ASPECTS OF OVERWEIGHT

VEHICLE OPERATIONS IN TEXAS

Prepared For:

State Highway & Public
Transportation Commission

by

Texas State Department of Highways
and Public Transportation

in Cooperation with

The Center for Transportation Research
The University of Texas at Austin

and

Texas Transportation Institute
Texas A&M University System

August 23, 1984

August 23, 1984

EXECUTIVE SUMMARY

INTRODUCTION

The purpose of this paper is to present aspects of overweight truck traffic on highways in Texas. The material presented is drawn from both recently- completed and on-going research ad technical studies by the State Department of Highways and Public Transportation, the Center for Transportation Research of The University of Texas at Austin, and the Texas Transportation Institute of the Texas A&M University System.

The paper reviews the status of the highway cost allocation study, overweight truck permit loads, illegal overweight truck loads, present truck size and weight enforcement activity, and concludes with recommendations. A Glossary is provided to facilitate the use of this paper.

The Status of the Highway Cost Allocation (HCA) Study

The joint CTR/TTI Study is to be completed by September 1985. The overall objective is to provide a methodology for determining an equitable highway cost responsibility to be allocated among highway users, especially vehicle classes.

When completed, the HCA study will facilitate analysis of options affecting: (1) truck weight laws and regulations; and (2)highway user fees and taxes.

Recommendations

Recommendation 1. A structure of fines for overweight violations should be graduated to reflect degrees of violation and should be administratively collected by DPS.

Recommendation 2. A structure of permits for all overweight vehicles should be developed under the same procedures that currently authorize the issuance of oil field servicing permits (SB 290). The essential features of this procedure are: (1) it is established by the Highway Commission; (2) it allows for effects of highway damages to be recouped in the value of the permit, and (3) it allows for the trip distance to be included in calculating the value of the permit.

Recommendation 3. The license fees for ready-mix concrete (exempt) vehicles should be established so that the dollar damages they inflict on the highway system are recovered. Failing this, the exempt nature of this vehicle should be lifted and made to conform with all applicable vehicle weight laws. Further, any study of city streets and county roads mandated by the Legislature should specifically include an analysis of the effects of these exempt vehicles upon the street/road network.

TABLE OF CONTENTS

TABLE OF CONTENTS, Continued

August 23, 1984

PREFACE

Selected aspects of truck traffic on the Texas highway system are discussed in this paper. An overall policy objective is to devise a set of mechanisms so that each highway user will pay its equitable share of the cost of building and maintaining the highway system.

The paper was prepared using information, analyses, and reports from related activities (both completed and on-going) conducted by SDHPT, CTR, and TTI. Consequently, the scope of the material reported here has these two characteristics:

(1) the bulk of the discussions focus upon the 72,000-mile state highway system and do not address the problems faced by municipal and county governments in providing streets and roads for use off the highway system. The focus, however, does not imply that "off-system" impacts of overweight vehicles are insignificant. In fact, the study mandated by the recent Special Session of the Legislature will likely document significant impacts occurring on the city streets and county roads.

(2) most of the analyzed data are from the 1979-1980 base period. More recent data, though, are currently being developed and analyzed by SDHPT, CTR, and TTI on a variety of related topics including highway cost allocation, overweight permit fees, truck lane needs, oversized vehicle operations, pavement damages and tire pressures.

SYNOPSIS

Chapter 1 describes some of the legal, institutional, and operational features of the relationships between truck weights and the effects on the highway system. Chapter 2 describes the highway cost allocation study now underway in Texas. Chapter 3 focuses upon the issue of legal overweight loadings and the permit system, and Chapter 4 looks at illegal overweight trucks. From all the discussions, recommendations are developed in Chapter 4. A Glossary of Terms follows the last chapter. Supplemental and more detailed information appears in the Appendices.

CHAPTER 1. INTRODUCTION

The most recent major change in Texas law regarding truck weights occurred in 1975, when the maximum gross vehicle weight was raised to 80,000 pounds, the maximum single axle load to 20,000 pounds, and the maximum tandem axle load to 34,000 pounds. There are also limits to the length and height of a vehicle, width of wheels, and allowable loads on farm-to-market and ranch-to-market roads. Other pertinent laws relate to:

- Statutes governing the issuance of oversize-overweight permits
- Provisions for special truck categories
- Statutes governing the enforcement of motor vehicle sizes and weights

The governmental units in Texas which are involved in regulating or enforcing the motor vehicle size and weight laws include the Department of Public Safety (DPS), the State Department of Highways and Public Transportation (SDHPT), the Office of the Attorney General (AG), the Texas Railroad Commission (RRC), and the Justices of the Peace (or the county court system).

The DPS plays the most direct role in enforcing the size and weight laws. Vehicles are examined for:

1. Gross weight allowed
2. Axle limitations
3. Tire size limitations
4. Wheel weight limitations

Further, DPS may examine license receipts:

1. To determine if the vehicle is registered for the proper amount relating to load being transported
2. To determine if the vehicle is displaying license plates assigned to that vehicle
3. For temporary registrations and permits
4. For exemptions and exceptions to registration laws
5. To determine if nonresident is operating in accordance with reciprocity agreement from state of residence
6. For general provisions of statutes regulating registration of all vehicles in Texas

When a truck is found in violation of legal size and weight limits, the driver of the vehicle is issued a citation with instructions to appear before a Justice of the Peace. The Justice of the Peace hears evidence to determine innocence or guilt.

SDHPT issues permits for vehicle loads which cannot be reasonably dismantled or disassembled and transported as a legal load. Five types of permits are issued:

1. Permit 598 -- for the movement of concrete beams
2. SB 290 Permit -- for vehicles constructed solely for oil well servicing, clean-out, and/or drilling purposes
3. Permit 591 -- for the movement of mobile homes
4. Permit 438 -- for general oversize-overweight (OS/OW) movements, obtained at local district offices
5. Permit 1407 -- for general oversize-overweight (OS/OW) movements, obtained through telecommunications with SDHPT's central office in Austin

The Texas Railroad Commission, which has regulatory authority over 30 percent of the truck traffic in Texas, is able to audit the records of its certificated motor carriers to determine if the 80,000 pound gross vehicle weight limit is being exceeded and remove their certification if found in violation. The Office of the Attorney General has the power to take legal action against shippers, carriers, and receivers of overloaded vehicles.

CHAPTER 2. COST ALLOCATION IN TEXAS

Currently, CTR and TTI, in cooperation with SDHPT, are working on a research study entitled "Analysis of Truck Use and Highway Cost Allocation in Texas," which is to be completed by September 1985. The objectives are:

- To define the nature of truck use of highways in Texas
- To provide a basic reference source for information on truck size and weight issues as well as truck-use alternatives
- To provide a cost allocation methodology for use in Texas

REVENUE TRACKING

The basic objective of a cost allocation study is to determine if each vehicle is paying its "fair share" of the highway costs incurred. Therefore, it is necessary to identify the total revenues attributable to a particular vehicle class. For calendar year 1980, the dedicated state revenues (motor fuel tax, registration fee, and lubricating oil sales tax) have been allocated by the various vehicle categories, such as by vehicle group (Figure 2.1), truck type (Figure 2.2), gross vehicle weight, and fuel type.

ALLOCATION OF COSTS

The highway cost allocation problem is one of determining an equitable charge for each of the vehicle classes sharing transportation facilities such as highways and bridges. <u>A completely non-controversial solution methodology for the cost</u>

