Executive Summary Report

The Study of Safe Speeds on National Highways for Setting Suitable Speed Limits

Department of Highways

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CONTENTS

CHAPTER 1

INTRODUCTION

1.1 Background

According to previous studies on road safety, it was found that 78 percent of the highway crashes are related to speeding. Despite the government and private sector efforts through awareness campaigning and enforcement, number of road fatalities continue to rise. Challenges in law enforcement and outdated speed limit laws are believed to be the key obstacles in improving road safety in Thailand.

On June 29, 2010, the cabinet passed the resolution setting the Decade of Action for Road Safety in Thailand 2011-2020. The cabinet resolution is aimed to improve the road safety situation in Thailand and reduce the road fatalities in Thailand to be less than 10 deaths per 100,000 population in 2020, adopted from the 2009 Moscow Declaration on Road Safety by the UN General Assembly. The Department of Highways is one of the main players in managing speeds on highways throughout Thailand along with other government agencies.

This study would enable the Department of Highways to better conduct a speed management practice by studying the driver' s speed choices on different road classifications as well as identifying any problems related to speed and road geometries to determine the safe speed and speed limit that is consistent with the driver' s perception. This study proposes the speed limit sets for different the road functional classifications, cross sections, and road environments. More road users are expected to comply with the proposed speed limits once the posted speed is more consistent with the road geometries. We have proposed only a few speed limit values for various facility types so that it is easier for the drivers to determine the associated speed limit on the highway. From the proposed speed limit scheme, It is expected that number of the speed violators and speed-related accidents will be reduced. The proposed speed limits will also serve a foundation for other speed management techniques such as variable speed limit and other road safety equipment for high speed facilities.

1.2 Project Objectives

Five key objectives were conducted to obtain the proposed speed limits for safe highways:

(1) Collect individual speed data on all highway classification type.
(2) Classify the highways based on the road geometries, road environments, and area types.
(3) Determine the road users' speed choice and speed distribution on different highway classifications.
(4) Propose appropriate speed limits for different highway classifications.
(5) Provide recommendations on speed management to reduce speeds on highways.

1.3 Scope of Work

Under supervision of the Department of Highways' Steering Committee, the following project activities were conducted:

(1) Literature Review

Speed limit setting in Thailand and other countries has been studied and compared.

(2) Data Collection Plan Development

Data collection plan for different road type and vehicle types were developed.

(3) Site Selection

The total of 380 sites were selected as the representatives of highways in Thailand based on their geometries, road type, land use type and location.

(4) Data Collection

The mobile microwave radars were used to collect speed and flow data for 24 hours at each site.

(5) Data Analysis

Various statistics parameters such as mean, median, percentiles, va were determined to gain understanding of the speed characteristics at each data collection site. New speed limit sets were proposed for different road types, vehicle types, and area types. Implementation plan were also proposed in this study.

(6) Seminar

A seminar session for the Department of Highways staff was held to present the findings in this study and obtain feedbacks from the practitioners in the field.

CHAPTER 2

LITERATURE REVIEW

2.1 Speed Limit in Thailand

For highways in Thailand, speed limits are strictly followed the Land Traffic Act of 1979 and the Highway Act of 1992. The details of the two Acts can be found in the following sections:

2.1.1 Land Traffic Act 1979

The speed limits set by the Land Traffic Act are applied for the municipal jurisdictions, Bangkok, and Pattaya as follows:

(1.1) Speed limits for trucks with the gross weight less than 1,200 kilograms and buses are 60 kilometers per hour in Bangkok, Pattaya, and municipal areas, and 80 kilometers per hour outside the aforementioned areas.

(1.2) Speed limits for trailer trucks not mentioned in (1.1) with gross weight over 1,200-kilogram or tri-wheelers are 45 kilometers per hour in Bangkok, Pattaya, and municipal areas, and 60 kilometers per hour outside the aforementioned areas.

(1.3) Speed limits for vehicles not mentioned in (1.1) or (1.2) or motorcycles are 80 kilometers per hour in Bangkok, Pattaya, and municipal areas, and 90 kilometers per hour outside the aforementioned areas.

2.1.2 Highway Act 1992

Highway Act 1992 is currently used to determine speed limits on five categories of highways including special highways, national highways, rural highways, local highways, and concession highways.

