Effects of Heavy Truck Operations on Repair Costs of Low Volume Highways

Aziz Saber, Ph.D., P.E.
Associate Professor of Civil Engineering
Louisiana Tech University
600 W. Arizona Ave.
Ruston, LA 71272
Voice: 318-257-4410
FAX: 318-257-2306
saber@latech.edu

Mark Morvant, P.E.
Associate Director of Research
Louisiana Transportation Research Center
4101 Gourrier Avenue.
Baton Rouge, LA 70808
Voice: (225) 767-9124
FAX: 225-767-9108
markmorvant@dotd.la.gov

Zhongjie "Doc" Zhang, Ph.D, P.E.
Pavement Geotechnical, Research Administrator
Louisiana Transportation Research Center
4101 Gourrier Avenue.
Baton Rouge, LA 70808
Voice: (225) 767-9162
FAX: 225-767-9108
doczhang@dotd.la.gov

Submitted to:
The Transportation Research Board
For Publication and Presentation at the 2009 Annual Meeting
Washington, D. C.

Word Count: 5,076;
Figure Count: 3* Equivalent words (250) = 750;
Table Count: 2* Equivalent words (250) = 500;
Total Word Count: 6,326
ABSTRACT
The economic impact of overweight permitted vehicles hauling sugar cane on Louisiana highways is evaluated. The highway routes that are used to haul this commodity are identified and statistical samples are selected and analyzed. Two different vehicle types and three different gross vehicle weights are chosen including 100,000-lb. and 120,000-lb. AASHTO design guidelines are used to determine the effects of heavy loads on pavements and bridges. The approach requires the overlay thickness needed to carry traffic from each gross vehicle weight for the design period and costs based on 20-year period. The state bridges are evaluated to satisfy regulations for the loading requirements and a fatigue cost is estimated for each safe crossing of a bridge. Results indicate that the damage from each FHWA Type 9, with a gross vehicle weight of 100,000-lb sugar cane load, to pavement and the bridge fatigue cost is about $5,500/year. Therefore, the current sugar cane trucks permit fee of $100 per vehicle per year is not adequate to recover these costs. It is recommended that the current 100,000-lb. gross vehicle weights be maintained, but the permit fees are increased, or the vehicle type is changed from a FHWA-Type-9 to a Type-10 vehicle. Under the second alternative, the permit fee can be reduced to zero and a tax incentive of $683 can be given to each truck for the conversion. Also, it is necessary to increase the highway funds to handle the extra damage caused by the increase of truck load limits.
INTRODUCTION

Sugarcane is grown in Louisiana and is currently hauled to market by truck trailer combinations FHWA Type 9 vehicles, commonly known as the 18-wheeler. Current state laws allow truck operators hauling certain agricultural commodities to purchase overweight permits and haul at gross vehicle weights (GVW) in excess of the legislated GVW limit of 80,000 lb. Sugar cane truckers may purchase an overweight permit for $100/year and then carry sugar cane at a GVW of 100,000 lb. Previous studies performed for the Louisiana Transportation Research Center (1 and 2) showed that the cost of pavement and bridge damage produced by trucks hauling in excess of 80,000 lb. far exceeded the harvest permit charged for the overweight permit. Moreover, the result of the study (3) indicated that the cost of pavement damage was greatest on roads designed for light, land access traffic. Since the pavement damage cost exceeded the permit fee, the Louisiana Department of Transportation and Development instituted this study to provide a more detailed evaluation of the effect of sugar cane trucks on the cost of damage to roadways (pavement and bridges) over which they travel. In addition, there is a need to evaluate the consequences of changing the FHWA Type 9 vehicle currently used to transport sugar cane. The FHWA Type 9 vehicle has a steering axle, and two load axles, one on the tractor and one on the semi-trailer. Both of these load axles are tandem axles with dual tires. The FHWA Type 10 vehicle has a steering axle and two load axles, but the load axle on the semi-trailer is a triple axle with dual tires instead of a tandem axle with dual tires. It is a well-established fact that, at the same GVW, triple axles produce much less pavement damage than tandem axles.

In this study, the roadway costs associated with changing the load axle on the semi-trailer from a tandem to a triple axle was determined. Moreover, roadway costs were developed for two other GVW scenarios. Pavement costs will be developed for a GVW of 80,000 lb. assuming that one option available to the Louisiana legislature is to rescind all overweight permits and return to the limits applied to non-agricultural and non-natural resource truckers. Roadway costs will also be developed for 120,000 lb. GVW, assuming that there is interest in evaluating this option. One reason for investigating this option is that the number of truck loads required to transport the annual sugar cane harvest can be substantially reduced if each truck payload could be increase by 20,000 lb. The five cases are FHWA Type 9 at GVW of 80,000-lb., 100,000-lb., 120,000-lb. and FHWA Type 10 at GVW of 100,000-lb. and 120,000-lb.