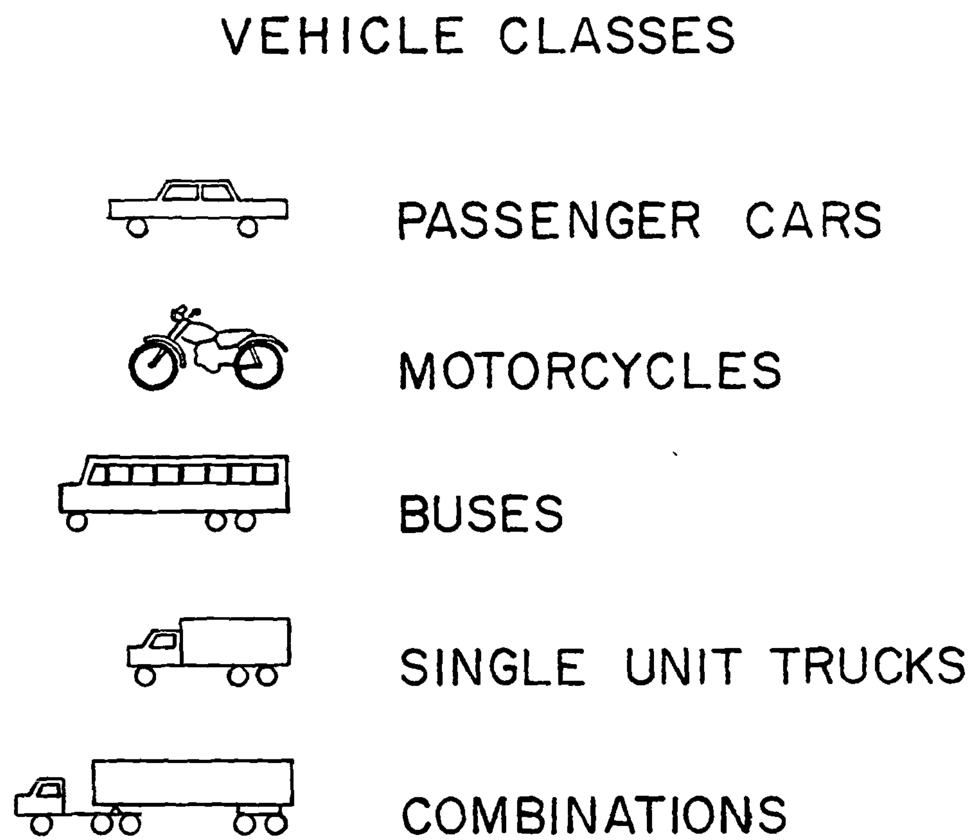

Figure 2.1. Basic Vehicle Classes

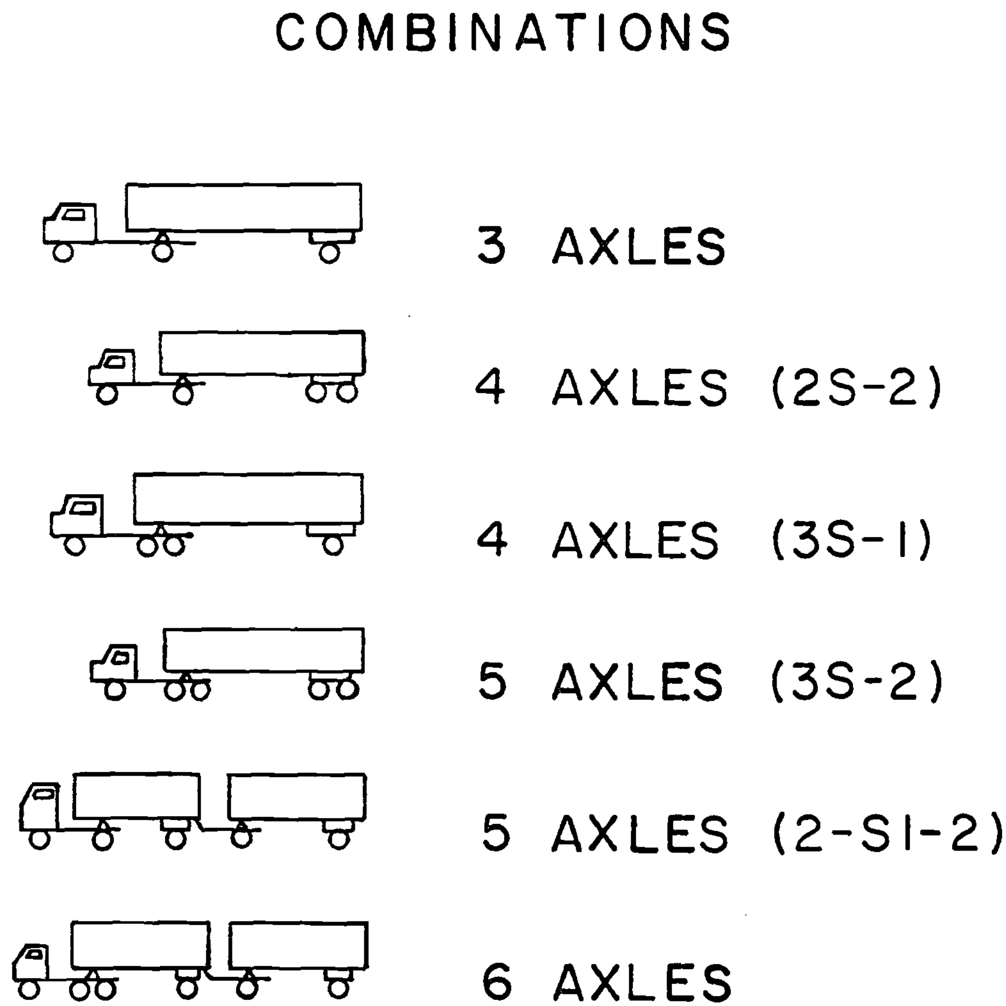

Figure 2.2. Six Types of Combinations

allocation problem may not exist; however, costs must be allocated in some rational and systematic way that is deemed equitable by all users of the system.

Previous attempts at solving the highway cost allocation problem can essentially be reduced to two major approaches: (a) proportional (consumption) allocation methods, which determine cost allocations in proportion to one or more measures of highway usage; and (b) incremental methods, which allocate costs on the basis of highway design, e.g., a pavement is designed for "automobile only" use then re-designed to accommodate trucks.

There are limitations affecting the validity of the traditional cost allocation methodologies. On one hand, proportional methods may yield results that conflict with the perception of fairness by some of the users, e.g., truckers claim they have to pay too much. On the other hand, incremental methods may yield inconsistent results due to the fact that if vehicle classes are introduced in different sequences, different cost allocations are obtained.

In an attempt to overcome the shortcomings aforementioned, two new solution approaches to the highway cost allocation problem have been developed: the Modified Incremental Approach and an optimization approach referred to as the Generalized Method. A significant feature of the two new methods is that they consider all possible combinations of the given vehicle classes as scenarios for which highway costs are computed for a specific planning period and traffic data.

STUDY STATUS

The work so far accomplished in the cost allocation study includes:

1. The conceptual models for the Modified Incremental Approach and the Generalized Method have been developed
2. The models mentioned above have been computerized and preliminary tests have been run with satisfactory results
3. The RENU2 program, the basic program for calculating pavement cost damages, has been reviewed and modified to make it more suitable to the needs of this problem and to improve its cost estimating capabilities
4. A few runs of the entire procedure have been made in order to test the program. More extensive runs with more realistic data will be conducted.
5. A report describing the work accomplished in Fiscal 83-84 is being prepared for submission in September 1984.

When completed, the highway cost allocation (HCA) study will facilitate analyses of policy options affecting: (1) truck weight laws and regulations; and (2) highway users fees and taxes. More detailed recommendations for use of the HCA procedures to illuminate policy alternatives await study completion.

CHAPTER 3. OVERWEIGHT PERMIT LOADS

Legally, some trucks can operate on the highway system even though the legal gross or axle weight limits are exceeded. The overweight permitting procedures operated by SDHPT are central to this issue.

PERMIT OPERATIONS

A summary of permits issued is shown in Tables 3.1 and 3.2. Oil field equipment permits constituted 1.2 percent of the total permits issued, and generated 7.8 percent of the fees.

ECONOMIC EFFECTS

Some economic effects relating to oversize-overweight vehicle operations are:

- Increased pavement maintenance and rehabilitation cost due to increased pavement damage
- Increased highway structure (bridges, culverts, etc.) maintenance and rehabilitation cost due to accelerated damage
- State expenditures to enforce vehicle size and weight laws (these include DPS expenditures for License and Weight Service and SDHPT expenditures for maintaining permit issuance operations)
- Savings to the owner-operators of oversize-overweight trucks from reduced vehicle operating cost
- Economic benefits accrued through the issuance of oversize-overweight permits and the fines paid by overloaded truckers

TABLE 3.1.

FEES COLLECTED FROM EACH TYPE OF PERMIT AND THEIR SHARE OF THE TOTAL (Sept. 1, 1982 - Aug. 31, 1983)

Permit Type	Average Yearly Permits Issued	% of Total	Fees Collected*	% of Total	Average Fee
Concrete Beams (598)	2,250	.4	$ 45,000	.4	$ 20
Oil Field Equip. (SB290)	6,587	1.2	816,325	7.8	124
Mobile Homes (591)	95,350	17.8	953,500	9.1	10
OS/OW (Dist.) (438)	420,639	78.8	8,412,780	80.7	20
OS/OW (Austin) (1407)	9,517	1.8	190,340	2.0	20
Totals	543,343	100.00	$10,417,945	100.0	19

*Fee rates as of September 1, 1983

Table 3.2.

COLLECTION FROM PERMITS ISSUED ACCORDING TO TIME-LENGTH
(Sept. 1, 1982 - Aug. 31, 1983)

Permit Types	Permits Issued	% of Total	Fees Collected	Total
Single Trip	500,467	93.7	8,504,550	82
30-day	27,123	5.1	1,084,900	10
90-day	5,483	1.0	669,595	6
Annual	1,270	.2	158,900	2
Totals	534,343	100.0	10,417,945	100

CTR has estimated the cost of the economic effects of oversize-overweight vehicle operations using two cases. The first case represented the existing condition with respect to the 1980 distribution of sizes and weights of vehicles operating on the highway system. The second case represented an assumed 100 percent compliance condition in which all vehicles were running at or below maximum size and weight limits. In the second case, overweight vehicles from the 1980 truck data were removed and their payloads assigned to a fleet of vehicles that would carry these payloads at maximum permissible loads.