(2.1) Speed limits on highways by different vehicle types

(a) Passenger cars or motorcycle: 90 km/hr

(b) Trailer vehicles or three-wheeler: 60 km/hr

(c) Truck with gross weight over 1,200 kilograms (with or without a trailer) or bus: 80 km/hr

(2.2) Speed limits on the Motorways numbers 7 and 9

(a) Trucks with gross weight not more than 1,200 kg or bus: 100 km/hr

(b) Truck other than those in (a) as well as vehicles with a trailer: 80 km/hr

(c) Vehicles other than those in (a) and (b): 120 km/hr

2.2 Speed Limit in Other Countries

Speed limit practices in European countries, the United States, Australia, and Asian countries are varied. It is also found that speed limits in European countries, the United Stated of America, and Australia are based on area, road geometries, and operating speeds (or the 85^{th} percentile speeds) However, speed limits in Thailand are based on vehicle types and jurisdiction regardless or road geometries and functional classifications. The speed limit practices in Thailand and other countries are compared in Table 2.1 and Table 2.2

Table 2.1

Speed Limit Scheme Comparison among Thailand, Korea, Malaysia, and Singapore

Aspect	Thailand	Korea	Malaysia	Singapore
Speed Analysis Methodology	- Not specified	- Not specified	- Not specified	- Not specified
Speed Limit Specification	Land Traffic Act 1979 Speed limits grouped by jurisdiction - Municipal area, Pattaya, Bangkok - Outside the aforementioned Highway Act 1992 Speed limits grouped by road type - Highways, Rural roads, Local Roads - Motorway numbers 7 and 9	By road classification: - Expressways - Highways - Two-lane roads	By road classification and area - Expressways - Highways - Intercity roads - Municipal roads	By road classification - Expressways - Highways - One-lane roads - School zones - Central Business District (CBD)
Speed Limit	Land Traffic Act 1979 - Municipal area, Pattaya, and Bangkok: 80 km/hr - Outside: 90 km/hr Highway Act 1992 - Highways, Rural roads, Local Roads: 90 km/hr - Motorway numbers 7 and 9: 120 km/hr	- Expressways: 100 km/hr - Highways: 80-90 km/hr - Two-lane roads: 60 km/hr	- Expressways: 110 km/hr - Highways: 90 km/hr - Intercity roads 90 km/hr - Municipal roads 60 km/hr	- Expressways: 70-90 km/hr - Highways: 50 km/hr - One-lane roads: 40 km/hr - School zones: 40 km/hr - Central Business District (CBD): 40 km/hr

Table 2.2

Speed Limit Scheme Comparison Among United Kingdom, Australia, United States of America, and Sweden

Aspect	United Kingdom	Australia	USA	Sweden
Speed Analysis Methodology	- Consider mean speed and the 85th percentile speed - Historical crash data - Harm minimization	- The 85th percentile speed - Speed distribution - 15-kph speed pace -Harm Minimization in urban area	- the 85th percentile speed - 10 mph pace - Land type - Historical crash data	- Harm minimization - 10 mph Pace - Land development around the highways. - Historical crashes - Zero vision concept
Speed Limit Specification	By road classification: - Motorways - Dual carriageway - Single carriageway - City area	By area type: - Built-up area - Rural area	Depeding on State laws. 1) By area type: - Built-up area - Rural area 2) By the road clssification - Freeway & Interstate - 4-lane highways and motorway - Rural two-lane road	By area type: - Built-up area - Rural area - Motorway
Speed Limit	- Motorways: 112 km/hr - Dual carriageway: 112 km/hr - Single carriageway: 96 km/hr - City area 48 km/hr	- Rural/Suburban: 100 km/hr - Urban: 50 km/hrd	- Built-up area: 105-120 km/hr - Rural area: 30-56 km/hr	- Motorway: 110 km/hr - Rural area: 70 km/hr - Urban area: 50 km/hr

CHAPTER 3

SITE SELECTION AND DATA COLLECTIONS

3.1 Site Selection

Speed data collection were conducted at 380 sites to determine operating speeds for various highway geometries and road environments.

- Based on land use surrounding the highways, three types of land use can be identified:
  - Urban area represents high density of residence and high traffic volume as shown in Figure 3.1.

Figure 3.1

Example of Urban Roads

  - Suburban area represents medium density of residence, mostly along the highways, with traffic movement conflicts due to low access control as shown in Figure 3.2.

Figure 3.2

Example of Suburban Roads

- Rural area represents sparse density of residence, vehicle can be operated freely as shown in Figure 3.3

Figure 3.3

Example of Rural roads

- Based on median type, four highway categories can be identified:
  - Undivided Highway
  - Divided Highway has four sub-categories include raised median, concrete barrier median, depressed median and painted median as shown in Figure 3.4 to Figure 3.7.

Figure 3.4

Raised Median

Figure 3.5

Concrete Barrier Median

Figure 3.6

Depressed Median

Figure 3.7

Painted Median

- Control of access and traffic characteristics
- Number of lanes ranges from 2 to 8 lanes (number of lanes on the frontage road is not included).
- Speed zones
    - School and hospital zones
    - Steep grade highways
- Highways with black spots which can be determined from the tangent sections with high accident frequency or high number of fatalities.

