

OVERLOADING OF HEAVY VEHICLES AROUND THE WORLD

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Abstract

It is impossible for any country to have a rapid economic growth without a good and efficient transportation system. However, there are several problems affecting the transportation systems. One of the most important and common problem nowadays is the overloading of heavy vehicles and trucks. Road pavements performance, infrastructure performance, and safety are severely reduced by heavy vehicles overloading. This paper presents a review on studies that has investigated overloading in different countries of the world including Malaysia, China, South Africa, Thailand, Pakistan, and Taiwan. It was found that several studies confirmed that overloading is a common and series problem around the world.

Keywords: Overloading, Pavement Performance, Road Infrastructure Performance, Road Safety, Transportation.

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Introduction

Transportation is very important. It is impossible for any country to have a rapid economic growth without a good and efficient transportation system. Development of good transportation systems facilitates the movement of resources from the location where they are found to the place where they are utilized. Without efficient transportation systems it would be difficult to send raw materials, fuel and machineries to the different industries to operate.

Good transportation systems also help in increasing the production of raw materials and industrial products by providing a wider market. Since products can move to distant places in a shorter time, which allows the product to reach to more customers. This causes a large scale production, as a result industries get the benefit and the country economy as well.

Another point of how good transportation system helps the economy is by solving the problem of unemployment in the rural areas, since it helps the unemployed to move to the industrial areas. In the same time, this helps the industries by providing labor force.

However, there are several problems affecting the transportation systems. One of the most important and common problem nowadays is the overloading of heavy vehicles and trucks. Overloading is to load the heavy vehicles beyond legal limits. The road pavement performance and road safety are severely reduced by overloading; this will cost the country not only in terms of money but also in terms of human lives. It is worth mentioning that in terms of road maintenance cost, the government of Malaysia spent 5 billion ringgit between 2001 and 2010 for federal road maintenance [1]; this value would be smaller if overloading stopped.

Overloaded trucks are a threat to the pavement structure. Overloading is one of the most important factors causing rapid increment in pavement deteriorations or distresses. A study that took place in Ghana demonstrated that overloading should be considered as a serious economic crime because of its negative impact on the pavement, especially when the pavement structure is thin as it is more sensitive to overloading, or when the maintenance and rehabilitation budget is relatively small. According to Molenaar, the only effective solution was to unload the overloaded vehicle on site. In addition, Molenaar believed that solving the overloading problem by increasing the pavement thickness to reduce stresses and strains at the lower layers was not an effective solution because of its expensive costs [2]. It was also reported by other scholars that allowing extra weight for a given type of trucks would increase the pavement damage because of the increase of axle loading [3].

Another study inspects the damage caused to the pavement by tridem and trunnion axle groups. The study included both flexible and rigid pavements by analyzing the mechanistic responses of both types of pavements to the different axle groups. The study concluded that pavement wear will increase due to the increase of axle loading. The study also concluded that axle spacing and tyre pressure will also have an impact on pavement structure wearing. It also showed that pavement deterioration is more affected by pavement type and axle load than by the other vehicle characteristics [4].

In the United States of America and South Africa, a lot of research have shown that the damage caused by overloaded vehicles exceeds all proportions. For instance, an overloaded axle carrying merely twice the loading of the permissible limits will cause more damage to the pavement than a legally loaded axle by four to sixty times, based on the pavement condition and its type [5].

