eter to an unknown parameter (for example, the future maximum GVW to the future average GVW). From the proposed truck weight limits, the future maximum practical GVW may be derived for a certain truck type. By multiplying the future maximum practical GVW with a given average GVW factor, the estimated average GVW for that truck type under the proposed limits may be obtained. Once the future average GVW is obtained, a future truck weight distribution may be projected by using the shifting methodology suggested herein.

Although the main data set came from the Texas Interstate system, the shifting procedure can be used for other types of highway systems and is considered applicable to other states. For a long-term investment on the existing federal and state highway systems, it is strongly recommended that truck weighing activities be intensified and operating efficiency be improved.

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This paper reflects our views, and we are responsible for the contents, facts, and accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of TSDHPT. This report does not constitute a standard, specification, or regulation.

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Truck Size and Weight Enforcement: A Case Study

C. MICHAEL WALTON AND CHIEN-PEI YU

In this paper the current state regulations affecting motor vehicle sizes and weights, the agencies involved directly or indirectly in the enforcement of these regulations, the characteristics of oversize and overweight vehicle movements within the state (both legal and illegal), and the cost of these vehicle movements to the state are discussed. The characterization of oversize and overweight movements in Texas is emphasized. To study the economic effects to the state, a 100 percent compliance case was set up to compare with the actual case. The case study of Texas showed that, although the current oversize and overweight movements may save the trucking industry up to $1.4 billion over the next 20 years at current conditions, these movements are estimated to cost the state an additional $261 million over the same 20-year period. Similarly, enforcement of the state laws is estimated to result in only $84 million if the current fine and permit fee structure is maintained. It was recommended that the current fine and fee structure be revised to discourage violation.

Due to the growth of truck traffic, interest in the effects of change in motor vehicle size and weights, and the challenge of perpetuating the nation's highway infrastructure, Texas has sponsored a series of truck size and weight investigations. These studies have focused on gaining a better appreciation of these trends and how to best integrate them into a rational decision framework for future highway programs and activities. The issues of legal limits, enforcement, and permitting were combined into a case study of the Texas experience, which may provide information and assistance to other states.

Almost two-thirds of all Texas communities depend entirely on trucks for service, and 98 percent of the fresh fruits and vegetables and 99 percent of the livestock are transported to principal markets by trucks (1). The importance of load limits and highway design practices was recognized early in the history of highway development. This interrelation led directly to limitations on vehicle loads, and laws were enacted in many states to establish maximum allowable motor vehicle sizes and weights (2). The first such law in Texas was enacted in 1929 (3). Since then the law has been modified several times. The most recent major changes of the law occurred in 1975, when the maximum gross vehicle weight was raised to 80,000 lb, the maximum single-axle load to 20,000 lb, and the maximum tandem-axle load to 34,000 lb.

As the highway system in Texas matured and there was a shift in emphasis from construction to maintenance and rehabilitation, the enforcement of motor vehicle size and weight laws became a highlighted issue. Strict enforcement of motor vehicle size and weight laws is a step toward reducing motor vehicle size and weight violations, heavy truck accidents, and, even more, highway maintenance and rehabilitation expenditures.

The various governmental units in Texas that are involved in regulating or enforcing the regulations on motor vehicle sizes and weights include the Department of Public Safety (DPS), the Texas State Department of Highways and Public Transportation (TSDHPT), the Office of the Attorney General (AG), the Texas Railroad Commission (RRC), and the Justices of the Peace (or the county court system). Among these governmental units, the DPS has the most direct role in enforcing size and weight laws.

A study was undertaken to summarize the current size- and weight-related activities in Texas and to

present an analysis of current oversize and overweight truck movements within the state based on existing available data. The following major areas are discussed in this paper:

1. A brief overview of the development of size and weight limits in Texas;
2. Characteristics of size and weight violations and legal oversize and overweight permit operations; i.e., characterization of both the size and weight violations and legal permit operations in the state; and
3. The cost of oversize and overweight operations to the state; i.e., an estimate of the costs is prepared with the objective of bounding the significance of this particular aspect of the more global issue.

METHODOLOGY

For evaluation of pavement rehabilitation costs, programs based on AASHO Road Test results were used to calculate equivalent single-axle load (ESAL). The REHAB model from TSDHPT was used to translate ESAL figures into dollar costs. A methodology identical to that used and documented in the first part of the study was used to compute vehicle operating cost and fuel consumption (4).

