Characteristics of Double-Trailer Trucks in New York State

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ABSTRACT

The characteristics of double-trailer truck operations are described for a selected location on the New York State Thruway in upstate New York. Vehicles were observed during a typical weekday for an 8-hour period and their characteristics were recorded. Of 13,999 vehicles passing the observation point, 1,322 (9.4 percent) were semitrailers and 90 (0.65 percent) were double trailers. Even though the New York State Thruway permits flexible operation of such vehicles, they were found to be quite uniform in overall characteristics. In 90 percent of the observed vehicles, one of two axle configurations were observed: eight or nine axles. For 51 percent of the observed vehicles, an out-of-state registered trailer was pulled by a New york State registered tractor; and 30 percent of the vehicles had New York registrations on both tractor and second trailer. Almost 90 percent of the vehicles observed were hauling two long trailers; that is, trailers 40 feet or more in length (double-bottoms). No combinations were observed in which the first trailer was shorter than the second trailer. Of all vehicles, 90 percent were owned by commercial transportation companies, but these represented only a handful of large transportation companies. United Parcel Service, Consolidated Freight, and Oneida Express accounted for 44 percent of the observed vehicles. Only nine vehicles were privately owned. The paper concludes that despite the flexibility permitted in operations, the double-trailer market operating on the New York State Thruway is represented by a narrow spectrum of vehicle types and companies.

For some time, the operation of longer combination trucks (often referred to as tandems, double-bottoms, doubles, and tripples) has been sanctioned in a number of western states and on selected toll facilities in eastern states. However, the Surface Transportation Assistance Act of 1982 substantially relaxed the regulatory environment within which such trucks will be permitted to operate.

New York State Department of Transportation (DOT) uses the term double-bottoms to refer to long (40 or more feet) double-trailer trucks operating only on the New York State (NYS) Thruway, and the term tandems to refer to 28.5-ft double-trailer vehicles. Only the latter would be permitted to operate on the national network. In this paper, the term double-trailer is used to refer to all truck vehicles hauling two trailers, regardless of length; thus it includes both doubles and tandems.

The Act specifies that larger vehicles be permitted to operate on a national network of routes designated by the Secretary of Transportation. On this system, federal law allows trucks with total weights up to 80,000 lb, per-axle weights up to 20,000 lb, and tandem-axle weights up to 34,000 lb. Further, trucks may carry tandem trailers up to 28.5 ft long, semitrailers may be up to 48 ft long, and trucks can be up to 102 in. wide. The Act requires that the states permit reasonable access to the national network to and from terminals and facilities, for fuel, food, rest, and repairs.

The Act specifically prohibits the states from imposing or enforcing more stringent-than-federal size and weight restrictions on the national network system. In addition, the Act directs the Secretary of Transportation to report to Congress concerning the potential benefits and costs, if any, associated with the development of a controlled access network for use by longer combination commercial motor vehicles. The Act also substantially increases heavy vehicle use and fuel taxes and mandates that states require proof of payment of such taxes before issuing licenses. On balance it indicates an intent by the federal government to ease interstate commerce regulations for the operation of large trucks.

These legislative actions have highlighted the clash of issues about whether the potential benefits (if any) of such vehicles are achievable and to whom they accrue (e.g., truckers, unions, or consumers) versus whether safety, operational characteristics in handling, vehicle congestion, and pavement damage are likely to be significantly impaired and by how much. Full analysis of these issues requires a complete and thorough assessment of present and anticipated double-trailer operations in the United States.

Such a review would require the collection of additional data describing operations; a thorough documentation of current operations; the development of reasonable alternatives to the current operating environment; the evaluation of alternative operational plans on productivity, safety, and pavement damage; and implementation of recommendations. However, the baseline data necessary for comparison are rapidly disappearing, because the operating environment is changing rapidly. If background information on the present operation of doubles is not immediately collected and summarized, it will be difficult if not impossible to show how the expanded operating situation is different (better or worse) than the situation it replaced. This paper is a first step in that process, because it obtains an initial baseline reading on the characteristics of the only present (August 1983) operating environment for double-trailer vehicles in New York State. Although the data base for this assessment is narrow, and as will be seen, the time frame is limited, this information is better than none at all and can be expanded if necessary in the future.