Table 3.1

Number of Study Sites for Different Road Geometries and Area

Highway Type	Frontage Road	Land Use	Median	Number of Combinations	Number of Sites/Combination	Total Number of Sites
Two-lane highway	NA	- Urban, with parking	-	1	20	20
		- Urban, no parking	-	1	10	10
		- Suburban	-	1	20	20
		- Rural	-	1	20	20
Four-lane highway	No	- Urban	- Raised	1	20	20
			- Markings	1	10	10
		- Suburban	- Raised - Depressed - Barrier	3	7	21
			- Markings	1	10	10
		- Rural	- Raised - Depressed	2	12	24
			- Markings	1	10	10
	Yes	- Suburban	- Raised	1	7	7
			- Depressed	1	5	5
Six-lane highway	No	- Urban	- Raised	1	20	20
			- Barrier	1	10	10
		- Suburban	- Raised - Depressed - Barrier	3	7	21
			- Markings	1	5	5
		- Rural	- Depressed	1	10	10
			- Raised - Barrier	2	7	14
	Yes	- Urban	- Raised - Depressed	2	10	20
		- Suburban	- Raised	1	5	5
			- Depressed - Barrier	2	7	14
		- Rural	- Depressed	1	4	4

Table 3.1 (Cont.)

Number of Study Sites for Different Road Geometries and Area

Highway Type	Frontage Road	Land Use	Median	Number of Combinations	Number of Sites/Combinations	Total Number of Sites
Eight-lane highways	No	- Urban	- Raised	1	20	20
			- Barrier	1	5	5
		- Suburban	- Raised - Barrier	2	5	10
	Yes	- Urban	- Barrier	1	5	5
		- Suburban	- Raised	1	5	5
Intercity Motorways				1	7	7
Highway in school zone				1	7	7
Highway in hospital area				1	7	7
Steep grade highways				1	7	7
Black spots				1	7	7
			รวม	41		380

3.2 Field Data Collection

The total of 380 sites were selected based on various road attributes.

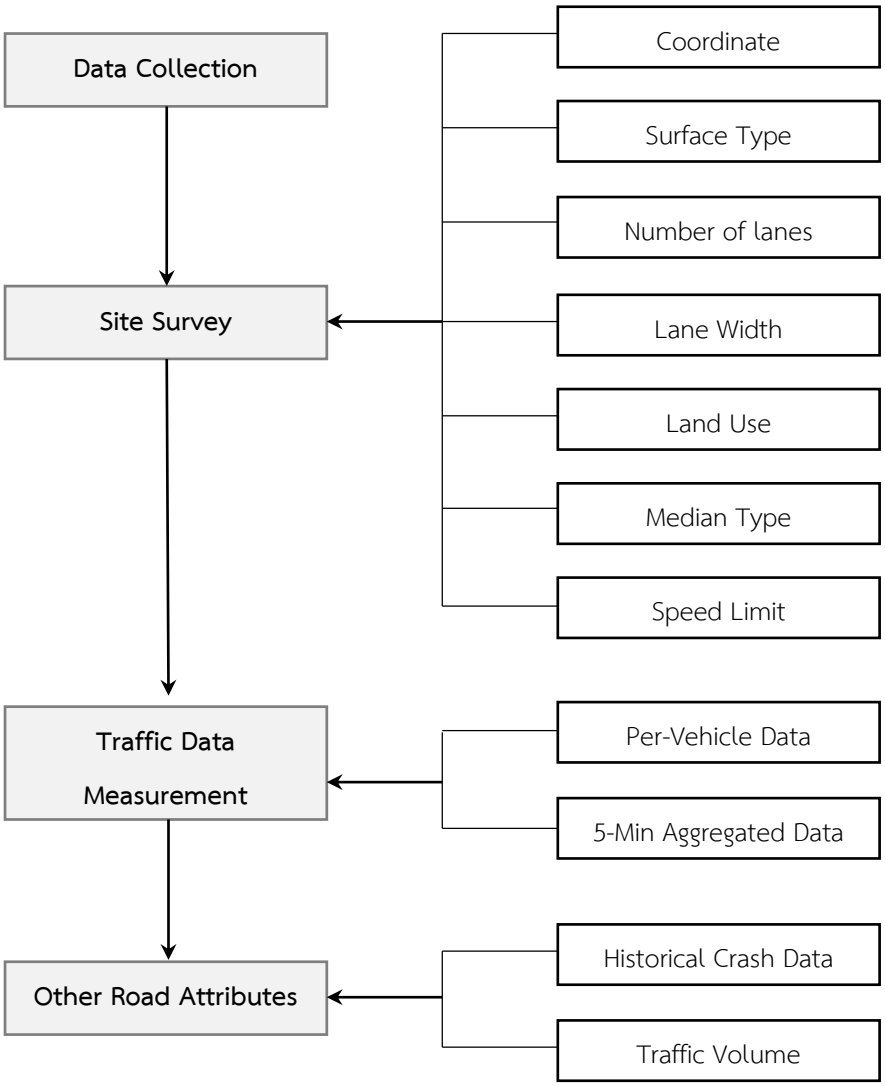

Figure 3.8

Data Collection Framework

- **Road Geometries** – Data collection in this step includes the coordinates, road surface types, number of lanes, lane width, median types, land use, and operating speeds.

