

RECLAIMED GLASS AGGREGATE DEMONSTRATION PROJECTS

In 1996 and 1997, TxDOT and its partners conducted three test projects using reclaimed glass aggregate, or glass cullet, in the cities of Devine and Abilene and in Orange County.

CITY OF DEVINE DEMONSTRATION PROJECT

The first test project involved the rehabilitation of Colonial Parkway and North Teel Drive in the City of Devine (Figure 5.1). Construction was done in July of 1996 and it involved reworking existing surface and base layers as the subbase for the new pavement. A blend of 80% crushed limestone and 20% glass cullet was used to construct the flexible base layer and hot mix asphalt with limestone rock asphalt (LRA) aggregate was used in the surface layer. Vista Fibers of San Antonio supplied 440 tons of waste glass for the project and Vulcan Materials of San Antonio blended it and crushed it with limestone.

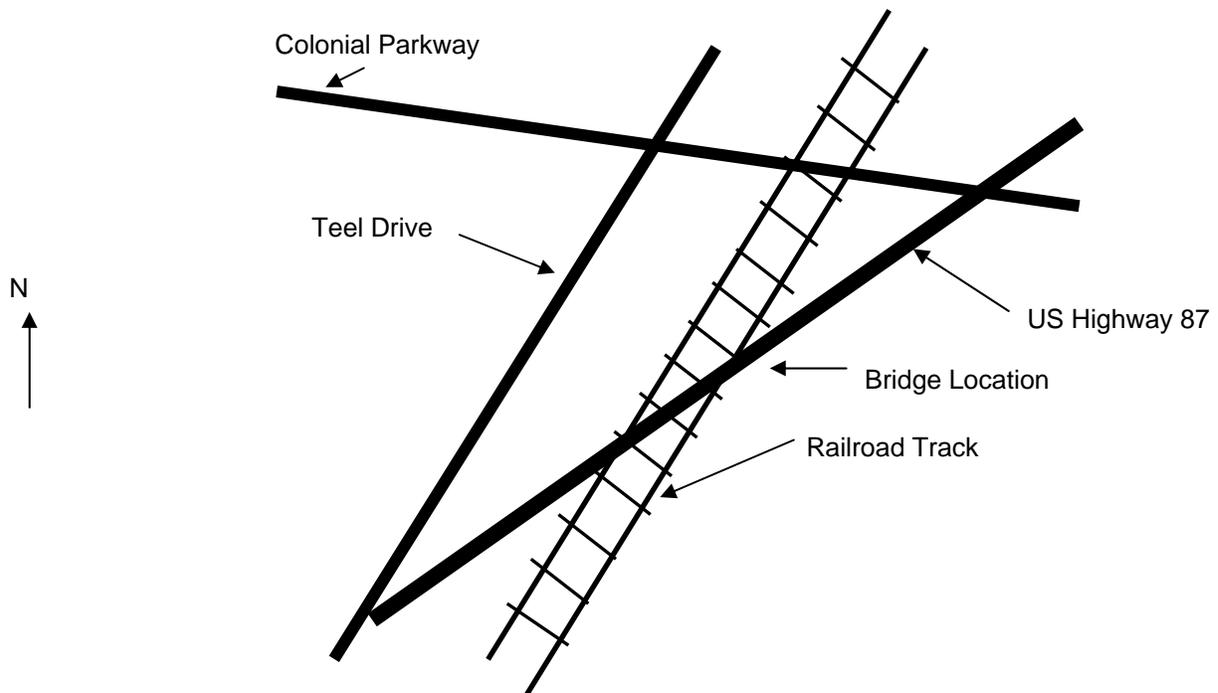


Figure 5.1. Schematic Drawing of the Devine Test Project Site Location

Laboratory Test Results

Tables 5.2 through 5.5 present laboratory test results for this project.

Table 5.2. Sieve Analysis Test Results (% Retained)

Sieve Size	Existing Subgrade	Existing Salvaged Base	Stockpile Mix with 15% Glass Cullet
1-3/4 in.	2	0	0
7/8 in.	6	3	0
3/8 in.	14	12	30
No. 4	21	19	53
No. 40	35	33	83

Table 5.3. Atterberg Limits Test Results

Material Type	Liquid Limit	Plastic Limit	Plasticity Index
Existing Subgrade	25	14	11
Existing Salvaged Base	27	27	0
Limestone Mix with 15% Glass Cullet	23	13	10

Table 5.4. Compaction Ratio Data

Material Type	Dry Density (pcf)	Optimum Moisture Content (%)
Existing Subgrade	125.0	9.5
Existing Salvaged Base	123.5	10
Limestone Mix with 15% Glass Cullet	136.3	7.1

Table 5.5. Triaxial Test Results

Material Type	Failure Stress at '0 psi' Confining Pressure (psi)	Failure Stress at '15 psi' Confining Pressure (psi)	Triaxial Classification
Existing Subgrade	185.9	702.7	2.9
Existing Salvaged Base	172.3	620.0	3.6

Tables 5.6 and 5.7 show laboratory test results on constructed pavement base and surface after one year.

