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16. Abstract <p>This study was undertaken to examine the feasibility of utilizing shredded tires in hazardous roadside ditches. The concept behind this examination is primarily twofold. First, Louisiana has many miles of rural two lane highway with little or no shoulder which are immediately adjoined by large/deep drainage ditches. Many severe and fatal accidents have occurred when a vehicle leaves the roadway and impacts the side of the ditch or an associated culvert. Filling the ditch with a porous material, such as shredded tires, may prove to benefit highway safety.</p> <p>The second reason behind this study is that this potential application could contribute to the reuse or consumption of a waste material that is becoming an environmental problem when stockpiled or normally disposed of or discarded.</p> <p>It is author's opinion that this concept is feasible if utilized under carefully controlled conditions.</p>			
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**FEASIBILITY OF UTILIZING SHREDDED TIRES
IN ROADSIDE DITCHES**

FINAL REPORT

BY

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**LTRC RESEARCH PROJECT NO. 92-2SS(B)
LTRC REPORT NO. 286**

**Conducted By
LOUISIANA DEPARTMENT OF TRANSPORTATION AND DEVELOPMENT
LOUISIANA TRANSPORTATION RESEARCH CENTER**

**In Cooperation With
U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION**

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SEPTEMBER 1994

ABSTRACT

This study was undertaken to examine the feasibility of utilizing shredded tires in hazardous roadside ditches. The concept behind this examination is primarily two-fold. First, Louisiana has many miles of rural two lane highways with little or no shoulder which are immediately adjoined by large/deep drainage ditches. Many severe and fatal accidents have occurred when a vehicle leaves the roadway and impacts the side of the ditch or an associated culvert. Filling the ditch with a porous material, such as shredded tires, may prove to benefit highway safety.

The second reason behind this study is that this potential application could contribute to the reuse or consumption of a waste material that is becoming an environmental problem when stockpiled or normally disposed of or discarded.

It is the author's opinion that this concept is feasible if utilized under carefully controlled conditions.

IMPLEMENTATION STATEMENT

The results of this feasibility study indicate that the concept of filling hazardous roadside ditches with shredded tires is feasible, yet it is not recommended for implementation at this time. Barriers to implementation are potentially in the areas of real or imagined concerns relating to leachates entering the groundwater, real or imagined concerns related to increasing localized flooding and the lack of information necessary to develop sufficient design parameters for this application. It is recommended that further study be conducted relative to this concept.

TABLE OF CONTENTS

	<u>PAGE NO.</u>
ABSTRACT	iii
IMPLEMENTATION	iv
LIST OF FIGURES	v
INTRODUCTION	1
OBJECTIVES	3
SCOPE	5
DISCUSSION	7
CONCLUSIONS	21
RECOMMENDATIONS	23
REFERENCES	25
APPENDICES	
A: EXAMPLE NEWSPAPER ACCOUNTS OF ACCIDENTS	27
B: PHOTOGRAPHS OF TYPICAL HAZARDOUS DITCHES	33

LIST OF FIGURES

<u>FIGURE NO.</u>		<u>PAGE NO.</u>
1	Detail of original concept	8
2	Shredded tires during a flume test	11
3	Detail of revised concept	12
4	Whole tires installation	13
5	Shredded tires being placed over whole tires	14
6	Shredded tires being placed over whole tires	14
7	Completed field installation	15
8	Field installation during a moderate rainfall	17
9	Field installation supporting a light vehicle	18

INTRODUCTION

The concept under evaluation is to determine if filling ditches with highly permeable shredded tires is feasible. This study was undertaken in an effort to address two major problems faced by the Louisiana Department of Transportation and Development (LA DOTD). The first problem is safety related and the second problem is environmentally related. If found to be feasible, the concept of filling select roadside ditches with waste tires would to some degree address both of these problems.

Louisiana has many miles of two lane rural roadways with little or no shoulders. Many of these roadways are parallel to drainage ditches located just off the paved surface. Frequent severe and fatal accidents have occurred when a vehicle leaves the roadway and impacts the walls of the ditch or the exposed driveway culverts within the ditch. These roadways provide little or no recovery or clear zones which if available should lessen both the number and severity of accidents. These roadways also provide no room for a vehicle to leave the roadway in the event of vehicle breakdowns. If it is possible to fill these ditches with a stable yet highly permeable material such as shredded tires, there becomes available the ability to greatly improve highway safety.

Waste tires are a major disposal problem throughout the United States. Transportation departments and other local, state and federal agencies are actively pursuing means and methods of waste tire disposal or re-use. Utilizing shredded tires as a porous media fill material provides another alternative to those agencies.

The concept behind this preliminary feasibility study was to determine if some hazardous roadside ditches could be filled with waste tires in such a manner that would provide both sufficient drainage and a stable clear/recovery zone. If determined to be feasible, this concept has the potential to improve both highway safety and the environment impact of a waste product in Louisiana.

