainous terrain (barrier jet or katabatic wind), and therefore will increase the possibility of strong crosswind to happen (Dr. Gary L. Jhonson, 2000).

The design speeds given in **Table 2.3** shall be adopted for various terrain classifications Terrain is classified by the general slope of the ground across the highway alignment (RK Puram, 2007).

Table 2.3 Design speed base on nature of terrain

Nature of terrain	Cross slope of the ground (%)	Design speed (km/hr)	
		Ruling	Minimum
Plain	<10	100	80
Rolling	10 - 25	80	65
Mountainous	25 - 60	50	40
Steep	>60	40	30

2.3.3 Terrain Roughness

The roughness of the surface over which the wind passes has two effects on the wind – speed and turbulence. Ground roughness is affected by surface objects such as buildings (including the sizes and density of the buildings in the area) and trees. It used to be thought that the sea surface provided a "reference" smooth surface. Present thinking is that during a severe cyclone the sea surface is sufficiently disturbed as to render it meaningfully less smooth than the surface of lakes. The collective effect of the terrain surface and obstacles, leading to an overall retarding of the wind near the ground, is referred to as the roughness of the terrain. Orographic elements, such as hills, cliffs, ridges, and escarpments, exert an additional influence on the wind. Roughness and orography are among the main factors that affect the wind speed (Durak and S¸en 2002).