Relaxing Vehicle Weight and Dimension Regulations Governing Truck Operation in Thailand

Pongrid Klungboonkrong*

Abstract

In Thailand, the relaxation of regulations governing the sizes and weights of trucks is an important issue. This is because such relaxation will potentially lead to truck operating cost savings realized by truck operators, but it possibly results in the increases of highway geometric, pavement, and bridge costs borne directly to the government agencies. Consequently, the most rational approach of relaxing such regulations would be the one which could efficiently and effectively raise truck productivity and simultaneously minimize government investments. This paper is organized to present : what Vehicle Weight and Dimension (VWD) regulations are and what they do; the rationale of the relaxation of VWD regulations; the comparison of governing VWD regulations in Thailand to those in other countries; implication to the relaxation of VWD regulations of Thailand; and lastly commetary.

---

* Lecturer, Civil Engineering Department, Faculty of Engineering, Khon Kaen University, Khon Kaen, 40002

การผ่อนผันข้อจำกัดเกี่ยวกับขนาดและน้ำหนักของรถบรรทุกที่ใช้ควบคุมในประเทศไทย

พลกฤษณ์ คล้ายบุตรอง*

บทคัดย่อ

การผ่อนผันข้อจำกัดเกี่ยวกับขนาดและน้ำหนักของรถบรรทุกในประเทศไทยเป็นประเด็นปัญหาสำคัญ เนื่องจากในขณะที่การผ่อนผันดังกล่าวจะช่วยลดค่าใช้จ่ายในการขนส่งสินค้าด้วยรถบรรทุกซึ่งผู้ประกอบการเป็นผู้ได้รับผลประโยชน์ แต่อาจนำไปสู่การเพิ่มขึ้นของค่าใช้จ่ายในการก่อสร้างหรือปรับปรุงและบำรุงรักษาถนนทางและสะพาน ซึ่งจะต้องรับผิดชอบโดยรัฐบาล ดังนั้นการผ่อนผันข้อจำกัดดังกล่าวจึงเหมาะสมหรือไม่ คือ การผ่อนผันจึงสามารถเพิ่มประสิทธิภาพและประสิทธิผลของการขนส่งสินค้าโดยรถบรรทุก แต่ในขณะเดียวกันรัฐบาลจะเสียค่าใช้จ่ายในการก่อสร้างหรือปรับปรุงและบำรุงรักษาถนนทางและสะพานต่าง ๆ น้อยที่สุด บทความนี้จะบรรยายถึงหัวข้อต่าง ๆ ที่เกี่ยวข้องกับการผ่อนผันข้อจำกัดเกี่ยวกับขนาดและน้ำหนักของรถบรรทุกดังต่อไปนี้ ข้อจำกัดเกี่ยวกับขนาดและน้ำหนักของรถบรรทุกคืออะไรและมีวิธีพิจารณาอย่างไร; เหตุผลของการผ่อนผันข้อจำกัดเกี่ยวกับขนาดและน้ำหนักของรถบรรทุก; การเปรียบเทียบข้อจำกัดเกี่ยวกับขนาดและน้ำหนักของรถบรรทุกในประเทศไทย และข้อจำกัดในประเทศอื่น; ความหมายโดยนัยหมดของการผ่อนผันข้อจำกัดเกี่ยวกับขนาดและน้ำหนักของรถบรรทุกในประเทศไทย; และสรุปวิจารณ์

---

* อาจารย์ ภาควิชาวิศวกรรมโยธา คณะวิศวกรรมศาสตร์ มหาวิทยาลัยขอนแก่น จ.ขอนแก่น 40002

1. Introduction

At the present, Thailand is experiencing in a rapid growth of the utilization of heavier and larger trucks. This is because the operation of heavier and larger trucks potentially decreases truck operating costs. However, such operation possibly increases highway geometric, pavement, and bridge costs in terms of both rehabilitation and maintenance costs. The issue is that whereas truck operators gain the benefits (saving in truck operating costs) according to the utilization of heavier and larger trucks, the government transport agencies will be responsible for highway geometric, pavement and bridge rehabilitation and maintenance.