OBJECTIVE

The objective of this study is to evaluate the potential of placing waste tires in selected hazardous roadside ditches. This is being considered in an effort to improve safety and utilize a waste product while maintaining acceptable drainage characteristics of the ditch.

SCOPE

The scope of this preliminary feasibility evaluation includes limited laboratory and field tests. The environmental impact of potential leachates from the waste tires is discussed but was not tested or evaluated during this study.

DISCUSSION

CONCEPT: The design concept behind this research is fairly simple. In large rural roadside ditches, the ditch from the upstream culvert to downstream culvert would be lined with a geotechnical fabric and then filled with shredded tires. The fabric (or a geotechnical grid) would then be overlapped over the top of the tires and a 8 to 10 inch layer of stone would be placed over the fabric and tires to provide both vehicle support and drainage along the longitudinal extent of the ditch. The following Figure 1 provides a detail which illustrates the concept.

ROADSIDE HAZARD: Examples of newspaper accounts of several accidents involving vehicles impacting rural roadside ditches in Louisiana are included in Appendix A. Although specific accident rate data related to this particular hazard are not available, it is the author's opinion that in Louisiana on rural two lane roadways, the percentage of serious or fatal single vehicle accidents wherein impacting the ditch or a culvert is primarily responsible for the seriousness of the accident is quite high.

Several photographs of roadway/ditches of the type under discussion are included in Appendix B.

WASTE TIRES: Waste tire stockpiles throughout the U. S. contain an estimated 2 billion tires and are growing at a rate of 279 million annually ⁽¹⁾. Louisiana's contribution to this waste problem is estimated at 4 million tires annually. Pressure to find suitable disposal methods or recycling alternatives is increasing and being felt nationwide.

SHREDDED TIRES: Waste tires can be mechanically shredded to sizes ranging from large (120 square inches or greater) to small (6 square inches or less). The size and uniformity of the shredded tire pieces generally depend upon the type of shredder and the number of time the tires are processed. The tire shreds utilized in this research were processed only once with the preponderance of pieces estimated to be in the 10 to 60 square inch range with a few pieces in the 60 to 100 square inch range. A determination of the gradation of the material was not attempted.

