Effects of Nationwide Introduction of Twin Trailer Trucks in the U.S.

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ABSTRACT

Twin trailer trucks--tractors pulling two trailers, each 27 or 28 ft long--have been operating in the United States for many years, but their use has been confined principally to the West. A 1983 federal act required state governments to permit the operation of twins on Interstate and primary routes designated by the federal government, and to provide access between these routes and origins and destinations.

The act also directed that the Transportation Research Board monitor the effects of twin trailer truck use on highways and highway safety. The TRB study's findings are in three areas:

- *Use of twins* - From interviews with carriers, equipment sales data, and traffic count data, the study determined which trucking industry segments are adopting twins, the percentage of total combination traffic that twins will comprise, and the cost savings from nationwide use of twins.

- *Safety effects* - The study assessed the effect of twins on safety by reviewing vehicle handling and accident research and by monitoring the accident experience of twins during the initial period of nationwide use. Safety consequences are determined not only by the accident involvement rate of twins relative to the vehicles they replace, but also by the magnitude of any travel reduction resulting from the operating efficiencies of twins.

- *Pavement and other highway effects* - Compared to the vehicles they replace, twins generally carry larger loads, travel fewer miles to haul a given quantity of freight, and transfer their loads to road surfaces differently. The study assessed the effect of these factors on pavement wear, as predicted by the load equivalency factors developed in the AASHO road test. The study also examined potential effects on traffic flow and geometric design requirements.

The study concluded that although greater use of twins has reduced the cost of shipping by truck, it has also increased some public costs, particularly pavement wear. These added costs will be small compared with the shipping cost savings. Greater use of twins will have little overall effect on safety.

INTRODUCTION

Twin trailer combination trucks are appearing more frequently on roads in many parts of the United States as a result of the Surface Transportation Assistance Act of 1982 (enacted January 1983). This federal act provided that the states cannot prohibit the operation of twin trailer trucks on the Interstate highway system and on a system of other principal roads designated by the Secretary of Transportation, and that the states must allow access between these routes and terminal and service stops. The twin trailer combination permitted under the act, and to which this paper refers, consists of a two- or three-axle tractor pulling two single-axle trailers, each up to 28 ft long and coupled by a single-axle single-drawbar dolly. The twins are subject to the same gross weight limit (80,000 lb on Interstates and most other major roads) and axle weight limits as are tractor-semitrailers.

Before passage of the act, twins were illegal in 14 eastern states. They have been common for many years, however, in other areas of the country, particularly in California and other western states.

In addition to permitting twins with individual trailer lengths of 28 ft, the 1983 act also required the states to allow 48-ft long semitrailers and vehicles 102 in. wide on major roads and 80,000-lb trucks on all Interstates. Semitrailers

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40 to 45 ft long and 96 in. wide had previously been the industry standard. Semitrailers 48 ft long were in use, but not common, in some parts of the country before the federal law; 102-in. wide trucks had been illegal in all but 10 states; and 80,000-lb trucks had been barred from the Interstate highways of three states.

The intent of the new truck size and weight limits was to increase the efficiency of freight transportation. The new federal limits sought to improve productivity by allowing larger trucks than had been legal in many states, permitting twins use nationwide, and providing more uniform size and weight regulations on a network of major national roads in place of the varying individual state regulations in effect previously. The productivity gains were regarded as compensation to truck operators for higher federal truck taxes enacted at the same time.

The new federal truck size and weight limits were controversial, and were contested in the courts by several states and private parties. The controversy had three main sources. First, the federal limits preempted state regulations in an area where federal involvement had historically been minimal: federal standards in effect before 1983 set only maximum weight and width limits (the states were free to set lower limits) applicable to Interstate highways only. Second, use of the newly authorized trucks was expected to accelerate pavement deterioration. The third and most prominent concern was for the safety of the larger vehicles. Public awareness of potential hazards associated with large trucks is currently at a peak in the U.S. The perception that trucks are a growing part of the highway accident problem--and that current truck safety problems are the consequence of more and larger trucks--has been a principal basis for opposition to liberalized truck size limits. In the East, where twins had been rare, safety questions have centered on these vehicles, while in other states 48-ft semitrailers have been of greater concern among state highway officials.

