MANAGING HAZARDOUS LOCATIONS ON THAI HIGHWAYS NETWORK

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Abstract: The Department of Highways has over 55,000 km. of highways under its jurisdiction. Most of the national trunk routes are four - lane dual carriage way with the remaining to be completed within the next year. Thailand road accidents in 1999 stood at 67,800 cases with 12,040 fatalities. The DOH highway network accounted for 13,343 cases of accidents or 20% of the total and 2,184 fatalities or 18% of the total fatalities. The Traffic Engineering Division is charged with the major task of making the highway safe for the road users. The Division has developed a system of accident data collection in 1992 . This paper describes the process of data analysis of the accident records collected between 1997 and 1999. It describes the criteria used to identify hazardous intersections on the network. Sixty one intersections were classified as being hazardous and were investigated in details. The 61 intersections were prioritized and allocated budgets for appropriate countermeasures. Two cases of intersection safety improvements were illustrated.

Key Words : Road accidents, Hazardous Intersection, Countermeasures,

1. INTRODUCTION

Despite the continuous decline in the number of road accidents since 1994 when it peaked at 102,610 cases to 67,800 cases in 1999, (See Table 1) road accidents is still among the 4 major causes of death in Thailand and is the number one killer in the provincial area outside

Bangkok (Taneerananon 2000). The economic loss from road accidents has been put at 114,688 million Baht or 2.47% of the country's GDP in 1998 (OCMLT 2000).

Table 1 : Thailand Traffic Accident Statistics, 1987 – 1999

Year	Bangkok Metropolis			Other Provinces			Whole Kingdom		
	Accidents	Killed	Injured	Accidents	Killed	Injured	Accidents	Killed	Injured
1987	19,745	752	6,333	4,387	1,352	2,256	24,132	2,104	8,589
1988	31,175	817	9,565	4,114	1,198	3,939	35,289	2,015	13,504
1989	31,709	917	10,005	6,388	4,451	3,076	38,097	5,368	13,081
1990	33,064	949	10,701	7,417	4,816	7,551	40,481	5,765	18,252
1991	38,355	1,057	10,778	7,946	5,276	8,777	46,301	6,333	19,555
1992	46,743	983	11,025	14,586	7,201	9,677	61,329	8,184	20,702
1993	64,006	1,011	11,031	20,886	8,485	14,299	84,892	9,496	25,330
1994	72,359	1,290	18,849	30,251	13,856	24,692	102,610	15,146	43,541
1995	64,469	1,284	21,697	24,898	15,443	29,021	94,362	16,727	50,718
1996	60,308	1,069	23,314	28,248	13,336	26,730	88,556	14,405	50,044
1997	54,324	903	20,933	28,012	12,933	27,828	82,336	13,836	48,761
1998	46,800	732	18,920	26,925	11,502	33,618	73,725	12,234	52,538
1999	37,868	594	17,104	29,932	11,446	35,434	67,800	12,040	52,538

Source : Police Information System Center, office of The National Police, and Traffic Engineering Division , Department of Highways (2000).

The population of Thailand was 61,661,701 in 1999 and number of registered vehicle 20,096,536. This gives the number of fatalities per 100,000 population at 19.52 and fatalities per 10,000 vehicles at 5.99.

The Department of Highways (DOH) is the main organization responsible for the design, construction and maintenance of highways. The recent development of dual. carriage way inter-city highways network including the widening of highways, has produced numerous intersections with local roads/highways. To make these intersections safe has become the main task of DOH. The Traffic Engineering Division has the responsibility to study and analyze accident data to identify hazardous locations including intersections throughout the country and to provide the best possible countermeasures for treating these locations.

This paper describes the DOH accident data collection and analyses process, the criteria used in identifying hazardous intersections and 2 actual cases to demonstrate the implementation of countermeasures.

2. ACCIDENT DATA FILE

DOH has set up a system to collect accident data from three sources : highways police records, from police stations, and the investigation by DOH district officers as reported in the accident report form S.3-02. Staff of the Traffic Engineering Division then edit and code the data and input them in the computer system. This system was developed in 1992. In this paper, accident data from 1997-1999 were used to analyze hazardous intersections.

3. INTERSECTION INVENTORY FILE

Traffic Engineering Division has designed the intersection inventory report form for use by DOH district officer who have used the form since 1992. The Division kept this data in computer and updated them annually. The identification of hazardous intersections was carried out with this inventory file. The definition of intersection area includes 50 metre length of each approach.