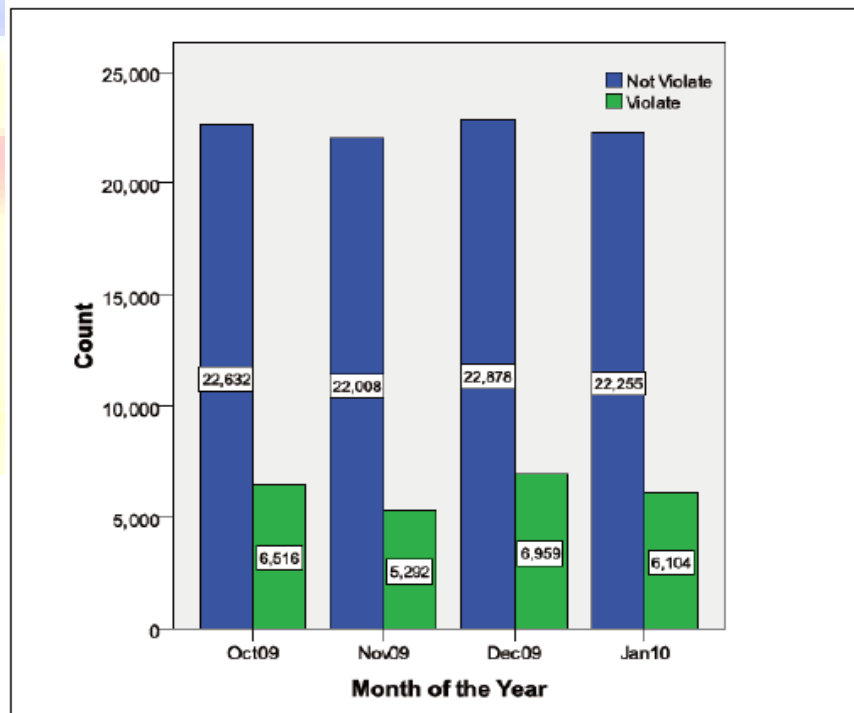
Consequently, Load limits were implemented by many countries with the main aim of reducing the effect of overloading on road infrastructures and to reduce the safety hazards caused by the overloaded vehicles. However, there are several studies proved that overloading is one of the widespread problems around the world.

This paper examines several published studies that have investigated vehicles weight from several countries around the world.

1. Overloading In Malaysia

A study has been done in Malaysia in 2009 and published in 2011 has checked the weight of approximately hundred thousand commercial vehicles in a period of four months. The study found that 24% to 29% of the total number of the investigated vehicles violated the total allowable gross weight limits. It was also reported in this study that some of the overloaded vehicles GVW is twice the permissible weight. Figure 1 [6].

Figure 1. No. of Gross Vehicle Weight Violation Cases at the Survey Station between (Oct 2009 – Jan 2010)[6]



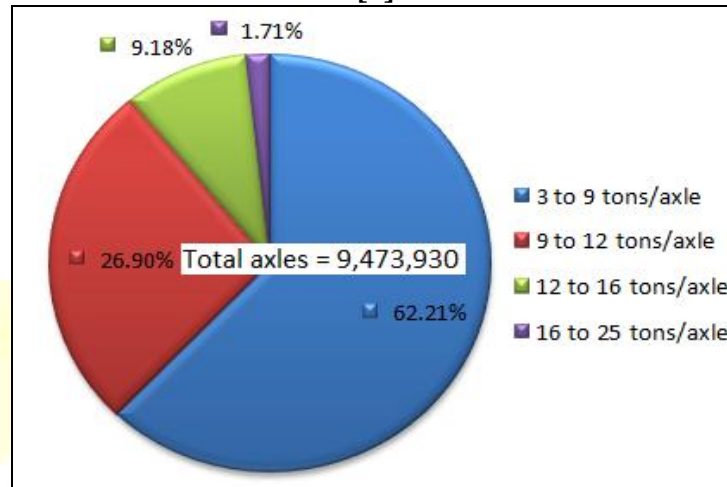
Another study was performed to evaluate the level of enforcement of the single axle load limitation in the northern part of Peninsular Malaysia's North-South Expressway. The axle weights were collected from selected sites along the North-South Expressway, over a period of one year, using Weight-In-Motion devices. The survey stations were located at Alor Setar, Bertam, Taiping, Gurun and Bukit Merah Figure 2 [7].

Based on the Study, The majority of axles weighted between 3 and 9 tons formed 62.21% of the total volume. The second major group was the axles that weighted between 9 and 12 metric tons; this group formed 26.90% of the total weighted axles. However, the overloaded axles formed 10.89% of the total volume. The majority of the overloaded axles weighted between 12 and 16 tons; they formed 9.18% of the total volume. The remaining 1.71% were the axles that weighted between 16 and 25 tons per axle. It is worth mentioning that axles that weighted above 25 tons were very rare, and they formed a negligible percentage of the total volume Figure 3 [7]. Another two studies by have been done by the same author confirmed similar results in other locations in Malaysia [8, 9].

Figure 2. WIM Approximate Locations. S1 At Alor Setar, S2 At Gurun, S3 At Bertam, S4 At Bukit Merah, And S5 At Taiping [7].



Figure 3. Axle Loading Distribution For The Five Stations [7].



2. Overloading in China

A site survey was published in 2004 based on the analysis of truck weights in Anhui province, China [10]. The study was an extensive overloading survey performed to assess the overloading status and enforcement effectiveness in Anhui with. The survey was done with the support of the World Bank. The number of survey sites were six at Fuyang, Huainan, Luan, Hefei, Huangshan, and Wuhu Areas with mainly four contents:

- 1- Traffic volume
- 2- Freight information
- 3- Registration information
- 4- Axle load [10].