OBJECTIVE

The main objectives of this research are: (1) to estimate the additional rehabilitation costs to roads damaged by heavy sugar cane trucks; (2) to develop truck-axle configurations which produce less roadway damage by permitted overweight trucks.

SCOPE

The scope of this study is to determine the roadway costs associated with changing the load axle on the semi-trailer from a tandem to a triple axle. Pavement costs will be developed for a GVW of 80,000-lb. assuming that one option available to the Louisiana legislature is to rescind all overweight permits and return to the limits applied to non-agricultural and non-natural resource truckers. Roadway costs will also be developed for 120,000-lb. GVW, assuming that there is interest in evaluating this option. One reason for investigating this option is that the number of truck loads required to transport the annual sugar cane harvest can be substantially reduced if each truck payload could be increased by 20,000-lb.
METHODOLOGY

The methodology used to assess the pavement damage caused by hauling sugar cane on Louisiana highways, is based on AASHTO design guidelines (4). Field and design information were collected from LA-DOTD offices and the American Sugar Cane League.

The pavement cross section data included the type and thickness of surface (hot mix asphalt, concrete, or surface treatment), type and thickness of base, and the most recent average daily traffic data (the number of autos and trucks per day over each road section). The roads (271 control sections) were divided into three groups of average daily traffic (ADT); (1) 88 control sections with ADT less than 2,000; (2) 91 control sections with ADT between 2,000 and 7,000; (3) 92 control sections with ADT greater than 7,000. For each group the structural number, a measure of pavement strength, was calculated; the average and the standard deviation of structural number were computed; and the sample size of control sections from each ADT group was determined. A detailed analysis was conducted to determine the cost of pavement overlays required to carry the normal traffic loads plus the sugar cane harvest under three different GVW scenarios using 2 different vehicles (FHWA-Type-9 and FHWA-Type-10 vehicles). These combinations produced the five different GVW scenarios for which detailed pavement analyses were conducted. The number of trucks required to carry the sugar cane harvest transported over each control section was determined by dividing the total sugar cane transported on the control section by the payload per truck. Detailed data tables were documented in (5). The net present worth (NPW) for each control section was determined using an interest rate of 5%/year for 20 years for each overlay in the control section, and the statewide total cost of overlay costs for a particular GVW and axle configuration scenario was determined.

The data was used to evaluate the costs associated with increasing the GVW or changing the axle load configuration. Also, to compare the cost of overlays for the LA-DOTD under various scenarios with the permit fees paid by the industry. The difference between the cost of permits paid by the industry under each scenario and the cost of overlays required by the LA-DOTD to keep the roads in satisfactory condition under each scenario represents the annual additional highway funds needed to handle the extra damage caused by the increase of truck load limits.

Pavement Cost

The statewide rehabilitation cost for all highways used to transport sugar cane were estimated based on the cost for all control sections in each ADT category. The net present worth of overlay cost for an individual control section is a product of the number of lanes, lane width, length of control section and the net present worth of the cost of the overlay per lane mile of length. The detailed calculations are presented in (4). The statewide NPW of overlay costs for each GVW scenario for all control sections carrying sugarcane is shown in Figure 1.
The annual costs of overlays for all control sections carrying sugarcane are determined using the statewide rehabilitation costs and 20 years of design life at 5% interest per year, and shown in Table 1.

### TABLE 1. Statewide Annual Cost of Overlays Due to Sugarcane Harvest

<table>
<thead>
<tr>
<th>FHWA Type 9</th>
<th>Scenario 1</th>
<th>Scenario 2</th>
<th>Scenario 2a</th>
<th>Scenario 3</th>
<th>Scenario 3a</th>
</tr>
</thead>
<tbody>
<tr>
<td>GVW</td>
<td>80,000 lb</td>
<td>100,000 lb</td>
<td>100,000 lb</td>
<td>120,000 lb</td>
<td>120,000 lb</td>
</tr>
<tr>
<td>Total</td>
<td>$38.90M/year</td>
<td>$40.45M/year</td>
<td>$37.97M/year</td>
<td>$41.98M/year</td>
<td>$38.88M/year</td>
</tr>
</tbody>
</table>

