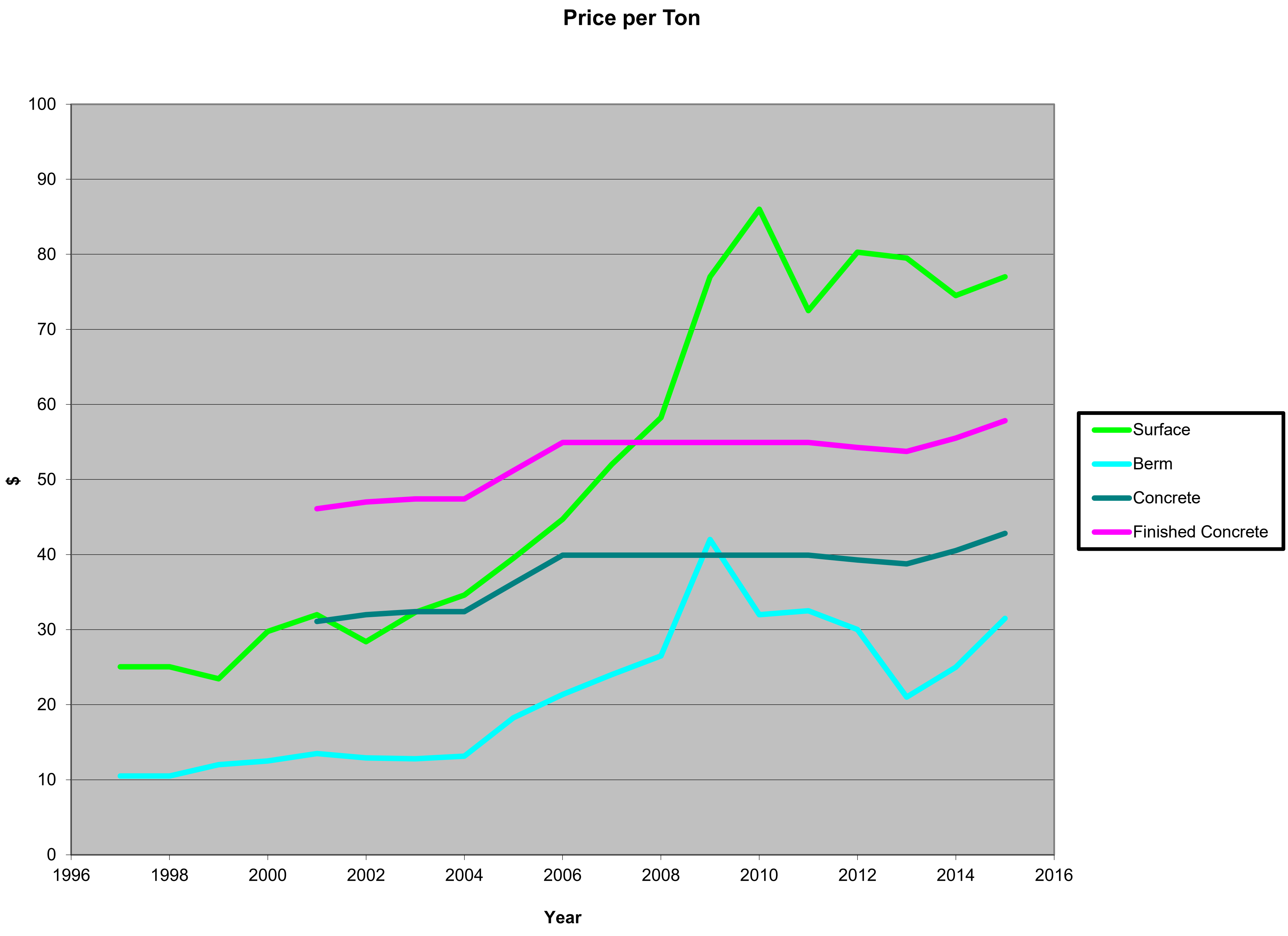
Defiance County Flexible Concrete

“Ruttable” Concrete

Defiance County, like many other counties in Ohio, has a roadway system with almost exclusively flexible pavements. Much of this is a result of economic forces. Many of the roads were never “designed” but rather were paved or chip sealed in an effort to improve the driving surface as funding was available. Flexible pavement fails by rutting which, while a defect, still provides a hard driving surface. It can also be built up in layers, allowing repair by overlaying areas having insufficient strength.