Figure 3.9

Example of Field Survey Form

- **Traffic Data Collection** – extensive traffic data collection in this study was performed using automatic traffic detector, namely, microwave radar. The data are collected both per-vehicle record (PVR) and 5-minute aggregated data. Traffic data obtained from the microwave radars, Lane ID, Headway, Gap, Volume, Class, Occupancy, Average Speed, and Density. Traffic data was collected for 24 hours continuously at each study site. Video recording were also performed during the off-peak for three hours. The video data was used to validate the traffic data collected from traffic sensors.

CHAPTER 4

RESULTS

It is believed that when the speed limits are properly determined and road users understand the speed setting process, the compliance rates would be high and hence promote highway safety. Consequently, this study was comprehensively collected speeds on different highway types in urban, suburban, and rural areas throughout Thailand to understand the speed choices on those facilities. Speed data on the total of 380 study sites were collected and the results are shown in this chapter.

4.1 Overspeed Percentages

Table 4.1 represents the overspeed percentages on different highway types and area types. Among the 380 sites, it was found that the overspeed percentages of passenger cars on rural highways are the highest (more than 50 percent), followed by those on suburban and rural highways, respectively. Overspeeding trucks were relatively low on the suburban highways, rural highways, and motorways while the urban areas represents high overspeeding trucks (32 percent).

It is possible that the high percentage of overspeeding passenger cars in the rural areas is caused by inappropriate speed limit values. That is, the speed limit specified for the rural highways is not consistent with the road geometries including number of lanes, lane width, vehicle performance, and speeds chosen by the drivers on the rural highways.

Table 4.1 Overspeed Percentages

Highway Types	Speed Limit (km/hr)	Sample Size (vehicles)	Number of Overspeeding Vehicles (vehicles)	Overspeed Percentages (%)
Urban Highways				
Passenger Cars	80	503,426	131,140	**26.0**
Trucks	60	22,887	7,260	**31.7**
Suburban Highways				
Passenger Cars	90	429,902	140,375	**32.7**
Trucks	80	41,479	1,757	**4.2**
Rural Highways				
Passenger Cars	90	159,494	84,814	**53.2**
Trucks	80	26,485	1,878	**7.1**
Motorways				
Passenger Cars	120	52,784	2,439	**4.6**
Trucks	80	9,188	957	**10.4**

4.2 Speed Distribution by Highway Types

Speed data were categorized by four attributes include area type, number of lanes, median type, with/without frontage road.

1) Area type – there are three area types including built-up area, suburban area, and rural area.
2) Number of lane – there are two types including Two-Lane Two-Way road and multilane highway.
3) Median type – there are two types including undivided Highways and divided highways.
4) Access control type – there area two types including mainline with the frontage road and mainline without frontage road.

Considering only the speed data during the free-flow condition, the 85th percentile speeds, a.k.a., operating speed, was calculated for each of the 380 study sites. Box plot technique was used to represent the distribution of the operating speeds of different highways in the same category. Speed data dispersion can be illustrated by the size of the box. The center line of each box represents the median value of the operating speeds in the same highway group. Unlike mean, median is a robust parameter to represent the group's operating speeds since the median considers the order of the operating speeds and are insensitive to the extreme values.

Box plots of the operating speeds of passenger cars in the rural multilane highways are shown in Figure 4.1. We proposed the new speed limit for each highway group based on the box plots as well as the speed limits currently used in Thailand and other countries.