The published literature on the operational characteristics of double-trailers and triples focuses largely on safety, rather than economic or other impacts. In 1973 the California Highway Patrol undertook an assessment of accidents with double-trailer trucks (1) and concluded that the accident rate of such vehicles, based on a review of 32,000 accidents, was favorable when compared with other

classes of vehicles. The study also reviewed handling characteristics and found them to be adequate: a 65-ft (total length) tandem was found to have a smaller required track width in a 60-ft radius turn than a 60-ft tractor semitrailer. Passing maneuvers around the tandem were found to be no more hazardous than passing any large truck or bus. The study concluded that tandems were at least as safe as tractor-semitrailer combinations and were more maneuverable.

Operational problems associated with the hitches of double trailers (e.g., dynamics of turns, braking, and fishtailing) were examined in a Canadian study (2) and found to be minimal. However, a report by White (3) showed that in 1972 accidents in Ontario involving double-articulated vehicles were more severe than those of single-articulated vehicles. Revised California assessments (4) based on 1974 data were inconclusive; they showed that doubles had a greater rate of accidents per million vehicle miles but that single vehicles had higher accident rates on the basis of cargo ton miles. A recent review of this literature by FHWA (5) showed that apparently conflicting results actually involve different populations of trucks and that the quality of data and analysis in several of the studies was questionable. Clearly, therefore, the issue of the safety of such vehicles remains unsolved.

Some theoretical models of vehicle dynamics have also been applied to double-articulated vehicles (6). These include theoretical studies of lane changing behavior and weight characteristics (7). A recent simulation model, the Truck and Tractor-Trailer Dynamic Response Simulation, developed by the Highway Safety Research Institute, has been used to investigate the effects of increased truck size and weight on vehicle handling (8).

Operational experience with triples has been reported from the early 1970s. Studies in Canada (9) concluded that triples did not create any special hazards to traffic safety and that pavement deflection was less than the stress created by five-axle semitrailer trucks. An 8-day road test in Sacramento in October 1971 (10) evaluated braking, acceleration, exterior noise, backing and off-tracking, and operation in traffic. No specific conclusions were drawn by the testing agency, but findings were generally favorable after reviewing approximately 1,800 miles of operation on various types of roads (11). Despite an apparent fuel savings of as much as 21 percent (12) and favorable operating experience in reducing operating costs and conserving fuel in Utah (13), triples have apparently not substantially increased their share of the market beyond that developed in the early 1970s.

NEW YORK SITUATION AND TEST SITE

New York State law permits the operation of semitrailer trucks up to 60 ft in overall length on any public highway in New York. Under state law tandem-trailer trucks of up to 65 ft in overall length have been allowed since 1981 to use 777 miles of New York's Interstates, and 503 miles of non-Interstates that have at least four lanes. The routes are all upstate (north of New York City). In addition, the NYS Thruway, a toll road stretching from New York City to the Pennsylvania line, has for many years permitted special tandems (double-bottoms) of up to 114 ft in overall length. These larger vehicles are also permitted on the Massachusetts Turnpike and its connection to the NYS Thruway, thus permitting operation in the Boston-Albany-Buffalo corridor.

Pursuant to the Surface Transportation Assistance Act of 1982, the Secretary of Transportation has designated (Federal Register, September 14, 1983) a system of other primary routes, in addition to the Interstate system, on which tandem trailers would be permitted to operate. This system includes New York's 503-mile system noted earlier, SR-219, and US-4 and SR-254, which connect the Northway to the Vermont state line. New York has passed enabling legislation and rules designating the upstate portion of this system; the downstate portion, including the Interstate routes, is still under discussion. Figure 1 shows the federal network as