In the years 2002-2004 a major change in asphalt prices began with prices shifting to a new normal ~3 times higher than the historically stable prices. This has led to a situation where concrete is now a lower cost road material than asphalt. (See Price per Ton Figure) Unfortunately, typical concrete is a hard, brittle material that requires installation with a proper design or failure occurs. Typical concrete failure occurs with large pieces coming apart.


Price per Ton
100
90
80
70
60
50
40
30
20
10
0
$
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Year
Surface
Berm
Concrete
Finished Concrete

In 2008 Defiance County began working with a local ready mix supplier to see if we could develop a flexible concrete that would act like asphalt but at a lower cost. The initial mix was a low strength, low cost, fiber reinforced mix that was first used as a base material for widening. It was used to widen one mile of a two mile project and has performed as well as the adjoining asphalt widening. Defiance County has used the material for widening, paving and pothole patching. In the field, it seems to be behaving and failing (in rare cases) similar to asphalt. We have struggled to pave with it and get a similar ride to asphalt, but have been happy with it in other applications.

Defiance County began testing with the University of Toledo to attempt to find a test to:

1. Verify the behavior of the material as compared to asphalt,

2. Test a variety of fibers\concrete mixes to gain a basic understanding of whether a mix could be developed which had similar behavior to asphalt,

3. Share these results with the local ready mix companies so that they could refine the test mixes and develop their own mix which had satisfactory performance to asphalt

After a number of tests, the most promising test method involved testing 4" diameter x 2" thick "pills" in indirect tension while measuring vertical strain and horizontal dilation strain. (See photos of test apparatus). The asphalt pills tested had an average peak strength of 85 psi and carried load until average strain in both the horizontal and vertical direction of 6%.




Concrete Mixes

Control

Material	g
#57	1200
#8	1200
Sand	3600
Cement	280
Fly Ash	160
Slag	190
Water	683

IIP

Material	g
#57	1200
#8	1200
Sand	3600
Cement	280
Fly Ash	160
Slag	190
Water	683
IIP	6

XLM

Material	g
#57	1200
#8	1200
Sand	3600
Cement	280
Fly Ash	160
Slag	190
Water	683
XLM	6

Multi

Material	g
#57	1200
#8	1200
Sand	3600
Cement	280
Fly Ash	160
Slag	190
Water	683
Multi	6

Forta

Material	g
#57	1200
#8	1200
Sand	3600
Cement	280
Fly Ash	160
Slag	190
Water	683
Forta	6

Pro F

Material	g
#57	1200
#8	1200
Sand	3600
Cement	280
Fly Ash	160
Slag	190
Water	683
Pro F	6

3/4" Pro F

Material	g
#57	1200
#8	1200
Sand	3600
Cement	280
Fly Ash	160
Slag	190
Water	683
3/4" Pro F	6

RF 4000

Material	g
#57	1200
#8	1200
Sand	3600
Cement	280
Fly Ash	160
Slag	190
Water	683
RF 4000	6

Pro S

Material	g
#57	1200
#8	1200
Sand	3600
Cement	280
Fly Ash	160
Slag	190
Water	683
Pro S	6

Eco Net

Material	g
#57	1200
#8	1200
Sand	3600
Cement	280
Fly Ash	160
Slag	190
Water	683
Eco Net	6

Sika MS 20

Material	g
#57	1200
#8	1200
Sand	3600
Cement	280
Fly Ash	160
Slag	190
Water	683
MS 20	6