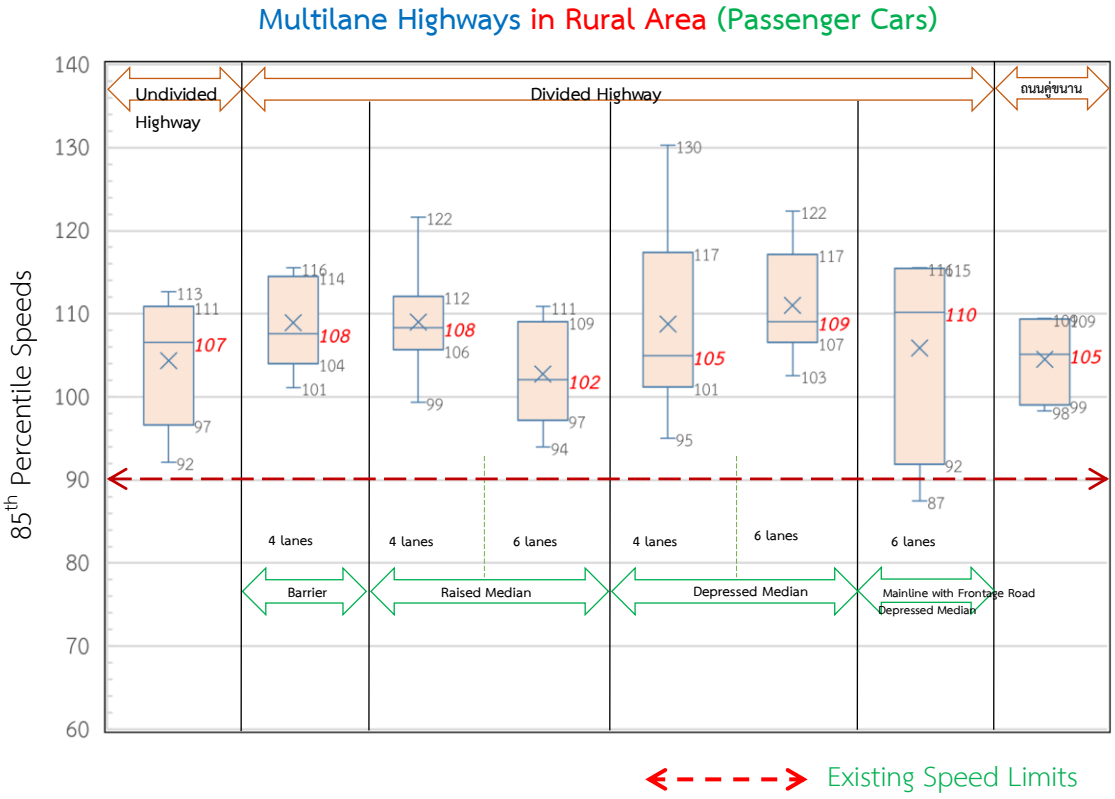

Figure 4. 1

Box Plots of The Passenger Car's Operating Speeds on Multilane Highways in Rural Area

Various highway types such as divided/undivided, concrete barrier, depressed median, raised median, multilane highways (4, 6, or 8 lanes) are plotted in the same graph. A few parameters that can be considered from the box plot include:

- Q_1-Q_3 Range Range between the first quartile speed and the third quartile speed of the highways in the same group.
- Median Range Range of median speeds of the highways in the same group.

Speed charactistics of different highway types and area types are shown from Tables 4.2 to 4.4. According to the summary in these tables, it is found that:

Urban Area, Passenger Cars

Divided highways and undivided highways has different speed characteristics

For the highways with raised median, the mainline highways with the frontage road has significantly higher speeds than the highways without the frontage roads.

Urban Area, Trucks

Truck speeds on the two-lane highways and the undivided multilane highway do not differ. However, truck speeds are significantly higher on highways with raised median and highways with the frontage road.

Table 4.2

Speed Charateristics in The Built-Up Area (km/hr)

Parameters	Two-Lane Road	Multilane Road without Median	Multilane Road with Median	Mulitilane Road with Frontage Road
Passenger Car				
Q_1-Q_3 Range	47 - 64	57 - 76	65 - 90	74 - 106
Median Range	55 - 56	70	75 - 85	94 - 99
Truck				
Q_1-Q_3 Range	45 - 64	49 - 55	47 - 73	55 - 75
Median Range	55 - 57	52	56 - 72	63 - 71

Table 4.3

Speed Charateristics in The Suburban Area (km/hr)

Parameters	Two-Lane Road	Multilane Road without Median	Multilane Road with Median	Mulitilane Road with Frontage Road
Passenger Car				
Q_1-Q_3 Range	69-85	65-100	72-113	82-116
Median Range	81	71-94	85-110	91-109
Truck				
Q_1-Q_3 Range	68-74	61-82	52-95	63-74
Median Range	70	67-74	67-74	67-73

Table 4.4

Speed Charateristics in The Rural Area (km/hr)

Parameters	Two-Lane Road	Multilane Road without Median	Multilane Road with Median	Mulitilane Road with Frontage Road
Passenger Car				
Q_1-Q_3 Range	79 - 100	97 - 111	97 - 117	92 - 115
Median Range	91	107	102 - 109	110
Truck				
Q_1-Q_3 Range	74 - 85	69 - 89	68 - 80	75 - 95
Median Range	76	74	70 - 75	85

Rural Area, Passenger Cars

Median speed on the two-lane highways is approximately 90 km/hr. However, the median speeds significantly increase for multilane highways. Specifically, divided multilane highways possess median speed of 105-110 km/hr, which is higher than the current speed limit.

The multilane highways with the frontage road has a similar speed distribution to the divided multilane highways

Rural Area, Trucks

The median speeds of trucks on rural highways do not differ for different geometries. The median speeds are between 70 and 80 km/hr and can be up to 85 to 90 km/hr for the multilane highways with the frontage road.

Suburban Area, Passenger Cars

Within the suburban highways, High variation are found for different highway cross sections. Based on the current Land Traffic Act, the suburban area is considered as rural area. Therefore, the rural speed limit would be applied.

Passenger cars speeds on undivided highways in suburban and rural areas are similar. In addition, speeds on the suburban two-lane highways and the undivided multilane highways are in between the speeds on the urban highways and the rural highways.