Although the early controversy over the 1983 federal truck size rules is subsiding, proposals for further revisions to the regulations governing truck dimensions and configurations are today receiving serious consideration in federal and state government agencies. The states and the federal government will therefore continue to confront the problem of balancing the benefits of freight cost savings against the potential safety, maintenance, and road construction costs of larger trucks.

ORIGIN AND SCOPE OF THE STUDY

Recognizing that the use of twin trailer trucks was controversial in some parts of the country and that there were uncertainties about the effects of their expanded use, Congress in the act that authorized nationwide use of twins also directed the National Academy of Sciences to monitor twins to determine (1) "the effects of the use of such vehicle combinations on highways and highway safety in urban and rural areas and in different regions of the country."

In response to this mandate, the Transportation Research Board (TRB) of the National Academy of Sciences assembled a committee of researchers and administrators with expertise in the trucking industry, highway safety, pavement design, and highway maintenance and operations. The committee's report is to be published in July 1986. The findings of the committee are in three areas:

- *Productivity:* More widespread use of twins and of longer and wider semitrailers is expected to reduce the cost of moving goods by truck.
- *Safety:* Twins and the longer and wider semitrailers possess differences in handling, maneuvering, and dynamic properties compared with the trucks they are replacing, which may affect their safety record.
- *Highway costs:* Greater use of twin trailer trucks and of longer and wider semitrailers may affect pavement wear, efficiency of traffic operations, and highway geometric design requirements.

In evaluating the productivity, safety, and highway costs of twins, it has been essential to make systemwide comparisons rather than to focus on the comparative performance of individual vehicles. Such systemwide impacts depend not only on the characteristics of the vehicles, but also on the total volume of traffic of the vehicles, the characteristics of the roads they are using, and the kinds of firms and trucking operations that are employing them.

Because the full effects of the 1983 legislation cannot yet be directly observed, they were estimated in this study using two kinds of tion. First, the study reviewed past experience with twin trailer trucks. Twins have been in use for many years in some parts of the country, so a record of their performance exists that has been valuable in helping to predict the full effects of their use nationwide. Second, the initial experience with nationwide twins use was monitored. This short-term monitoring provided information about changes in the volume of traffic in twins, the characteristics of the roads they are using, the kinds of trucking operations that are using twins and the benefits they are realizing, and the frequency and circumstances of recent accidents involving twins. The sources for the short-term monitoring included data on truck use and accidents that are regularly collected by government and private organizations, as well as three surveys conducted specially to support this study: a survey of all the state highway agencies concerning their experiences with twins and their regulations governing twins use; a survey of professional truck drivers to learn of their perceptions of performance differences between twins and tractor-semitrailers; and a series of interviews with trucking companies using twins and with trailer manufacturers to learn of the extent of expansion of twins use and the benefits and drawbacks of twins.

The remainder of this paper is a summary of the findings of the TRB Twin Trailer Truck Monitoring Study, addressing each of the major categories of impact identified: trucking productivity impacts and the characteristics of twins use; the safety effects of twins; and the impact of twins on highway condition, operations, and design practices. Because the question of safety now dominates the debate over truck size regulation, findings in this impact area will be presented in the greatest detail. The effects of the longer and wider semitrailers that were legalized at the same time as twins also will be addressed briefly. The study committee also offered recommendations concerning truck safety policies in general and needs for improved long-term monitoring of truck impacts, which will not be discussed here.[1]

EXTENT OF USE OF TWINS AND RESULTING PRODUCTIVITY GAINS

The study's projection of the growth of twins use is derived from the interviews conducted with carriers and equipment manufacturers, together with recent travel data from the Federal Highway Administration (3,4) to establish the base level of twins travel. The productivity gain estimate is based on the interviews and on the twins travel estimate.

The use of twin trailer trucks is concentrated within certain segments of the trucking industry, and this pattern of use is likely to continue. In particular, the general freight common carriers are rapidly integrating twins into their operations, replacing tractor-semitrailers. Most of these trucking companies specialize in shipments that are less than a full truckload, transported in trucks loaded with multiple shipments. Such firms account for about 15 percent of combination-truck travel in the U.S. Because these firms carry freight of relatively low average density, they can take advantage of the added volume capacity of twins to carry more freight within the gross weight limit (which is the same for both twins and tractor-semitrailers). Twins also offer productivity gains because the flexibility afforded by having freight loaded into two small trailers rather than one large one allows a truck operator hauling small shipments to reduce the average number of handlings per shipment at terminals and break-bulk centers, and to avoid some circuitous routings. The general freight common carriers are expected to perform about 70 percent of their intercity combination-truck travel with twins by 1990.