RF 4000/IIP

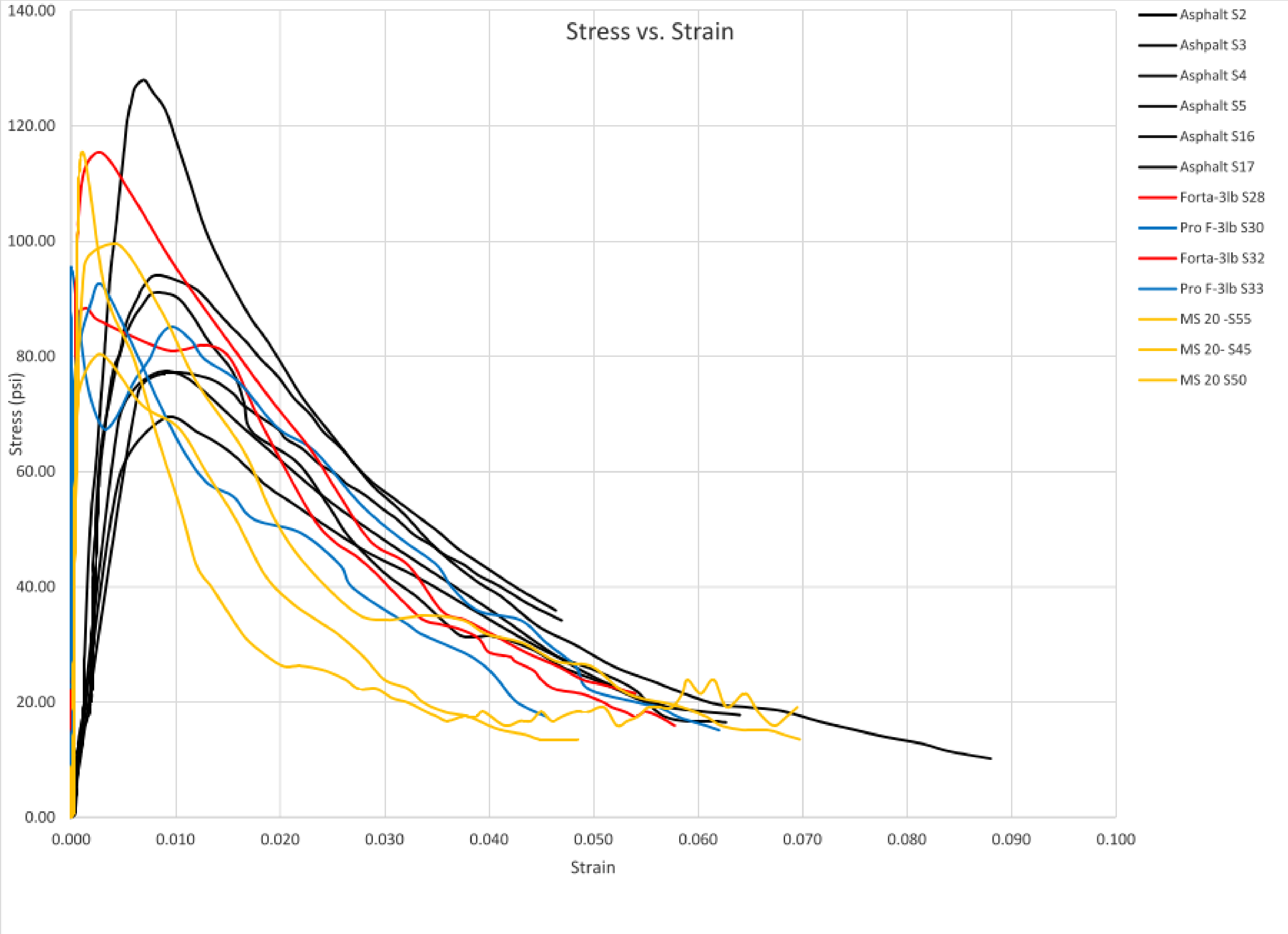
Material	g
#57	1200
#8	1200
Sand	3600
Cement	280
Fly Ash	160
Slag	190
Water	683
RF4000	3
IIP	3