For both cases, the total equivalent single axle loads (ESALs) for each highway type were used to estimate total pavement rehabilitation costs for 1980 and a 20-year analysis period. The estimated 20-year pavement damage resulting solely from overweight trucks was approximately $125 million (in 1980 dollars) -- or an average of $6.3 million/year.

Governmental expenditures associated with the enforcement of size and weight laws were also estimated. The total state costs for administration, maintenance, and rehabilitation resulting from oversize-overweight movements were estimated as $261 million (in 1980 dollars) over 20 years, or an average of $13 million/year.

The trucking industry, nevertheless, was estimated to derive financial savings from oversize-overweight operations, primarily in the form of vehicle operating cost savings per ton of cargo hauled. The information presented in Table 3.3 (based on limited Truck Weight Survey data) shows the net savings to the trucking

Table 3.3

SUMMARY OF THE ECONOMICS OF OVERSIZE-OVERWEIGHT MOVEMENTS

(MILLIONS OF 1980 DOLLARS)

	1980	1980-1999	Average /Year
Cost to State	14.6	260.6	13.0
Payments from Trucking Industry	4.2	84.3	4.2
Net Cost to State	10.4	176.3	8.8
Net Savings to Trucking Industry	42.3	1,233.4	61.7
Overall "Benefit"	31.9	1,057.1	52.9

industry after subtraction of fines and permits. The numbers indicate that the trucking industry is benefitting from oversize-overweight movements, but that they are not paying fully for the additional state costs.

PERMIT FEES

Any change in the weight permit fee schedule should consider the actual costs to the state, in terms of:

1. Administrative collection costs;
2. Actual pavement "damage" or "wear" costs to the highway system.

Additional costs might be considered in special cases.

It is very difficult to identify the true "damage" cost to the highway system inflicted by a single overweight permitted vehicle. However, some of the assumptions incorporated in SDHPT's pavement design procedures can be used to describe overweight vehicles in terms of their "relative effect" on pavements.

Research continues to resolve highly controversial relationships with this concept. At the moment, and until these complicating questions are answered, existing damage factors (18-KESALS) can be used to develop a set of multipliers -- adjusted for trip distances -- for deriving an overweight permit fee schedule of GVW in excess of 80,000 lbs. This effort is underway and will be reported by TTI and CTR on 1 October 1984.

It is recommended that the Highways and Public Transportation Commission be given the authority to establish weight permit fee based on sound economic principles.

Concrete Trucks - A Special Exempt Class

The ready-mix concrete trucks are legally allowed to haul 44,000 pounds on a tandem axle and 20,000 pounds on the steering axle, provided that a $15,000 surety bond in filed with SDHPT. The surety bond is to cover possible damage to roadways. This vehicle is used most heavily on streets and roads that are not a part of the state system. Consequently, most of the pavement damage and failure attributable to this exempt vehicle be repaired by municipal and county agencies.

Some research results have been reported by TTI that show:

1. the single 20,000 pound axle is the critical axle in causing pavement failure
2. the tandem 44,000 pound axle is the critical axle in causing pavement fatigue

This study was conducted using a sample of city streets, and the results are not generalized to include segments of the state highway system.

Since ready-mix concrete trucks and solid waste transport vehicles may (by statute) be operating at a weight above the maximum gross weight allowed on other vehicles, it is recommended that these vehicles be required to follow normal weight limits or be required to pay an additional fee that would be set by the Commission based on the damage caused to the highways and roads by the operation of these vehicles.

CHAPTER 4. ILLEGAL OVERWEIGHT LOADS

BACKGROUND

Any vehicle that operates at a gross vehicle weight in excess of its gross registered weight and does not have a special permit or an exemption provision is operating illegally. The following discussion concentrates on vehicles which exceeded the single axle weight limit of 20,000 pounds, the tandem axle weight limit of 34,000 pounds, or the gross vehicle weight limit of 80,000 pounds.

Data obtained from DPS for the first nine months of 1980 indicated the following distribution of violations:

- single axle weight, 2 percent
- tandem axle weight, 20 percent
- gross vehicle weight, 6 percent
- legal dimensions, 16 percent

Of the overweight violations, 26.9 percent were on interstate highways, 61.5 percent were on U.S. and state highways, 10.1 percent were on farm-to-market roads, and 1.5 percent were on other highways. When the amount of truck travel is taken into account, the number of violations per 1,000 miles of truck travel is slightly more than the number for the U.S. and state highways.

Other significant information obtained from the DPS files can be summarized: (1) Most overweight vehicles exceeded their registered weight by 4,000 to 8,000 pounds; (2) a few exceeded it by as much as 50,000 pounds; and (3) violations are most often incurred by the haulers of grain, gravel, sand, and timber.

An analysis was also made on the truck-weight survey data collected by SDHPT's Transportation Planning Division (D-10). Based on 1980 truck weight study data, the five-axle "18-wheeler" accounted for 87.3 percent of overweight trucks on Interstate highways and 89.3 percent of overweight trucks on U.S. and State highways. Of all "18-wheeler" trucks weighed on Interstate highways, 27.5 percent were overweight, compared to 39.1 percent of all "18-wheeler" trucks on U.S. and State highways. The significance of the overweight problem since 1959 is shown in Figure 4.1. The data suggests that there has been an upsurge in overweight trucks since 1974.

BENEFITS OF OVERWEIGHTING

[NOTE: Much of the material in this section has been excerpted from a 1981 paper by James P. Glickert and David S. Paxon entitled "The Value of Overweighing to Intercity Truckers" and presented to the Transportation Research Board.]

The benefit a trucker receives from overweighting is increased financial returns. This results from decreasing costs per ton-mile as cargo weight is increased and is shown in Table 4.1. The example given is the average line-haul cost for a typical intercity trucker.

The more a truck is overweight, the greater the financial benefit that results. Table 4.2 illustrates the incremental advantage that a trucker has as the amount of the overweight increases.

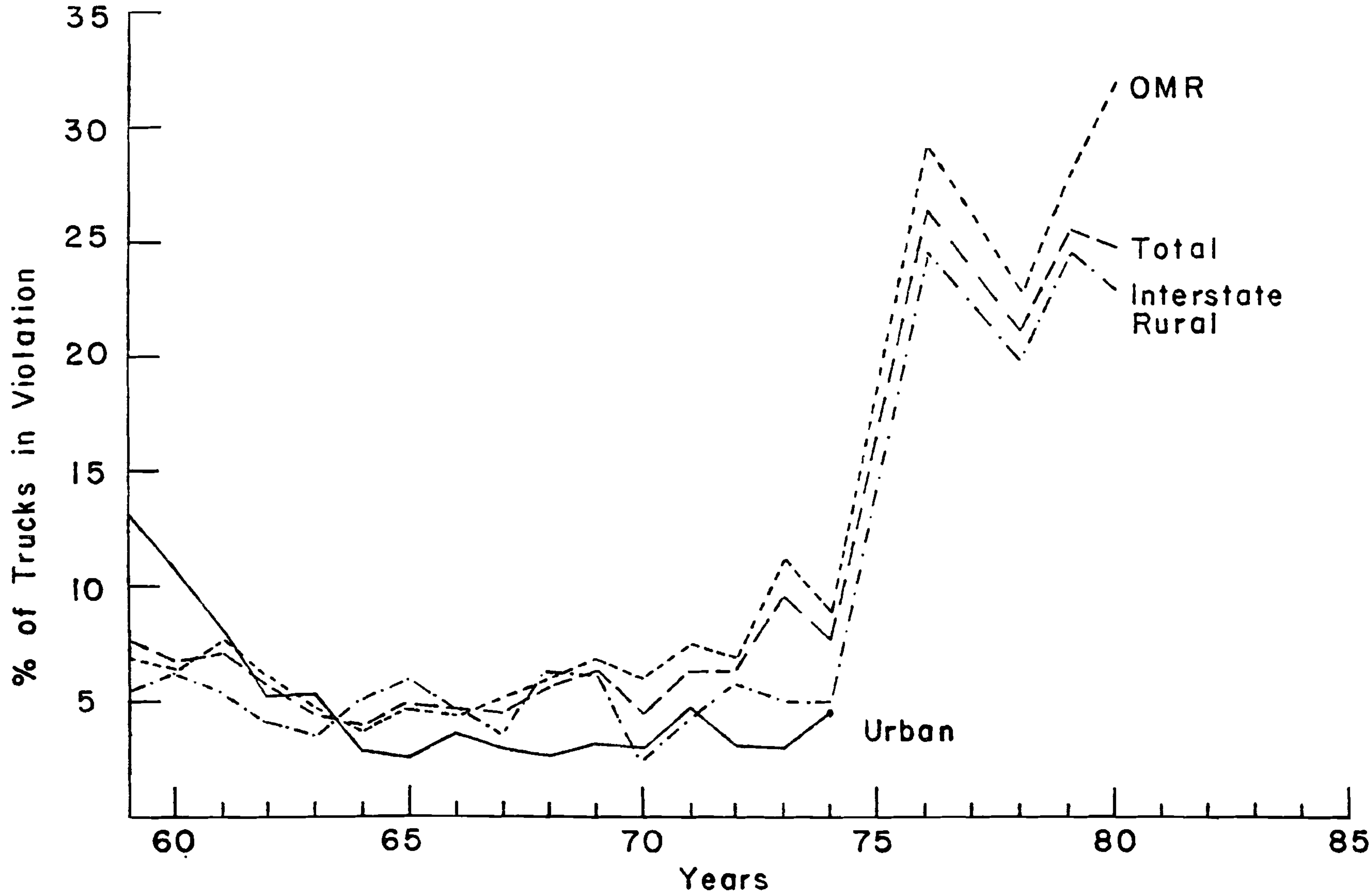

Figure 4.1. Historical trend of oversize-overweight movements on Texas highways, 1959-1980.