Truck sizes and weights are strongly influenced by the governing Vehicle Weight and Dimension (VWD) regulations. Lill (Lill, 1986) pointed out that "...Trucks are designed to obtain the most effective use of what the size and weight laws permit." To increase the cubic and/or weight payload capacities of trucks which, in turn, enhances truck productivity, those VWD regulations must be properly relaxed. This is the major reason why the governing VWD regulations in several countries have been gradually changed.

This paper is organized to present the topics of what vehicle weight and dimension (VWD) regulations are and what they do; economic rationale of the relaxation of VWD regulations; comparison of governing VWD regulations in Thailand to those in other countries; implication to the relaxation of VWD regulations in Thailand; and commentary.

2. What are Vehicle Weight and Dimension (VWD) Regulations?

VWD regulations are mainly set up as the governmental tool to protect highway infrastructures such as vertical and horizontal roadway geometry, pavements, and bridges, etc. from rapid deterioration due to the operation of too heavy and too large trucks. However, VWD regulatory setting is also influenced by a number of considerations such as truck operational performance (i.e. offtracking, braking, passing manoeuvres, etc.), traffic aspects (i.e. level of service, roadway capacity, etc.), truck safety (i.e. truck stability and control and historical accident records, etc.),environmental impacts (i.e. vibration, noise, air pollution, etc.), and public concerns (i.e. big truck vs small car, etc.).

VWD regulations generally restrict on the maximum sizes (height, width, and length) and maximum weights (axle weight and gross vehicle weight (GVW)) for different types of trucks. These VWD restrictions are the principal VWD regulatory elements. Figure 1 shows the influences of the principal VWD regulatory elements on dimension and weight characteristics of trucks and the distribution of that weight on roadway surface. These will, in turn, affect the design of trucks and the quantity of hauled goods.

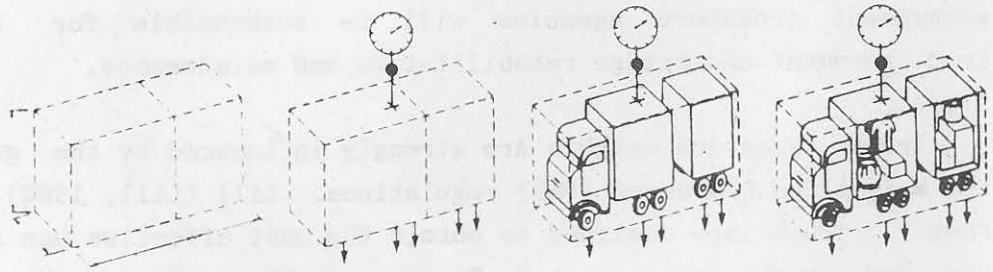


Figure 1. What Are VWD Regulations and What They Do
Source: (Clayton et al, 1989)

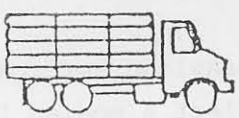
In addition to the principal VWD regulatory elements, there are a number of other VWD regulatory elements (derived from Canadian experiences) such as road class (primary vs secondary highways), seasonality (spring weight reduction vs winter weight premium), lift axles, inter-vehicle axle spacing (axle spread and axle spacing), kingpin-to-rear and behind cab-to-rear of units, etc., interacting and complicating those principal VWD regulatory elements (Nix, 1987).

3. Economic Rationale of the Relaxation of VWD Regulations

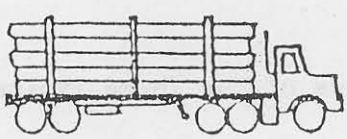
The main factor encouraging the use of heavier and larger truck combinations is economic improvement. The heavier and larger truck combinations can carry freight at higher payload capacity. This, in turn, reduces the operating costs of those truck combinations. Some relevant findings regarding this matter are summarized as follows:

Thailand Experiences

Leong (Leong, 1985) conducted the study concerning the economic consequences of operating trucks of higher gross vehicle weight on highways in Thailand. By adopting Highway Design and Maintenance Standard Model (HDM) developed by world Bank, the three truck scenarios were analysed. The first and second truck scenarios were 3-axle (10-wheel) straight trucks with different load carrying capacities, while the third truck scenario was 5-axle (18-wheel) tractor semitrailer unit as shown in Figure 2.