The records at LA-DOTD permits office show that 748 permits were sold for sugarcane trucks in the 2003 harvest season. The total income paid to the State of Louisiana by trucks hauling sugar cane under these 748 permits in 2003 was $74,800 ($0.0748 million/year). The philosophy in (6) the 1997 Federal Cost Allocation Study was that each vehicle class should pay for the highway costs produced by the presence of those vehicles on the roads over which they travel. If this philosophy is applied to sugarcane trucks, all extra overlay costs on the 271 control sections induced by these vehicles should be borne by these vehicles. So under scenario two, sugarcane haulers using the FHWA Type 9 truck should be paying the difference between scenario one and scenario two, see TABLE 1 ($40.45M - $38.90M), or $1.55 million/year,
instead of $0.0748 million/year. Since they were not, the State of Louisiana paid the difference
of $1.475 million/year as a subsidy to the sugarcane industry. Based on the data, if the
sugarcane trucks pay for the overlay costs occasioned by the heavier loads, then the cost for the
sugarcane permit would be, ($1.55 million/year)/748 sugarcane permits issued, $2,072/year.

If the semi-trailer is converted from a tandem axle in the FHWA Type 9 vehicle to a
triple axle in the FHWA Type 10 vehicle, the cost of a permit could be decreased from
$2,072/permit/year to (−$1,243)/permit/year, [($37.97M - $38.90M) = $0.93M/year/748 trucks],
meaning that the state could afford to offer each sugarcane transporter utilizing a FHWA Type 9
vehicle $1,243/year, as a tax subsidy to reduce pavement overlay costs. However, if the FHWA
Type 9 vehicle is allowed on sugarcane trucks hauling 100,000 lb. GVW; the permit fee for a
vehicle should be increased from $100/year to $2,072/year.

As a result of hurricane devastation and increased fuel costs, there have been some
discussions of increasing the GVW from 100,000 lb. to 120,000 lb., this GVW scenario for both
the FHWA Type 9 and Type 10 vehicles was also included in the cost analysis. The annual
overlay cost would increase as the GVW increased from 100,000 lb. GVW to 120,000 lb. GVW
utilizing the FHWA Type 9 trucks by, ($41.98M - $38.90M) $3.08 million or $4,1175/truck/year
just to pay for pavement costs incurred at the higher GVW level. One other significant factor
should be noted; the bridge fatigue costs for the sugarcane trucks. As discussed in (7 and 8), the
bridge fatigue cost for FHWA Type 9 vehicles with 120,000lb. GVW would exceed
$5,400/truck/year; making the total cost per permit about $9,500/truck/year. Obviously, this
level of permit fees would be untenable for the sugarcane industry.

If the GVW is increased from 100,000 lb. to 120,000 lb. and a FHWA Type 10 vehicle is
used to haul the sugarcane, the annual overlay cost to produce equity would decrease from
$38.90 million/year for scenario one to $38.88 million/year for scenario 3a as shown in Table 1
or -$20,000/748 permits or −$27/permit/year as shown in FIGURE 2. This shows again the
savings in overlay costs associated with changing from a semi-trailer with a tandem axle to a
semi-trailer with a triple axle. However, the problem of over stressing the bridges remains, and
even with a triple axle it is a big hurdle to overcome, as discussed in LTRC Report 418, (9).
Bridge Fatigue Costs

One other significant factor should be noted; the bridge fatigue costs should be included in this evaluation. The estimates are based on the following assumptions: (1) In 2002 the sugarcane production was estimated at 15 million tons; (2) In 2003 there were 748 permits for sugarcane trucks; (3) In 2003 there were 748 permits for sugarcane trucks. (4) The average weight of empty truck is 37,300 lb.; (4) Each truck will cross one bridge per trip; (5) The sugarcane season starts on August 1 and ends on December 31, ie 153 days.