Suburban Area, Trucks

Median speeds of the trucks on the suburban highways are similar across the highway types, between 65-75 km/hr.

4.3 Proposed Speed Limits

Based on our data analysis, it is found that the existing speed limtis are not appropriate for the current situation.

For example, speed limit in the urban area is 80 km/hr, which is too high for the city area with pedestrian and bicycle activities. When there is an accident between a motor vehicle and a pedestrian or bicycles, there is little chance of survival for the pedestrian or the bicyclist. As shown in other coutries, the city speed limit should follow the harm minimization concept.

For the rural area, the Land Traffic Act limit the driving speed at 90 km/hr. Based on our study, it is found that the 85^{th} percentile speeds presented at the study sites are between

105-110 km/hr. Low percentage of drivers comply with the current 90 km/hr speed limit. Therefore, the speed limits in the rural area should also be revised.

4.3.1 Proposed Speed Limit in Urban Area

There are two alternatives to determine the speed limits in the urban area. For Alternative 1, speed limits are speficied by the higway cross section. For the Alternative 2, single speed is used for various highway cross sections.

Alternative 1: Multiple Speed Limits for Different Cross Section

For this alternative, different speed limits are proposed for different highway cross section based on the free-flow speed data collected in this study. The prposed speed limits are shown in Table 4.5.

Table 4.5

Proposed Speed Limits for Urban Area (Alternative 1)

Cross Section	Car	Truck
2 lanes	50	50
> 2 lanes, undivided	50	50
> 2 lanes, divided	70	50
> 2 lanes, divided with frontage road (mainlines)	90	70

Alternative 2: Single Speed Limit for Urban Area

Single speed limit can be effective since it is easier for drivers to understand and follow the limit in the city zone. This alternative can be found in other countries. The driver can intuitively reduce his/her speed when entering the city area where pedestrian and bicycles exist. However, if the single speed limit is much lower than the desire speed (based on the driver's judgement to the higway cross section and environment), it is likely that the drivers will not obey the speed limit law.

In addition, speed limits should be further categorized by the level of access such as mainline highway with the frontage road. The divided highways with more than 2 lanes, with the frontage road should be able to serve higher speed than the highway without the frontage road. As a result the speed limit of 90 km/hr is proposed for the multilane highways with the frontage road. The proposed speed limits are proposed in Table 4.6.

Table 4.6

Proposed Speed Limits for Urban Area (Alternative 2)

Cross Section	Car	Truck
2 lanes	60	60
> 2 lanes, undivided	60	60
> 2 lanes, divided	60	60
> 2 lanes, divided with frontage road (Mainlines)	90	60

4.3.2 Proposed Speed Limit in Rural Area

Speed limits on rural highway should be able to balance many issues such as driver behavior, safety, and mobility. The proposed speed limits, based on this study, not only correspond to most driver behavior but also maintain safety standard as well. The proposed speed limits are proposed in Table 4.7

Table 4.7

Proposed Speed Limits for Rural Area

Cross Section	Car	Truck
2 lanes	90	70
> 2 lanes, undivided	90	70
> 2 lanes, divided	100	80
> 2 lanes, divided with frontage road (Mainlines)	100	80

4.3.3 Speed Limits on Other Facilities

Speed limits on other highways facilties are proposed as follows:

Motorways

1) The existing speed limits on the motorways are appropriate and consistent with the speed data collected in this project. The passenger car speeds range from 85 km/hr to 110 km/hr while the truck speeds range from 60-75 km/hr which is lower than the current truck speed limit.
2) There are only 4.6% of the overspeeding passenger cars, which is relatively low compared with other highway types. However, number of vehicles on the motorway are very high. Also, the speeding vehicles can be higher than 149 km/hr.
3) The existing speed limits on the motorways should be strictly enforced because the current operating speeds on the motorways are rather high.
4) It is interesting to note that, based on our speed data on motorways, some vehicles operated at low speed, i.e., between 50-60 km/hr, which are significantly lower than other vehicles on the motorways. This speed difference might be dangerous and minimum speed limit should be considered in the future. Comprehensive studies should be conducted before implementation.

School Zone and Hospital Zone

1) Speed limit in the school zone should be enforced during specific hours such as from 7:00 to 9:00 and 15:00 to 16:30 during weekday. The speed limit in the school zone should not be active during the school break.
2) A similar concept should also be applied to the hospital. During the peak period in the hospital, time-specific speed limit should be enforced, especially at the pick-up/drop-off area where there are high number of patients exist.

Black Spot

1) At the black spot area, the responsible party should determine the speed distribution. If there is an evidence of high speed variation, the authority should determine whether the existing speed limit is appropriate. If the speed limit is suitable, the authority should determine other causes of high accident frequency.