Single-unit Truck



Tractor Semi-trailer

Figure 2. Truck Scenarios
Source: (Leong, 1985), pp.16

The first truck scenario was set to operate at the existing maximum GVW limit of 21 tonnes in Thailand, while the second truck scenario is allowed to haul 9.0 tonnes higher. (from 21.0 to 30.0 tonne limit). In addition, the third truck scenario is set to carry 3.6 tonnes higher comparing to the GVW limits presently governing this truck scenario. (from 37.4 to 41.0 tonne limit).

Leong (Leong, 1985) found that for each of truck scenarios, the truck operating costs and total transportation costs decreased when increasing the allowable GVW limits governing that truck. He recommended that"...There is economic justification for raising the legal load limit

from the 21-metric tonne gross vehicle mass that is currently in force in Thailand". Leong also pointed out that to transport the given amount of commodities, fewer larger trucks would be more productive than a greater number of smaller trucks.

Canadian Experiences

Klungboonkrong Klungboonkrong, 1989) conducted the analysis of truck operating costs in Canada 1986 based on the report entitled "Operating costs of trucks in Canada 1986" (Motor Carrier Branch, 1986) prepared by TRIMAC Consulting Services Ltd. The TRIMAC Costs medel has been used to determine the truck operating costs and truck rates in Canada on a biennial basis.

The Manitoba bulk-payload base-case costs in 1986 were examined. These costs potentially reflect a median truck condition in Manitoba. The three typical truck types determined were the 2-axle straight truck, the standard 5-axle tractor-semitrailer, and 7-(8-) axle (A-train) double-trailer units. The characteristics of the three typical truck types are given in Table 1.

Table 1 The Characteristics of the Three Typical Truck Types in Manitoba

	 2-Axle Dual Rear Wheel Straight Truck	 Standard 5-Axle Tractor Semi-Trailer Combination	 7/8 Axle Tractor Double-Trailer (A-Train) Combination
VEHICLE CHARACTERISTICS			
Maximum Weight on Steering Axle (kg)	5500	5500	5500
Maximum Weight on Single Axle (kg)	9100	9100	9100
Maximum Weight on Tandem Axle (kg)	N/A	16000	16000
Maximum Gross Vehicle Weight (kg)	14600	37500	56500
Typical Tare Weight (kg)	7300	12300	15800
Typical Payload Capacity (kg)	7300	25200	40700
Maximum Overall Length (m)	12.5	20.0	23.0

Source: (Klungboonkrong, 1989), pp.5-4

From his analysis, Klungboonkrong (Klungboonkrong, 1989) found that at a specific annual utilization level (annually traveled distance), the total operating costs, in terms of Canadian cents per km., increased as truck sizes and GVW's increased. For example, at the utilization level of 80,000 km/year, the total operating costs for 2-axle,5-axle and 7/8-axle truck types operated on gravel roads were 114.2,144.2, and 167.5 cents/km., respectively. However, total operating costs per payload tonne-km., in term of Canadian cents per payload tonne-km., significantly decreased as truck sizes and GVW's increased. For example, at the same utilization level, the total truck operating cost per payload tonne-km., for 2-axle, 5-axle, and 7/8-axle truck types were 17.4,6.4, and 4.5 cents/tonne-km.,respectively. These findings were illustrated in Figure 3 and 4.