In order to evaluate the cost of highway rehabilitation due to oversize and overweight trucks, two cases were selected for comparison. Case 1 represents actual conditions as reflected in the 1980 truck weight survey, where oversize and overweight trucks were included in all computations. Case 2 represents an artificial 100 percent compliance condition in which 1980 data were modified so that all vehicles were running at or below the legal maximum. Total payload for both case 1 and case 2 remained the same. These two cases were selected in order to bound the cost of highway rehabilitation due to oversize and overweight trucks and the benefits in terms of truck operating cost differences between violators and nonviolators.

The study was restricted to data for the first 9 months of 1980 because comparable data were not available after September 1980 and prior years' data were not maintained by DPS.

CHARACTERISTICS OF ILLEGAL OVERSIZE AND OVERWEIGHT VEHICLES ON TEXAS HIGHWAYS

There are three types of oversize and overweight vehicles on Texas highways--those operating (a) illegally; (b) with a permit; and (c) under special, separate legislations (e.g., ready-mixed concrete trucks; vehicles transporting cotton seed modules, fertilizer, milk, poles, piling, unrefined timber, electric power transmission poles, and unladen lift equipment; and cotton trucks).

Operation of illegal oversize and overweight trucks was characterized according to the following items: category of violation (oversize, overweight, and so on), monthly, location, highway class, vehicle body type, permit category, carrier type, amount overweight, disposition, vehicle lease status, and fine levied.

Category of Violation

There are four categories of size or weight violations:

1. Single-axle weight in excess of 20,000 lb;
2. Tandem-axle weight in excess of 34,000 lb;
3. Gross vehicle weight (GVW) in excess of the permissible maximum [the permissible maximum for both 3-S2 and 2-S1-2 is 80,000 lb, for 2D it is 40,000 lb, and for 3A it is 54,000 lb, legal maximum GVW for other vehicle types is the sum of all legal axle weights (GVW not to exceed 80,000 lb)]; and
4. Vehicle size in excess of those permitted by law.

Monthly Frequency and Location

Violations were also studied according to the month of occurrence. Figure 1 plots the frequency of violation versus month. It appears that weight violations peak during the months of April, May, June, and July, whereas size violations show relatively the same peak all the way into September.

An effort was made to determine the spatial distribution of size and weight violations by county throughout the state. Violations in each county were analyzed in relation to their major business category. Interviews were also conducted with experienced personnel regarding the causes of violations in different counties. The results suggest that independent grain, gravel, and log transporters are the major recorded violators in Texas. [These data were from an interview with Inspector Haddock, Traffic Law Enforcement Division, DPS, on May 6, 1981.]

Highway Class

The violation data were also arranged according to highway class. The four different types of violations on each class of highway are given in Table 1. Data show that 61.1 percent of the cases filed took place on U.S. and state highways, 27.7 percent on Interstate highways, 9.6 percent on farm-to-market roads, and 1.5 percent on other highways. However, a rather different picture emerges when these violation cases are compared on a per mile or per lane-mile basis. On a per mile basis, the number of violations that occur on Interstate highways is about 6 times that on other state highways. This indicates that, on a mileage or lane-mileage basis, the Interstate highways have the highest rate of recorded violations. The table below gives the violation rate on a per mile basis:

Rural Highway System	Mileage	No. of Violations	Violations per Mile
Interstate	1,395	9,194	6.59
Other main	17,725	20,249	1.14
Farm-to-market	29,674	3,193	0.11

Figure 1. Histogram of violation frequency versus months (by category).

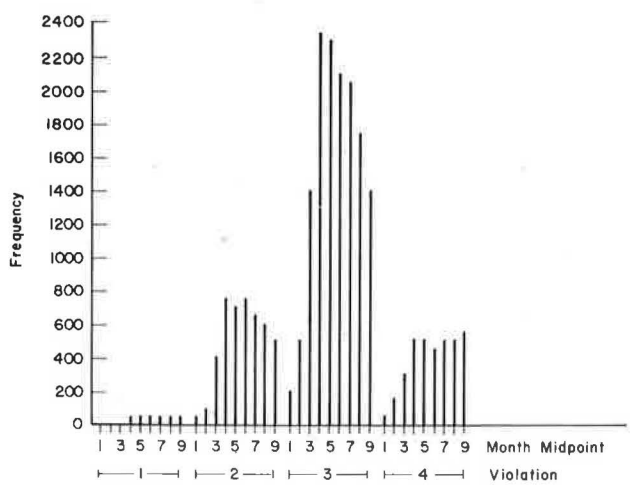


Table 1. Oversize and overweight violation cases by highway class.