Based on the analysis of the collected data from the six sites, it was concluded that vehicles illegal overloading is very severe and common at the major highways in the study areas, the actual load of nearly all of the trucks running in the study areas are higher than their registered weights, except a small number of small freight trucks [10]. The actual loading caused by traffic is far higher than the designed bearing capacity of the highways. Thus, it causes premature damages to road pavements, particularly rigid pavements [10]. Table 1 shows the overloading proportion in the study areas. Overloading proportion is the percentage of overloaded trucks to the total of operating vehicles.

Table 1. Trucks Overloading Proportion in Anhui [10]

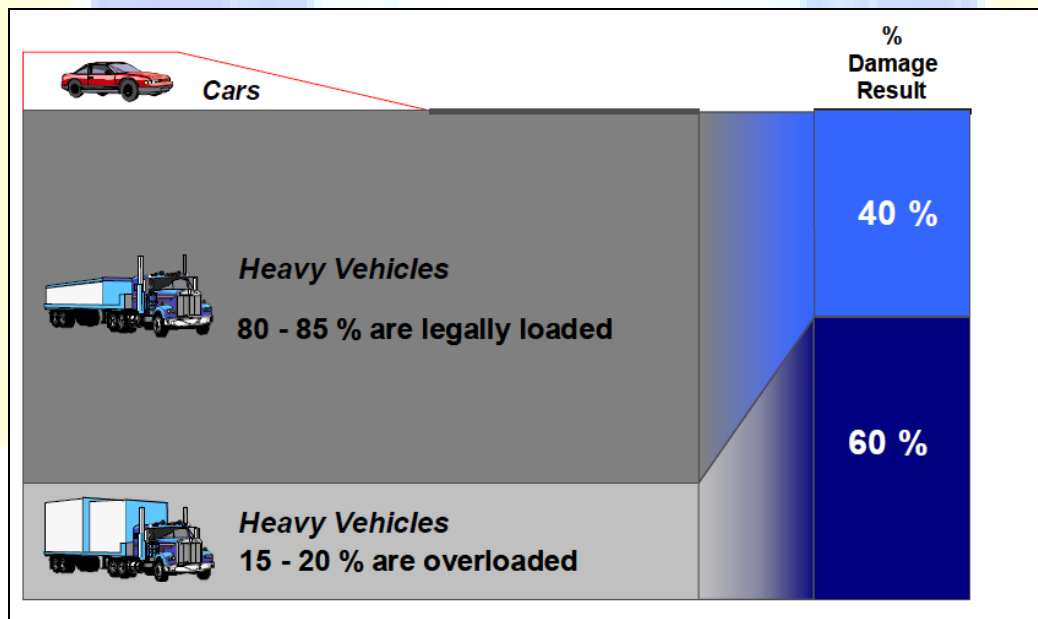
Index	Highway Types	SU2	SU3	2-S2	2-F2
OLP (%)	type one	60.3	75.6	76.5	91.3
	type two	50.6	70.9	51.9	67.2
	type three	18.6	-	-	-

3. Overloading in South Africa

Based on the information published by South African department of transport in 1997 [5]. A study was done in 1996 on 58,904 vehicles. The studied vehicles were weighed at weighbridges. It was found that 33% of the investigated vehicles were loaded beyond legal limits. Moreover, only 24% of the weighted overloaded heavy vehicles were fined. Till February 1996, the drivers of illegally overloaded heavy vehicles were fined only if the overload on non-steering single axles and axle units exceeded the maximum allowable load limit by a percentage of more than 15% or if the maximum allowable gross vehicle weight of the vehicle or the allowable load based on the bridge formula, exceeded by percentage of more than 5%. These tolerances were change on beginning of March 1996 after the rise of maximum allowable weights. The tolerance changed to only 5% to all load limits [5].

In the same published document, it was stated that legally loaded heavy vehicles causes a small amount of pavement damage when compared to overloaded heavy vehicles. Overloaded heavy vehicles causes approximately 60% of the damage compared to only 40% caused by legally loaded heavy vehicles. This represents approximately 400 million Rands per year [5]. Figure 4 shows a comparison between the damage caused by overloaded vehicles and legally loaded vehicles.