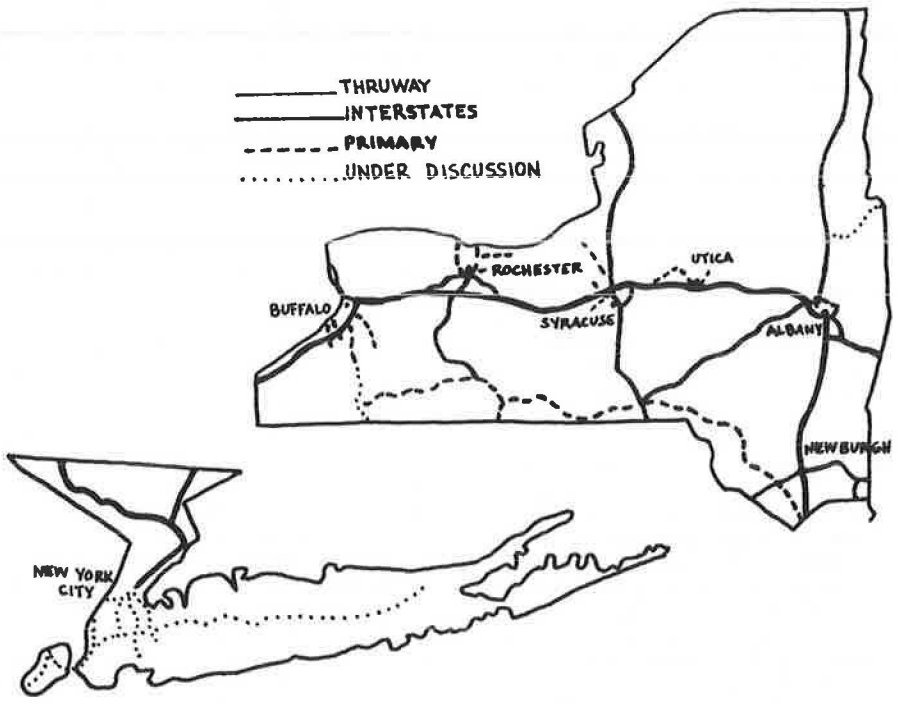


FIGURE 1 National network, New York portion.

designated in the Federal Register, September 14, 1983.

The site chosen for the classification study was just outside of Albany, New York, between Albany and Schenectady. Figure 2 shows the site, which is located on a bridge over the NYS Thruway. Traffic on the Thruway observable from this bridge would include traffic moving from Buffalo to Albany, and traffic moving from Albany (and New York City) west to Buffalo; New York City-Albany traffic would not be observable from this site. This particular section of the Thruway is heavily traveled (the annual average daily traffic from January 1983 through July 1983 was 30,100) and contains a high proportion of commuting vehicles. It is six lanes wide (three per direction) and generally straight and flat. Since the enactment of the 1978 Surface Transportation Act, vehicles originating from I-88 that are destined to I-87N do not pay a toll; otherwise, the traffic is subject to toll.

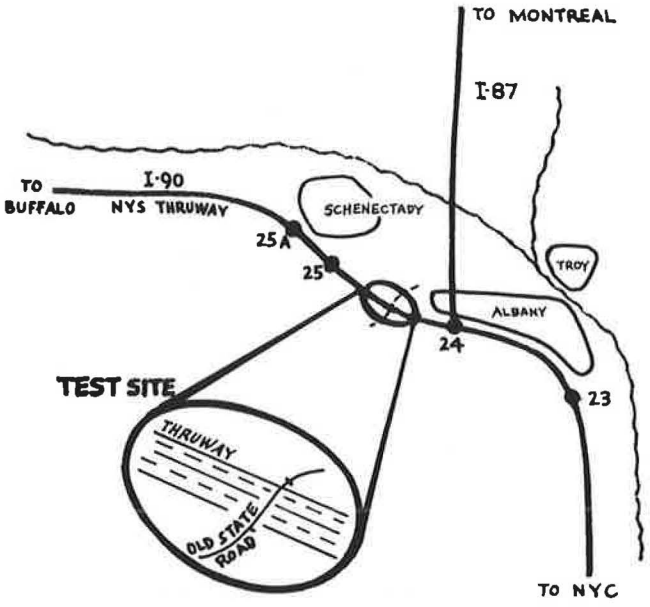


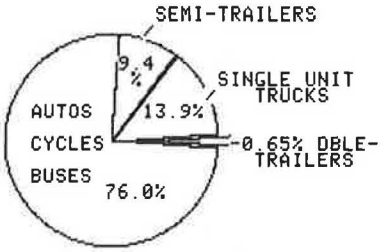
FIGURE 2 Observation site.

The ticket structure of the NYS Thruway does not permit the identification of double-trailers. The vehicle classification was undertaken to determine the exact size and other characteristics of such vehicles. No vehicle weighing was done nor were the commodities being transported determined. The study took place on Wednesday, July 27, 1983. Classification was for 8 hours from 8:00 a.m. to 4:00 p.m. Because no nighttime classification information was obtained, it is not possible to determine whether the proportion of such vehicles operating at night is greater than observed here or whether their characteristics are different.