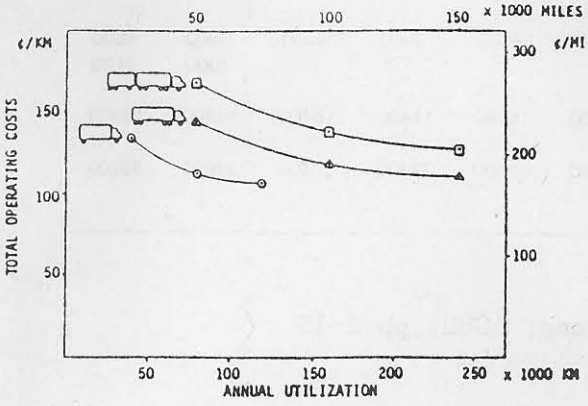


Figure 3. Total Operating Costs (cents/km.) vs Annual Utilization

Source: (Klungboonkrong, 1989), pp.5-6

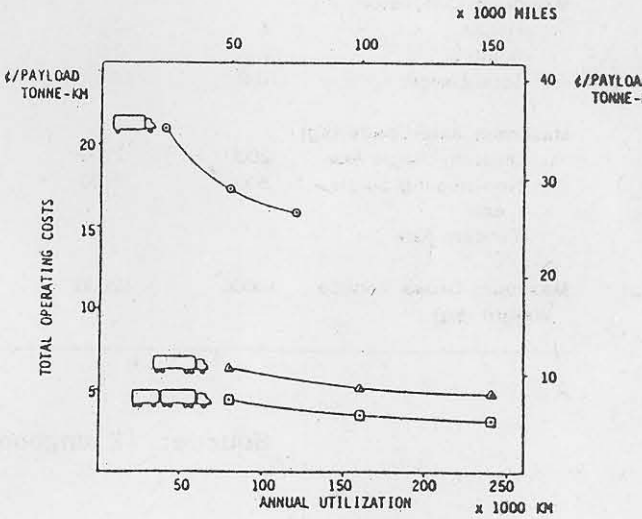


Figure 4. Total Operating Costs per Payload tonne-km vs Annual Utilization

Source: (Klungboonkrong, 1989), pp.5-7

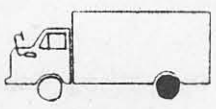
In addition to the above two studies, a number of other researches [(Walton and Burke, 1980), (WHI,1980), (Sparks and Nendorf,1986), (Boucher, 1988), and (Nix, 1988)] consistently found that the utilization of the heavier and larger trucks was more productive than the lighter and smaller ones. The responsive outcome for these are the VWD regulatory relaxations

to permit the operation of heavier and larger truck combinations in The United States (Lill, 1986), in Canada (Nix, 1987), in European countries (Clayton and Johansson, 1988), and in Thailand (Klungboonkrong, 1989). In Thailand, the VWD regulations were recently changed in 1976 due to the economic reasons. These VWD regulatory changes for four typical truck types operated in Thailand are shown in Table 2 and the features of those truck types are also illustrated in Figure 5.

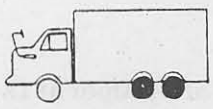
Table 2 The Changes in Maximum VWD Regulations in 1976 for the Four Typical Truck Types Operated in Thailand.

Vehicle Characteristics	Vehicle Type I		II		III		IV	
	Pre-1976	Post-1976	Pre	Post	Pre	Post	Pre	Post
Maximum Dimension (m)								
Height	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8
Width	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Total Length	10.0	10.0	10.0	10.0	15.0	15.5	18.0	18.0
Maximum Axle Loads (kg)								
Steering Single Axle	2000	2900	3600	4600	3600	4600	3600	4600
Non-steering Single Axle	8000	9100	-	-	-	-	8000	9100
Tandem Axle	-	-	14400	16400	14400	16400	14400	16400
Maximum Gross Vehicle Weight (kg)	10000	12000	18000	21000	32400	37400	34000	39200

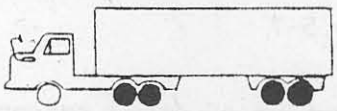
Source: (Klungboonkrong, 1989), pp.2-15



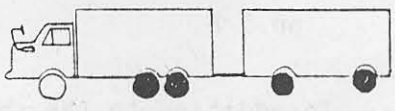
2-axle, 6-wheel (2) straight trucks (vehicle type I)