4. DATA ANALYSES

The accident data between 1997 and 1999 were analyzed, only those data concerning accidents at Four -arm (+) intersections, Y and T intersections were used. The outline of data analysis is shown in Figure 1 below.

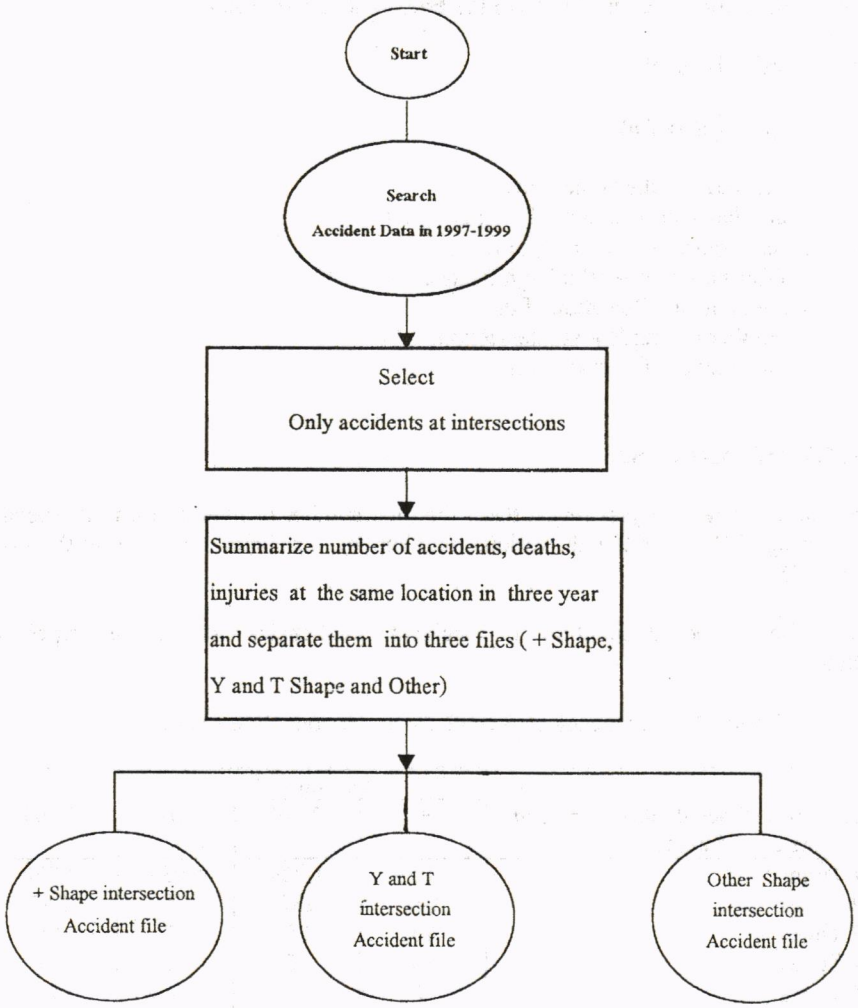

Figure 1. Flow Chart for Accident Data Analyses

Identification of Hazardous Intersection

According to statistical principles, the chance of an occurrence of an accident on highways will be follow a Binomial Distribution. When X is the number of times of accident occurrence, so the probability of X is 0 (failure) or 1 (success). And if the variation of X is large the distribution of P(X) will be a Normal Distribution.

Accordingly, it will be assumed that the occurrence of the number of accidents on highways has Normal Distribution and only 10 % of the area under the distribution graph will be accepted as hazardous locations.

According to the above assumption the critical value is the number of accidents at intersection in the critical region of 10 % of the Probability Distribution.

The critical value is equal to

$$\mathbf{X} + Z_{(\alpha=0.10)} * (\mathbf{S.D.} / \mathbf{n})$$

Where **X** is the mean of the number of accidents at a group of intersections
$Z_{(\alpha=0.10)}$ is the Statistics value of Normal Distribution at level of significance of 10 %
S.D. is the Standard Deviation of the number of accident at intersections
n is the number of intersections

5. RESULT OF ANALYSES

The results of data analyses reveal that , the total number of intersections at specific locations during 1997 - 1999 with various number of accidents occurring at the same site were 4,285.