TABLE 4.1. TRUCK COST SENSITIVITY TO CARGO WEIGHT

CARGO WEIGHT (TONS)	LINE-HAUL COST/MILE	LINE-HAUL COST/TON-MILE
10	89.1¢	8.9¢
15	89.5¢	6.0¢
20	90.3¢	4.5¢
25	90.5¢	3.6¢

SOURCE: 1980 AAR TRUCK COST MODEL,
1979-1980 NATIONAL MOTOR TRANSPORT DATA
BASE (NMTDB) DATA

TABLE 4.2. INCREMENTAL INCENTIVES TO OVERWEIGHT

VEHICLE WEIGHT	CARGO WEIGHT	RATE/ POUND*	RESULTING RATE	INCENTIVE
73,000	45,000	5.6¢	$2520	$0
75,000	47,000	5.4¢	$2540	$20
80,000	52,000	5.2¢	$2700	$180
90,000	62,000	5.0¢	$3100	$580
100,000	72,000	4.8¢	$3460	$940

PRESENT ENFORCEMENT ACTIVITY

A central issue regarding permits and fines is the State's enforcement capability. Since available data suggests that illegal overloading is a common occurrence, an expanded, improved, and consistent enforcement program is needed. Portable scales should be upgraded with state-of-the-art equipment.

On state highways, the primary enforcement responsibility has been assigned to the Department of Public Safety's License and Weight Service, a part of the Traffic Law Enforcement Division. Beginning in 1984, police departments in cities of over 1.5 million population are also authorized to enforce size and weight laws on state highways within city limits. County Sheriffs and their deputies share the authority to enforce these laws, but do not ordinarily do so on state highways.

Currently, the Department of Public Safety's License and Weight Service is organized into six geographical regions and deploys 196 officers -- 12 senior administrators (Captains and Lieutenants), 18 Sergeants, and 166 troopers. Their primary objective is to protect the highways from unnecessary damage by securing compliance with the statutory provisions of law regulating the weight of commercial vehicles. However, their duties also include enforcement of motor vehicle registration laws, the Motor Carrier Act (transportation of persons or property for hire), Hazardous Materials Regulations, and enforcing other traffic laws and general law enforcement.

Vehicle weighing operations included the use of 8 permanent scales, 15 semiportable scales (12 State owned and 3 County owned), and portable hand-scales assigned in sets of four to all troopers. A summary of the 1983 enforcement activity using these scales is shown below:

1. Enforcement Activity

a.	Vehicles weighed	213,408	
b.	Vehicles checked	633,409	
c.	Vehicles measured	181,531	
d.	Incidence of loads reduced or off-loaded	25,080	
e.	Incidence of loads shifted	4,527	

2. Citations

a.	Oversize	11,760	
b.	Overweight	46,498	
	1) Axle weight violations over 20,000 single axle		865
	2) Axle weight violations over 20,000 tandem axle		12,891
	3) Over gross weight		32,742
TOTAL OVERSIZE AND OVERWEIGHT CITATIONS		58,258	
	4) Bridge formula included in overgross weight category		14,912
	5) Fines assessed on completed cases by magistrates		
	a) Oversize violations (Average $28.50)		$269,331.92
	b) Overweight violations (Average $42.53)		$2,002,320.03

The numbers indicate that 22 percent of the vehicles weighed were found to be overweight.

FINES AND DISINCENTIVES

An examination of the effectiveness of fines must take into account the probability of being caught. The expected cost of fines to the trucker is a function of his ability to avoid routes that have weigh stations, or if he travels such routes, the chance of the weigh stations being in operation.

As of September 1, 1983, first offense fines were set at a range of $100 to $150. The fine for a second conviction within one year of the first offense ranges from $150 to $250, or imprisonment for a period of 60 days or both fine and imprisonment. A third conviction within one year of the second offense carries a fine of $200 to $500 or imprisonment in the county jail for not more than six months or both fine and imprisonment. Second and third offenses must be tried in the County Court system, since the limit of the fine the Justice of the Peace can issue is $200. Due to the backlog of robbery, assault, and other (presumed higher) priority cases, violators of vehicle weight laws are almost always tried in J.P. courts, even though it may be the second, third, or more violation. If multiple violators were brought to the County Court, the number of cases dismissed might increase.

Of the cased filed by DPS officers, 98.6 percent were fined by the judges, with an average fine in 1983 for a gross vehicle weight violation of $42.53. It was noted that there was not a definite relationship between the amount of excess weight a trucker is charged with and the amount of fine levied in the courts.

An examination of the effectiveness of fines must take into account the probability of being caught. When the amount of fine likely to be charged times the probability of being caught is far below the profit that a trucker may obtain by running overloaded, an incentive exists for the trucker to run overloaded. Examples of fine structures for overweight trucks from other states are shown in Tables 4.3 and 4.4.

Penalties other than fines are also an effective deterrent to overloading. Forced unloading of the overweight freight can inflict substantial inconvenience and time cost on the driver. Unloading policies vary, and can be either discretionary (up to enforcement officer) or mandatory. The laws are often not enforced due to the lack of available storage space, the nature of the freight (if perishable), a concern for other motorists' safety, and the possibility of vandalism.

In those cases where the excess weight is not unloaded, the financial impact of the fines is not high enough to deter the trucker from overloading. Unless the current systems are revised, so that the disincentives to overload are increased, the truckers may continue to overload when it is in their economic interests.

The DPS has stated that, since the increased fine structure and the Aiding and Abetting complaints against the company or persons loading the vehicles in excess of 15 percent went into effect, there has been a 12 percent reduction in overweight vehicles.

In an effective enforcement program there are two basic components: probability of detection and penalties for violation. These two components cannot be separated when evaluating an enforcement program. Combined, these two make up the expected cost of overweighting to the trucker. At the

TABLE 4.3. TYPICAL FINES FOR VARIOUS LEVELS OF THREE-AXLE TRACTORS WITH TWO-AXLE SEMITRAILERS GVW OVERWEIGHT (FIRST OFFENSES)

STATE	Fine for Amount of Overweight				Comments
	1,000 lb	2,500 lb	6,000 lb	12,000 lb	
Arizona	$ 30	$ 55	$ 255	$ 280	
Arkansas	110	200	400	700	Set by Court or by Statute
California	10	20	160	910	Fines Are Mandatory
Colorado	20	30	45	75	By State
Connecticut	10 - 20	25 - 50	120 - 180	600 - 720	Fines Set by Statute
Delaware	20	50	150	450	By State
District of Columbia	100	100	100	100	Fine Independent of Severity
Florida	10	85	260	560	Civil Penalty - Lien on Vehicle
Georgia	8	30.5	138	418	
Idaho	12.5	26.25	67.5	132.50	
Illinois	0	60	320	920	
Iowa	10	25	75	480	
Kansas	20	50	120	240	Bond System - Judicial Discretion
Kentucky	50	55	280	500	Fine Assessed above 5% tolerance
Louisiana	200	200	400	700	
Maine	0	40	80	200	
Maryland	0	30	100	400	
Massachusetts	30	90	180	420	
Michigan	20	60	320	920	Court Discretion
Minnesota	50	50	400	500	Supreme Court Guidelines - Judicial Discretion
Mississippi	17.50	52.50	105	210	Minimum 50 Mile Violation
Missouri	52	202	552	1,152	
Montana	30	40	50	125	Set Minimum - Judicial Discretion
Nebraska	25	25	100	200	Strictly Judicial Discretion
Nevada	0	20	100	475	Set Fine Schedule - No Judicial Discretion
New Jersey	50	50	120	260	
New Mexico				200	Fine Set by Court - No Minimum
North Carolina	10	30	130	430	Exceeding 5% tolerance
North Dakota	10	25	190	670	
Ohio	25	50	145	385	
Oklahoma	75	85	155	250	Bail Bond System
Oregon	15	25	420	840	Maximum Fine--Judicial Discretion
Pennsylvania	150	150	1,050	2,850	
Rhode Island	10	25	60	120	Possible Suspensions
South Carolina				100	Maximum Fine - Judicial Discretion
South Dakota	0	85	350	950	
Tennessee	25			80	Maximum Fine - Judicial Discretion
Texas	25			200	Fine Function of Number of Offenses - Judicial Discretion
Utah				299	Maximum Fine - Judicial Discretion
Vermont	5	15	60	180	No Judicial Discretion
Virginia	20	50	300	600	Possible Suspension
Washington	80	125	230	410	
West Virginia	20	20	60	180	
Wisconsin	60	100	470	890	
Wyoming	100			100	Set Maximum Fine for the No. of Offenses and Time of Day

Source: NCHRP Synthesis #68 Motor Vehicle Size and Weight Regulations, Enforcement, and Permit Operations, 1980.