3-axle, 10-wheel (3) straight truck (vehicle type II)



5-axle tractor-semitrailer (3-S2) combination (vehicle type III)



3-axle, 10-wheel straight truck plus 2-axle full-trailer (3-2) combination (vehicle type IV)

○ Single wheel

● Dual Wheel

Figure 5. The Four Typical Truck Types in Thailand

Source: (Klungboonkrong, 1989), pp.2-12

4. The Comparison of Governing VWD Regulations around the World

As described earlier, the relaxation of VWD regulations potentially improves the economic situation and also accelerates the growth of trucking industry in Thailand and in other countries. This has strong linkage to the development of economy of those countries. The comparison of the governing VWD regulations presently enacting in Thailand to those in other countries would, to some extent, direct to the more logical VWD regulatory relaxation and/or possibly indicate what can be improved in the existing VWD regulations of Thailand.

Table 3 illustrates the comparison of governing VWD regulations in Thailand to those in Canada, the United States, and European countries. Several observations are presented as follows.

- the maximum height limit of trucks in Thailand (3.80 m) is slightly less than those in Canada (4.15 m), Europe (4.00 m), and the U.S. (4.11-4.27 m). This will reduce the cubic capacity of trucks operated in Thailand and also lead to inefficient container transportation. It is very difficult to transport a standard container on a flat-deck truck under the 3.80 m. height limit.

- the maximum width limit in Thailand (2.50 m.) is compatible to those in other countries. (2.44-2.60 m).

- the maximum length for both individual (i.e. straight truck, tractor, trailer and semitrailer) and combination (i.e. straight truck plus fulltrailer and tractor-semitrailer) units in Thailand are generally less than those in other countries.

- in Thailand, the axle-weight limit (4.60 tonnes) for a steering single axle is significantly less than those in other countries (5.50-13.0 tonnes). For a non-steering single axle, the axle-weight limit governing in Thailand is generally comparable to those in other countries. However, for tandem-axle, the axle-weight limit enacting in Thailand approximately lies at the minimum values of those in Canada and Europe. This is because, in Thailand, the extra tandem-axle load is not permitted when spreading out the axle. Furthermore, the triple axle has never been legally permitted in Thialand.

Table 3 The Comparisons of Governing VWD Regulations in Several Countries

	VWD Regulatory Elements	THAILAND	CANADA[1]	EUROPEAN COUNTRIES	U.S.A.
(I)	DIMENSION LIMITS (metre)				
	Max. height	3.80	4.15	4.0	4.11-4.27
	Max. width	2.50	2.60	2.50-2.60	2.44-2.60
	Max. length				
	- straight truck & tractor	10.0	12.5	11.0-12.4	10.7-18.3
	- trailer	8.0	12.5-14.7	11.0-12.5	8.5-15.2
	- semitrailer	12.5	13.5-15.5	12.0-N.S.	14.6-N.R.
	- tractor-semitrailer	15.5	20.0-23.0	15.5-24.0	**
	- straight truck plus trailer	18.0	20.0-23.0	18.0-24.0	**
	- double trailer	-	21.0-23.0	18.0-24.0*	**
(II)	AXLE LOADS LIMITS (tonnes)				
	Steering single axle	4.6	5.5-9.1	10.0-13.0	9.0-10.0
	Non-steering single axle	9.1	9.0-10.0	10.0-13.0	9.0-10.0
	Tandem axle	16.4	16.0-20.0	16.0-21.0	15.4-16.3
	Triple axle	-	16.0-30.0	21.0-27.0	19.0-24.5
(III)	GROSS VEHICLE WEIGHT LIMITS (tonnes)				
	Straight truck	21.0	26.0-47.5	24.0-32.0	20.9-26.3
	Tractor-semitrailer	37.4	37.5-57.5	38.0-44.0	36.3***
	Straight truck plus trailer	39.2	50.0-63.5	38.0-44.0	36.3***
	Double trailer	-	50.0-63.5	38.0-44.0	36.3***