Table 2 shows the distribution of accident frequencies at various types of intersection

Table 2 : Frequency of Accidents at Various Intersections

The frequency of accidents occurred at the same intersection	Intersection Type			Total
	+	Y, T	Others	
1 Time	1,059	1,724	1,037	3,820
2 Times	102	130	65	297
3 Times	23	25	17	65
4 Times	19	18	12	49
5 Times	4	6	3	13
6 Times	4	7	4	15
more than 6 times	13	9	4	26
Total	1,224	1,919	1,142	4,285

From the above table, the intersections with only one accident in three years were excluded from further analyses. The critical value was then determined for each type of intersection as shown in Table 3.

Table 3 : Critical values for Identification of Hazardous Intersections.

Intersection Type	Number of Intersections	Mean (X)	Standard Deviation (S.D.)	Critical Value
+ Type	165	3.5758	4.3141	4.1283
Y, T Type	195	3.0462	2.6110	3.3538
Others	105	3.5905	5.4503	4.4656

From Table 3, it can be concluded that the intersections identified as hazardous were those where the number of accidents occurred were larger than the critical values. These are shown in Table 4.

Table 4 : The criteria use in Identification of Hazardous Intersections

Intersection Type	**Criteria**
+ Type	more than 4 times
Y, T Type	more than 3 times
Others	more than 4 times

Using the above criteria, 61 hazardous intersections were identified.

These intersections were further prioritized for the purpose of budget allocation. Table 5 shows examples of hazardous sites and types of interventions implemented.

Table 5. Examples of Hazardous Locations and Plans for Countermeasures in Thailand

No.	**District (Bureau) Changwat**	**Intersection Name**	**Route No. (K.M.) And Route No. (K.M.)**	**Allocated Budget Year (Countermeasures)**
1	Lopburi1 (Bureau 9) Lopburi	Tha Ma nao	2089-0202 (66+808) 2338-0101 (13+809)	1997 (Traffic Signs) 1999 (Traffic Signal)
2	Nakhonsawan 2 (Bureau 9) Nakhonsawan	Paisali	11 – 0202 (71+870) 3004-0200 (52+175)	1997 (Traffic Marking) 1998 (Traffic Signs) 1999 (Maintenance Lamp)
3	Lopburi 2 (Bureau 9) Lopburi	Bua Chum	2243 – 0200 (4+436) 2272 - 0100 (5+160)	1997 (Lighting)
4	Chanthaburi (Bureau 12) Chanthaburi	Krathing	3249 – 0101 (17+545) Rural Road	1997 (Lighting)
5	Uthaithani (Bureau 10) Chainat	Kung Sam Pao	1 -1002 (294+360) 3265 - 0101 (0+000)	1997 (Lighting)

7. CASE STUDIES

Two cases are presented below. One is a T grade separated intersection located in Nakhonpatom Province (about 80 km from Bangkok). The other is a Four - arm (+) intersection located in Chumporn Province (about 600 km from Bangkok to the South).

7.1 The T intersection (Nakhon Chaisri Interchange)

The grade separated intersection consists of a directional ramp. The hazardous location is located on the compound curve with the control speed 45 km/hr. as shown in Figure 2. The problem identified was caused by the concrete noise barrier 2 m. in height. When motorists drive vehicles on the curve, they try to change from the inner lane to the outer lane. This was probably due to the fact that they felt greatly constrained by the noise barrier which created significant side friction. The changing of lane situation has an effect on the vehicles coming on the outer lane (See Figure 3). There were two major accidents, one was a side collision and the other a rear-end collision.