Road Class	Overweight Violations: No. by Violation Code 1	2	3	Total	Percent	Oversize Violations: No. by Violation Code 4	Percent	Overweight and Oversize Violations: Total[a]	Percent
Interstate	276	2,752	4,498	7,526	26.9	1,668	32.4	9,194	27.7
Other main	512	3,240	13,468	17,220	61.5	3,029	58.8	20,249	61.1
Farm-to-market	89	481	2,246	2,816	10.1	377	7.3	3,193	9.6
Other	24	100	298	422	1.5	79	1.5	501	1.5

[a]Total of all violations (1-4).

Table 2. Analysis of size and weight violation cases filed by body type.

Vehicle Type	No. of Violations by Code Type: 1	2	3	4	Total Violations	Percent of Total
Float	170	1,858	3,831	3,589	9,718	29.1
Pole	22	178	1,470	194	1,864	5.6
Tank	33	827	2,342	20	3,222	9.7
Refrigerator	12	155	198	64	423	1.3
Van	55	369	505	176	1,105	3.3
Livestock	25	139	238	360	762	2.3
Dump	257	2,482	11,060	147	13,946	41.8
Special	31	513	749	783	2,076	6.2
Unknown	4	52	96	64	216	0.6
Passenger car				9	9	0.0

This next table gives the violation rate on a per lane-mile basis:

Rural Highway System	Mileage	No. of Violations	Violations per Lane-Mile
Interstate	9,066	9,194	1.01
Other main	40,131	20,249	0.50
Farm-to-market	59,392	3,193	0.05

[Note that these data are from TSDHPT records as of August 31, 1981.]

Another comparison was made based on truck vehicle miles of travel (VMT) for each highway system. A comparison was made by dividing the number of violation cases filed for each highway system by the total VMT on each respective highway system. The computation indicates that the other main rural highways (U.S. and other state highways) have the highest rate of violation per VMT, followed by Interstate highways and farm-to-market roads.

Body Type

The size and weight violation records released by DPS also give the body types of vehicles found to be oversize or overweight. The results of the body-type analysis are summarized in Table 2. The data indicate that 41.8 percent of all oversize and overweight vehicles are dump trucks and approximately 29.1 percent are float trucks. Dump trucks are the most frequent violators of weight limitations (50 percent), whereas float trucks (a truck combination with a flatbed trailer that has no side boards) violate size limitations most often (66.4 percent).

Permit Category

The DPS size and weight violation data were analyzed according to permit category. The findings revealed that 52.6 percent of the weight violations were committed by private carriers and 42.8 percent by special carriers. Also, 59.3 percent of the size violations were attributed to private carriers and 37.2 percent to special carriers. Common carriers as well as contract carriers have low rates of violation. These data correspond to comments rendered by DPS personnel with respect to their observation that independent trucks are the significant challenge to License and Weight officers (according to interview data from Inspector Haddock).

Lease Status

An analysis of size and weight violation data according to lease status indicated that more than two-thirds of the violations are by unleased vehicles.

Type of Carrier

A review of the violation cases filed according to type of carrier indicated that intrastate carriers committed 83.4 percent of all weight violations and 82.9 percent of all size violations, whereas interstate carriers committed only 10.5 percent. Exempt carriers committed only 6.2 percent of the violations (intrastate, 2.6 percent; and interstate, 3.6 percent).

Amount Overweight

DPS violation records provided the distribution of excess over registered weight each vehicle was carrying. It is observed that most vehicles exceed their registered weight by 4,000 to 8,000 lb, although a few exceed it by as much as 50,000 lb.

Disposition of Cases

During the first 9 months of 1980 there were 22,833 size and weight violation cases filed by DPS License and Weight officials. Of these cases, 22,502 (98.6 percent) resulted in fines administered in the courts and 323 (1.4 percent) met other dispositions.

Fine Analysis

Section 15(b) of Article 6701d-11 of the Revised Civil Statutes of Texas states, "Any person, corporation or receiver, who violates any provision of this Act shall, upon conviction, be punished by a fine of not more than Two Hundred Dollars ($200.00)." Previous law stipulates a minimum of $25 for a first conviction. The court fee for processing a case is usually $3.50. The data in Figure 2 show the distribution by amount of fine charged. Average fines range from $28.75 to $40.41. Paxson and Glickert (5) discussed the influence of the inadequate fine structure on truckers' tendency to overload. When the amount of fine likely to be charged times the probability of being caught is far below the profit that can be obtained by running overloaded, an incentive exists to run overloaded.