RESULTS

Overall Percent Distribution

Of 13,999 vehicles observed during the 8-hour period, 90 (0.65 percent) were double-trailers and 1,322 (9.4 percent) were semis. Figure 3 shows that doubles constituted less than 1 percent of all vehicles observed and less than 7 percent of heavy trucks.



TOTAL VEHICLES = 13,999

FIGURE 3 Vehicles by classification.

The distribution of vehicles by hour (Figure 4) shows fairly constant traffic at this location. The distribution of double-trailers by hour is too fine to distinguish; however, the distribution of heavy trucks by hour shows a pattern similar to that of total vehicles.

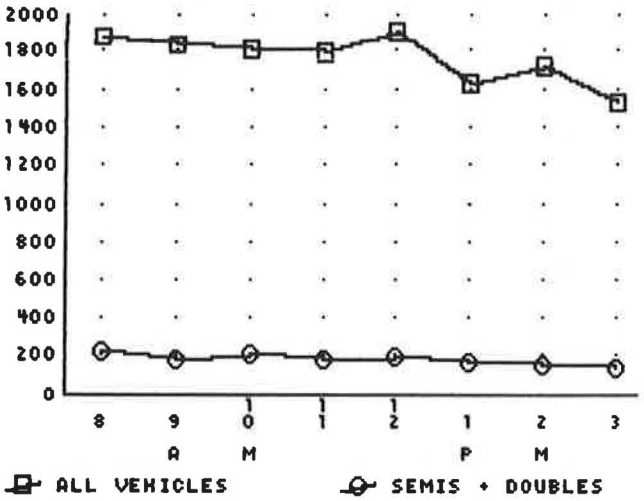
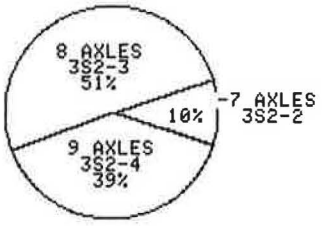


FIGURE 4 Vehicles by hour.

Axle Configuration

Most of the vehicles in the double-trailer group were operating with eight or nine axles. Configurations were largely 3S2-3 and 3S2-4 (Figure 5).



TOTAL VEHICLES = 90

FIGURE 5 Double-trailer axle configurations.

Length and Site

Lengths were estimated as long (40 ft or more), medium (20 to 40 ft), and short (less than 20 ft). Because vehicles were not stopped and measured, it was not possible to determine these lengths exactly. However, the New York State DOT has considerable confidence in its ability to distinguish groups of trailers by length.

The particularly permissive operating environment on the Thruway apparently has led to the predominance of longer trailers. As Table 1 shows, the predominance of vehicles were long (40 ft or more) trailers (double-bottoms) in both the first and the second trailer position. Of the combinations observed, the combination long-long was the most common, followed by the combination short-short, and the combination medium-medium. No vehicles were observed operating with the first trailer shorter than the second trailer.

TABLE 1 Trailer Lengths

First Trailer \ Second Trailer	L	M	S	TOTAL
L	80 Double Bottoms	1	1	82
M	—	3 Tandems	—	3
S	—	—	5 Tandems	5
TOTAL	80	4	6	90

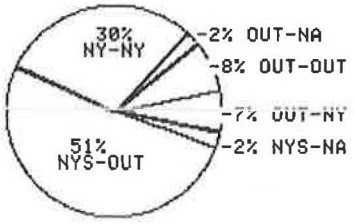
L = Long 40 ft or more
M = Medium 20 to 40 ft
S = Short 20 ft or less
} Estimated

Vehicle Registration

Vehicle license plates were recorded for the tractor and for the last trailer. As Figure 6 shows, 83 percent of the vehicles observed were being pulled by a New York registered tractor; however, 59 percent of the vehicles were trailering out-of-state trailers, indicating that the operations being observed were not all within New York State, even though these vehicles are not operating extensively on other roads.

Body Type

Of the 90 vehicles observed 87 were box-type combinations, 2 were tank combinations, and 1 was a flatbed combination. No vehicle with mixed body type was observed.



TOTAL VEHICLES = 90

FIGURE 6 New York State and out of state tractor and trailer registrations.