In the other segments of the trucking industry--for-hire carriers who transport freight in truckload-sized shipments and private carriers such as manufacturers or retail trade firms that maintain their own truck fleets to transport their goods--opportunities for using twins advantageously are limited. In the Far West, twins sometimes carry agricultural and other bulk commodities, apparently because twins at one time had a small legal gross weight advantage over tractor-semitrailers in California, and are well suited for California harvesting operations. In addition, some private carriers are now making experimental use of twin vans. However, outside the general freight common carrier segment of trucking, twins will constitute a very small share of all truck travel for the foreseeable future.

1 This paper draws extensively on the report of the TRB Twin Trailer Truck Monitoring Study committee soon to be released (2). The Committee was chaired by Kenneth W. Heathington, Associate Vice President for Research, University of Tennessee. Conclusions and recommendations are summarized in the Executive Summary and Chapter 7 of the report.

Before 1983, twins accounted for less than four percent of all combination truck travel in the U.S. They were most common in California and nearby states--twins were 30 percent of all combinations on rural Interstates in California in 1982, and about half of all twin travel nationwide occurred in California. By 1990, twins will account for about 11 percent of nationwide combination-truck miles. Nearly 90 percent of this increase will occur outside the western states where twins were common before 1983. General freight common carrier conversion to twins will be largely complete by 1990 and will account for most of the growth between 1982 and 1990.

As a result of increased capacity and greater flexibility in operations, general freight common carriers adopting twins will achieve on average a nine percent reduction in combination-truck miles of travel in the portion of their freight hauling that is switched from tractor-semitrailers to twins. Cost savings from twins are not expected to stimulate any appreciable new combination-truck travel because the general freight common carriers have no strong competitors for the less-than-truckload freight that they specialize in carrying. Consequently, because of the nationwide use of twins, by 1990 combination-truck travel in the U.S. will total about 500 million vehicle-miles (two-thirds of a percent) less than it would have been otherwise.

Because of these travel reductions and the equally important savings from reduced handling that twins allow, truckers adopting twins are increasing productivity. General freight common carriers will achieve cost reductions of $500 million annually (1985 dollars), 2 percent of their total costs and 0.5 percent of total intercity trucking costs, compared with costs using pre-1983 equipment and operating practices, when twins are fully integrated into their operations.

Neither the current scope of the highway network open to twins nor existing restrictions on access to that network will ultimately have much impact on travel by twins. In general, the network allows carriers to operate twins on the Interstates and major primary routes that account for the bulk of combination-truck traffic. In some areas, the limited extent of the network and state restrictions on access to the network have slowed the introduction of twins, but access restrictions have generally lessened with time.

SAFETY CONSEQUENCES

The increased use of twins will have little overall effect on highway safety because the resulting net reduction in miles of truck travel will approximately offset a possible small increase in accident involvements per mile traveled.

Twins probably have slightly more accident involvements per mile traveled than tractor-semitrailers operated under identical conditions at highway speeds. Although the information available for comparing the relative safety of twins and tractor-semitrailers is imperfect, this conclusion is supported by two independent lines of evidence: studies of the performance and handling characteristics of large trucks using experimental vehicle testing and simulations, and analyses of historical twin trailer truck and tractor-semitrailer accident and travel experience.

HANDLING AND STABILITY OF TWINS

Studies of the handling and stability of large trucks have identified four handling difficulties that are characteristic of twins. First, when twins are steered through an abrupt maneuver such as a sudden lane change to pass another vehicle, the rear trailer may exhibit an exaggerated side-to-side motion often described as a crack-the-whip effect. This phenomenon is known as rearward amplification and may result in rollover of the rear trailer (5-9).

Second, drivers of twins are less able than drivers of tractor-semitrailers to sense impending trailer instability and prevent related accidents (10, 11). This impaired sensory feedback is the result of the greater number of coupling points in a twin trailer truck (a total of three compared with one in a tractor-semitrailer). To properly control a vehicle the driver must be able to sense the dynamic forces acting on it.