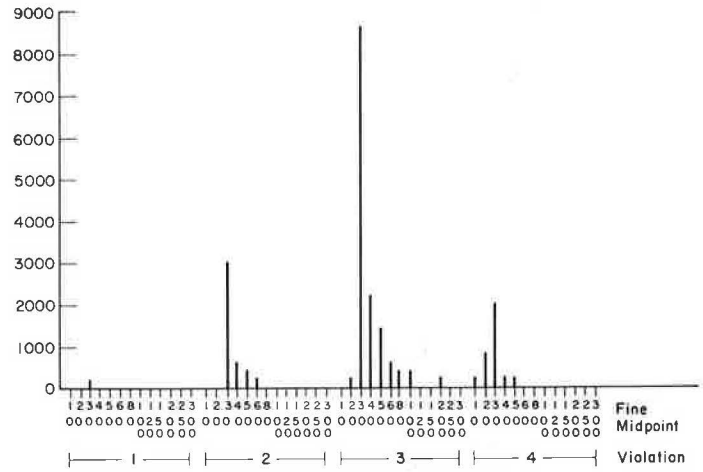


Figure 2. Distribution of fines charged by the court for each category of fine.

CHARACTERISTICS OF OVERSIZE AND OVERWEIGHT PERMIT OPERATIONS

The characteristics of legal oversize and overweight permit operations are discussed according to permit type, time length of permit, location where permit is issued, and historical trend.

Permit Type

As indicated previously, TSDHPT issues five types of permits to applicants for oversize and overweight movement:

1. Permit 598--movement of concrete beams;
2. Senate Bill 290 permit--oil field activities such as oil well drilling, cleaning, and servicing equipment;
3. Permit 591--movement of mobile homes;
4. Permit 438--general oversize and overweight vehicle movement; and
5. Permit 1407--oversize and overweight permit issued through telecommunication.

Detailed permit issuance data from September 1, 1979, to August 31, 1980, were made available to the researchers. Analyses indicate that oversize and overweight permits represent 77.6 percent of the permits issued.

Based on another set of data obtained from TSDHPT, which classified all permits as oversize only, overweight only, or oversize and overweight, the data in the table below give the distribution of permits issued from October 1, 1978, to September 30, 1980:

	Distribution of Permits			
	10/01/78 to 09/30/79		10/01/79 to 09/30/80	
Type of Permit	No. Issued	Percent	No. Issued	Percent
Overweight only	6,518	1.5	6,137	1.3
Oversize only	102,961	24.2	205,924	22.7
Oversize and overweight	315,464	74.2	353,682	75.9
Total	424,943		465,743	

Time Length and Fees

The Revised Civil Statutes of Texas (3) allow four types of permits according to time length: (a) single trip, (b) 30 day, (c) 90 day, and (d) annual. During 1978 and 1979 single-trip permits comprised about 94 percent of all the permits issued. The fees collected from each type of permit and their share of the total are given in the table below:

Permit	Permits Issued		Fees Collected	
Type	No.	Percent	Amount ($)	Percent
598	3,270	0.7	16,350.00	0.4
SB290	4,812	1.0	556,298.52	18.6
591	80,650	17.3	403,255.56	13.5
438	361,368	77.6	1,929,347.06	64.8
1407	15,643	3.4	78,215.00	2.6
Total	465,743		2,993,466.14	

SB290 permits consitute only 1 percent of the total issued, yet fees collected from the sale of this permit constitute 18.6 percent of the total collection. This is explained by the fact that a large number of SB290 permits are 30 day, 90 day, or annual--all of which cost substantially more than single-trip permits.

Over the past few years there has been a steady increase in the issuance of oversize and overweight permits. The data in the table below summarize the number of permits issued over the past 4 years:

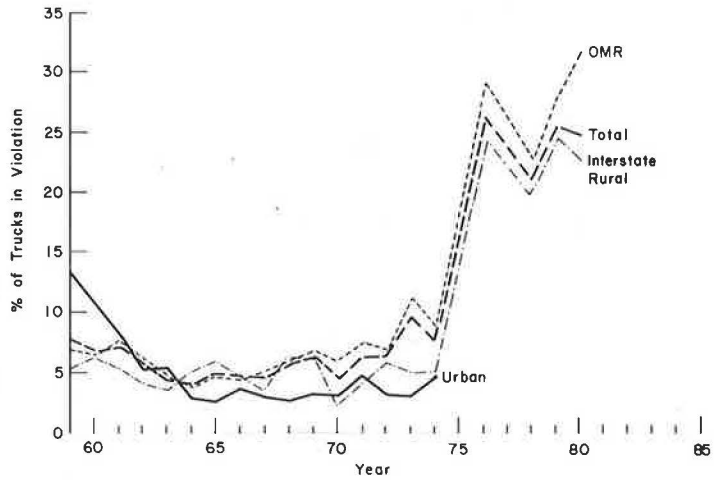
Date	No. of Permits	Increase Over Previous Year (%)
10/76 to 9/77	360,000	12.7
10/77 to 9/78	406,000	4.7
10/78 to 9/79	425,000	4.7
10/79 to 9/80	466,000	9.6