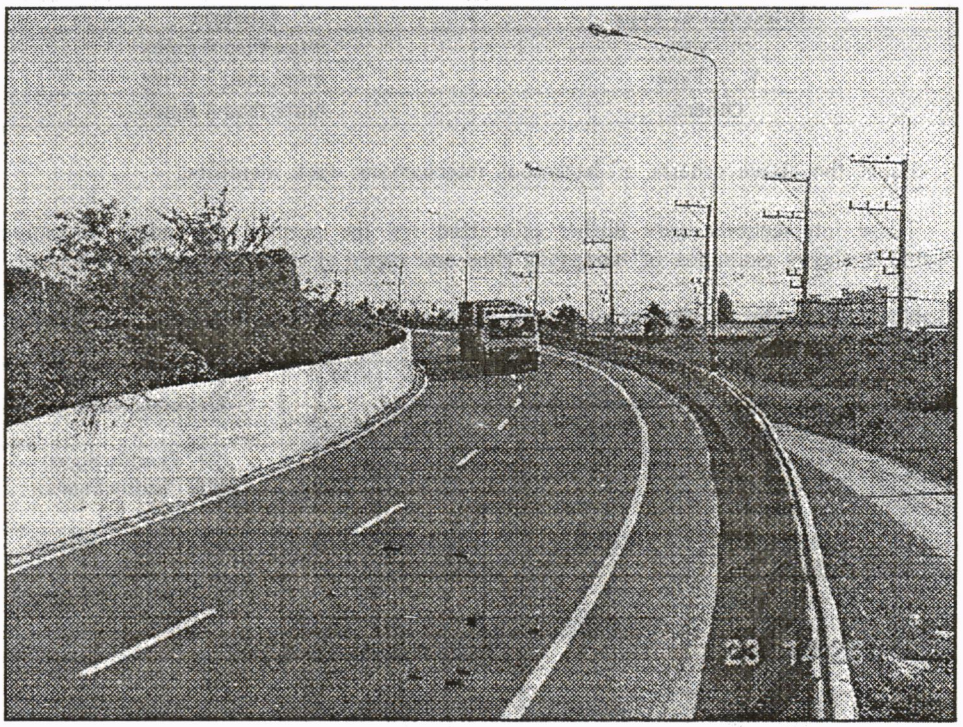

Figure 2. The Truck Driver Drove the Trailer in the Middle of Two Lanes to Avoid Hitting the Tall Barrier

Figure 3. The Driver Changing from the Inner to the Outer Lane Could Cause a Side Collision.

The steps for the mitigation taken are;

1. The 2.0 m height of the concrete noise barrier was cut down to 0.80 m height and steel pipes were installed on the top of the barrier as shown in the Figure 4.
2. Group of trees and plastic noise barriers were provided behind the concrete barrier. (See Figure 4).

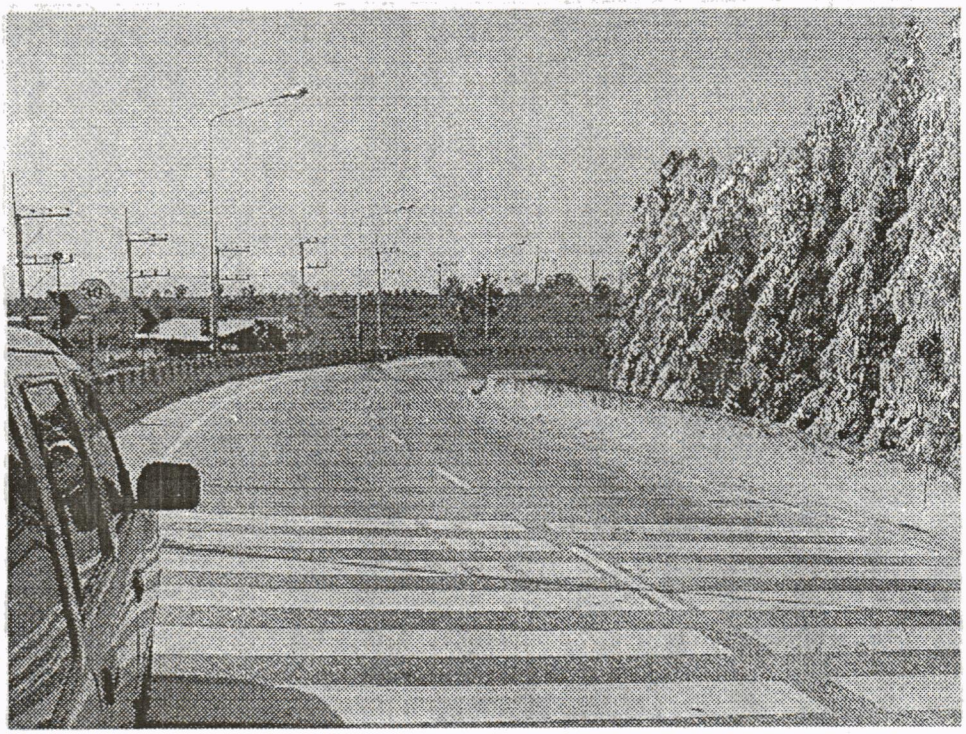

Figure 4. Show Improvement to the Concrete Noise Barrier by Reducing the Height to 0.80 m.

3. The traffic marking (white solid line) and road studs were painted on the pavement.
4. The traffic light (flashing signal) was installed on the outer concrete barrier.
5. Speed limit signs were also installed at the outer barrier.

The traffic and safety situation are being monitored by DOH, so far there have been no accidents. However, to measure the effectiveness of the treatment at least 24 months records of accidents before and after the invention should be used in the comparison. These records are being collected by the Department.