Third, twins can undergo a low-amplitude rear-end oscillatory sway during routine operations (12-15).

Finally, when a twin trailer truck rounds a curve at highway speeds, its rear wheels deviate from the path of the front wheels (offtrack) toward the outside of the curve and may encroach on the opposite lane or the shoulder. Tractor-semitrailers also offtrack in this way, but less so than twins at highway speeds. At slow speeds the offtracking performance of twins is superior to that of tractor-semitrailers (5, 16). Consequently twins are more maneuverable than tractor-semitrailers in low-speed situations such as driving on city streets.

These four handling characteristics of twins are not of equal importance for the vehicle's safety performance. Rearward amplification is probably the most important physical feature that affects the relative safety of twins and tractor-semitrailers, and may explain the high frequency of rear-trailer rollover in twins accidents (5). Impaired sensory feedback may affect twins safety mainly to the extent that it tends to lessen driver awareness of the rearward amplification problem. Low-amplitude oscillatory sway is largely avoidable through proper operating practices and is a potential hazard only to the extent that other motorists may take anomalous action to avoid operating near a swaying twin. The difference in offtracking at high speeds between twins and semis is slight, and outward offtracking may be offset by normal superelevation of curves. Twins' superior tracking in low-speed turns seems a significant advantage, especially compared with the new 48-ft semitrailers, and suggests that twins should be less frequently involved in collisions while turning.

Twins' special handling characteristics were corroborated in a survey of professional truck drivers conducted for the TRB study. The respondents, nearly all experienced union drivers employed by large general freight common carriers, expressed a clear preference for driving tractor-semitrailers rather than twins and perceived semis to be safer and to perform better than twins. The drivers found semis especially easier to handle on slick pavement, in severe crosswinds, and in emergency braking, but preferred the handling of twins on city streets and turning sharp corners. Asked to compare the frequency of encountering certain adverse situations in twins and in semis, the drivers most commonly identified trailer sway and rearward amplification of steering response as situations encountered more often with twins. The most experienced twins drivers usually agreed with the majority, but tended to see less difference between twins and semis in most situations.

SAFETY IMPLICATIONS OF TWINS IMPACTS ON TRAFFIC

The safety of combination trucks depends not only on their handling and stability properties but also on the influence of their presence in the traffic stream on the operations of other vehicles. The twin trailer study examined the literature on seven categories of operational effects of large trucks--speed differential, passing behavior, freeway merging and lane changing, splash and spray, aerodynamic buffeting, blockage of view, and lateral placement--to determine whether differences between twins and tractor-semitrailers in their interactions with traffic might affect safety. For all categories of effects except splash and spray, there are some grounds for expecting twins to have adverse impacts on traffic operations compared to the tractor-semitrailers they are replacing. Twins generate less spray than five-axle semis (17, 18). However, in all categories the differences are slight and seem unlikely to have an important effect on safety.

The marginal degradation of traffic operations due to twins that is suggested by these comparisons of the performance of individual vehicles will be offset by the net reduction in combination truck travel that accompanies expanded twins use.

ACCIDENT RATES AND SYSTEMWIDE SAFETY IMPACTS

Taken together, the special handling characteristics of twins (rearward amplification of steering, impaired sensory feedback, and high-speed offtracking) are mechanisms that could lead to a higher accident rate for twins operating at highway speeds. However, it is not possible to tell from vehicle handling observations alone how differences in handling affect the frequency of accidents in on-the-road experience. To predict changes in accidents, actual accident and travel data are necessary.

Analyses of historical accident and travel experience before the nationwide adoption of twins in 1983 indicate that twins had slightly more accident involvements per mile traveled than did tractor-semitrailers similarly operated on rural highways. The relative accident rates of twins and tractor-semitrailers as reported in the literature appear on first inspection to be extremely variable and conflicting. Among all the studies identified, the reported rate for twins ranged from about one-half the rate for tractor-semitrailers to more than six times as large. To narrow this range of uncertainty, a critical review of this literature identified which studies were most successful in measuring accident rate differences that are genuinely attributable to vehicle configuration rather than to the confounding influences of environmental factors.