TABLE 4.4. FINE STRUCTURES FOR OVERWEIGHT TRUCKS FOR 10 SELECTED STATES

	Graduated	Fine
Tennessee	No	\$25 minimum, \$50 maximum
Indiana	Yes	2¢/lb for 1000-2000 OW 4¢/lb for 2000-3000 OW 6¢/lb for 3000-4000 OW 8¢/lb for 4000-5000 OW 10¢/lb for 5000 + over
Iowa	Yes	\$10 + 1/2¢/lb up to 1000 lbs OW \$15 + 1/2¢/lb 1000-2000 lbs OW \$80 + 3¢/lb 2000-3000 lbs OW \$150 + 5¢/lb 3000-4000 lbs OW \$200 + 7¢/lb 5000-6000 lbs OW \$200 + 10¢/lb 6000 lbs and above
Arizona	Yes	Ranges from \$30 for 1000 lbs OW to \$280 for 6000 lbs and over, maximum fine is \$300
California	Yes	Ranges from \$10 for 1000 lbs OW to \$1000 for over 12500 lbs
Colorado	Yes	\$15 + \$5/1000 lbs over legal weight
Connecticut	Yes	\$2/100 lb for 2-5% OW \$3/100 lb for 5-10% OW \$4/1000 lb for 10-15% OW \$6/1000 lb for 15-20% OW \$8/1000 lb for 20-25% OW \$10/1000 lb for over 25% OW
Maryland	Yes	\$20 minimum 2¢/lb to 5000 lbs OW 6¢/lb for over 5000 lbs OW
Minnesota	Yes	\$50 for 1000-2999 lbs OW \$100 for 3000-3999 lbs OW \$200 for 4000-4999 lbs OW \$300 for 5000-5999 lbs OW \$400 for 6000-6999 lbs OW \$500 for 7000 + more
Texas	No	\$25 minimum, \$200 maximum

Source: Overweight Vehicles - Penalties and Permits, U.S. Department of Transportation, November 1979.

present time the enforcement level is probably not enough to act as a deterrent. To increase the enforcement level it would take approximately $45,500 per year to fund each additional DPS Officer. This additional Officer would be able to check an additional 3,800 vehicles and weigh an additional 1,300 vehicles per year. Another alternative would be to hire civilians as weight technicians to work with DPS Officers. The estimated cost per year to hire these civilians would be $25,000 each. Therefore, with the same increase in funds the impact would be over double, since they would not have the additional duties of the DPS Officers.

Penalties are the second component of an effective enforcement program. If fines are levied for overweights, the fines must be of a level higher than the economic benefit of overweighting. Since the present fine structure does not accomplish this, it should be changed by (1) increasing the fine level and (2) introducing graduated fines that take into account the amount of overweight. The level of the fine must be in excess of the overweight permit fee that is currently being developed. Also the fine should be changed to a Civil Penalty. This would keep cases out of the crowded County Courts except those cases that were contested. The costs derived from implementing the above program would be matched against the benefits derived from the decreased damage to the highway system.

In some states (Louisiana, Virginia, etc.) violations of size and weight laws generate penalty assessments against the offenders that accrue to the treasuries of the jurisdictions responsible for roadway maintenance and law enforcement where the offense took place. Civil penalties, or "liquidated damages," these fees can be assessed according to a schedule that increases with the amount of oversize-overload and the distance travelled. Assessment can be administratively accomplished, with appeal to the courts provided for the offenders under certain circumstances, as Texas law now provides for appeals from Railroad Commission rulings (V.C.S 911b, Sec. 20), for example. Such an alternative would eliminate the criminal implications of violations and instead, utilize a schedule of civil penalties for illegally OS/OW vehicles, to be administratively assessed.

CHAPTER 5. RECOMMENDATIONS

Recommendation 1. A structure of fines for overweight violations should be graduated to reflect degrees of violation and should be administratively collected by DPS.

Recommendation 2. A structure of permits for all overweight vehicles should be developed under the same procedures that currently authorize the issuance of oil field servicing permits (SB 290). The essential features of this procedure are: (1) it is established by the Highway Commission; (2) it allows for effects of highway damages to be recouped in the value of the permit, and (3) it allows for the trip distance to be included in calculating the value of the permit.

Recommendation 3. The license fees for ready-mix concrete (exempt) vehicles should be established so that the dollar damages they inflict on the highway system are recovered. Failing this, the exempt nature of this vehicle should be lifted and made to conform with all applicable vehicle weight laws. Further, any study of city streets and county roads mandated by the Legislature should specifically include an analysis of the effects of these exempt vehicles upon the street/road network.

GLOSSARY

AASHO ROAD TEST: A study conducted from 1958 to 1961 to study the performance of various pavement designs subjected to loads of known magnitude and frequency.

AXLE WEIGHT: The weight transmitted to the pavement surface by a single axle or a tandem axle.

COMBINATION: A truck-tractor coupled to a semitrailer; also known as a multiple unit truck.

COMMON CARRIER: A company that engages in for-hire transportation of property and offers services to the general public.

CONSUMPTION APPROACH: The "wear-and-tear" method of apportioning cost responsibility in which the extra pavement thickness required to accommodate traffic loading is assigned to each vehicle class according to its share of total ESALs on that segment.

COST ALLOCATION: Determination of the share of a particular cost item to each vehicle class.

COST RESPONSIBILITY: The share of highway costs legitimately assignable to a given vehicle class; also, the general principle that payments by highway users should be in proportion to the highway costs for which they are responsible.

CTR: Center for Transportation Research, The University of Texas at Austin.

ENVIRONMENTAL FACTORS: Weather-related factors such as freeze-thaw cycles and engineering factors such as poor sub-soils that can lead to pavement deterioration.

EQUITY: A situation in which highway users pay their "fair share" of highway costs; the term sometimes refers to taxation according to ability to pay or benefits received.

ESAL: Equivalent Single Axle Load, usually expressed in terms of an 18,000 pound (18 Kip) standard: 18 KESAL. ESAL factors, as developed from the AASHO Road Test, are used to compare the relative wear caused by vehicles of different single and tandem axle weights.

GROSS REGISTERED WEIGHT: The weight at which a motor vehicle is registered and taxed, and therefore the maximum weight at which it can legally operate.

GROSS VEHICLE WEIGHT (GVW): The combined weight of a vehicle and its load.

INCREMENTAL ALLOCATION: A method of apportioning costs in which an additional highway increment is shared by all vehicles requiring this increment.

INEQUITY: A situation in which the public or special interest groups see evasion of fuel taxes, violation of weight limits, or legal weight concessions as grossly unfair.

MARGINAL COST PRICING: The setting of user fees that are tied directly to the actual amount of usage by the individual users.

OCCASIONED COSTS: The costs which can be associated with the presence of a particular vehicular class.

PAVEMENT DAMAGE: Pavement damage (or deterioration) resulting from structural fatigue due to repeated applications of various single and tandem axle weights.

REVENUE TRACKING: The process of estimating the proportion of revenues contributed by each vehicle class.

SEMITRAILER: A truck trailer equipped with one or more axles and constructed so that the front end rests upon a truck-tractor.

SINGLE UNIT TRUCK: A truck with the body and engine mounted on the same chassis.

TANDEM AXLE: Two consecutive axles less than eight feet apart.

TIUS: Truck Inventory and Use Survey, produced every five years by the Bureau of the Census.

TON-MILE TAX: A tax in which the fee schedule varies for each trip according to either the cargo weight or the actual gross operating weight.

TRIP PERMIT: A temporary permit issued by a jurisdiction in lieu of reciprocity or registration.

TTI: Texas Transportation Institute, Texas A&M University.

USER: The owner of a motor vehicle in use on highways, roads, and streets.

USER CHARGE: An amount paid by a highway user that is contingent upon access to the highway system.

VEHICLE CLASS: A subdivision of the total vehicle fleet, consisting of a group of vehicles defined by similar characteristics (weight, vehicle type) for purposes of allocating costs and setting user charges.

VMT: Vehicle miles of travel.

WEIGHT-DISTANCE TAX: A tax in which the fee schedule is tied to a vehicle's weight and distance traveled. Proxies for gross operating weight include gross registered weight and number of axles.