At-Grade Intersection in Chumporn Province

The intersection is located on the four - lane dual carriage way national route number 4 to the South. Previously, there was no intersection at this site. When the locals wanted to get across the highway, they had to use the median opening 1.5 km. from the present intersection in the south direction to Surattani Province and do a U-Turn under the bridge located at a further 1 km. Figure 5 shows layout of the improved intersection.

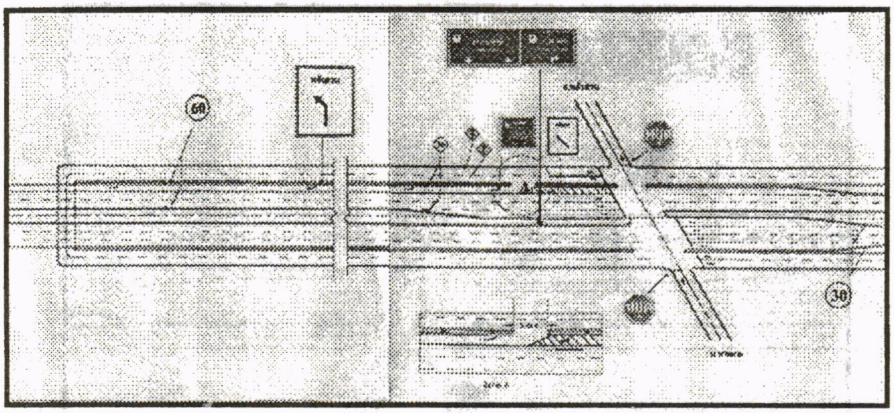

Figure 5. Geometric Layout of the Intersection and Direction of Traffic Flows

In 1998 a local politician wanted an intersection built at the site despite a strong opposition from the district engineer for fear of safety of the junction. However, the Member of Parliament influenced the Director General of DOH to build the intersection citing the need of the local people. Since its opening in 1999, 12 crashes have occurred resulting in 3 fatalities and 44 injuries. The DOH sent two engineers to investigate the crashes who made the following improvements :

1. Improve the traffic signal (from Fixed Time to VA- Vehicle Actuated Traffic Signal)
2. Increase the number traffic lamps including mast arm.
3. Provide the traffic signs to advise and warn road users to drive pass the intersection safely.
4. Provide wider exit and traffic marking (solid line) on the left of the carriage ways for high volume of traffic wanting to turn left to Lungsuan District.
5. Change the 2 directional flow on frontage roads to one way flow.

The details of these remedies are illustrated Figure 6. Since the implementation of the improvements 3 crashes have happened with 5 reported injuries but no fatalities. This appears to indicate the effectiveness of the improvements.

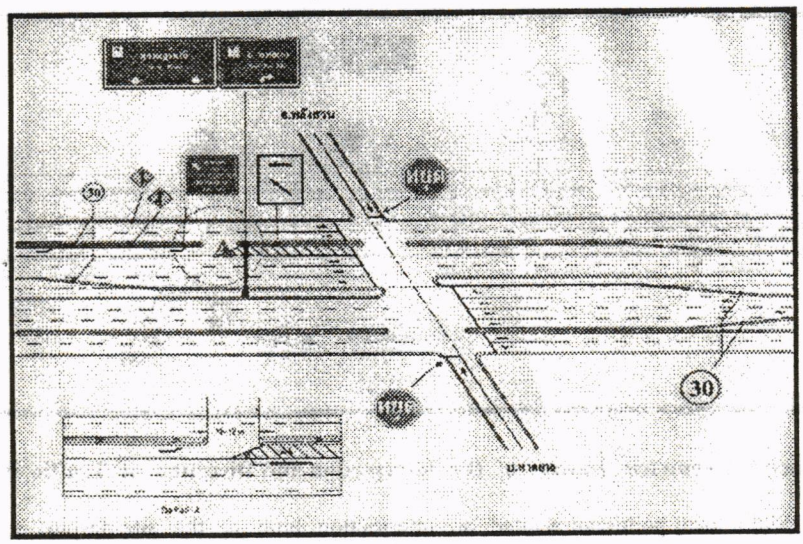

Figure 6. Details of Exit to the Frontage Road of Traffic Signs.

8. CONCLUSION

The paper describes the process of identifying hazardous locations on highways in Thailand. Using 1997 – 1999 accident records, 61 intersections were classified as hazardous locations. The Traffic Engineering Division has embarked on a program to improve safety at these locations despite the limited budget it received from the government. Two case studies were illustrated where countermeasures introduced appear to be effective in reducing the number of crashes.

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