CHARACTERIZATION OF OVERSIZE AND OVERWEIGHT OPERATION FROM ANNUAL TRUCK WEIGHT SURVEY

The annual truck weight survey conducted by the states in cooperation with FHWA is a third source of information on oversize and overweight operations in the state. In Texas the annual truck weight survey is conducted through the weigh-in-motion method in which a truck is weighed through some electronic devices while in motion. Due to the nature of the scheme it is not possible to know if the trucks passing over the weighing equipment possess legal oversize and overweight permits or are overloading illegally. Nevertheless, the results obtained from such data are objective and present the opportunity to gauge actual oversize and overweight operations on the highways.

In Texas truck weight data are collected through five permanent weigh stations, three of which are located on Interstate highways and two on other state highways. Collected data can be checked through a computer program to determine whether or not a truck is overloaded. Results indicate that 3-S2, the most

Figure 3. Historical trend of oversize and overweight movements on Texas highways, 1959-1980.



commonly used truck carrier on Texas highways, is the truck group most often operating overweight. This is followed by 2-S1-2 on Interstate highways and 3A on other main highways. Because of its lesser frequency of operation on other state highways, 2-S1-2 has not been a major contributor to overweight operations on those highways. The 3A, which constitutes a large portion of the traffic on other main highways, has been found to operate overweight in large numbers on those highways.

A summary of the percentage of vehicles overweight on various highway systems from 1959 through 1980 is shown in Figure 3. The data suggest that there has been an upturn in overweight trucks on highways since 1974. Hence in 1980, 22.98 percent of all trucks on Interstate highways and 32.01 percent on other state highways were overweight. This is a significant increase from the 5.08 percent on Interstate and 8.60 percent on other state highways noted from the same data files for 1974.

COST OF OVERSIZE AND OVERWEIGHT OPERATIONS TO THE STATE

In an attempt to gain a perspective of oversize and overweight operations, an assessment of selected economic effects was undertaken, which include

1. Increased pavement maintenance and rehabilitation cost due to increased pavement damage;
2. Increased highway structure (bridges, culverts, and so on) maintenance and rehabilitation cost due to accelerated damage by oversize and overweight trucks;
3. State expenditures to enforce vehicle size and weight laws, which include DPS expenditure for License and Weight Service and TSDHPT expenditure for maintaining permit issuance operations;
4. Savings to the owner-operators of oversize and overweight trucks from reduced vehicle operating cost; and
5. Economic benefits accrued through the issuance of oversize and overweight permits for special truck movements (e.g., concrete beams, mobile homes).

The foregoing list is only a brief and partial summary of the economic effects of oversize and overweight vehicle operations. In order to arrive at an estimated cost of the economic effects of oversize and overweight vehicle operations, two cases were structured. The first case represented the existing condition with respect to the current distribution of sizes and weights of vehicles operating on the highway system. In this case truck weight data from the 1980 truck weight survey were used. The second case represented an artificial 100 percent compliance condition in which all vehicles were running at or below maximum size and weight limits. To represent the second case, data from the 1980 truck weight survey in Texas were modified by removing all overweight vehicles from the truck fleet and reassigning their payloads to a fleet of vehicles that would carry their payloads at the maximum permissible load. This analysis was based on 1980 truck weight survey data and, hence, its results must be qualified by the reliableness and the representativeness of the 1980 truck weight survey.

Data representing case 1 and case 2 were used in conjunction with the computer program "Trucky," which calculates total payload per 100 vehicles, total number of load vehicles, truck operating cost, fuel consumption, and ESAL on rigid or flexible pavement. These figures, together with ton-mileage and truck traffic forecasts, were input into a program called "Twenty," which generates a 20-year forecast for ESAL for rigid and flexible pavements, vehicle operating cost, and fuel consumption (4). The data in Table 3 give program Twenty's computation for both case 1 and case 2. It is clear that in case 2 (the 100 percent compliance condition) pavement damage is lessened and pavement life is extended.

Estimated ESAL figures for each highway type were then input into the REHAB program at TSDHPT. This program generated pavement rehabilitation cost estimates for the next 20 years. Pavement rehabilitation cost figures were based on unit cost data taken from the 12-month moving average of statewide bid prices (January to December 1980). For 1980, estimated extra pavement cost due to oversize and overweight trucks is approximately $9 million. Estimated damage for the next 20 years is approximately $125 million. An estimate was not made for the impact on bridges.