APPENDIX A. COMPARISON OF EQUIVALENCIES FOR DIFFERENT TRUCK TYPES

After completion of the AASHO Road Test in 1960, equations were developed for measuring the relative effects caused by different axle weights on flexible and rigid pavements. Any single axle or tandem axle of a known weight can be identified in terms of an equivalency to a standard 18,000 pound single axle load (18 KESAL: 18 Kip Equivalent Single Axle Load). By adding the equivalencies for all axle loads expected to operate over a specific highway segment during a certain period of time, the total 18 KESALs can be determined. This concept is presently used in Texas-- as well as most other states -- for the design of pavement thicknesses.

Equivalencies can be used to examine the "relative damage" effects caused by overweight trucks of a specific axle configuration. As shown on Table A.1, two single unit truck types and seven multiple unit truck types were examined. Table A.2 shows 18 KESAL factors on a "per truck" basis, for both legal and illegal ("overweight") loadings. Texas law limits trucks to a single axle weight of 20,000 pounds, a tandem axle weight of 34,000 pounds, and a gross vehicle weight of 80,000 pounds. The weights of front steering axles are limited by safety considerations as well as the Texas law that the load carried by each wheel cannot exceed 650 pounds per inch width of tire (a steering axle with 10 inch-wide tires could thus legally carry 13,000 pounds).

The same information is presented in a more readable form in Tables A.3 and A.4. These tables clearly point out that

TABLE A.1. DESCRIPTION OF TRUCK TYPES

SINGLE UNIT

2D : 2 SINGLE AXLES

3A : 1 SINGLE, 1 TANDEM

MULTIPLE UNIT	AXLES ON TRUCK TRACTOR	AXLES ON SEMITRAILER	AXLES ON SECOND TRAILER	TOTAL AXLES
2-S1	2 SINGLES	1 SINGLE		3
2-S2	2 SINGLES	1 TANDEM		4
3-S2	1 SINGLE 1 TANDEM	1 TANDEM		5
2-S1-2	2 SINGLES	1 SINGLE	2 SINGLES	5
3-S1-2	1 SINGLE 1 TANDEM	1 SINGLE	2 SINGLES	6
3-S1-3	1 SINGLE 1 TANDEM	1 SINGLE	1 SINGLE 1 TANDEM	7
3-S2-3	1 SINGLE 1 TANDEM	1 TANDEM	1 SINGLE 1 TANDEM	8

TABLE A.2. DEVELOPMENT OF 18 KESAL FACTORS FOR TRUCKS

WEIGHT, IN THOUSANDS OF POUNDS

TRUCK TYPE	SINGLE AXLES 1	SINGLE AXLES 2	SINGLE AXLES 3	TANDEM AXLES 1	TANDEM AXLES 2	GROSS VEHICLE WEIGHT	18 KESAL/TRUCK FLEX. [a]	18 KESAL/TRUCK RIGID [b]
2D	2	2	0	0	0	4	0.0006	0.0004
	4	6	0	0	0	10	0.024	0.012
	8	12	0	0	0	20	0.28	0.21
	10	20	0	0	0	30	1.61	1.63
	13	20	0	0	0	33	1.81	1.82
(OVER.)	14	26	0	0	0	40	4.71	4.77
3A	8	0	0	12	0	20	0.07	0.06
	10	0	0	20	0	30	0.28	0.29
	12	0	0	28	0	40	0.78	1.03
	13	0	0	34	0	47	1.43	2.14
(OVER.)	12	0	0	38	0	50	1.92	3.09
(OVER.)	14	0	0	46	0	60	3.98	6.49
2-S1	6	6	8	0	0	20	0.09	0.05
	8	10	12	0	0	30	0.40	0.29
	8	16	16	0	0	40	1.35	1.25
	10	20	20	0	0	50	3.10	3.18
(OVER.)	12	24	24	0	0	60	6.41	6.64
2-S2	8	10	0	12	0	30	0.19	0.14
	8	12	0	20	0	40	0.44	0.42
	8	16	0	26	0	50	1.12	1.27
	8	18	0	34	0	60	2.16	2.90
	12	20	0	34	0	66	2.83	3.60
(OVER.)	12	22	0	36	0	70	3.78	4.81
(OVER.)	14	24	0	42	0	80	5.98	7.88
3-S2	8	0	0	16	16	40	0.13	0.19
	10	0	0	20	20	50	0.44	0.50
	10	0	0	25	25	60	0.85	1.16
	10	0	0	30	30	70	1.52	2.34
	12	0	0	34	34	80	2.45	3.92
(OVER.)	12	0	0	39	39	90	3.98	6.64
(OVER.)	14	0	0	43	43	100	5.88	9.81

(CONTINUED)

TABLE A.2 DEVELOPMENT OF 18 KESAL FACTORS FOR TRUCKS (CONTINUED)

TRUCK TYPE	WEIGHT, IN THOUSANDS OF POUNDS: SINGLE AXLES 1	2	3	4	5	TANDEM AXLES 1	2	3	4	GROSS VEHICLE WEIGHT	18 KESAL/TRUCK FLEX.[a]	RIGID[b]
2-S1-2	6	8	10	8	8	0	0	0	0	40	0.29	0.18
	8	10	12	10	10	0	0	0	0	50	0.64	0.45
	8	13	13	13	13	0	0	0	0	60	1.31	1.09
	10	15	15	15	15	0	0	0	0	70	2.22	2.00
	10	18	18	17	17	0	0	0	0	80	3.77	3.69
(OVER.)	10	20	20	20	20	0	0	0	0	90	6.08	6.28
(OVER.)	12	22	22	22	22	0	0	0	0	100	8.91	9.30
(OVER.)	14	24	24	24	24	0	0	0	0	110	12.76	13.27
3-S1-2	6	8	8	8	0	10	0	0	0	40	0.18	0.11
	6	10	10	10	0	14	0	0	0	50	0.78	0.30
	8	12	12	12	0	16	0	0	0	60	0.81	0.65
	8	14	14	14	0	20	0	0	0	70	1.41	1.29
	8	16	16	16	0	24	0	0	0	80	2.31	2.31
(OVER.)	10	18	18	18	0	26	0	0	0	90	3.54	3.71
(OVER.)	10	20	20	20	0	30	0	0	0	100	5.29	5.86
(OVER.)	10	21	21	21	0	37	0	0	0	110	5.61	8.46
(OVER.)	11	23	23	23	0	40	0	0	0	120	10.13	11.95
(OVER.)	12	24	24	24	0	46	0	0	0	130	13.08	16.01
3-S1-3	6	8	8	0	0	14	14	0	0	50	0.20	0.17
	6	10	10	0	0	17	17	0	0	60	0.44	0.39
	6	12	12	0	0	20	20	0	0	70	0.80	0.79
	8	14	14	0	0	22	22	0	0	80	1.31	1.35
(OVER.)	8	15	15	0	0	26	26	0	0	90	1.94	2.25
(OVER.)	8	16	16	0	0	30	30	0	0	100	2.75	3.51
(OVER.)	8	18	18	0	0	33	33	0	0	110	4.05	5.37
(OVER.)	8	20	20	0	0	36	36	0	0	120	5.79	7.83
(OVER.)	10	22	22	0	0	38	38	0	0	130	7.84	10.46
(OVER.)	12	24	24	0	0	40	40	0	0	140	10.53	13.74
3-S2-3	6	10	0	0	0	15	15	14	0	60	0.29	0.27
	6	10	0	0	0	18	18	18	0	70	0.47	0.51
	8	12	0	0	0	20	20	20	0	80	0.76	0.84
(OVER.)	8	13	0	0	0	23	23	23	0	90	1.18	1.44
(OVER.)	8	14	0	0	0	26	26	26	0	100	1.71	2.27
(OVER.)	8	16	0	0	0	29	29	28	0	110	2.50	3.47
(OVER.)	8	16	0	0	0	32	32	32	0	120	3.37	5.05
(OVER.)	8	20	0	0	0	34	34	34	0	130	4.87	7.19
(OVER.)	10	22	0	0	0	36	36	36	0	140	6.43	9.41
(OVER.)	12	24	0	0	0	38	38	38	0	150	8.39	12.14
(OVER.)	12	24	0	0	0	42	41	41	0	160	10.36	15.56

a ASSUMPTIONS FOR FLEXIBLE PAVEMENT FACTORS:

STRUCTURAL NUMBER = 3.0
TERMINAL SERVICEABILITY INDEX = 2.5

b ASSUMPTIONS FOR RIGID PAVEMENT FACTORS:

SLAB THICKNESS = 8 INCHES
TERMINAL SERVICEABILITY INDEX = 2.5

TABLE A.3. 18 KESALs BY TRUCK TYPE, FLEXIBLE PAVEMENTS*

GROSS VEHICLE WEIGHT, POUNDS	SINGLE UNIT		COMBINATION TRACTOR AND TRALER (S)						
	2D	3A	2-S1	2-S2	3-S2	2-S1-2	3-S1-2	3-S1-3	3-S2-3
20,000	0.28	0.07	0.09						
30,000	1.61	0.28	0.40	0.19					
40,000	4.71	0.78	1.35	0.44	0.13	0.29	0.18		
50,000		1.92	3.10	1.12	0.44	0.64	0.78	0.20	
60,000		3.98	6.41	2.16	0.85	1.31	0.81	0.44	0.29
70,000				3.78	1.52	2.22	1.41	0.80	0.47
80,000				5.98	2.45	3.77	2.31	1.31	0.76
90,000					3.98	6.08	3.54	1.94	1.18
100,000					5.88	8.91	5.29	2.75	1.71
110,000						12.76	5.61	4.05	2.50
120,000							10.13	5.79	3.37
130,000							13.08	7.84	4.87
140,000								10.53	6.43
150,000									8.39
160,000									10.36