For trucks with 120,000 lb. GVW, each truck will be making about three (3) trips per day; 

\[ \frac{(15M*2,000lb/748permits/(120,000-37,300)lb/153days)}{15} \]

For trucks with 100,000 lb. GVW, each truck will be making about four trips per day;

\[ \frac{(15M*2,000lb/748permits/(100,000-37,300)lb/153days)}{15} \]

For Type 10 vehicles with 120,000lb GVW, the average cost for bridges as determined in [8] at $11.75 per crossing, making the bridge fatigue cost at about $5,400/truck/year,

\[ ($11.75/trip/truck*3trips/day*153days/year) \]

For Type 10 vehicles with 100,000 lb. GVW, the average cost for bridges as determined in [8] at $0.91 per crossing making the bridge fatigue cost at about $560/truck/year;

\[ ($0.91/trip/truck*4trips/day*153days/year) \]

For Type 9 vehicles with 100,000lb GVW, the average cost for bridges as determined in [4] at $5.75 per crossing, making the bridge fatigue cost at about $3,500/truck/year,

\[ ($5.75/trip/truck*4trips/day*153days/year) \]

Most of the bridges on the roads that are heavily

FIGURE 2. Statewide annual overlay additional costs per sugar cane vehicle.
traveled by sugarcane trucks have simple support end conditions, therefore the cost for simply supported bridge was used in this case.

**Highways Cost**
The statewide annual cost per vehicle for all GVW and truck type combinations is determined by adding the overlay cost to the bridge fatigue cost as shown in Figure 3.

![FIGURE 3. Statewide annual additional cost per sugar cane vehicle.](image)

**Trailer Axle Configurations**
Pavements are stressed by loads on individual axles and axle groups directly in contact with the pavement. The GVW along with the number and types of axles and the spacing between the axles, is used to determine the axle load. Over time, the accumulated strains produced by axle loads deteriorate the pavement structure, eventually resulting in cracking and rutting of pavements. Pavements not routinely maintained experience accelerated cracking and rutting as a result of axle loads combined with the environmental effects such as moisture and temperature. To properly design a pavement the engineer must know the axle loading as well as the highway system. As the axle load increases, pavement deterioration increases quite rapidly. However, changing an axle type such as, adding one axle to make a tandem to produce a triple-axle group, permits a higher GVW to be carried without increasing pavement damage. In this paper the benefit is shown of changing the tandem axle on the semi trailer to a triple axle. In other words, changing the current FHWA Type 9 truck to a Type 10 truck. Pavement rehabilitation costs can
be reduced while hauling the same payload if a tridem axle is used instead of a tandem axle because pavement damage decreases as the number of tires supporting a load increases. Three options were investigated which represent alternatives to the current truck/trailer transport system and would reduce highway damage and/or reduce costs. These options are: (1) adding an extra axle to truck/trailer; (2) using lighter trucks and different trailer types; (3) mill delivery system or bin transport system. In the following paragraphs each option was discussed in detail and the costs incurred by each alternative were compared.

### Adding an Extra Axle to Truck/Trailer

To study the costs involved in adding an extra axle to the truck/trailer, Equivalent Truck Loads (ETL) were developed for different gross vehicle weight scenarios. They were generated by dividing the annual sugarcane harvest in tons by the payload per truck for all the five scenarios. For a particular scenario, the ETLs for both truck types were compared. The costs required for the additional truck loads and to add an extra axle were estimated. The sum of these two costs were used as the total cost incurred to modify a FHWA Type 9 truck to FHWA Type 10. This overall cost was then compared with the pavement damage savings. The following paragraphs detail the method used to generate this overall cost and the assumptions considered.

The procedure involved the following factors: (1) Louisiana sugarcane crop milled for sugar was 15 million tons in 2002; (2) gross vehicle weight of 100,000 lb. (special permit); (3) 31.35 tons of cane/truck; (5) ETL = 15 million tons/31.35 tons per truck load = 479,233 truck loads. Similarly, ETLs were calculated for both the truck types and for all the scenarios and are shown in Table 2.

<table>
<thead>
<tr>
<th>Truck type</th>
<th>Equivalent Truck Load</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>scenario one 80,000 lb. GVW</td>
</tr>
<tr>
<td>FHWA Type 9</td>
<td>697,670</td>
</tr>
<tr>
<td>FHWA Type 10</td>
<td>735,300</td>
</tr>
<tr>
<td>Increase in truck loads</td>
<td>37,630</td>
</tr>
</tbody>
</table>

From the above table it is evident that the tare weight of the truck increases in the case of FHWA Type 10 truck as the weight of the empty truck increases. If a Type 9 truck is converted to a Type 10, the tare weight of the Type 9 will increase by approximately 1,900 lb. The cost of adding this axle ranges from $4,500 to $7,500. Adding an extra axle on existing trailers, with axles properly balanced, will reduce the number of equivalent single axle loads required to carry the total sugarcane crop payload and this will reduce pavement overlay costs. Adding a third axle to the tractor was discussed with the sugarcane industry. Their thoughts were that it would be
much less costly to modify the semi-trailer than to add a third axle to the tractor. However, for
the Type 10 truck, the amount of sugarcane hauled per truck is decreased by approximately one
ton since the tare weight increased by approximately one ton. The cost comparison between
pavement damage costs and the costs incurred by changing the truck axle configurations and
carrying additional truck loads is explained using the following example.