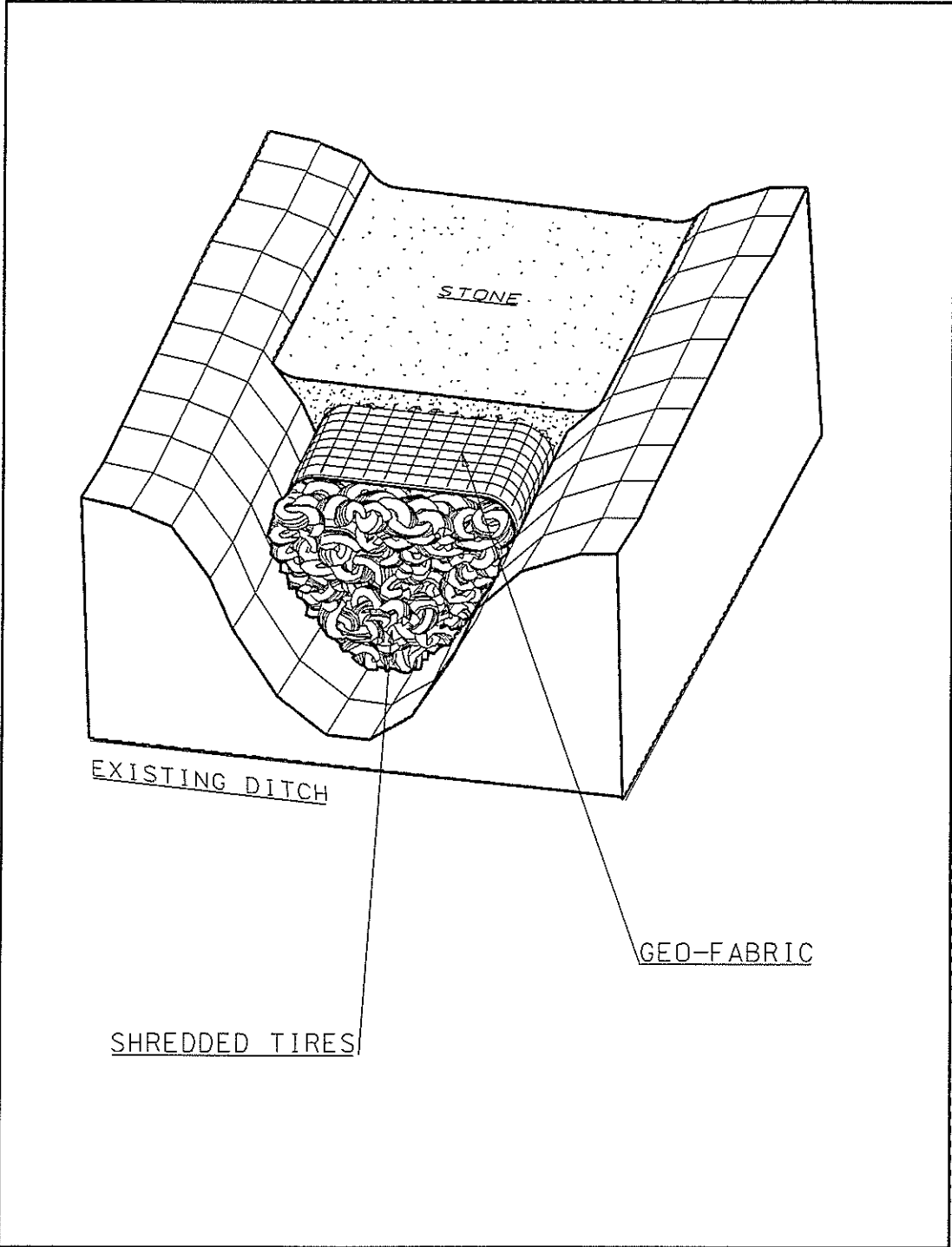


Figure 1. Detail of original concept.

The loose bulk density of the shredded tires was determined by weighing a sample of the tires in a large container of known volume. The bulk density was found to be 28.8 pounds per cubic foot. The specific gravity of the tires was determined in the laboratory to be 1.09. The porosity of the shredded tires was determined by weighing the same container containing only water and then reweighing with both the uncompacted tires and water utilizing the following formula:

$$\text{porosity \% , } n = V_v/V$$

V_v = Volume of voids

V = Total volume

wherein V_v equals the volume of voids calculated in the following manner:

$$V_v = W_{tw} - W_t / G_w$$

W_{tw} = weight of tires and water

G_w = Specific gravity of water

W_t = weight of tires

The porosity of the shredded tires was calculated to be 79%.

The void ratio, e was calculated in the following manner:

$$\text{void ratio, } e = V_v/V_s$$

V_v = Volume of voids

V_s = Volume of solids

The void ratio of the shredded tires was calculated to be 3.47.

Because of the large size, porosity and void ratio of the shredded tires, the permeability of the material could not be determined in the laboratory.

FLUME TESTS: Flume tests were conducted for this project (McDonald, J. R. and Langlinais, S. J. (2)) in an effort to determine the hydraulic characteristics of shredded tires when placed in an open channel situation. The tests were conducted by placing ten, four foot long sections of shredded tires in an outdoor concrete lined flume. Figure 2 is a photograph taken during the flume tests. As each four foot long section was placed in the flume, the head loss before and after the section was measured. The results of this investigation were head losses ranging from 0.4 ft. across four feet of shredded tires to 0.9 ft. across forty feet of shredded tires. The calculated Manning's coefficient, assuming non-uniform flow, ranged from 0.613 for four feet of shredded tires to 0.737 for forty feet of tires. These parameters will change depending upon the specific application under consideration.

Ditches filled with shredded tires do not fit normal previously established flow/hydraulic modeling or estimation techniques. Flow under these circumstances cannot be characterized as open channel, conduit or porous media. In actuality, it is a combination of all these regimes. The complexity of the potential flow regime(s) made further examination of this issue beyond the scope of this study.

FIELD INSTALLATION: A 20 foot long field installation was constructed in the summer of 1993 at a site near the LTRC Pavement Research Facility. Due to the relative high head loss and Manning's coefficients found during the flume testing, it was decided to change the original concept to improve flow characteristics. This conceptual change involved utilizing whole tires placed side to side which formed a conduit. Prior to installation, five one-inch diameter holes were drilled along the perimeter of the tires to allow water to enter the casing and prevent floating. This change in concept is depicted in Figure 3. Photographs of the field installation are presented in the following Figures 4 through 7.