Attempts were also made to estimate government expenditures associated with the enforcement of size and weight laws. Expenditures for permit operations by the License and Weight Service (DPS) and TSDHPT were considered as the two major outlays in this area. The 1980-1981 fiscal year budget for DPS License and Weight Service is $3.845 million. The budget level proposed for 1981-1982 and 1982-1983 reflects substantial increases. To estimate expenditures for the next 20 years at the current enforcement level, an average of the annual budget from 1980-1983 is used. In forecasting 20-year permit operation expenditures for TSDHPT, the 1980 expenditure figure is used. Hence the estimated 20-year expenditure (in constant 1980 dollars) is $96.607 million for the DPS License and Weight Service and

Table 3. Comparison of estimated 18-kip ESAL for cases 1 and 2, 1980-1999.

Item	18-kip ESAL for Next 20 Years		Ratio of Pavement Life in Case 2 to Case 1
	Case 1[a]	Case 2[b]	
Interstate highways			
Rigid pavement	15,333,025	14,287,704	1.07
Flexible pavement	9,865,324	9,329,357	1.06
Farm-to-market roads			
Rigid pavement	161,797	136,040	1.19
Flexible pavement	101,014	84,770	1.19
Other state highways			
Rigid pavement	1,634,257	1,402,829	1.16
Flexible pavement	1,037,768	899,565	1.15

Note: All figures shown above are per mile figures.
[a]Case 1 is based on actual field data.
[b]Case 2 is an artificial case in which no overloading exists.

$38.857 million for oversize and overweight permits (TSDHPT) for a total of $135.464 million. The state costs (in constant 1980 dollars) from oversize and overweight vehicle movements for 1980 as well as those estimated for the next 20 years are summarized in the table below (note that highway bridge structures are not included in the highway costs):

Category	1980 Base Year Cost ($000,000s)	20-Year Cost Forecast ($000,000s)
Administrative		
DPS	3.667	96.607
TSDHPT	1.943	38.857
Total	5.610	135.464
Highway pavement maintenance and rehabilitation	9.008	125.105
Total	14.618	260.569

Nevertheless, the trucking industry is estimated to derive financial savings from oversize and overweight operations. These financial savings accrue primarily in the form of vehicle operating cost savings, which include savings on fuel, labor costs, and so on. Estimated vehicle operating cost for the next 20 years is given in the table below, which indicates that the cumulative vehicle operating cost savings are estimated to be $1.3 billion, or about 5 times the cost accrued to the state (note that costs are in constant 1980 dollars):

Highway Class	Cost ($000,000s)		
	Case 1	Case 2	Case 2 - Case 1
Interstate	43,015.568	43,427.682	412.144
Farm-to-market	9,294.951	9,437.702	142.751
Other state highways	37,382.574	38,145.109	762.535
Total	89,693.093	91,010.493	1,317.400

Considering these findings, the next question to address is whether the oversize and overweight vehicles have been paying for the damage, if any, to the highways. The operators of oversize and overweight vehicles may reimburse the state in two forms. The first is through fees charged by TSDHPT for oversize and overweight permits, and the second is through fines levied by the courts for size and weight violations. The actual amount of fines levied against violators during the first 9 months of 1980 was $914,716. This figure was multiplied by four-thirds to obtain the estimated fine for the whole year. Receipts from permits issued during the 1979-1980 fiscal year amounted to $2,993,466. Costs and benefits from oversize and overweight operations for cases 1 and 2 over the next 20 years are given in the table below:

Item	Cost ($)
Savings in vehicle operating cost	1,317,710,000
Truckers' payment for oversize and overweight operations	
Fines for size and weight violations	24,392,000
Payment for oversize and overweight permits	59,869,000
Total	84,261,000
Net savings to the trucking industry	1,233,449,000

Enforcement activity at the current level is assumed for the 20-year estimate. Based on these considerations, it is estimated that net savings to the trucking industry from oversize and overweight operations in 1980 was about $42.3 million. If current enforcement activity is assumed constant for the next 20 years, the trucking industry's net savings would be approximately $1.23 billion in constant 1980 dollars. However, it must be emphasized that the above figures, particularly pavement maintenance and rehabilitation cost, are based on 1980 FHWA truck weight survey data, which are a 1-day sample of the truck traffic on Texas highways. Because the data are collected through five permanent weigh stations, and because these stations cover only selected areas in the state, the weight survey data may not be representative of the actual truck weight situation on the Texas highway system. Hence the reader must be cautioned in using or quoting these figures.