Assume that all the trucks hauling sugarcane are of FHWA Type 9 and that all will
convert in one year. Using the average cost of adding an additional axle as $6,000 on all trucks
hauling sugarcane (748 permits), then the total cost incurred for adding the axle would be $4.5
million ($6,000 x 748). From Table 2, the additional FHWA Type 10 truck loads required for
scenario two due to the extra tare weight is 14,187. Assume average distance traveled by a
loaded truck with sugarcane is 50 miles. The average total cost per mile to operate a loaded
track = $1.8/mile (10). The average annual cost for additional truck loads required by the 1,900
lb. increase in truck tare weight = 14,187 trips x 50 miles x $1.8/mile = $1.28 million/year.
Therefore, the total cost incurred for changing the axle configurations from a tandem axle to a
tridem, if all the trucks convert in the first year is ($4.5 + $ 1.28) $5.78 million.

The pavement damage costs for scenario 2, GVW conditions compared between FHWA
Type 9 and Type 10 trucks as shown in Table 1 would be calculated as the annual pavement
damage cost from FHWA Type 9 at 100,000 lb. reduced by the annual pavement damage cost
from FHWA Type 10 at 100,000 lb. The pavement damage reduction would be $2.48 million per
year ($40.45 million/year – $37.97 million/year). So the annual savings are about $1.2 million
($2.48 – $1.28 million) if the FHWA Type 10 trucks are used instead of FHWA Type 9 trucks.

Use of Lighter Trailers

By using lighter weight trailers the investment costs are significantly reduced and the light
weight of the trailer allows hauling more sugarcane per truckload. The cost and weight of
different trailer types considered in this paper are: (1)The side dump trailer which weighs
between 22,000lb. to 24,000lb. and costs between $25,000 to $30,000. (2)The rear dump trailer
which weighs between 17,000lb. to 19,000 lb. and costs between $14,000 to $16,000. (3)The
rollover trailer which weighs between 18,000lb. to 20,000 lb. and costs between $16,000 to
$30,000.

If the lighter trailer weight is 18,000 lb. and the lighter truck weight is 17,000 lb. then the total
empty weight of the truck/trailer would be 35,000 lb. At this empty weight, the pay load at
100,000 lb. weight limit would be 32.5 tons of cane, instead of 31.35 tons calculated earlier.
Therefore, the payloads per truck increases with the use of lighter truck/trailers and hence reduce
the cost of hauling sugarcane.

The cost incurred by using lighter truck/trailers is illustrated here. The ETL would be
461,538 truck loads (15 million tons/32.5 tons per truck load). This will reduce the number of
truck loads by 17,695 (479,233–461,538). The average annual savings by using the lighter
trailers would be $1.59 million/year (17,695 trips x 50 miles). The pavement damaged savings
calculated earlier is $2.48 million/year. Therefore, total savings would be $4.07 million/year
($2.48million + $1.59 million). The cost incurred for modifying the trailer is $14.96 million
($20,000 x 748). Hence, it would require approximately four years ($4.07 million/year x 4
years = $16.28 million > $14.96 million) to recover the investment cost and from then on the
annual savings would be $4.07 million.

Mill delivery system
The Mill delivery system or “Rolloff” Bin Transport System improves harvest and transport efficiency. In this system, sugarcane would be loaded into standard bins in the field and the bins would be loaded in trucks for transport to the sugar mills. Harvester operation is not dependent on truck availability and loaded bins can be hauled to the mill day or night whenever needed.

The key features of the Bin system are: (1) Trailer and bin weight is approximately 22,000 – 26,000 lb. (2) One bin or basket holds the same amount of sugarcane as one standard cane trailer. However, increased trailer weight may reduce maximum load by 1-2 tons of cane per truck load. (3) One truck/trailer can handle approximately 15 bins. So there is a significant reduction in total number of trucks and trailers required. (4) Trailer is self-dumping at the mill or can be used with a rear dump system.

Significant cost savings can be made in trailer tires and brakes as well as number of trucks and trailers required. In addition, there are possible cost savings at the mill related to handling and moving cane. The number of bins required would need to be determined for specific mill situations, logistics related to quantity of cane and distance hauled.