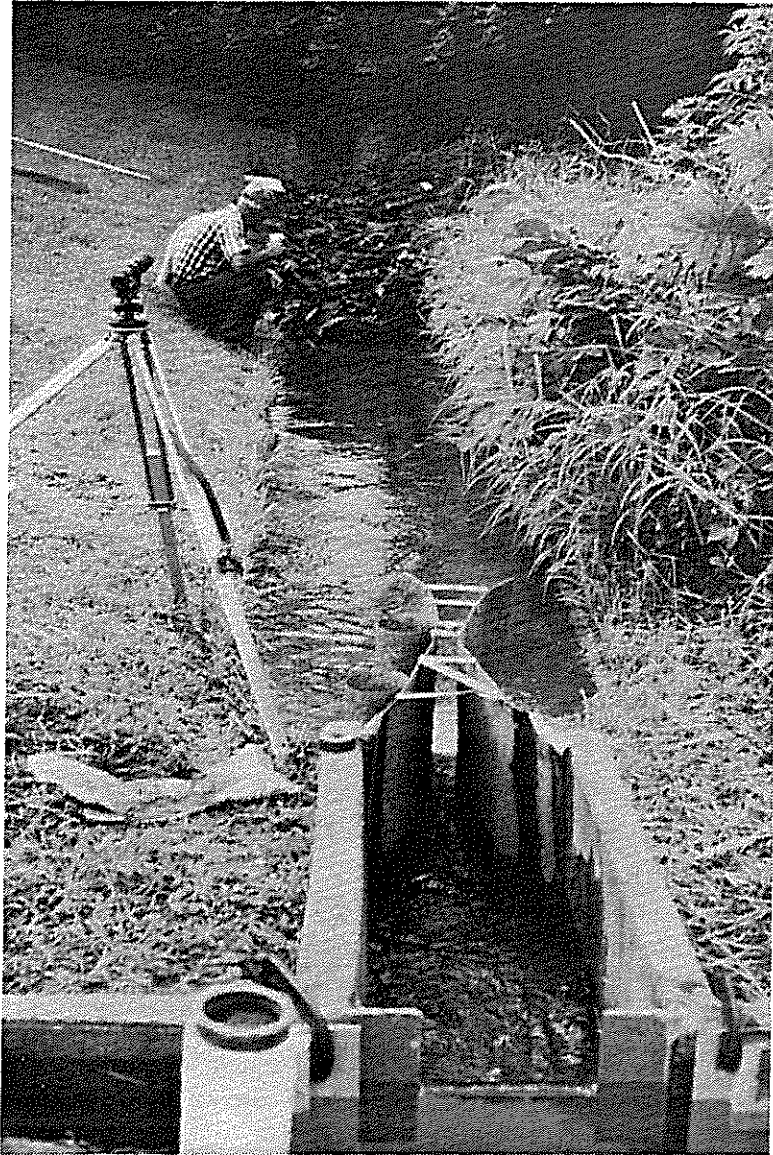


Figure 2. Shredded tires during a flume test.