Of the studies reporting relative accident rates for twins and tractor-semitrailers reviewed, five stood out as the ones that were the most nearly free from obvious methodological flaws, that made reasonable attempts to minimize the obscuring effects of the operating environment, and that reflect accident experience under conditions that are typical of many roads throughout the nation. The three most reliable pre-1983 analyses comparing involvement rates in all reported accidents for twins and tractor-semitrailers on rural highways estimated rates for twins that were 2 percent less (19), 6 percent more (20), and 12 percent more (21) than the rates for tractor-semitrailers. In the three most reliable analyses of involvements in accidents resulting in fatalities, rates for twins of involvement in fatal accidents were estimated to be 7 percent less (21), 5 percent more (22), and 20 percent more (23) than the rates for tractor-semitrailers. (For two of these accident studies (21, 23) the ratios reported here were derived from a re-analysis of the data rather than from accident involvement rates reported in the source reference.)

Comparisons of accident rates for twins and tractor-semitrailers are necessarily imprecise because they must be made between the two vehicle types operating under very similar conditions--for example, similar routes, drivers, and times of day--if they are to reflect safety differences between the vehicles rather than safety effects of the operating conditions. Even these relatively reliable accident rate analyses were unable to fully allow for the effects of such extraneous factors, and in no single analysis was the difference measured between twins and tractor-semitrailers large compared with the inherent uncertainty of the estimates.

Nonetheless, when taken together, the accident rate analyses and the handling and stability studies indicate that twins will have a slightly higher rate of involvement in accidents per mile traveled than the tractor-semitrailers they replace. However, the safety consequences of twins depend not only on their relative accident rates, but also on the reduction in truck travel that accompanies their expanded use. The nine percent reduction in truck miles in operations that are converted from tractor-semitrailers to twins approximately offsets the possible increase in accident involvements per mile. Hence the likely net safety impact of expanded use of twins will be slightly fewer miles of truck travel with slightly more accidents per mile of travel, resulting in very little change in the number of accidents. When all factors are considered, despite the uncertainty in comparing accident rates of twins and tractor-semitrailers, twins clearly appear to be about as safe a method of hauling freight per ton-mile of travel as the tractor-semitrailers they replace.

SEVERITY OF TWINS ACCIDENTS

An investigation of the relative severity of twin trailer accidents was conducted by using the records of accident involvements reported by motor carriers to the U.S. Department of Transportation's Bureau of Motor Carrier Safety (24). Comparisons were limited to five-axle combination trucks carrying general freight in van trailers and operated by Interstate Commerce Commission-authorized carriers. To control for possible operating environment influences, the data, aggregated over the period 1976-1981, were partitioned into 32 categories representing all possible combinations of four regions, four highway types, and two land uses. The severity measures analyzed in most detail were the fraction of all involvements that were in accidents resulting in injury and the fraction in accidents resulting in death.

This severity analysis showed that overall, twins were involved in 7.5 percent fewer fatal accidents (not statistically significant) than would be expected if the fractions of twins accident involvements resulting in injury and death had been identical to those of tractor-semitrailers. The difference in injury involvement was attributable primarily to accidents on divided highways of four or more lanes in rural areas. Regional differences, if any, were not pronounced.

The most notable difference between accidents involving twins and those involving tractor-semitrailers was that a significantly higher proportion of twins accidents were single-vehicle accidents (that is, involved no vehicle other than the truck), a factor partially explaining the reduced overall severity of twins accidents. In automobile-truck accidents, differences in severity between accidents involving twins and those involving tractor-semitrailers were small and in no case statistically significant.

RECENT ACCIDENT TRENDS

Experience since 1982 shows an increased twins' share of accident involvements that is roughly the same as twins' increased share of miles traveled. For example, excluding involvements in California, the number of multitrailer vehicles involved in fatal accidents increased from an average of 1.8 percent of all combinations involved in accidents in 1980-1982 to 2.6 percent in 1984 and 3 percent in 1985 (25). Collectively, the recent data are still too fragmentary to confirm or revise the results of pre-1983 analyses that estimated the accident rates of twins relative to those of tractor-semitrailers, but they show no surprising changes in truck accident experience that could be attributed to twins.