Figure 4. Damage Caused by Overloaded Vehicles [5]



4. Overloading in Thailand

It was stated by Ying [11] that truck is a remarkable social issue in Thailand. According to the surveys performed in 1996, overloading is usually caused by class 5 heavy vehicles (3 axles and ten wheels). Although they forms only 25% of the total operating trucks, the carry approximately 78% of the total weight carried by operating trucks [12]. Based on the data collected by weight-in-motion devices it was found that 33% of class 5 trucks are overloaded. Furthermore, 94% of these vehicles weighted between 21 to 30 tones, while the legal limits for this type of vehicles is only 21 tons [12]. [12] point out that almost 80% of the highway pavements damages are caused by merely 33% of the overloaded vehicles.

5. Overloading in Pakistan

A study was published by Rabia et al. [13] investigated the variation in truck factor on pavement performance in Pakistan. Data was collected using weight-in-motion devices located at two survey stations at Sanghjani and Mullah Mansoor. The survey stations are located on Grand Trunk Road (N-5), which connects two major cities in Pakistan (Peshawar and Rawalpindi). The data was collected for a period of three months from October to December 2006 at Sanghjani weight -in-motion station. On the other hand, data was collected in a period of six months at Mullah Mansoor weight-in-motion station.

The collected data contains varies details such as:

- 1- Time
- 2- Date
- 3- Gross Vehicle Weight (GVW)
- 4- Overloading Status
- 5- Axle load
- 6- Percentage of Overloading, etc.

Based on the analysis of the collected data, it was concluded that 62% of the operating trucks at Sanghjani weight-in-motion station were loaded, out of these loaded trucks 33% were overloaded. Similarly, 76% of the operating trucks at Mullah Mansoor weight-in-motion station were loaded, out of these loaded trucks 48% were overload Figure 5 and 6 [13].

Figure 5. Total Truck Traffic Summary of Sanghjani (3 Months Data) [13]

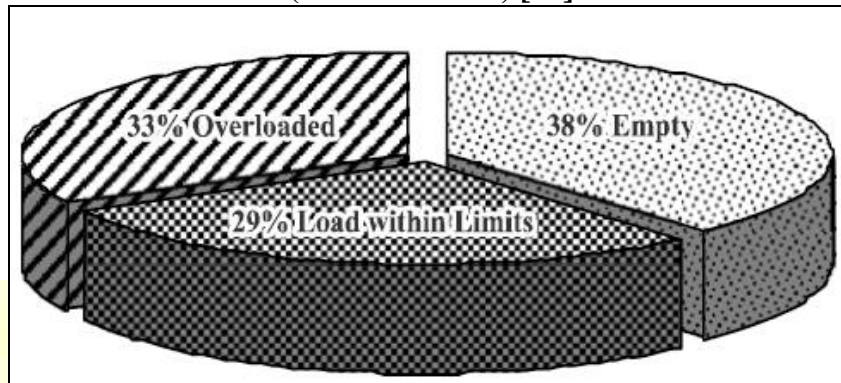
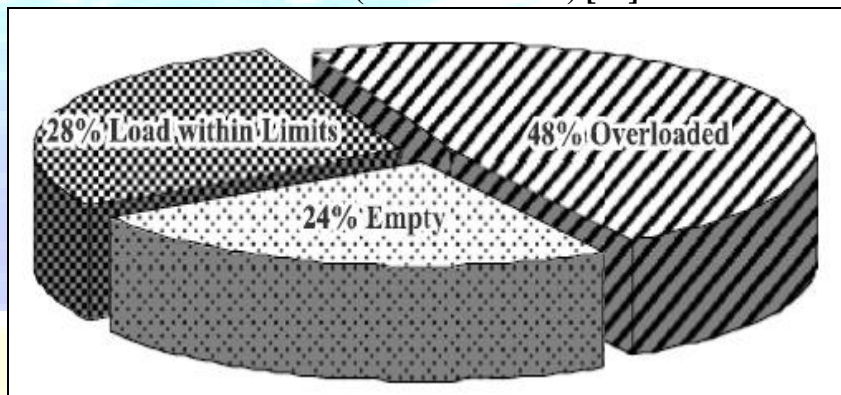


Figure 6. Total Truck Traffic Summary Of Mullah Mansoor (6 Months Data) [13]



6. Overloading in Taiwan

In Taiwan, one of the studies reported that overloading formed 14.2% of the total volume of the traffic along the National freeway [14]. Moreover, It was found that for certain vehicle type the overloading percentage reaches 24%.