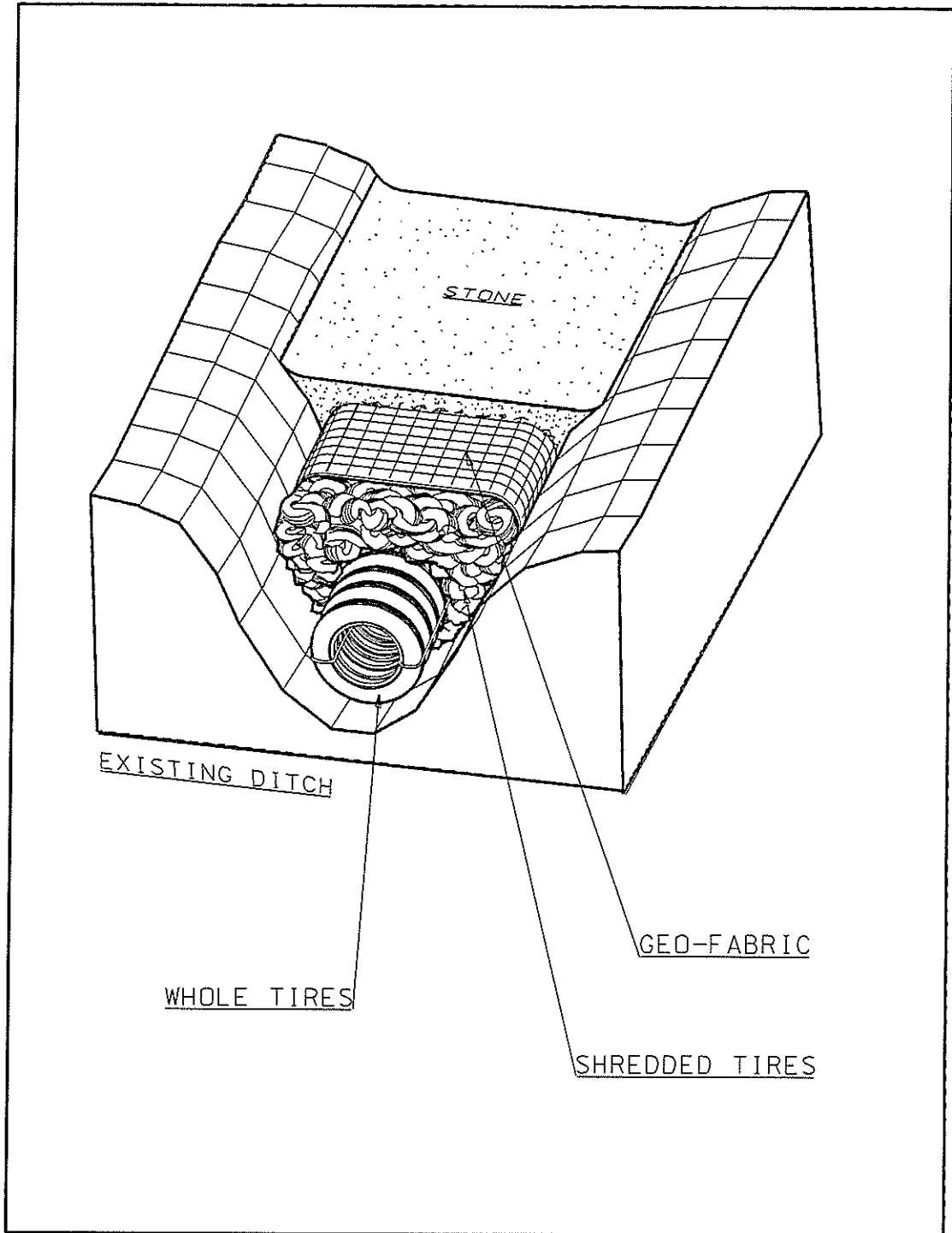


Figure 3. Detail of revised concept



Figure 4. Whole tires installation.



Figure 5. Shredded tires being placed over whole tires.



Figure 6. Shredded tires being placed over whole tires.

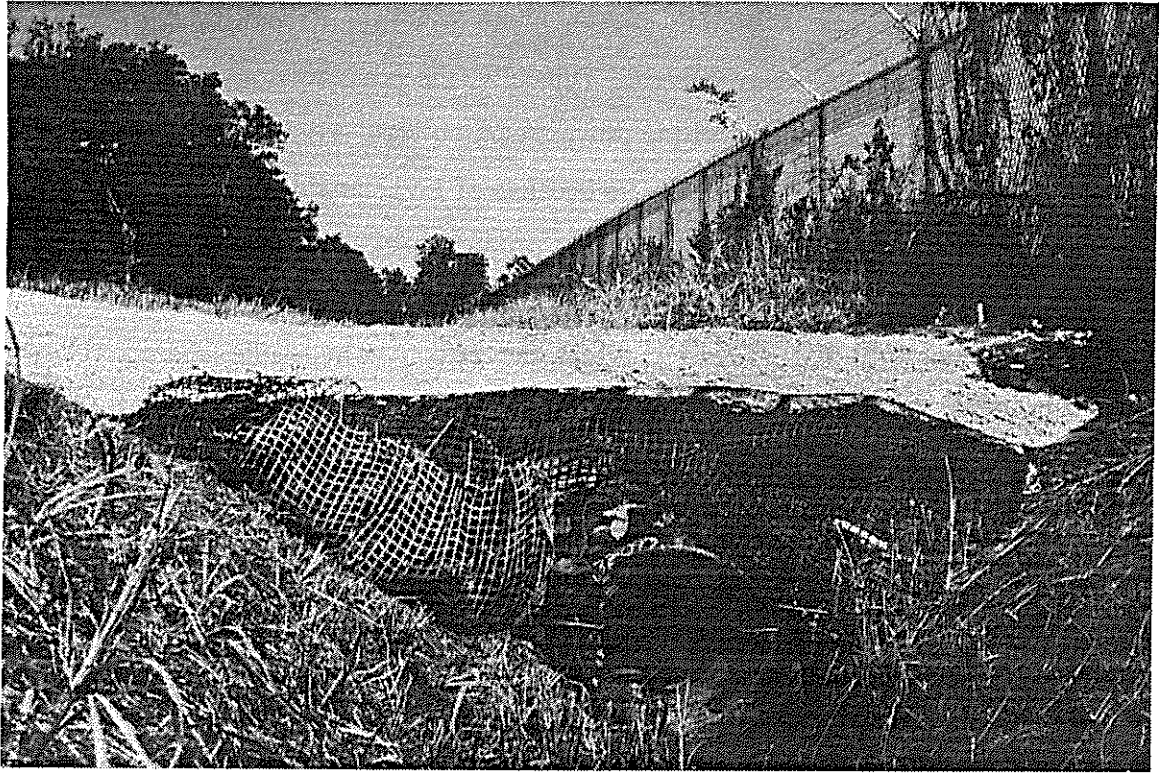


Figure 7. Completed field installation.

To date, the author has not been able to quantify the head loss or other hydraulic parameters of the open channel containing the field installation of shredded and whole tires. Visual observations during moderate rains indicate good drainage characteristics with negligible head loss. Figure 8 is a photograph of the field installation during a moderate rain. Observations during very heavy rainfalls were not obtained.

HYDRAULIC CONSIDERATIONS: The concept of placing shredded tires in ditches is intended for large rural ditches only. Generally speaking, the flow in this type of ditch is controlled by an existing downstream driveway culvert. Typically, the cross sectional area of the ditch is 4 to 8 times the cross sectional area of the downstream culvert. Hydraulically, these ditches are generally much larger than they need to be because of Louisiana's flat terrain. In heavy rains or rains of long duration, the culverts typically produce backwater in the upstream ditch. It is believed that under these previously described conditions shredded and whole tires placed in large rural ditches will not adversely affect the effective hydraulic characteristics of the ditches/culverts. The tires will, however, reduce the holding capacity of the ditch by approximately 22% based upon the previously established void ratio.