Some forms of oversize and overweight operations are necessary for the state's economy, such as the movements of concrete beams and mobile homes, trucks carrying oil well servicing and cleanout equipment, and other oil field-related activities. To prohibit these oversize and overweight movements would slow down the progress of the state's economy. Hence permits are still necessary for certain types of movements. Nevertheless, illegal oversize and overweight movements should be strictly regulated to preserve the highway infrastructure and reduce public nuisance.

CONCLUSIONS

The benefits to and the need for certain currently permitted oversize and overweight movements are readily apparent. Of primary concern, however, are illegal oversize and overweight movements. Highway vehicle loads must be limited in order to avoid rapid deterioration of roadways and the consequent high maintenance and rehabilitation costs that both TSDHPT and, ultimately, the taxpayers must bear.

Hence size and weight laws should be strictly enforced to ensure adequate protection of the state's highway investment. In addition, strict enforcement of size and weight laws leads to a reduction in unfair and illegal competition among the motor carriers.

The findings of this study can be briefly summarized as follows:

1. On a commodity basis, grain, sand, gravel, and log transporters are the major recorded violators in the state.
2. Overall, U.S. and state highways have the highest number of violation cases filed, followed by Interstate and farm-to-market roads. However, on a violation per lane-mile basis, the Interstate system ranks first, followed by U.S. and state highways and farm-to-market roads.

3. On the basis of violation cases filed per VMT, U.S. and state highways have the highest ratio, followed by Interstates and then farm-to-market roads.

4. Through DPS violation files it was discovered that dump trucks are the major violators of weight limitations (50 percent) whereas float trucks are the major violators of size limitations (66.4 percent).

5. Private and special carriers together constituted 95.4 percent of the weight violation cases filed and 96.5 percent of the size violation cases filed. Only 0.3 percent of weight violations are filed on common carriers and 3.1 percent on contract carriers; 1.6 percent of the size violations filed are on common carriers and 0.5 percent on contract carriers.

6. When classified according to lease status, two-thirds of the cases filed come from unleased vehicles and one-third from leased vehicles.

7. Of the weight violation cases filed, 86.3 percent were committed by intrastate carriers and 13.7 percent by interstate carriers. With respect to size violations, 83.6 percent of the cases filed were on intrastate carriers and 16.2 percent were on interstate carriers. The interstate carriers have a higher percentage of violations of size than of weight limitations.

8. In most violation cases vehicles exceed their registered weight by approximately 4,000 to 8,000 lb, although a few exceed it by as much as 50,000 lb.

9. Of the oversize and overweight cases filed by DPS officers, 98.6 percent were fined by the judges.

10. The average fine for a weight violation ranges from approximately $35 to $40 for a GVW violation. The average fine for a size violation is $29. The fine is not set in scale to the amount over the limit each vehicle is charged with carrying; therefore, vehicles slightly overweight and those heavily overweight may be levied identical fines. The fine structure should be such that the incentive to overload is nonexistent or even negative.

The following points relate to oversize and overweight permit operations.

1. During the period from September 1, 1979, to August 31, 1980, 81 percent of the permits issued were for oversize and overweight movement (77.6 percent of these through form 438 and 3.4 percent through telecommunication), 17.3 percent for mobile home transport, 1 percent for oil field-related activities (form SB290), and 0.7 percent for concrete beam movement.

2. Of the permits issued, 93.8 percent were single day, 5.2 percent were 30 day, 0.8 percent were 90 day, and 0.3 percent were annual.

3. Frequency of the type of permits issued in each highway district depends on the types of industries present there. Districts 2, 7, 10, and 12, for example, issued a large number of mobile home permits because of the presence of large mobile home industries in those districts.

By using TSDHPT published data to study the overweight vehicle movements in the state, the following items were noted.

1. Based on the TSDHPT truck weight survey, vehicle types 3-S2 and 2-S1-2 are the most frequent overweight truck types (each with more than 25 percent overweight), whereas on U.S. and other state highways 3A and 3-S2 are the major overweight truck types (each with more than 25 percent).

2. There has been an upsurge in oversize and overweight movement since 1974. In 1980 the percentage of trucks overweight on Interstate highways increased from 5.08 to 22.98 percent, while on U.S. and state highways the increase was even higher, from 8.60 to 32.01 percent.

3. The economic analysis (based on 1980 FHWA truck weight survey data) indicates that, through overloading, the trucking industry has realized a significant savings. Yet this savings by the trucking industry has been at the expense of the state's highway system, which has been damaged by overloaded vehicles. Moreover, the trucking industry has not fully paid for its share of this damage. However, caution must be exercised in quoting these figures due to the shortage of sample data in the truck weight survey.