* STRUCTURAL NUMBER = 3.0

TERMINAL SERVICEABILITY INDEX = 2.5

TABLE A.4. 18 KESALs BY TRUCK TYPE, RIGID PAVEMENTS*

GROSS VEHICLE WEIGHT, POUNDS	SINGLE UNIT		COMBINATION TRACTOR AND TRAILER (S)						
	2D	3A	2-S1	2-S2	3-S2	2-S1-2	3-S1-2	3-S1-3	3-S2-3
20,000	0.21	0.06	0.05						
30,000	1.63	0.29	0.29	0.14					
40,000	4.77	1.03	1.25	0.42	0.19	0.18	0.11		
50,000		3.09	3.18	1.27	0.50	0.45	0.30	0.17	
60,000		6.49	6.64	2.90	1.16	1.09	0.65	0.39	0.27
70,000				4.81	2.34	2.00	1.29	0.79	0.51
80,000				7.88	3.92	3.69	2.31	1.35	0.84
90,000					6.64	6.28	3.71	2.25	1.44
100,000					9.81	9.30	5.86	3.51	2.27
110,000						13.27	8.46	5.37	3.47
120,000							11.95	7.83	5.05
130,000							16.01	10.46	7.19
140,000								13.74	9.41
150,000									12.14
160,000									15.56

* SLAB THICKNESS = 8 INCHES

TERMINAL SERVICEABILITY INDEX = 2.5

"relative damage" is not related solely to gross vehicle weight. For example, an 80,000 - pound 3-S2, the most common type of heavy truck operating in Texas, has about the same effect on pavements (according to AASHO equivalency factors) as an eight-axle truck weighing 110,000 pounds.

APPENDIX B. RELATED RESEARCH STUDIES

EFFECTS OF HEAVY TRUCKS

Senate Resolution 589, passed by the Texas Senate on May 10, 1977, during the 65th Legislature, required that a report describing the planning system being used by SDHPT be submitted. A supplement to SDHPT's "Report to the 65th Legislature," prepared April 1, 1978, was another report prepared September 1, 1978, entitled "Effects of Heavy Trucks on Texas Highways." The objective of this study was to assess the effects of projected truck traffic on the highway system of Texas in consideration of the social and economic vitality of the State over a 20-year planning horizon.

The study included an evaluation of two scenarios -- one representing the current statutory gross vehicle and axle weight limits, and the second representing large increases:

	(In Thousands of Pounds)	
	Scenario A	Scenario B
Single Axle Limit	20	26
Tandem Axle Limit	34	44
Gross Vehicle Weight Limit	80	120

Since Scenario B implies that there will be more trucks operating above the legal limit of 80,000 pounds, these will be replacing some trucks that had been operating near and below the old limit. As a result of the shift, ton mileage remaining constant, there was an overall reduction in the number of loaded vehicle trips and, correspondingly, a decrease in the number of empty trips. Table B.1 shows the comparative 20-year tax dollar costs required to perpetuate the state highway system in an acceptable condition

TABLE B.1. COMPARATIVE TWENTY-YEAR COSTS FOR SCENARIOS A AND B*

	Interstate Highways	Farm-to-Market Roads	Other State Highways	Total State System
	(Millions of Constant 1977 Dollars)			
Scenario A				
Pavement Maintenance & Seal Coats	$ 240	$1,100	$ 960	$ 2,300
Pavement Rehabilitation	1,334	1,512	3,084	5,930
Bridge Replacements *	4*	76*	50*	130*
Totals	$1,578	$2,688	$4,094	$ 8,360
Scenario B				
Pavement Maintenance & Seal Coats	$ 240	$1,100	$ 960	$ 2,300
Pavement Rehabilitation	1,888	1,953	4,618	8,459
Bridge Replacements*	172*	376*	554*	1,102*
Totals	$2,300	$3,429	$6,132	$11,861

*Bridge replacement costs include only the estimated cost of upgrading existing bridges to carry the loads included in the two scenarios. The cost of structure maintenance, bridge replacement and rehabilitation due to functional deficiencies and wear-out are not included because of the inability to isolate structure maintenance requirements associated with heavy loads and the lack of current technology for analyzing the effects of repetitive heavy loadings on the life of structures. **Therefore the totals do not reflect the entire cost of maintaining the existing system.**

while carrying the estimated traffic for both scenarios. The cost estimates (in 1977 dollars) do not include city streets and county roads and bridge maintenance, nor bridge rehabilitation and replacement resulting from functional deficiencies and deterioration. These costs were excluded due to the inability to isolate bridge maintenance requirements associated with heavy loads and the lack of current technology for analyzing the effects of repetitive heavy loadings on the life of structures. Pavement rehabilitation costs were projected with the REHAB computer program. The methodology for adjusting pavement service life due to heavier trucks was based on the 18-KIP equivalencies developed during the AASHO Road Test.

TRUCK USE OF HIGHWAYS

A major research project at CTR that has resulted in the publication of a number of reports is entitled "Truck Use of Highways in Texas." Three of these reports will be reviewed in this section.

Changes in Truck Dimensions

A CTR report entitled "An Assessment of Changes in Truck Dimensions on Highway Geometric Design Principles and Practices" was published in 1981. The report emphasizes that any significant change in the vehicular operating characteristics would require an assessment of the geometric design practices and the impact on the existing highway system in terms of operational aspects and safety. In order to accommodate larger vehicles, additional costs would be required to redesign and modify the current network or segments of the network.

Truck Size and Weight Studies

A CTR report entitled "An Assessment of Recent State Truck Size and Weight Studies" was published in 1982. The report documents the status of current legislation in each state with respect to laws governing truck size and weight, with emphasis placed on laws pertinent to the operation of larger motor carriers such as "doubles" and "triples", overall vehicle length, width, axle weight, and gross vehicle weight. It was emphasized in many studies that highway engineers concerned with pavement design, maintenance, and general serviceability are more interested in the magnitude and frequency of axle weights than in gross vehicle weights.

An analysis of the results of the Texas Size and Weights study indicated that the introduction of triple trailer combinations, as well as the so-called "turnpike doubles", into Texas may not create serious additional pavement damage or require extensive geometric redesign cost if these large combinations are confined to the Interstate system. Allowing these combinations on U.S. and State highways would result in considerable trucking benefits, but allowing these vehicles on farm-to-market roads would be very impractical.

Shifting Methodology

A CTR report entitled "Truck Weight Shifting Methodology for Predicting Highway Loads" was published in 1983. The report documents a new procedure for the projection of changes in future truck weight distribution patterns due to changes in legal truck weight limits. The methodology can be used to predict both gross vehicle weight and axle weight distributions. Weight distribution patterns can have a significant effect on cost-effective design and rehabilitation of pavements.

THE TRUCK WEIGHING PROGRAM IN TEXAS

A number of studies have been made of SDHPT's truck weight survey program over the last 15 years. The general consensus of these studies is that an adequate sample of the actual axle weights operating over Texas highways is extremely important to highway planning and design. In the early 1960's, SDHPT collected weight data from 21 manual "loadometer" stations. By 1983, six weigh-in-motion stations were in operation. It is believed that SDHPT's ability to project the costs required to perpetuate the highway system in Texas could be significantly improved if weight data was collected at a larger number of locations throughout the state.

TRAFFIC LOAD FORECASTING

A CTR research project entitled "Estimation of Truck Loadings for Design and/or Rehabilitation of Pavements" will be completed this year. The objective of this study is to examine SDHPT's existing traffic load forecasting procedure and determine if any improvements should be made. The typical purpose of the Texas procedure is to determine the total 18-KIP equivalent single axle loads (18 KESALs) that are expected to operate over a particular highway segment during a 20-year period.

A fundamental assumption of the Texas procedure, as well as the procedure used in most other states, is the applicability of the AASHO equivalency factors for calculation of total 18 KESALs. If the equivalencies are accurate, it is possible to determine the amount of damage caused by one vehicle in relation to the damage caused by a standard vehicle. Since this can be a very important concept for the assessment of permit fees for overweight trucks, additional detail has been provided in Appendix A.

STUDY OF TRUCK LANE NEEDS

Traffic increase is an inevitable by-product of the phenomenal growth of the State of Texas. Both general and commercial traffic are on the rise, in metropolitan and rural areas alike, impinging upon the ability of the current highway system to meet the future needs of the State's economy and the mobility of its residents in a safe and efficient manner. Furthermore, current trends toward larger and heavier trucks on one hand, and toward more compact fuel-efficient passenger vehicles on the other, raise serious safety considerations due to the sharing of roadways by vehicles with such dissimilar extreme characteristics.