VEHICLE SUPPORT: A rigorous determination of vehicle support conditions provided by the stone surfaced tires was not accomplished during this study. A vehicle was driven onto the field installation with no observed problems (see Figure 9). It is believed that the shredded tires and stone will provide sufficient support for emergency egress.

INCREASED FLOODING: Louisiana has many problems with localized flooding. A potential problem with the concept of utilizing shredded tires in rural ditches is the real or imagined increase in localized flooding attributed to filling a ditch with shredded tires. If this concept is utilized, the Department must selectively locate installations and be ready to defend its actions to adjacent landowners whether or not these concerns are justified.



Figure 8. Field installation during a moderate rainfall.



Figure 9. Field installation supporting a light vehicle.

CLEARZONE ISSUES: The concept under evaluation should lessen the hazards associated with large roadside ditches and exposed culvert ends but may inadvertently expose vehicles to other hazards. For example, a vehicle leaving the roadway would no longer impact the ditch or culvert but may pass over the ditch and hit a tree or other obstruction on the far side of the ditch.

ENVIRONMENTAL ISSUES: As indicated earlier, examining the environmental issues associated with utilizing shredded tires under these conditions was outside the scope of this study. Many states are utilizing used tires in various applications. These applications range from disposal in landfills and incineration for power generation, to embankments and retaining walls. There are some concerns that leachates from tires may enter the groundwater. It is the author's opinion that except for incineration, all other applications including that under consideration here have the potential for exposing the groundwater to tire leachates.

CONCLUSIONS

The following conclusions are based upon the findings of this preliminary feasibility study:

1. It is potentially feasible to fill hazardous, large rural roadside ditches with shredded and whole tires in an effort to improve safety and to reduce the disposal problem associated with used tires.
2. If utilized, the concept must be selectively applied taking into consideration accident potential, hydraulic efficiency of the existing ditch and culverts, localized flooding and other clearzone/recovery obstructions. Specific environmental issues related to this proposed use need to be evaluated prior to extensive application.

RECOMMENDATIONS

It is recommended that further research in this area be conducted particularly in an effort to determine the design hydraulic characteristics of this potential application. It is also recommended that at least one full-scale field installation be placed to enable further evaluation of this concept.

REFERENCES

1. Franklin Associates, Ltd., and R. L. Hershey, "Markets for Scrap Tires," Report EPA/530-SW-90-074A. Office of Solid Waste, Environmental Protection Agency, Oct. 1991.
2. J. R. McDonald, and S. J. Langlinais. "A Support Study on the Feasibility of Utilizing Shredded Tires in Roadside Ditches," Unpublished report FHWA/LA-92/267, Louisiana Transportation Research Center, Louisiana Department of Transportation and Development, May 1993.

APPENDIX A

EXAMPLE NEWSPAPER ACCOUNTS
OF ACCIDENTS

\$15 million awarded boy left quadriplegic following accident

DONALDSONVILLE — The state Department of Transportation and Development must pay a child more than \$15 million following a 1987 accident that left the Ascension Parish boy a quadriplegic, a state court judge ruled.

Outgoing 23rd Judicial District Court Judge John L. Goldsmith ruled in favor of Harold Dylan Johnson, who was 9 years old when he was hit by a car along La. 73 in Prairieville on Sept. 4, 1987.

The lawsuit, filed on Johnson's behalf by his parents, alleged that the section of the road where the accident occurred was defective and violated various regulations and industry standards designed to allow a driver to safely take evasive action in case of an emergency.

According to Goldsmith's ruling, Johnson and some older friends were attempting to cross the highway when a car approached, traveling within the posted, 55 mph speed limit.

The older boys crossed the highway, leaving Johnson behind. As Johnson tried to cross alone, he headed into the path of the car. The driver, who had traveled the same road for eight to 10 years, tried to evade the boy.

The driver swerved to the left, although he thought he could have missed the boy had he been able to go off the road to the right. However, according to the judge's findings, "there was nowhere to go to the right without hitting obstacles, such as a cement culvert, mailboxes, a steep ditch, trees

The driver was aware of the obstacles to his right, tried to turn left, but could not avoid hitting Johnson, the judgement said.

The accident left Johnson a quadriplegic, unable to breathe for himself or move any of his body, except his eyes and his mouth.

"It is the most devastatingly injured person that I have ever defended," said attorney Paul Due. "The sad thing is that the kid is fully cognizant of his situation."

Johnson's lawsuit alleged that DOTD was responsible for the accident because the roadway, the shoulder, adjacent ditch and area at the accident site "were unreasonably defective in their original design, and as maintained . . . the accident occurred because (the) roadway violated various regulations and industry standards that are all designed to allow a driver to safely take evasive action in case of an emergency."

Based on projections of health-care costs and other needs, Goldsmith awarded Johnson \$14,113,272. He also ruled that Johnson should receive \$479,135 to pay for past medical expenses.