Based on the analysis of Weight in Motion results it was also found that the tandem axle group overloading is a lot higher than that of the single axle. The tandem axle group has an overloading percentage of 53% while the single axle group only reaches 12%. Figure 7 shows the legal limits based on vehicle gross weight of the vehicles in Taiwan. It was found that vehicle S112 type has the highest overloading rate for tandem axle (71.1%) (Figure 8).

Figure 7. Legal Gross Weights of Heavy Vehicles in Taiwan [14]

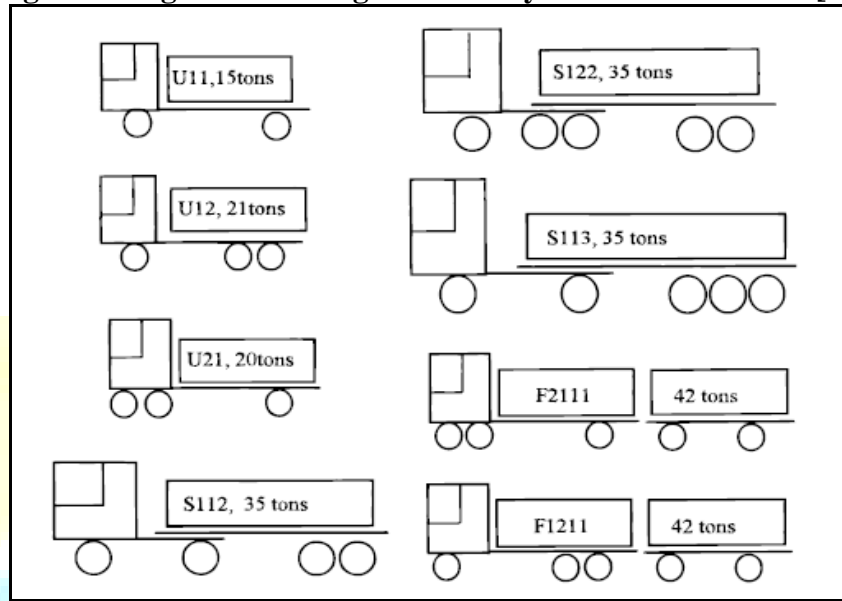
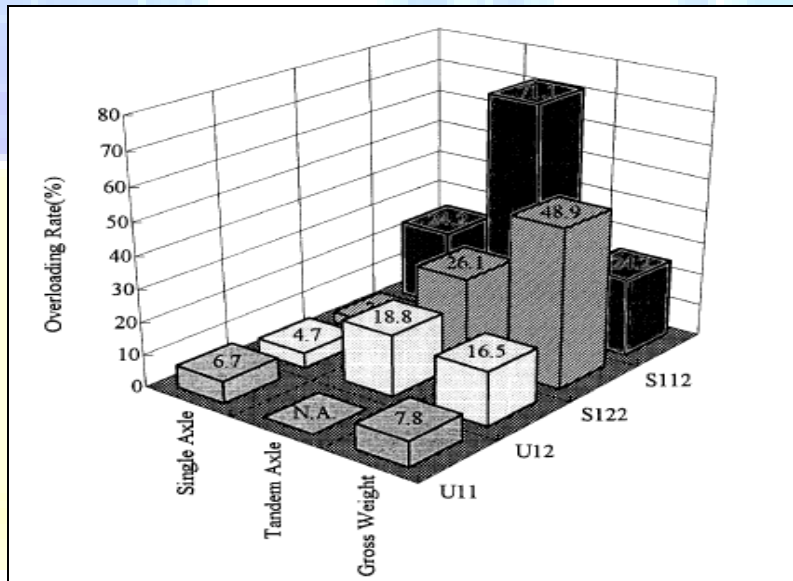


Figure 8. Overloading Rates for S112, S122, U12, and U11 on Taiwan National Freeways [14]



Only few studies are shown in this paper. However, there are plenty of studies investigating several locations in the world and confirming similar results that overloading is a common problem around the world. The following studies investigating overloading and its damaging effects on road pavements, infrastructure and environment, some also investigate the safety hazard caused by overloading [14-51].

Conclusion

Several studies investigated overloading in Malaysia, Thailand, China, South Africa, Pakistan, Taiwan and several other countries showed that overloading is a common and serious problem around the world. The studies also showed that overloading causes a rapid deterioration for road pavements and infrastructures. Furthermore, Studies showed that overloading causes safety hazards and affects the environment as well.

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