Steep Highways

1) Based on our study sites, it is found that truks going downhill at higher speed than usual. Therefore, speed limit should be strictly enforced at dangerous sections such as steep grade highways.
2) Speed highways with critical legth longer than 2 km should have speed limit to control the truck speed in the specific stretch.

4.4 Implementaion Plan

There are four aspects to implement the proposed speed limits including legistrative aspect, speed review process, law enforcement, road design process.

4.4.1 Legistrative Aspect

The existing speed limits do not take into account of the road geometries such as number of lanes, median type, access control. Therefore, the govement should amend speed limits in the Land Traffic Act and the Highway Act to incorporate such factors into the law.

To change the speed limits, Section 5 (1) of the Highway Act B.E. 2535 allows the Minister of Transport and the Minister of Interior to issue the ministerial regulation with regard to the new speed limits.

4.4.2 Speed Review Process

Department of Highways should measure free-flow speeds on the highway every year to determine the operating speed, median speed, as well as speed distribution and compare with the posted speed limit on the highways. If the operating speed is significantly higher than the posted speed limit or the speed variation is high, the Department of Highways should consider managing the speeds on a particular highway using the 3E's principle:

- Engineering – speed can be controlled using the traffic control devices such as pavement markings, flashing signs, lane width, and changing the roadside visualization.
- Education – Department of Land Transport should integrate the speed limit concept and understanding in its driver license test so that drivers can decide the correct speed on different road type and area.
- Enforcement – Speed enforcement should be the last option to deter speeders when the education and engineering approaches do not work effectively.

If the operating speed measured on the highway is not greater than the speed limit, the Department of Highways should compare the 3-year historical crash frequency with the expected value of the same road classification and area. If the historical crash frequency is higher than the expected value, the Department of Highways should investigate the site and determine the safety measure to improve the road safety. The annual speed review process is shown in Figure 4.2.

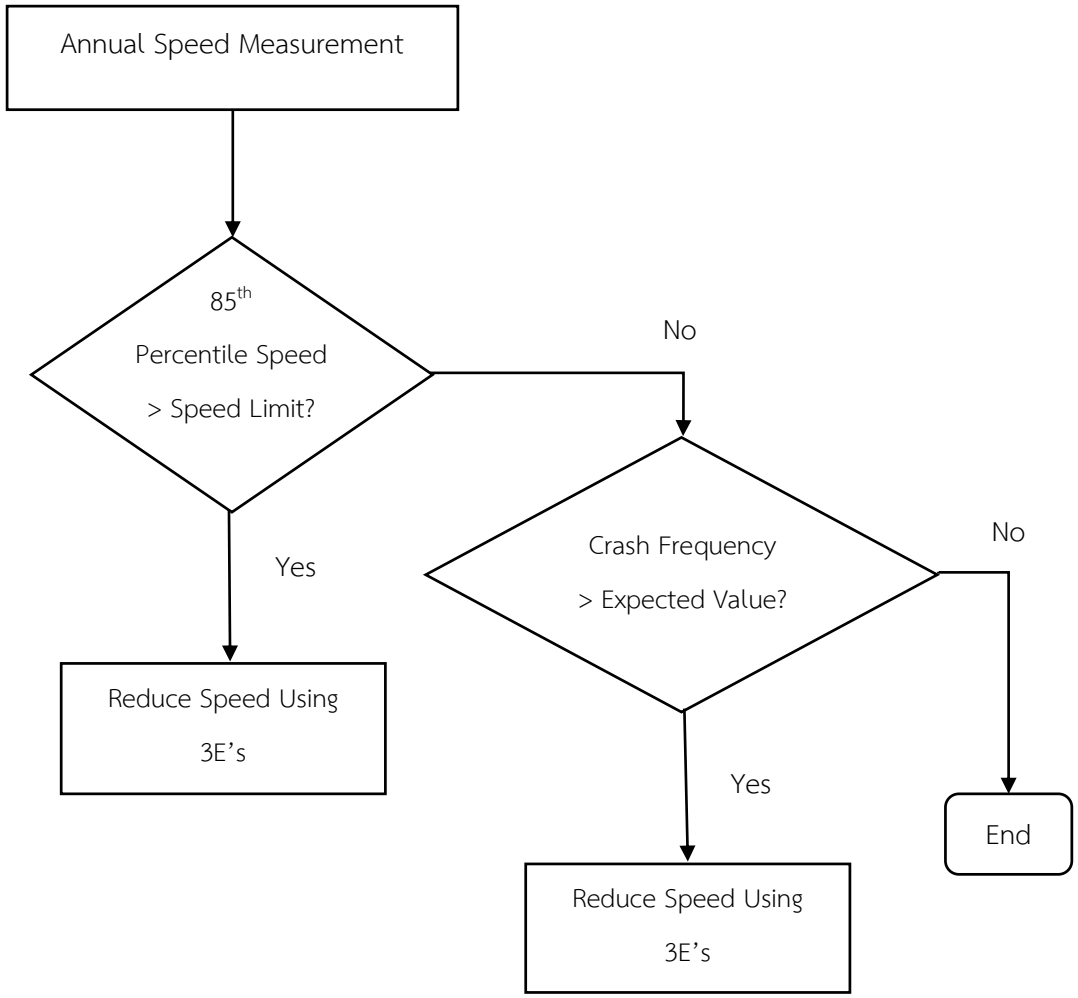

Figure 4.2

Annual Speed Review Process

4.4.3 Law Enforcement

The Department of Highways should install automatic speed enforcement caemeras at the black spot locations with high number of speed-related accidents. To install the automatic speed enforcement cameras, the following aspects should be considered:

- Sites with promise – before installing the automatic speed enforcement camera, the Department of Highways should determine the causes of accident and the safety issue at the site first. It is important to note that the automatic speed enforcement camera is only effective on the black spots with high number of speed-related accidents.

However, there are several reasons that the black spots site has many accidents such as road geometries, lighting, improper signal timing, poor access management, and DUIs.

- Safety Promotion Campaign – Acceptance and support from the public is one of the key successes in speed enforcement. Therefore, it is important that the police, local authority, and the Department of Highways provide information regardin the benefits of complying with speed limit on the highways. The speed tickets are often misunderstood as revenue generation for the enforcement units. One-month warning period is recommended to provide a headsup for the public before the actual enforcement so that the public has enough time to adjust their behaviors.
- Maitenance Cost – The capital cost of the automatic speed enforcement camera in Thailand is approximately 3 million Baht. Local agencies often overlook the cost associated with the operations and maintenance including the office stationaries, printing, mailing, personnel, and equipment schedule maintenance, which cost around 20-25 percent of the equipment cost. Therefore, it is important that the Department of Highways has a continuous budget planning to finance the speed enforcement programs once implemented.

4.4.4 Road Design Process

The design speed should be consistent with the speed limit. Therefore, it is recommended that the highway engineer should incorporate the speed limit values in the design process with regards to the road geometries, area types, and vehicle types.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

According to the speed data analysis in the previous chapter, key findings are listed as follows:

1) Speed data from the 380 study sites showed high speed dispersion and low compliance rate, which can be caused by inappropriate speed limits set by outdated laws. Potentially, High speed variation high number of overspeeders could result in high number of accidents.

2) Speed limits in Thailand are currently categorized by area type and vehicle type. However, it is suggested that the road geometries such as median type, number of lanes, and access control should also be considered in setting speed limits.

3) Based on the analysis in the previous chapter, new speed limits for both urban and rural areas are proposed as follows:

Proposed speed limits for **urban area:**

Cross Section	Car	Truck
2 lanes	60	60
> 2 lanes, undivided	60	60
> 2 lanes, divided	60	60
> 2 lanes, divided with frontage road (Mainlines)	90	60

Proposed speed limits for **rural area:**

Cross Section	Car	Truck
2 lanes	90	70
> 2 lanes, undivided	90	70
> 2 lanes, divided	100	80
> 2 lanes, divided with frontage road (Mainlines)	100	80

The proposed speed limits can be illustrated in simple graphics as follows:

	Road types / Types of vehicle	SCHOOL ZONE	Undivided Highway or Frontage Road	Divided Multilane Highway	Multilane Highway (Mainlines)	MOTORWAYS
BUILT-UP AREAS		40	60	60	90	120
			60			100
			60			80
Rural Areas		40	90	100	100	120
			80	90	90	100
			70	80	80	80

4) Once the new speed limit scheme is implemented, the Department of Highways should promote the new speed limits so that road users has better understanding related to the new speed values. In addition, rigorous speed enforcement is also a key factor in reducing number of speed-related accidents. Lastly, the Department of Highways should regularly measure speed and its distribution on the highways and review its speed limit and crash frequency every year. The crash frequency should be compared with the expected values from the similar road type.

5) The speed characteristics at the black spot locations were also investigated. It was found that the speed variation of the black spot locations are significantly higher than those of other locations. Consequently, it is likely that bringing down the operating speeds at these black spot locations would also reduce number of accidents on these locations.

6) Based on the data, it was found that speeds on the steep highways are relatively high. It can be foreseen that over-speed trucks would result in high severity crashes. Therefore, the speed limit on the steep highway section should be strictly enforced. The speed limit sign should be posted to warn road users on the long steep highway sections.

7) Speed limits in the school zone should be enforced based on time of day such as 7:00-9:00 and 15:00-16:30 where pedestrian activity is high in the school area. The posted speed limit in the school zone should 40 km/hr.

8) In addition to overspeeding vehicles, slow vehicles should also be considered. Vehicles with the operating speed of 50 to 60 km/hr on the motorways caused high speed diffrerence. It is known that high speed difference would increase the chance of accidents as well as the accident severity. Thefore, the Department of Highways should consider the minimum speed limits on the highways to keep majority of vehicles in the same speed sprectrum.