Twice the Cement (2x)

Material	g
#57	1199
#8	1200
Sand	3600
Cement	560
Fly Ash	320
Slag	380
Water	1366
IIP	6

Half the Cement (0.5x)

Material	g
#57	1199
#8	1200
Sand	3600
Cement	140
Fly Ash	80
Slag	95
Water	342
IIP	6


Stress vs. Strain
Stress (psi)
Strain
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
0.000
0.010
0.020
0.030
0.040
0.050
0.060
0.070
0.080
0.090
0.100
Asphalt S2
Ashpalt S3
Asphalt S4
Asphalt S5
Asphalt S16
Asphalt S17
Forta-3lb S28
Pro F-3lb S30
Forta-3lb S32
Pro F-3lb S33
MS 20 -S55
MS 20- S45
MS 20 S50

These results were shared with both local ready mix suppliers who supplied mixes for testing as well. (See figure of CCI and Baker Shindler)

Beginning in 2014 mixes were tested to verify that they have an average peak tensile strength of 85 psi as well as carrying load until average strain in both the horizontal and vertical direction of 5%. (See table of average results for mixes tested) A number of mixes meeting this specification have been tested and both ready mix suppliers have submitted mixes very close to this specification.

In 2016 the Ohio Research Initiative for Locals (ORIL) completed a research project titled *Investigation of In-Situ Strength of Various Construction/Widening Methods Utilized on Local Roads* which measured field strengths on a number of construction methods including this method. The project showed an average strength in place comparable to asphalt as well.

All pills were tested at 7 day strength with samples kept at ambient conditions after production.

For more information contact:

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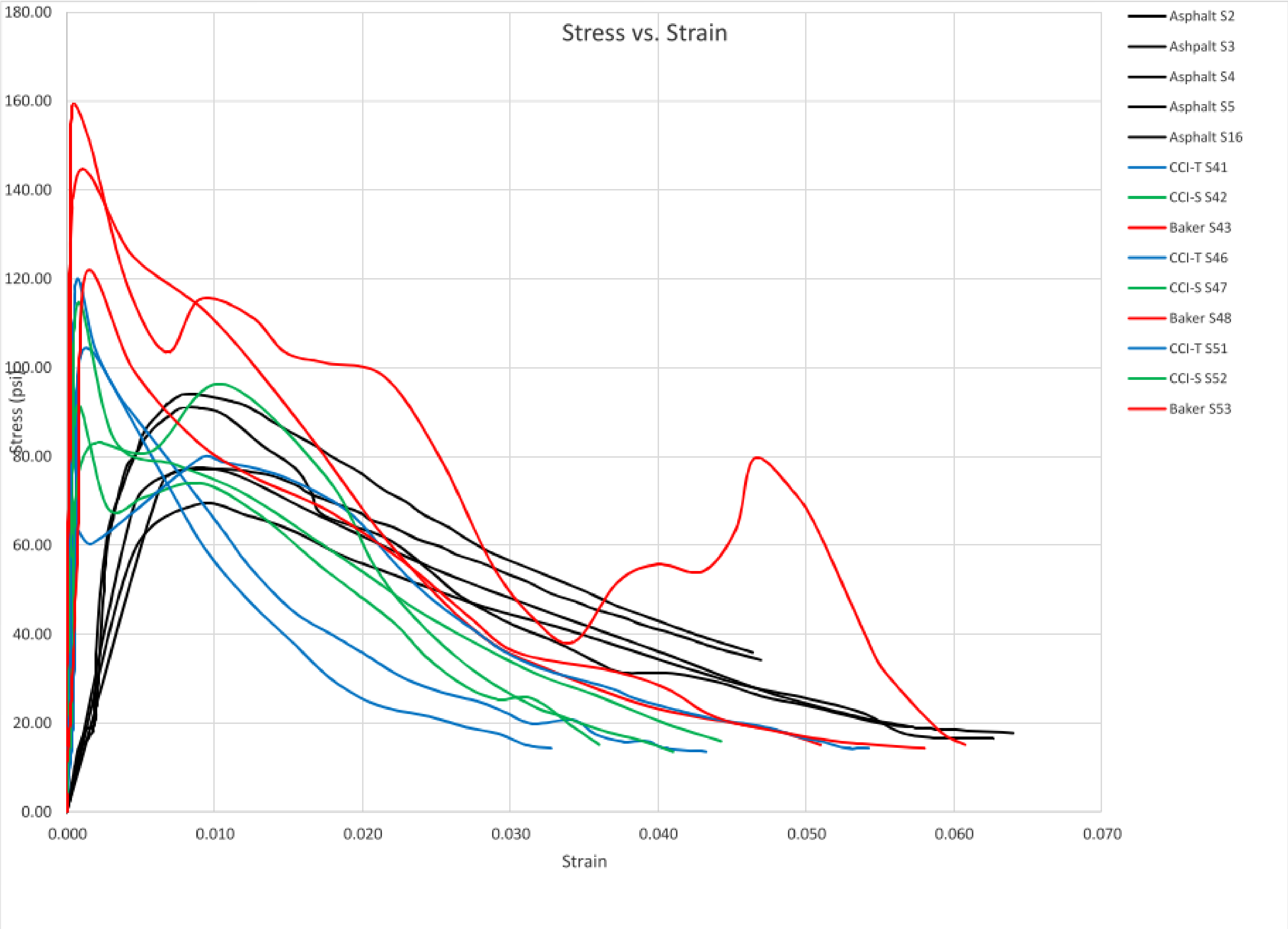
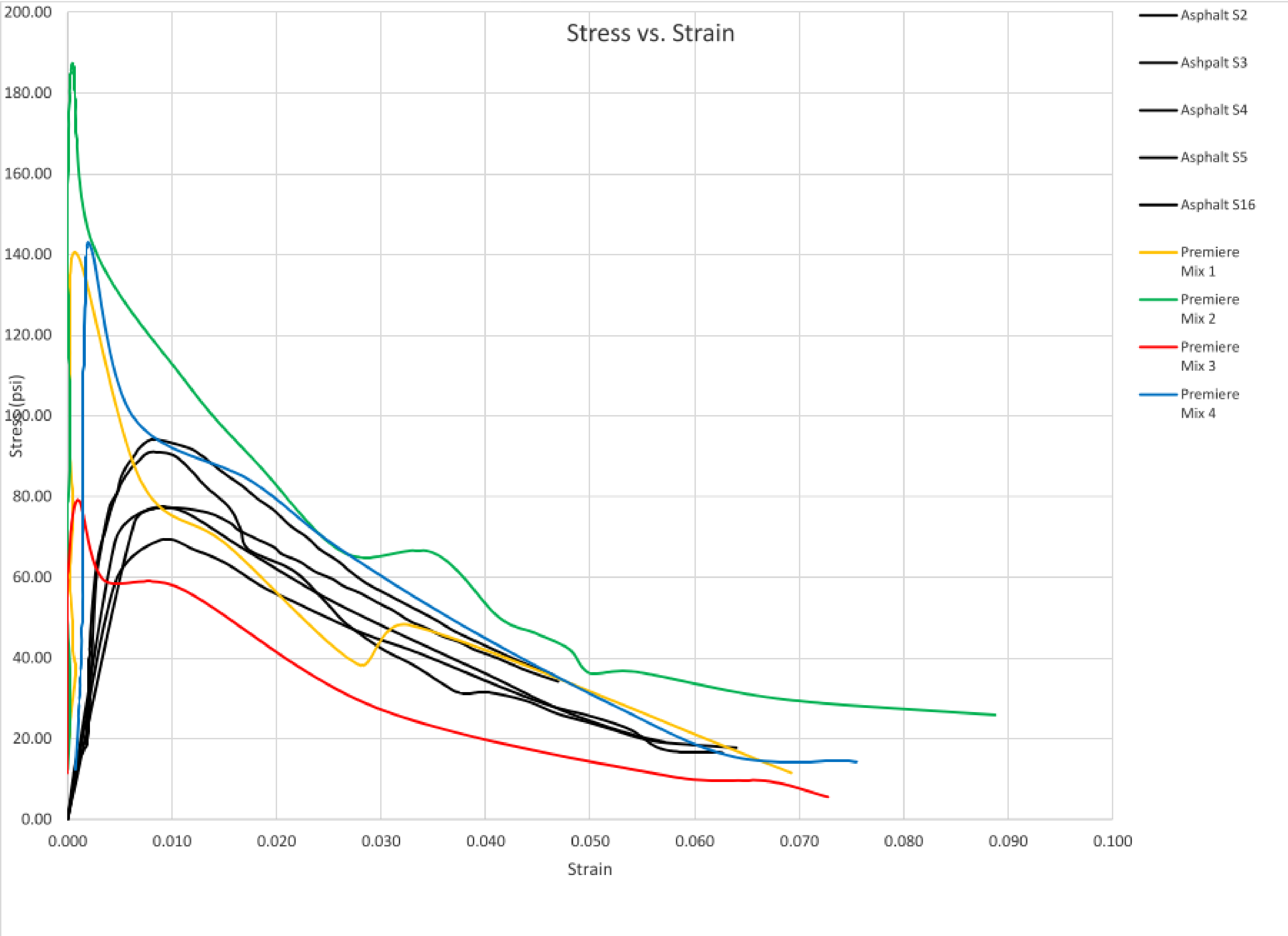
Test Summary