Table 5.6. Test Results of Constructed Pavement Base

Sieve Analysis		Compaction
Sieve Size	% Retained	
1-3/4 in.	0	Maximum Dry Density: 137.1 pcf Optimum Moisture Content: 5.9%
7/8 in.	1	
3/8 in.	34	
No. 4	57	
No. 40	81	

Table 5.7. Test Results of Constructed HMAC Pavement Surface

Sample Location	Percent Air Voids	Core Density (pcf)	Nuclear Density (pcf)
Colonial Parkway: Between Indian Rd and J.T. Moore Rd	18.8	119.6	135.7
Colonial Parkway: Between J.T. Moore Rd and Gutierrez Rd	18.4	120.3	140.3
Colonial Parkway: Between Gutierrez Rd and Oakridge Rd	16.7	122.8	142.8
Teel Drive	14.5	126.0	137.0

Field Test Results

Table 5.8 shows test results on Glass Base during the Compaction Operation.

Table 5.8. Nuclear Density and Moisture Field Test Results, 1996

Highway	Station	Lab Density (pcf)	Lab Moisture (percent)	Field Density (pcf)	Field Moisture (percent)
Teel Drive	21+00	136.2	7.1	142.6	3.7
Teel Drive	15+00	136.2	7.1	136.1	3.9
Colonial Parkway	12+00	136.2	7.1	142.5	3.1
Colonial Parkway	12+50	136.2	7.1	144.9	3.6

Table 5.9 shows results of the pavement ride quality measurements using TxDOT Profiler/Rut Bar equipment conducted in October of 1997.

Table 5.9. Ride Score and International Roughness Index (IRI) values for Left Wheel Path (LWP) and Right Wheel Path (RWP) on Teel Drive and Colonial Parkway

Roadway	Average Ride Score		Average IRI	
	LWP	RWP	LWP	RWP
Teel Drive	3.4	2.8	1.9	1.8
Colonial Parkway	2.8	2.8	2.9	2.0

Results, Discussion & Findings

The Texas Tech University research team made several visits to the Devine glass-cullet project. This test project showed premature alligator cracking. These two roads are residential streets. However, due to a train accident on US 87, a bridge was damaged and the resulting temporary closure of US 87 resulted in a significant increase of heavy truck traffic on the two streets. City officials estimated this increase in heavy traffic to be 3 to 4 times greater than the design traffic.

Values in Table 5.9 indicate that the given pavements have ride qualities in the low to medium range after one year of service. The ride score is assigned to a pavement based on a scale of 1 to 5 with 5 indicating a pavement with perfect ride quality. These values indicate a rate of deterioration that can be typically rated as high.

Based on what was observed in the field, this rapid deterioration was the result of unusually high levels of heavy vehicles on the road due to highway detours. Once US 87 was opened, the rate of deterioration on Colonial Parkway and North Teal Drive showed a significant decrease and the subsequent visits to the site as late as August of 1998 and June of 1999 showed that no further significant deterioration has taken place since then. These observations were supported by measurement of rutting using TxDOT rutbar profiler measurements.

The reason for premature distress can possibly be attributed to unusually high heavy traffic. The FHWA also directed all states to report pavement roughness data by International Roughness Index (IRI) for all paved rural arterials and urban freeways and expressways, including Interstates, beginning in 1989. The IRI is an objective and consistent measure of pavement condition which was chosen as the FHWA Highway Planning and Monitoring System (HPMS) standard reference roughness index to provide more consistency between states. IRI values for these pavements are also shown in Table 5.9.

Specification

The flexible base material shall be crushed limestone to meet the requirements herein and shall consist of durable coarse aggregate, glass cullet and binding materials.