In an effort to enhance the current enforcement level, several recommendations are made.

1. The current joint program of enforcement by the DPS, AG, and RRC in Texas should be continued. However, because filing suit is currently considered as only an extraordinary measure, a stronger statute is needed to limit the shipping, operating, and receiving of oversize and overweight trucks.

2. Because size and weight violations occur most often in the private independent carrier and special carrier sectors and most often are incurred by the haulers of grain, gravel, sand, and timber, special means should be found to curb violations by these groups.

3. Revision of the current fine structure is advised in order to remove the incentive for truckers to operate oversize and overweight. Fines should be scaled so that persistent violators will be punished to a greater degree than occasional violators.

4. A highway cost-allocation study to determine the relation between highway truck size and weight and the cost incurred is advised. Such a study would aid in the determination of a fairer fine structure for size and weight violations.

5. An increase in the DPS License and Weight Service enforcement force and budget is recommended to allow the establishment of additional checkpoints and the purchase of better detection equipment.

6. Establishment of a more effective truck weight survey program for the state is recommended. Such a program would aid the state in the design, planning, and administration of highway-related facilities and other funding-related questions.

The question of the appropriateness of current size and weight limits was addressed in previous phases of the study (1,6,7). The underlying premise of this study is that the highway users should bear their share of the cost.

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This paper reflects out views, and we are responsible for the contents, facts, and accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of TSDHPT. This paper does not constitute a standard, specification, or regulation.

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Impact of Oil Field Truck Traffic

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Oil field truck traffic is identified in this paper as a special highway user, and an estimate of the annual cost associated with reduced pavement serviceability on thin surface-treated pavements is provided. Identification of oil field traffic through site-specific observation provides the basis for the investigation. The study includes a description of traffic during the development of an oil well, an estimate of reduced pavement service under these operating conditions, and an estimate of increased annual pavement cost due to oil well traffic. Three main components of the analysis procedure include a pavement analysis, a traffic analysis, and an estimate of traffic generated by an oil well. The AASHTO concept of pavement serviceability was used to determine a reduction in pavement service life due to this concentrated traffic demand. Photographic documentation of the evolution of an oil well provided both an axle count and a description of the physical characteristics of the vehicles. Axle weights were estimated by using standard state loadometer data. Estimates indicate a 50 percent loss of service life due to this special-use industry (considering only one well) as compared with the expected service life if the road had continued to serve its intended purpose. An increased annual cost of $16,500/km was determined for a low-volume, light-duty pavement section. The increase in annual cost is a separable cost attributable to the concentration of a special-user activity.

Continued interest in determining the effects of truck traffic on highways has prompted individual states to investigate future impacts of vehicle size and weight limits on pavement service life. Such investigations (1-4) have generally addressed statewide needs to justify corresponding increases in revenues required to meet the costs of new construction and rehabilitation. However, there have been limited studies to assess the site-specific impacts created by specialized industrial development.

Walton and Burke (2), in an unrelated study, discuss the lack of commodity information and the nature of economic (industrial) activities in assessing the economic efficiency of large vehicles. Although special-use industries need to be identified in order to differentiate highway costs and corresponding savings in truck operating costs, additional quantitative estimates are also needed. Among the important estimates are the effects on accident rates and severity, geometric and cross-section improvements, load zoning, truck route delineation, and efficient maintenance of traffic in construction and work zones.

SCOPE

The first phase of a study conducted for the Texas State Department of Highways and Public Transportation (TSDHPT) is presented in this paper. The purpose of the initial research was to characterize oil field truck traffic and develop a preliminary estimate of the potential effects of this traffic on light-duty pavements (Figure 1). This special-use industry can conservatively reduce the expected intended-use service life of a thin pavement by approximately 50 percent or more. Although the successful ventures of oil production efforts have resulted in the benefits of economic growth, the adverse effect of this intense concentrated activity has caused the physical destruction of the pavement surface on the highways that serve the entire oil-producing area (Figure 2).

County roads, state farm-to-market and secondary roads, and city streets in many oil-producing areas were not initially constructed to endure the concentration of intense oil field truck traffic, some of which is well above legal load limits. The responsible road agency (city, county, or state) had not anticipated the resulting persistent rehabilitation under normal (intended-use) operating situations, and a restoration cost was not normally accounted for in the planning of maintenance expenditures. As a result the burden of associated costs has fallen on the public agency that is already obligated with the maintenance responsibilities.

Figure 1. Light-duty pavement section.