SOURCE: References [6], [7], [9], and [41]
N.S.: not specified, N.R.: not restricted
* not permitted in some countries
** no length limits on the Interstate system (as per STAA, effective June 1988) [6]
*** GVW limits up to 36.3 tonnes (80,000 lbs) allowed on all Interstate highways [41].
[1] Pre-RTAC proposed VWD regulations

Source: (Klungboonkrong, 1989), pp.2-16

- The maximum GVW limits for all truck types operating in Thailand are generally less than those in Canada and European countries. The main reasons for this are the lower allowable axle-weight limits for all axle categories, no extra tandem-axle load allowance when spreading

out the axle, and no legal allowance for the use of triple axle. It should be noted that the GVW limit for each truck type in Thailand based on the summation of allowable axle-weight limits of the axles existing on that truck types. For example, the axle system of tractor semitrailer combination consists of a steering single axle and two sets of tandem axles with axle-weight limits of 4.60 and 16.4 tonnes, respectively. The maximum allowable GVW limit for this combination is, therefore, equal to 37.4 tonnes.

5. Implications to the Relaxation of VWD regulations in Thailand

The issue of VWD regulatory relaxation boils down to the trade-off between the extra highway and bridge costs borne directly to the government agencies according to the utilization of heavier and larger trucks and the operating cost savings realized by truck operators. This issue is a critical matter to Thailand where much of the development relies on the shipment of high-weighted and relatively low-valued commodities to the market places. Hence, the most rational approach of VWD regulatory relaxation would be the one which can efficiently and effectively enhance truck productivity and simultaneously minimize governmental investments on roadway geometric, pavement and bridge rehabilitation and maintenance.

In general, each truck combination will be designed to carry a particular freight density, namely "design density". This means the truck combination will be simultaneously filled with loads and reaches its maximum GVW limit when employed to carry the commodity having its design density. This truck combination will be experienced the "cube-out" and "weight-out" situations when carrying the lower and higher density freights, respectively. The "cube-out" situation is that the truck space is filled before the truck weight reaches its GVW limit. In contrast, the "weight-out" situation is that the truck weight reaches its GVW limit before the truck space is completely filled. The understanding of both "cube-out" and "weight-out" trucking operations are important to the VWD regulatory relaxtion in that while "cube-out" truck combinations need their size limits to be changed, "weight-out" truck combinations need their GVW limits to be relaxed.

In case of size limit relaxation, significant increases in vehicle height and width limits are generally impractical approaches to raise truck productivity (TRB, 1973). Consequently, height and width limits

in Thailand (Klungboonkrong, 1989) and other countries [(Nix, 1987) and (Clayton and Johansson, 1988] remained constant for a number of years. The most appropriate way to achieve greater truck cubic capacity is to increase the individual and/or combination length limits. However, small changes of height and width limits governing some truck operations such as standard container transportation, refrigerated truck units, etc. should be considered because these changes potentially facilitate the operation of those trucks.

In case of weight limit relaxation the "spreading-truck-weight" strategy in which weight payload capacity and therefore the maximum GVW limit can be increased by adding more axles and lengthening the truck unit without increasing the maximum allowable axle-weight limits is recommended. Keeping axle weight limits fixed and adding more axles, while raising the maximum GVW capacity, will reduce load bearing on each axle which, in turn, decreases the adverse effects on pavements. Spreading these axles over the longer truck length will be intended to reduce the adverse effects on bridges. This strategy performed well to increase truck productivity and to reduce the adverse effecs on pavements and bridges (WHI, 1980).

Based on the above explanation and analysis, a number of feasible alternatives of relaxing VWD regulations being enforced in Thailand are presented as follows:

- the maximum height limit (3.80 m.) of trucks operating in Thailand should be increased to the level which will facilitate some truck operations such as a standard container on a flat-deck truck operation, "cube-out" truck operation, etc. However, the vertical clearance of bridges and wires and truck operational stability and control performance (the higher the center of gravity, the lower manoeuvring stability) must be carfully examined regarding this matter.