Major Operating Companies

The classification team recorded names on tractors and trailers, where possible. The results were classified according to whether one, two, or all three names were legible and identical. A surprisingly high proportion of vehicles were owned by a few common freight carriers. United Parcel Service (20 trucks), Consolidated Freight (13 trucks), and Oneida Freight (7 trucks) accounted for 40 vehicles, or 44 percent of the total. St. Johnsbury, Red Star, KJ Transportation, and Freihofer's (a local baking company) accounted for 12 more vehicles. An additional 14 trucks were observed operating with the same names on all sections; of these, 5 were private companies and 9 were commercial transportation companies. For trucks on which one or more names were not legible or blank, the vehicles were dominated by commercial transportation companies.

Based on this survey, double-trailer traffic on the NYS Thruway is dominated by a small number of major freight haulers. Private (nontransportation) companies appear to have made limited use of their own double trailers: of the 90 vehicles observed, only 7 were identified on the tractor as belonging to nontransportation corporations. However, a number of mixed-operating situations were observed, in which commercial haulers were pulling trailers identified as belonging to private nontransportation corporations (5 cases). One operator, Consolidated Freight, accounted for 4 of the 5 observed small trailer combinations.

DISCUSSION OF RESULTS

Only one site was observed, and truck operating characteristics for the Thruway are undoubtedly not applicable to other locations. Nevertheless, the observations made from the data are instructive in understanding the present nature of double-trailer use.

In spite of the considerable flexibility permitted in operation, most vehicles conformed to one of two axle configurations (3S2-3 and 3S2-4). The majority of trailers observed were long, that is, up to the limit allowed by the NYS Thruway. Few mixed-length combinations were observed, probably because companies tend to buy vehicles of similar dimensions for purposes of providing freight services. Few private nontransportation companies appear to have taken advantage of double-trailer services by operating their own vehicles. Major haulers were represented by a few large transportation companies; it appears that few private companies have enough concentrated freight markets to move their products with their own double-trailer vehicles.

Although state-to-state restrictions on vehicle operation may hinder some commerce, in this survey a considerable portion of vehicles observed were registered out of New York State. Therefore the operating restrictions may not be as severe as they appear to be. Connections west to (but not through) Pennsylvania and east to Boston were possible on Interstate routes; the eastern connection already permits long doubles. These policies have been in place for a number of years, and therefore it may be concluded that the traffic structure has stabilized.

It is surprising perhaps that more double-trailer vehicles were not observed in the traffic stream: in spite of flexibility in operations, double-trailers account for less than 1 percent of observed traffic and less than 7 percent of heavy truck traffic. Market restrictions, of course, offer one explanation, but a more likely explanation is that east-west movement of this type is not a substantial portion of total movement, because many truck movements are not that long. Given the additional staging and terminal requirements necessary to connect and disconnect them, double-trailer vehicle operation would appear to be more feasible for that portion of the traffic which is particularly long haul. To the extent that such traffic constitutes a major share of the given market, therefore, these vehicles would account for a disproportionately greater share. In this case study, however, numerous cities between New York and Buffalo, and Buffalo and Boston, intervene to trim off their own share of the through traffic.

POLICY IMPLICATIONS

How does this study assist in the clarification of the issues identified earlier? Because the sample size is small and the data are highly constrained to a controlled operating environment, only preliminary assessments can be made. However, the data suggest the following policy implications:

Productivity

Considering the time double-bottom operations have been permitted on the Thruway (since the late 1960s), the present small market share of double-bottoms suggests that overall productivity for trucking has not substantially increased. If the observed double-bottom trailers were hauled separately, a net increase of only 6.4 percent of truck traffic (and 0.65 percent of all traffic) would have been observed at this location.

The increased flexibility of operation permitted by a designated doubles network, however, would probably have the effect of increasing the range of opportunities for which such vehicles are economically feasible. The number of firms capable of benefiting from the use of such vehicles is therefore likely to be greater. Most trucking movements would not be diverted to a doubles operation for the reasons described previously, but the proportion is likely to be greater than the 6.4 percent observed here.

Overall double-trucking traffic might increase by as much as 10 percent nationwide but for large trucks only. The operations of delivery vans and smaller vehicles are not likely to be affected substantially. Operations of middle-sized trucks may be affected outside of urban areas where such movement is not delivery oriented; this is a fairly small portion of all truck traffic.