Physical Requirements

Type D. Master Grading

Sieve	% Retained
3/4 in	0
5/8 in.	0-15
3/8 in.	15-40
No. 4	35-65
No. 40	70-90

Maximum Liquid Limit – 30

Maximum Plasticity Index – 12

Additives

20 percent by weight of glass cullet

Preparation for Soil

Testing of flexible base materials shall be in accordance with the following standard laboratory test procedures:

Constants and Sieve Analysis	Tex-101-E
Liquid Limit	Tex-104-E
Plastic Limit	Tex-105-E
Plasticity Index	Tex-106-E
Linear Shrinkage	Tex-107-E
Sieve Analysis	Tex-110-E
Los Angeles Abrasion	Tex-410-A

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CITY OF ABILENE DEMONSTRATION PROJECT

The test project was performed on Antilley road, a city street in front of Wiley High school (Figure 5.2). Glass cullet was mixed with crushed limestone at the job site to form the flexible base.

Construction involved spreading 12 inches of crushed limestone followed by glass cullet (Figure 5.3). A pavement material recycler mixed the two materials on the pavement and then the blend was compacted (Figures 5.4 and 5.5). A 1.5 inch (38-milimeter) thick hot mix asphalt concrete surface layer was placed on top of the flexible base layer containing glass.

The eastern section of the road used a 10 percent glass cullet while the western section used 15 percent. Each section is 750 feet (275 meters) long and 12 feet wide (3.66 meters) and both sections are along the eastbound outside lane. Conventional limestone base was used on the remaining four lanes.

This construction project used 240 tons of glass collected by the City of Abilene over a one-year period. Pine Street Salvage, a local salvage company, provided 75 percent of the glass while Dyess Air Force Base provided the remaining 25 percent. TxDOT collected and transported the glass from Pine Street Salvage to Dyess AFB where the glass was crushed into cullet.

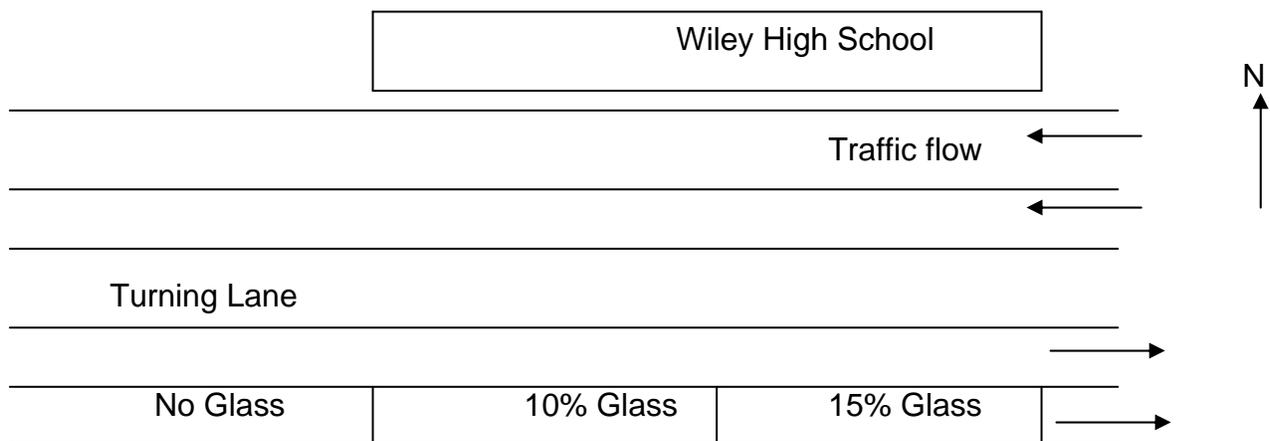


Figure 5.2. Schematic Drawing of the Test Project #2 Site Location



Figure 5.3. Dumping of Glass-Cullet by a Belly Dump Truck



Figure 5.4. Mixing of Glass with Limestone



Figure 5.5. Compacted Limestone-Glass Base

Laboratory Test Results: Table 5.10 presents laboratory test results on limestone and limestone-glass base.

Table 5.10. Test Results on Limestone & Limestone-Glass Base

Material Type	LL	PI	WBM Value & % Increase	Density & % Moisture	Sieve Analysis* Sieve No.	Sieve Analysis* % Retained
Limestone	22.2	7.1	19 & 13 %	134.0 & 7.8	1 ¾ in.	0
					1 in.	12
					7/8 in.	17
					1/2 in.	34
					3/8 in.	39
					No.4	55
					No.10	68
					No.40	81
Limestone with 10% Glass	30.2	12.8	16 & 7	136.8 & 7.3	1 ¾ in.	0
					1 in.	17
					7/8 in.	21
					1/2 in.	44
					3/8 in.	53
					No.4	68
					No.10	74
					No.40	84
Limestone with 15% Glass	23.5	7.0	16 & 7	135.4 & 6.3	1 ¾ in.	0
					1 in.	17
					7/8 in.	21
					1/2 in.	44
					3/8 in.	53
					No.4	68
					No.10	74
					No.40	84

Field Test Results: Falling Weight Deflectometer (FWD) testing was performed on limestone-glass flexible base section in April of 1999. Figure 5.6 shows FWD testing at the test section. A control (non-glass) section was also chosen to the east of 10% glass section for comparison with the glass-cullet sections. Results are shown in Figure 5.7.