- despite the maximum width limit (2.50 m.) in Thailand is compatible to those in other countries, such limit should be increased to the level of 2.60 m. This is because the 2.60 m. width limit provides more efficient truck operation such as for refrigerated trucks with the thick insulating walls, trucks handling standard pallets (120x80 cm.) or other standardized building equipment. Furthermore, the increase in width limit can also improve the operational stability

and control performances and, to some extent, increase cubic capacity of these trucks.

- both individual vehicle length limits and overall combination length limits were questionably set up. For example, while individual straight truck and trailer length limits are restricted to 10.0 m. and 8.0 m., respectively, the overall truck plus trailer length limit is set at 18.0 m. This means that the individual truck and trailer lengths will never simultaneously reach their own limits under the overall combination length limit of 18.0 m. because part of overall length is occupied by draw bar length. The increases in individual and/or overall combination length limits will improve truck operational efficiency and productivity. It is, therefore, necessary to increase individual and/or combination length limits governing different types of trucks in Thailand. However, these increases would probably cause unacceptable problems concerning highway geometric considerations (i.e., passing sight distance, turning characteristics, etc.), traffic considerations (i.e. level of service, highway capacity, etc.), load carrying capacity of bridges, and truck safety considerations (stability and control). Consequently, these increases must be strongly based on both economic and technical justifications.

- the axle-weight limit for steering single axle in relatively low. This axle-weight limit should be legally increased when replacing the existing tires with the wider-width tires. This increase will facilitate some trucking operations such as trucks carrying high density commodities (i.e. ready mixed concrete, gravel, etc.). The axle-weight limit for non-steering single axle in Thailand is compatible to those in other countries and should be kept constant. The tandem-axle weight limit should be legally increased when spreading it out. The axle-spreading regulations should be established to control the damaging effects of load bearings of different axle types (i.e. tandem and triple axles etc.) on highway pavements. Triple axle should be legally permitted because the axle can carry more load than tandem axle.

- GVW limits of many truck types in Thailand can be enhanced by increasing the existing axle-weight limits for some axle categories (steering single axle and tandem axle) to the more appropriate

levels, by allowing the use of triple axle, and then applying the "spreading-truck-weight" strategy to the VWD regulatory relaxation in Thailand. Despite axle-spreading regulations developed to control the adverse effects of higher load bearings of different axle types on the highway pavements, these axles will possibly cause the adverse effects on bridges. The axle-spacing regulations should be, therefore, established to control this matter. The examples of possible alternatives of increasing GVW limits for (18-wheel) tractor-semitrailer and 10-wheel straight truck plus full frailer units are presented as follows:

For (18-wheel) tractor-semitrailer units, GVW limit can be effectively raised by changing the semitrailer axle from a tandem to a triple axle, as shown in Figure 6. The distance between the tandem axle of the tractor unit and the triple axle of the semitrailer must conform the axle-spacing regulations, and axle spread of the triple should be kept within the suitable range because the triple axle with wide spread will aggravate dynamic manoeuvres of the combination (RTAC, 1986).

For 10-wheel truck plus full trailer units, GVW limit can be effectively enhanced by changing the rear axle of the trailer unit from a single to a tandem axle, as shown in Figure 7. The axle-spacing regulations will also be applied to this case.

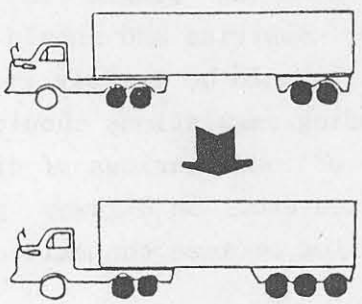


Figure 6 Semitrailer Axle Change from Tandem to Triple Axle
Source: (Klungboonkrong, 1989),pp.2-34

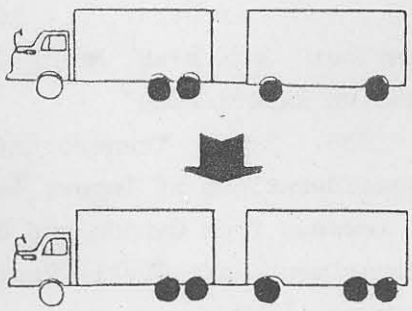


Figure 7 Full Trailer Axle Change from Two Single-Axle Sets to One Single Axle Plus One Tandem-Axle Sets.
Source: (Klungboonkrong, 1989),pp.2-34