Efficiency of Operation

A small number of carriers, relative to the many thousands in operation, have found it worthwhile to expand into large doubles operation. These particular carriers, both private and public, presumably have undertaken the expansion because the savings in labor associated with double-trailers more than outweigh the additional cost of breakdown at each end of the Thruway portion of the trip. Clearly, such movements improve efficiency most when terminal costs are low relative to overall savings.

An example will serve to describe the situation. If a 1-hour trip (on the Thruway) is contemplated, the savings by operating a double rather than two semis would be a driver for 1 hour. Assuming a doubles-related terminal/staging time of an hour (which is likely even for terminals that are close to Thruway exits), then no overall savings would be achieved because labor costs would merely be shifted to terminal operations rather than over-the-road operations. Assuming equal pay scales, therefore, the cutoff point for efficient double operation would appear to be at least 1.5 hours. There are many pairs of cities on the Thruway that are closer than this distance and, therefore, not likely to be significantly affected by doubles operations. (The average truck trip length on the Thruway is 71 miles.) The time saving factor would not be the same for operations where direct access to terminals is permitted; however, this example illustrates the point that opportunities for doubles are not as extensive as one might think.

Fuel Savings

No data were available on the relative fuel savings of doubles operations versus operations of semitractors. One study mentioned in the review of literature suggested that fuel use would be greater than for semis on a per vehicle mile basis (obviously) but lower on a ton mile basis. Because fuel is a relatively small portion of total transportation costs, and transportation costs themselves are a small portion of the delivered prices of commodities, it appears unlikely that fuel savings would be the driving force behind the decisions to operate doubles. Given that other positive forces are present, however, it is likely that fuel savings would count favorably toward doubles operation.

Impact on Consumers

On the positive side, there should be a small (perhaps not measurable) decrease in the price of delivered goods as a result of doubles operation. Because only a small portion of the cost of delivered goods is in transportation, and an even smaller portion of that could be diverted to doubles, it is unlikely that the cost of commodities could, on balance, be decreased by more than 0.5 percent as a result of doubles operation. Numbers in this range are extremely difficult to detect because they tend to be overshadowed by the general economy and supply and demand of particular goods.

Operation

The section of the Thruway studied in this test was wide, straight, and contained multiple lanes. There was no evidence during the classification studies that doubles pose a traffic hazard or operational difficulties for other vehicles in the traffic stream. Many doubles were observed operating in the center lane of three lanes, and cars were observed both passing and being passed by doubles, on both

the left and right. The operation of such vehicles on city streets, however, is another matter entirely.

Over the years a number of questions have been raised concerning the ability of motorists to pass doubles, particularly in slippery or icy road conditions. Wind drafts around these trucks are more complex than around semitrailers, and small, light cars are particularly affected if passing is attempted at high speeds under conditions of blowing snow, and so forth. So far as can be determined, no studies have been undertaken on these on the Thruway, but the matter warrants investigation.

Geometry

Certain geometric features of highway sections (particularly number of lanes, lane width, curve, grade, and sight distance) may substantially affect the operation of doubles and may impinge substantially on safety. Table 2 provides data on certain features of the New York State designated network. Although the proportion of miles with two lanes or substandard lane width is not large, marginally substandard lane width (9 to 11 ft) predominates on the primary portion of this network. Further, a substantial portion of the mileage is in poor condition, consists of old rigid or overlay pavement, and has a variety of special problems, particularly faulting.

The cost of bringing this mileage up to standard and correcting pavement deficiencies would be substantial, and Congress has provided no special funds for this work. New York particularly has numerous Interstate systems sections where lanes are inadequate; some of these miles are at toll plazas or large interchanges, but many are in New York City where some older roads were incorporated into the Interstate system. For these roads, narrow lanes and shoulders pose special problems for 102-in.-wide trucks, as well as doubles.