HIGHWAY CONDITION, OPERATIONS, AND DESIGN IMPACTS

Compared with the tractor-semitrailers they replace, twins accelerate pavement wear and will increase pavement rehabilitation costs. Twins' pavement impacts were estimated using the relationships between pavement wear and the number and magnitude of single- and tandem-axle load applications embodied in the pavement design method of the American Association of State Highway and Transportation Officials (26). First, an estimate was made of the annual cumulative loading of the highway system by the traffic of vehicles that are being replaced by twins (primarily, a portion of the traffic of five-axle tractor semitrailers with van bodies hauling general freight), expressed in annual equivalent-single-axle-load-miles using load equivalency factors from the AASHTO method. Next, equivalent axle loads were similarly estimated for the expected 1990 new twins traffic, taking into account the reduction in vehicle-miles required to haul the same volume of freight in twins. The change in equivalent-axle-load-miles with twins is a measure of the change in pavement wear. All the computations used actual axle weight distributions and vehicle classification count data compiled by the Federal Highway Administration (3), disaggregated by pavement type, highway class, and region.

The computations illustrated that three characteristics of twins and the loads they carry increase pavement wear:

- Twins typically weigh more than the tractor-semitrailers they replace. Twins carry higher average payloads, and they weigh more when empty, but they typically have the same number of axles as tractor-semitrailers. Pavement wear increases exponentially with axle load.

- The loads on twins are usually distributed less uniformly among their five axles than tractor-semitrailer loads. Uniform loading minimizes pavement wear, again because wear increases exponentially with increasing load.

- Twins transfer their loads to the pavement with an axle arrangement (five single axles) different from that of tractor-semitrailers (usually one single axle and two pairs of tandem axles). On asphalt pavements, a tandem axle causes less wear than two single axles equally loaded. On portland cement concrete pavements, however, a tandem axle causes more wear than two single axles equally loaded.

These factors are partially offset because greater use of twins reduces combination-truck travel, but with all factors considered, on asphalt pavements twins will on average cause about 90 percent more pavement wear than the tractor-semitrailers they replace, whereas on portland cement concrete pavement twins will cause about 20 percent more pavement wear on average.

Nationwide, at the expected 1990 level of twins use, the additional wear twins will cause would cost roughly $50 million annually to repair, about 2 percent of current highway rehabilitation expenditures by states and 10 percent of the expected 1990 annual productivity gains in trucking. This estimate assumes a load-related pavement repair cost of $.016/equivalent-single-axle-load-mile, which was the average expenditure on rural Interstates in 1983.

Twins will have no effect on the rate of deterioration of existing bridges and will not require any change in design procedures for new highway structures. The forces created in bridge components by fully loaded twins are less than those created by equally loaded tractor-semitrailers.

The nationwide use of twins probably will not affect overall highway congestion and traffic delay. As described in the preceding section, a twin is in most respects slightly more disruptive to traffic flow than the typical tractor-semitrailer it replaces, but this degradation will be offset by a reduction in combination-truck miles of travel and the better low-speed turning maneuverability of twins.

Expanded use of twins will not require changes to geometric design policies and practices for highways. Because twins are more maneuverable at low speeds than the tractor-semitrailers they replace, they can more easily negotiate interchange ramps, intersections, and other roadway facilities that are designed to accommodate combination-truck turning movements.

SAFETY AND PAVEMENT WEAR CONSEQUENCES OF 48-FT LONG SEMITRAILERS AND 102-IN. WIDE TRUCKS

The federal law that legalized nationwide use of twins also permitted use of trucks with 48-ft long semitrailers and trucks 102-in. wide on the same network of roads. In contrast to twins, 48-ft semitrailers and 102-in. wide trucks had seen little use in the U.S. before 1983. Consequently they do not have a historical record on which to base definite projections of their ultimate effects on highway safety, freight productivity, or pavement wear. Nonetheless, the available information does support some general conclusions about the potential extent of use of these vehicles and their impacts.

The 48-ft semitrailer is particularly appealing to private carriers and truckload for-hire carriers who need added volume capacity but do not have a potential for savings in handling costs through use of twins. The 48-ft length accounts for almost 60 percent of recent sales of new van trailers and is becoming the industry semitrailer standard, replacing the 45-ft semitrailer (27). The safety effects of 48-ft semitrailers have not yet been established. Compared with the combination trucks with shorter semitrailers that they replace, which usually also have shorter wheelbases, combination trucks with 48-ft semitrailers are less maneuverable (5) and therefore more likely to have accidents on turns. However, they will travel fewer miles to carry a given quantity of freight because of their greater cubic capacity.