Johnson also was awarded \$500,000 for lost future earnings.

Walter L. Smith, who also represented Johnson, now 12, said he expects a long appeal process from the state DOTD. So far, Johnson's medical bills have been paid by his father's insurance policy, Smith said.

Steve Watsky, a spokesman for the state attorney general's office, who defended the case, said no decision has been made on whether to appeal the ruling.

Holden teen-ager dies in wreck; other teen booked

One 15-year-old girl died and another was charged with negligent homicide in a wreck Saturday in Livingston Parish, state police said.

Angela Zeigler of Holden was driving a 1991 Toyota sedan east on the gravel portion of La. 441 north of Holden when she lost control, slammed on her brakes and slid into a ditch.

The car then flipped onto its roof, Troop A Sgt. Kermit Smith said.

Krystal Grantham, also of Holden, was partially ejected from the car and pronounced dead at the scene of the 7:15 p.m. accident, Smith said.

Zeigler and a 14-year-old passenger sustained minor injuries.

None of the girls wore seat belts, Smith said.

Zeigler was charged with negligent homicide and careless driving, Smith said.

Grantham was one of six people killed on Louisiana highways over the weekend.

A White Castle man died Sunday afternoon from injuries he suffered in a 1:45 a.m. wreck on La. 75 in Iberville Parish, Smith said.

William Hanchett III, 19, was driving south on La. 75 near Bayou Pigeon when he lost control of his 1984 Ford Ranger.

The vehicle ran off the road to the right and flipped, ejecting Hanchett and his passenger, Smith said.

Hanchett died several hours later at Our Lady of the Lake Regional Medical Center. His passenger had minor to moderate injuries, Smith said.

In Allen Parish, an 18-year-old Oberlin man died early Sunday in a wreck on La. 26, just a day after a 22-year-old Kinder man died on the same highway about two miles away, state police said.

In the Sunday wreck, Brentt Meaux was driving east on La. 26 about two miles east of Oberlin. His pickup ran off the road to the right and when he overcorrected, it spun around on the highway and smashed into an embankment, Troop D. Sgt. B.J. Heinen said.

Meaux, who was not wearing a seat belt, was pronounced dead at the scene of the 4 a.m. wreck. Alcohol is

believed to have been a cause of the accident, Heinen said.

On Saturday on the same highway, Richard Baggett, 22, of Kinder, was speeding west about four miles east of Oberlin when he apparently misjudged a sharp curve. His van flipped over four times and landed upright in a ditch, Heinen said.

Baggett and two passengers were ejected from the van. Baggett died at the scene of the 1 a.m. wreck. His passengers sustained moderate to serious injuries, Heinen said.

In East Baton Rouge Parish, 79-year-old Elda Ledeker, of 1588 N. Little John Drive, died several hours after being involved in an accident 2 p.m. Saturday on Joor Road, state police said.

Ledeker was a passenger in a 1993 Plymouth sedan driven by Rudolph E. Meunier, 81, of 11837 E. Fair Oak Ave., Troop A Sgt. Kermit Smith said.

Meunier was northbound on Joor and tried to turn left onto Lovett Road in front of a southbound 1992 Mitsubishi sedan. The Mitsubishi, driven by Lance Davis, 29, of 14902 Russett Road, Pride, crashed into the passenger side of the Plymouth, Smith said.

Meunier was in serious condition late Saturday at Baton Rouge General Medical Center. Davis sustained minor injuries, Smith said.

Meunier was ticketed for improper left turn and additional charges are pending, Smith said.

On Saturday, near the Ascension Parish/St. James Parish line, a 17-year-old girl died when her car smashed into a tree on Interstate 10 south of Gonzales, state police said.

Julie Floyd, of Memphis, Tenn., was driving west on I-10 when she apparently was distracted, Troop A Sgt. James Waymire said.

Her 1993 Mitsubishi sedan veered into the center median on the interstate.

When she tried to correct her steering, her car careened across two lanes of highway and plowed into a tree, police said.

She was pronounced dead at the scene of the 12:10 p.m. wreck. She was wearing a seat belt, Waymire said.

5 killed in La. wrecks over weekend

Advocate staff report

A 39-year-old Houma man was killed and a woman was injured in an accident on La. 307 in Kraemer about 2 a.m., Sunday, Troop C Sgt. Ernest LaRose said.

Wilton Malbrough of Houma was speeding south on La. 307 and failed to slow down in a curve. His car veered into a ditch and rolled over onto its side, LaRose said.

His passenger, Theresa Hotard, 42, of Kraemer was transferred to the Medical Center of Louisiana in

New Orleans.

Details about her condition were not available late Sunday.

Three teen-agers died Saturday afternoon in a wreck on a rain-slicked Ascension Parish highway, state police said.

Amanda L. Acosta, 18, of Belle Rose was driving east on La. 42 near the Manchac Acres subdivision when she lost control of the car on the slippery road just before 5 p.m., Senior Trooper Stephen Baum said.