TABLE 2 Selected Geometric Features, New York State Designated Network, 1983 Data

	Centerline Miles			
	NYS Thruway	Other Interstates	Other Primary	Total
No. of lanes				
2	0	7.73	72.87	80.60
4 or more	556.49	944.43	475.62	1,976.54
Total	556.49	952.16	548.49	2,057.14
Lane width (ft)				
8 or less	0	8.02	0.51	8.53
9 to 11	0	14.01	26.64	40.65
12 or more	556.49	930.13	521.34	2,007.96
Total	556.49	952.16	548.49	2,057.14
Pavement type				
Rigid	216.32	628.00	316.97	1,161.29
Flexible	0	202.06	63.97	266.03
Overlay	340.17	122.10	167.55	629.82
Total	556.49	952.16	548.49	2,057.14
Pavement problems				
O.K.	NA	671.09	354.42	1,025.51
Faulting >¼ in.	NA	121.70	39.21	160.91
Faulting <¼ in.	NA	108.16	129.11	237.27
Shoulder washout	-	0	5.56	5.56
Distortion	NA	0	0.58	0.58
Local distress	-	45.10	16.03	61.13
Other	NA	6.11	3.58	9.69
Total	556.49	952.16	548.49	1,500.65
Surface condition (lane miles)				
Poor (1-5)	79.91	478.47	147.78	706.16
Good (6-8)	987.95	3,253.99	1,604.11	5,846.05
Excellent (9-10)	133.09	800.78	355.76	1,289.63
Total	1,200.95	4,533.24	2,107.65	7,841.84

Pavement Damage

Pavement damage is known to be largely a function of equivalent axle loads, rather than the number of passes of individual vehicles. Pavement damage increases exponentially with axle load. Operation of doubles might have the effect of decreasing overall damage if the loads carried in such vehicles tend to be fairly light (and are spread over a larger number of axles). Many of the operations on the Thruway were package-oriented vehicle movements, moving fairly light vehicles containing prewrapped packages for numerous destinations (e.g., United Parcel). A preliminary calculation shows that, if the doubles traffic observed on the Thruway were carried by semitrailers, only a 0.65 percent increase in the number of trucks would be necessary, but the increase in equivalent axle loads would be as great as 10 percent. Because these additional axle loads may occur late in the life of a pavement, additional damage could be as much as 20 percent. These questions remain open to speculation.

CONCLUSIONS

What situation might be expected to evolve as the provisions of the Surface Transportation Assistance Act of 1982 take effect? Although it is tempting to say that a large increase in the number of tandems is likely, that is not believed to be the case. The greater density of destinations in the eastern United States, coupled with continuing restrictions on tandem access to primary as well as to Interstate highways, means that the market is not as large as might be expected. The recently initiated double-trailer monitoring study by the Transportation Research Board should shed considerable light on this question. It is anticipated that double-trailer traffic, as an important element of the trucking system, will increase, building on the flexibility provided by the provisions of the act; however, a large increase is not anticipated.

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Characteristics of Double and Triple Trailer Truck Combinations Operating in the United States

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ABSTRACT

The enactment of the Surface Transportation Assistance Act of 1982 may have signaled the beginning of more widespread use of double and triple trailer truck combinations in the United States. This enactment has provided a new incentive to the ongoing study of doubles and triples; past works focused on the economics, operations, use, and safety aspects. This work concentrates on the characteristics of doubles and triples found in the Truck Inventory and Use Survey (TIUS) and the Truck Weight Study (TWS). TIUS and TWS are the two major data bases of the nation's truck resources. The TIUS has a well-designed sampling strategy but has a rather small sample of doubles and triples. The TWS has a large sample size, but when compared with TIUS it does not have a well-designed sampling strategy. To assist further in the monitoring of the development of the nation's truck resources on highways, some modifications may need to be made in both data bases, particularly for the doubles and triples. Data obtained from TIUS and TWS on some aspects of the doubles and triples are analyzed and the results are presented.

The enactment of the Surface Transportation Assistance Act of 1982, and the various provisions relating to double and triple trailer truck combinations, will have a significant effect on the transportation sector in general and the motor carrier industry in particular. It may be the beginning of a new era of more widespread use of multitrailer truck combinations. One provision outlines a study to be performed of the feasibility of a designated Intercity Truck Route Network that will allow the operation of multiple trailer units up to 110 ft in overall length. This increased emphasis on the longer truck combinations has provided a new incentive to explore various characteristics and important features of these trucks.

The data on doubles and triples from the Truck Inventory and Use Survey (TIUS) (1) and the Truck Weight Study (TWS) (2) conducted by FHWA in cooperation with various state highway departments were used as the basis for the analysis presented in this paper. The analysis is not a comprehensive treatment of the subject; much more work could be done to characterize the double and triple trailer combinations from these two files.

TIUS DATA BASE: USE AND LIMITATIONS

The TIUS is performed by the U.S. Bureau of the Cen-