All the three options are feasible, but an appropriate decision must be made by the legislature keeping in view the pavement damage costs, one time investment costs, number of trucks to be modified, bridge fatigue costs etc. Switching to any one of these options would prove very beneficial, in the long term, to the sugarcane industry.

IMPLEMENTATION STATEMENT

The results from this project can be immediately implemented by the Louisiana legislature. A review of the pavement costs compels the legislature to define the level of subsidy to be provided to the sugar cane industry by the state of Louisiana. In analyzing the effect of the current GVW defined by Louisiana statutes, it is determined that the current 100,000 lb. GVW prescribed for sugar cane trucks provides a minimum subsidy of $5,445 per vehicle per year. This minimum value is based on the data from the permit office on how many of the agricultural harvest permits are for sugar cane trucks. Therefore, the current sugar cane trucks permit fee of $100 per year is not adequate and should be increased to $5,545 to recover the pavement overlay costs and bridge fatigue costs. Since this permit fee is so large, it is recommended that the legislature keep the allowed GVWs at the current level but stipulate the change in the configuration of the axle on the trailer from a tandem to a triple, effectively changing the vehicle from a FHWA Type 9 to a Type 10 vehicle. Under these circumstances, the permit fee can be reduced to zero and a tax incentive of about $683 can be given to each truck for the conversion.

When investigating the effect of increasing the GVW from 100,000 lb. to 120,000 lb., the added cost of overlays doubled when compared to current conditions. In addition, bridge repair costs will likely increase significantly. As a result it is recommended that no consideration be given to increasing the GVW from current levels to 120,000 lb. primarily because the magnitude of impact from the 120,000 lb. GVW for a FHWA Type 9 truck makes the risk of bridge damage and even failure too significant to ignore.

CONCLUSIONS

The GVW for FHWA Type 9 sugar cane trucks should be reduced from 100,000 lb. to 80,000 lb. or the permit fee increased from $100/truck/year to $5,545/truck/year. However, if the legislature requires that the semi-trailer on the FHWA Type 9 truck be converted from a tandem axle to a triple axle, the permit fee could be reduced to $0/truck/year and each truck could be given a $683/year tax incentive to pay for the conversion.
The GVW for FHWA Type 9 sugar cane trucks should not be increased from 100,000 lb. to 120,000 lb. If such a GVW increase should occur, the pavement overlay costs and bridge fatigue costs increase from about $5,545/truck/year at 100,000 lb. GVW to over $9,517/truck/year at 120,000 lb. GVW. However, axle loads under the 120,000 lb. GVW would produce very severe overstressing of bridges. Thus, the risk of bridge damage and even bridge failure is too significant to ignore.

Allocate more highway funding for handling the extra damage caused by the increase of truck load limits.

RECOMMENDATIONS
It is recommended to keep the GVW for sugar cane trucks at 100,000 lb., however, require that the axle configuration on the semi-trailer be changed from a tandem to a triple axle. If the axle configuration has been changed, each sugar cane truck could be given a tax incentive of $683/year to assist with the conversion cost. Such a combination would reduce the damage to pavements to below the level produced by the FHWA Type 9 vehicle hauling freight at the legislated level of 80,000 lb. GVW.

It is not recommended that the legislature increase the GVW from 100,000 lb. to 120,000 lb. Even if sugarcane trucks were required to convert from FHWA Type 9 to Type 10 vehicles, the higher GVW will overstress the bridges, and could potentially damage or produce serious safety concerns for the bridges. The extra costs to roadways far outweigh the potential savings in transportation costs for the trucks hauling sugarcane.

It is recommended that future studies should evaluate alternative transport systems and develop an investment business plan for sugarcane harvest which will reduce highway damage and/or reduce costs. These options should include: (1) use of lighter trucks and various trailer types; (2) mill delivery system or bin transport system.

It is recommended to allocate more highway funding for handling the extra damage caused by the increase of truck load limits.

ACKNOWLEDGMENTS
The authors would like to dedicate this paper to Dr. Freddy Roberts who passed away before completing this study.

This report could not have been completed without the assistance of LA-DOTD personnel from all districts, representatives of the American Sugar Cane League, and the Project Review Committee and many others who provided direct assistance to the project team as we developed information needed to complete the study.

The contents of this study reflect the views of the authors who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the Louisiana Department of Transportation or the Louisiana Transportation Research Center. This paper does not constitute a standard, specification, or regulation.

REFERENCES
2. Saber, Aziz, Roberts, Freddy. Cost of Higher Truck Loads on Remaining Safe Life of