The car slid sideways and a westbound 1985 Ford Bronco II smashed into the passenger side of the car, Baum said.

Acosta and her two 13-year-old passengers, cousin Brett Leggette of Prairieville and his friend Brett Frederick of St. Amant were pronounced dead at Riverview Medical Center.

A 22-year-old Homer man was killed on La. 3062 near Homer about 11 p.m. Friday when his car ran off the road and hit a tree, Troop G Sgt. David Staton said.

Gregory L. Williams, of 403 Meadow Drive, was westbound on La. 3062 at high speed and ran off the road in a curve, Staton said.

DOTD ordered to pay \$8.25 million award

Florida parishes bureau

LIVINGSTON - An \$8.25 million court award against the state Department of Transportation and Development was issued Thursday by Judge Edward Brent Dufreche in 21st Judicial District Court.

Testimony was completed last fall in the case brought by Laurie Jenkins, 29, of Denham Springs after an accident on La. 42 near Port Vincent in April 1988.

The court found that the state was

responsible for defects in the roadway, for the elevation of its surface and for a double curve in the road, according to Baton Rouge attorney Jerry McKernan, who represented Jenkins.

The highway had recently been overlayed and there was a dropoff of more than five inches from the road surface to the shoulder. No signs warned of the dropoff or the curve, McKernan said.

According to the attorney, Jenkins was a passenger in a car that was eastbound on La. 42 when the wheels on

one side went off the roadway and the driver was unable to get the car back onto the road. The car hit an embankment and Jenkins was ejected. She will be a quadriplegic for the rest of her life because of the injuries, McKernan said.

In addition to the \$8.25 million award to Jenkins, Dufreche ordered that her 6-year-old son receive \$100,000 for loss of relationship, McKernan said.

McKernan said the state usually appeals such verdicts.

APPENDIX B

PHOTOGRAPHS OF TYPICAL
HAZARDOUS DITCHES



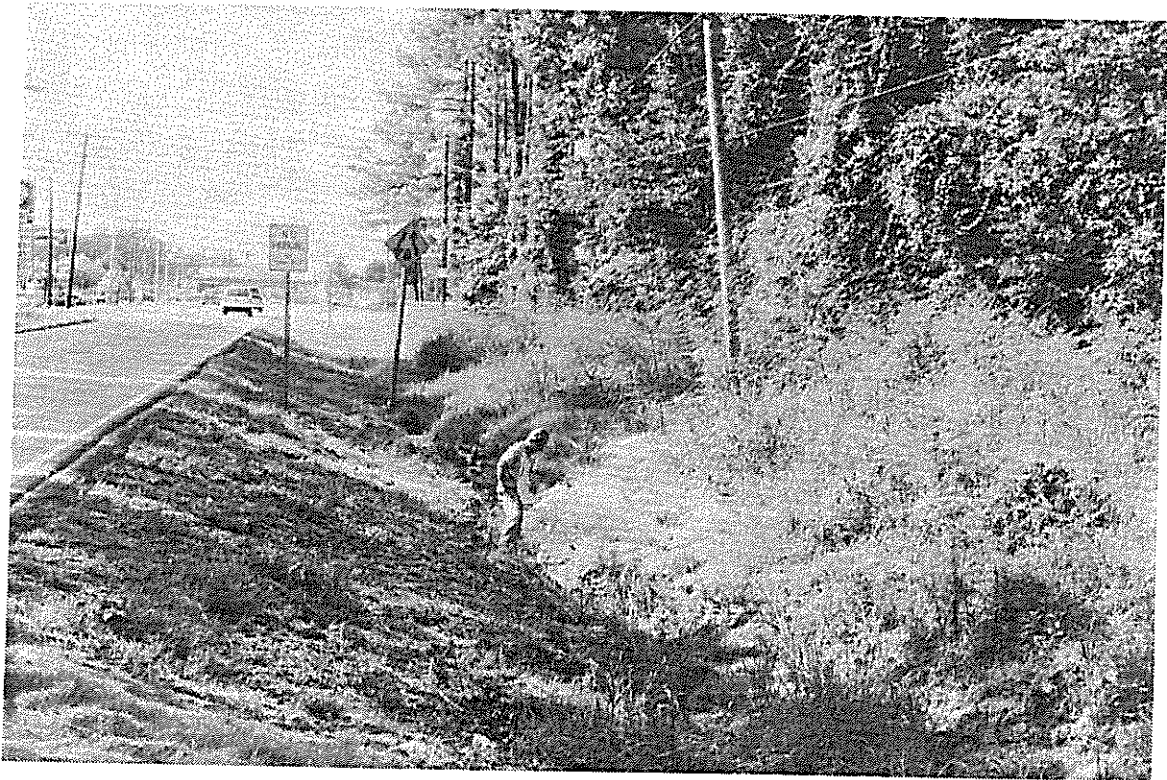
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