Commentary

The VWD regulations are the principal factor influencing truck fleet and operating characteristics. The VWD regulatory relaxations will potentially raise truck productivity. This is the major reason of the VWD regulatory changes in many countries around the world. The feasible alternatives of relaxing truck weight and size limits in Thailand are presented. However, to achieve the most appropriate VWD regulatory setting, the structure, interaction, complexity, and implications of each element of VWD regulations must be fully understood; the actual responsive mechanism of trucking industry to the VWD regulatory changes must be realized; and the proper database, in terms of its quantity and quality, must be established. In addition to these considerations, a number of other factors such as truck operational performances, traffic considerations, safety considerations, environmental impacts and public concerns will also be determined simultaneously.

References

(1) Boucher, M., 1988, **"Long Combination Vehicles"**, Presented at the Conference on Large Truck Operations Now and in the Future, Stockholm, Sweden, May, 1988.

(2) Clayton, A.M. and Johansson, M., 1988, **"Weight and Dimension Regulations Governing International Trucking in the Nordic Region (Report 1988:6E)"**, Transport Research Commission, Stockholm, Sweden, June, 1988.

(3) Clayton, A.M., Nix, F., and Lindkvist, A., 1988, **"Harmonizing Weight and Dimension Regulations Governing Multi-Jurisdictional Trucking: Scandinavian and Canadian Experiences"**.

(4) Klungboonkrong, P., 1989, **"Truck Transportation Operating Efficiency and Performance Considerations of Import to Highway Development in Northeast Thailand: Lessons from Canada and Other Countries"**, M.Eng. Project Report, Department of Civil Engineering, University of Manitoba, Canada, January, 1989.

(5) Lill, R., 1986, **"Geometric Design for Large Trucks-An Overview of The Issues from The Perspective of The American Trucking Associations, Inc."**, TRR 1052, Transportation Research Board.

(6) Leong, H.K., 1985, **"Economic Consequences of Operating Trucks of High Gross Vehicle Mass on Highways in Developing Countries"**, M.Eng. Thesis, Department of Civil Engineering, Asian Institute of Technology, Bangkok, Thailand, April, 1985.

(7) Motor Carrier Branch, 1986, **"Operating Costs of Trucks in Canada 1986"**, Prepared for the Surface Transport Administration, Transport Canada by TRIMAC Consulting Services Ltd.

(8) Nix, F.P., 1987, **"Vehicle Weight & Dimension Regulations Canada's Trucking Industry : Final Report"**, Transportation Development Centre, Trasport Canada, April, 1987.

(9) Nix, F.P., 1988, **"Impact of RTAC Regulations on Trucking in Canada"**, A Paper Prepared for Transport Canada for Presentation to: Transportation Research Board (TRB), November, 1988.

(10) Roads and Transportation Association of Canada (RTAC), 1986, **"Vehicle Weight and Dimension Study: Technical Steering Committee Report"**, December, 1986.

(11) Sparks, G.A. and Nendorf, R.D., 1986, **"Productivity Implications of Vehicle Weight and Dimension Regulations in The Transportation of Petroleum Products"**, CTRF, Annual Conference Proceedings, May, 1986.

(12) Transportation Research Board (TRB), 1973, **"Changes in Legal Vehicle Weights and Dimensions:Some Economic Effects on Highways"**, Prepared for National Research Council, NCHRP 141.

(13) Western Highway Institute (WHI), 1980, **"Motor Vehicle Size and Weight Standard, Western Regional Objectives:Executive Summary"**, Prepared for the TRED Foundation, July, 1980.

(14) Walton, C.M. and Burke, D., 1980, **"Truck Sizes and Weights:A Scenario Analysis"**, Transportation Research Record (TRR) 747, 1980.