Figure 5.6. Falling Weight Deflectometer Testing on Antilley Road, 1999

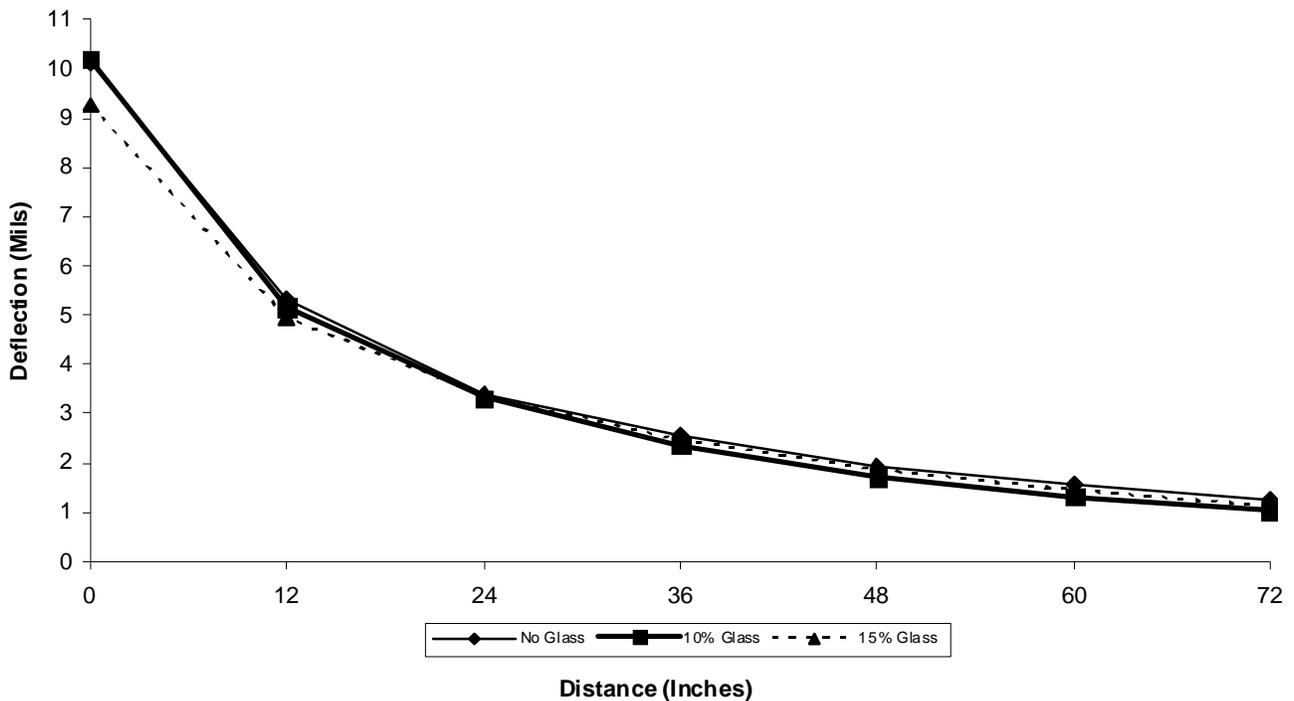


Figure 5.7. FWD Test Result on Antilley Road, 1999

Specifications

Specifications were the same as for the City of Devine project only 10 percent and 15 percent glass mixes were used.

Results, Discussion & Findings

The glass-cullet project on Antilley Road, Abilene is performing well and no significant non-routine maintenance was required in these sections since it opened to traffic (Condry, 1999). FWD tests on these sections show no significant difference in structural integrity among no glass, 10% & 15% glass cullet sections (Figure 5.7).

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ORANGE COUNTY PIPE BEDDING DEMONSTRATION PROJECT

In November 1997, TxDOT's Beaumont District placed ¼-inch size glass cullet as bedding material around two culvert pipes at the intersection of SH 62 and FM 105 in Orange County, near the Orange County Airport.

Results, Discussion & Findings

Visual inspection of the culvert constructed using glass cullet indicates that the test project in Orange County is performing satisfactorily at this point.

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