The development and implementation of economically and technically viable solutions require concerted planning efforts supported by careful analysis of anticipated truck traffic on the highway network. The implications of various proposed solutions in terms of required expenditures and resulting service levels for both the trucking industry and the general public should be systematically assessed and evaluated. No quick fixes to a problem of this magnitude exist, and the decisions and strategies developed now will have long-ranging effects on future development. Adequate methodological support for this planning activity is essential for its proper conduct.

Objective

The overall objective of this study is to develop information that will be useful to SDHPT in solving the unique problems associated with heavy truck usage of highway facilities. The major tasks are: (1) identifying critical highway sections from the perspective of excessive truck traffic; (2) establishing criteria or warranting procedures for measures to cope with truck traffic; and (3) evaluating the corridor and systemwide impacts of various relief or prevention measures.

Implementation and Benefits

The results of this study will provide SDHPT with a systematic procedure for identifying, analyzing, and evaluating the truck lane needs on the Texas highway system. As the SDHPT intensifies its activities in reconstructing and performing heavy maintenance on the major intercity routes, the presence of significant truck traffic will affect the expenditures needed. In its decision making, SDHPT can make better use of the taxpayers' dollars if it has reliable information about the best truck lane design counter-measures applicable for use on the network. The results will provide for the safest, most efficient facilities available for a given level of expenditures.

ANALYSIS OF HIGHWAY COST ALLOCATION IN TEXAS

Introduction

The highway cost allocation problem is one of determining equitable charges for each of the vehicle classes sharing transportation facilities such as highways and bridges. A completely non-controversial solution methodology for the cost allocation problem may not exist; however, cost must be allocated in some rational and systematic way which is deemed equitable by all users of the system.

Previous attempts at solving the highway cost allocation problem can essentially be reduced to two major approaches: (a) proportional (consumption) allocation methods, which determine cost allocations in proportion to one or more measures of highway usage; and (b) incremental methods, which allocate costs on the basis of highway design differences necessary to accommodate gradually heavier vehicle classes.

There exist, however, some limitations affecting the validity of the traditional cost allocation methodologies. On one hand, proportional methods may yield results that conflict with the perception of fairness by some of the users, hence hindering the acceptability of such results and questioning the overall applicability of proportional approaches. On the other hand, incremental methods may yield inconsistent results, since they identify cost responsibilities on the basis of cost differences associated with the specific ordering of vehicle classes. The inconsistency is due to the fact that if vehicle classes are introduced in different sequences, different cost allocations are obtained. Since a rational basis to support a particular sequence does not exist, this inconsistency constitutes a serious flaw in any cost allocation method that seeks to be equitable.

New Methods

In an attempt to overcome the shortcomings aforementioned, two new solution approaches to the highway cost allocation problem have been developed: the Modified Incremental Approach and an optimization approach referred to as the Generalized Method. A significant feature of the two new methods; is that they consider all possible combinations of the given vehicle classes as scenarios for which highway costs are computed given a planning horizon and traffic data. In the analysis, the costs associated with all scenarios are used to compute final vehicle class allocations that satisfy the following three requirements:

(a) Completeness: the provision of highway facilities must be entirely financed by the various vehicle classes that utilize them.

(b) Rationality: The common facility is the most economically attractive alternative for all vehicle classes to meet their transportation needs; that is, any other alternative to satisfy this need, such as using an exclusive facility, would be more expensive for any vehicle class.

(c) Marginality: the allocated costs associated with any vehicle class must be sufficient to at least cover its corresponding marginal costs.

Work Accomplished

The work so far accomplished in this project can be summarized as follows:

1. The conceptual models for the Modified Incremental Approach and the Generalized Method have been developed.
2. The models mentioned above have been computerized and preliminary tests have been run with satisfactory results.
3. The RENU2 program has been reviewed and modified to make it more suitable to the needs of this problem and to improve its cost estimating capabilities. In particular:
   (a) The program was made sensitive to traffic intensity (for instance, number of vehicles per year);
   (b) Results from other studies were implemented to upgrade the pavement survival estimation capability of the program;
   (c) The age adjusting procedure was substantially revise to reflect a more realistic behavior;
   (d) The program was simplified to yield only results related to cost allocation. All computations

associated with changes in legal load limits were eliminated.

(e) Work is being conducted to develop performance and survivor curves that are responsive to changes in traffic composition. This work is needed, since RENU2 contains curves that are representative of past traffic conditions. Therefore, new curves must be developed for new scenarios.

4. A few runs of the entire procedure have been made in order to test the program. More extensive runs with more realistic data will be conducted.

5. A report describing the work accomplished in FY 83-84 is under preparation.

COMPUTERIZED METHOD OF PROJECTING REHABILITATION AND MAINTENANCE REQUIREMENTS DUE TO VEHICLE LOADINGS

The goal of this research project is to revise and combine the REHAB and NULOAD computer models into a new approach to forecast pavement rehabilitation costs. The new model is called RENU and it incorporates the following three main elements: (a) revised pavement performance equations, (b) design-oriented survivor curves, and (c) a procedure to predict the increment in axle loads when higher pay loads are allowed. The most relevant contribution of the new model in the area of flexible pavements is the development of a serviceability/distress approach to investigate the effect of vehicle loading on the life cycle of highways. This approach has the capability to predict if a pavement needs light to medium rehabilitation as a result of distress signs, when the riding conditions (PSI) have not yet reached a terminal value.

The new approach is considered more reliable, for Texas flexible pavements, than the AASHTO methodology. In the area of rigid pavements the two most important improvements are the formulation of a modified AASHTO equation to include soil support values, regional factors, design characteristics, and traffic conditions typical of the Texas highway system, and the development of a failure prediction model to estimate maintenance needs.

The RENU approach was built using experimental values of material properties, climatic conditions, design factors, and traffic measurements obtained by the Texas Transportation Institute (TTI) and the Center for Transportation Research (CTR).

Briefly, the overall methodology can be summarized in four steps: (a) a load distribution procedure is incorporated to investigate the shift toward higher loads is a new legal axle load limit is considered, (b) generation of a pavement performance functions based upon statistical criteria, (c) generation of a survivor curve to predict the extent of road rehabilitation requirements in each of the periods of a planning horizon, and (d) determination of rehabilitation costs considering life cycles for both the current and new axle load legal limits.

EFFECTS OF OIL FIELD DEVELOPMENT ON RURAL HIGHWAYS

The principal objectives of this study were to identify the primary phases of development of an oil well, describe the vehicle-mix during the development, and estimate an annual cost associated with a reduced pavement life. Five general activities comprise the sequential development: site preparation, rigging up, drilling, completion, and production.

Traffic generated by the drilling of an oil well was recorded using an 18mm movie camera. Peak volumes of up to 350 vehicles per day occurred during the rigging stages. Approximately 200 vehicles per day were present during the drilling phase. An average daily traffic of 150 vehicles per day was observed over the 73 day filming period. The average daily traffic is estimated at 50 vehicles per day once the production phase stabilizes.

Truck combinations made up 14 percent of the traffic mix during the filming period. Seven (7) percent of the total traffic mix consisted of the 3-S2 (tractor-semitrailer) type. Since actual axle weight measurements were not possible in this study, the observed truck counts were distributed across the axle load ranges compiled by the SDHPT and listed in the axle load distribution tables ("W-Tables). When converted to 18-KESAL, 945 equivalent load repetitions were estimated in the design lane at the oil well site for the first year.

When the oil well traffic repetitions (945) are added to the intended use 18KESAL repetitions (445), 1390-18KESAL repetitions result after one year of service. The concept of pavement serviceability developed at the AASHO Road Test was then used to determine a reduction in pavement service life due to this increased traffic demand.

An increased annual cost of $12,500 per mile was estimated for a low volume (250 ADT), light duty (1/2 inch bituminous surface treatment on a 6-inch foundation base course) pavement section. This cost considered only a capital investment for a surface treatment pavement and the cost to resurface the pavement for the intended use condition. The initial pavement placement cost was estimated at $61,000/mile and $8,600/mile for a future seal coat surface treatment. It was further assumed that oil production would last at least 3 years. Final pavement design may actually necessitate the reconstruction of a higher type pavement to cost-effectively serve the increased traffic demand generated by ultimate oil field development.

Reduction in service life generally range from 60 to 75 percent. Actual loss of pavement utility varies among the distress types. Raveling and flushing distress experience a 75 percent reduction in service life for both the 6-inch and 10-inch pavements. Since these distresses are traffic-associated, the increase in average daily traffic is primarily responsible for this loss of service. Load associated distresses result in approximately 60 percent loss of life. The thinner 6-inch pavement is, as expected, very sensitive to increased axle loading.

This technique can be used to evaluate alternative maintenance strategies or to select pavement thickness commensurate with a truck traffic demand. Potentially, the procedure can aid SDHPT in allocating funds to districts that are in particular need of additional maintenance or reconstruction monies. The versatility of the computer program provides a framework for examining other "special-use" truck traffic conditions.