Because they are less maneuverable than the shorter semitrailers they replace, 48-ft semitrailers are more likely to override shoulders and curbs during turns and at curves. Therefore, widespread use of 48-ft semitrailers will accelerate deterioration of highway shoulders and roadside signing and guardrails and will probably require changes in highway design standards. According to the survey of state highway agencies conducted for this study, at least 18 states have made or plan to make changes to their design policies to better accommodate these vehicles.

Most new van trailers (70 percent in 1984) are purchased with widths of 102 in. instead of the older 96-in. standard. Of new twins, about 90 percent are purchased with the 102-in. width (27). As with 48-ft semitrailers, the safety consequences of increasing truck widths to 102 in. have not yet been demonstrated. Although wider trucks may be more hazardous on roads with narrow lanes, the added width increases stability and reduces the possibility of overturn, provided that the trailer is equipped with wider axles matching the increased width of the cargo space (5). Moreover, the added width increases the payload per trip on average and therefore reduces miles of travel required to transport a given amount of freight.

The use of 102-in. wide trucks and 48-ft semitrailers increases pavement wear, because these vehicles generally weigh more on average than the ones they replace. The greater weight increases net pavement wear despite the accompanying reduction in miles traveled.

CONCLUSIONS

The TRB Study of Twin Trailer Trucks, conducted at the direction of the U.S. Congress, estimated benefits and costs of the 1983 nationwide legalization of twins in the three areas of trucking productivity, safety, and pavements and other highway impacts. It showed (Table 1) that although greater use of twins has reduced the cost of shipping goods by truck, the growth of twins traffic has also increased some public costs, particularly road pavement wear. However, these added costs will be small compared with the shipping cost savings gained. Greater use of twins will have little or no overall effect on highway safety.

The safety of trucks in general continues to be a major concern, but truck safety depends on many factors in addition to the kinds of vehicles allowed. Many opportunities are at hand for improving the safety of twins and all large trucks, for example, through improved vehicle design, controls on drivers, appropriate highway design and maintenance, enforcement of truck safety regulations, and effective safety management by trucking firms. The goals of safety and trucking productivity are not inherently in conflict--in fact, it may be possible to develop trucks that are safer than present vehicles yet are more productive and less wearing to roads. The optimum values of vehicle dimensions that can be safely and cost-effectively accommodated on U.S. roads have yet to be established.

Table 1 — The effects of nationwide legalization of twin trailer trucks

Use and productivity gains by 1990	
Twins travel	7.8 billion mi/year - 10.8 percent of all combination truck travel; up from 3.7 percent in 1982; less-than-truckload carriers account for nearly all growth
Net combination-truck travel savings	500 mi/year - 0.7 percent of total combination-truck travel
Freight cost savings	$500 million/year (from reduced freight handling and reduced mileage) - 0.5 percent of intercity truck freight costs
Highway safety impacts	
Handling of twins	Severe rear-trailer sway in response to abrupt steering maneuvers
	Driver's ability to sense impending trailer instability impaired
	Rear wheels deviate more from track of front wheels at highway speeds; tracking is better than that of tractor-semitrailer at city street speeds
Accident rates	Twins probably have slightly higher rates than similarly operated tractor-semitrailers on rural roads
Accident severity	No difference between twins and tractor-semitrailers under similar conditions
Systemwide safety	Reduction in travel offsets slightly higher accident rate; therefore little or no net overall effect on safety
Impacts on pavement and other highway features	
Pavement	Twins cause 90 percent more pavement wear on asphalt pavement and 20 percent more on portland cement concrete than tractor-semitrailers carrying the same freight
Systemwide pavement cost	$50 million/year increase in pavement rehabilitation cost by 1990 - 2 percent of total rehabilitation expenditures
Wear of structures, traffic flow and geometric design requirements	Impacts all negligible

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SESSION 6
COMMERCIAL VEHICLES AND BRIDGE CAPACITY

Chairman:

I.C. Campbell
Ontario Ministry of Transportation
and Communications
Canada