	Horizontal Strain Avg	Vertical Strain Avg	Peak Stress (psi) Avg
Control	0.02	0.011	103
Asphalt	0.06	0.06	85
IIP	0.035	0.025	76
XLM	0.0196	0.0225	91
Multi	0.019	0.016	55
Forta	0.056	0.055	101
Pro F	0.054	0.058	93
3/4" Pro F	0.0267	0.021	99
RF 4000	0.04	0.03	87
Pro S	0.035	0.03	91
Eco Net	0.032	0.022	95
MS 20	0.063	0.077	98
RF 4000/IIP	0.032	0.033	65
IIP double	0.05	0.065	71
IIP	0.035	0.025	76
IIP half	0.008	0.005	18
CCI-T	0.043	0.045	100
CCI-S	0.04	0.033	100
Baker Shindler	0.057	0.043	140


Stress vs. Strain
Stress (psi)
Strain
180.00
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
0.000
0.010
0.020
0.030
0.040
0.050
0.060
0.070
Asphalt S2
Ashpalt S3
Asphalt S4
Asphalt S5
Asphalt S16
CCI-T S41
CCI-S S42
Baker S43
CCI-T S46
CCI-S S47
Baker S48
CCI-T S51
CCI-S S52
Baker S53



Stress vs. Strain
200.00
180.00
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
Stress (psi)
0.000
0.010
0.020
0.030
0.040
0.050
0.060
0.070
0.080
0.090
0.100
Strain
Asphalt S2
Ashpalt S3
Asphalt S4
Asphalt S5
Asphalt S16
Premiere Mix 1
Premiere Mix 2
Premiere Mix 3
Premiere Mix 4


30
MPH

After Chip sealing

Applications so far

- Widening
- Small full width patching
- Pavement cross slope modification
- Pothole patching
- Utility patches

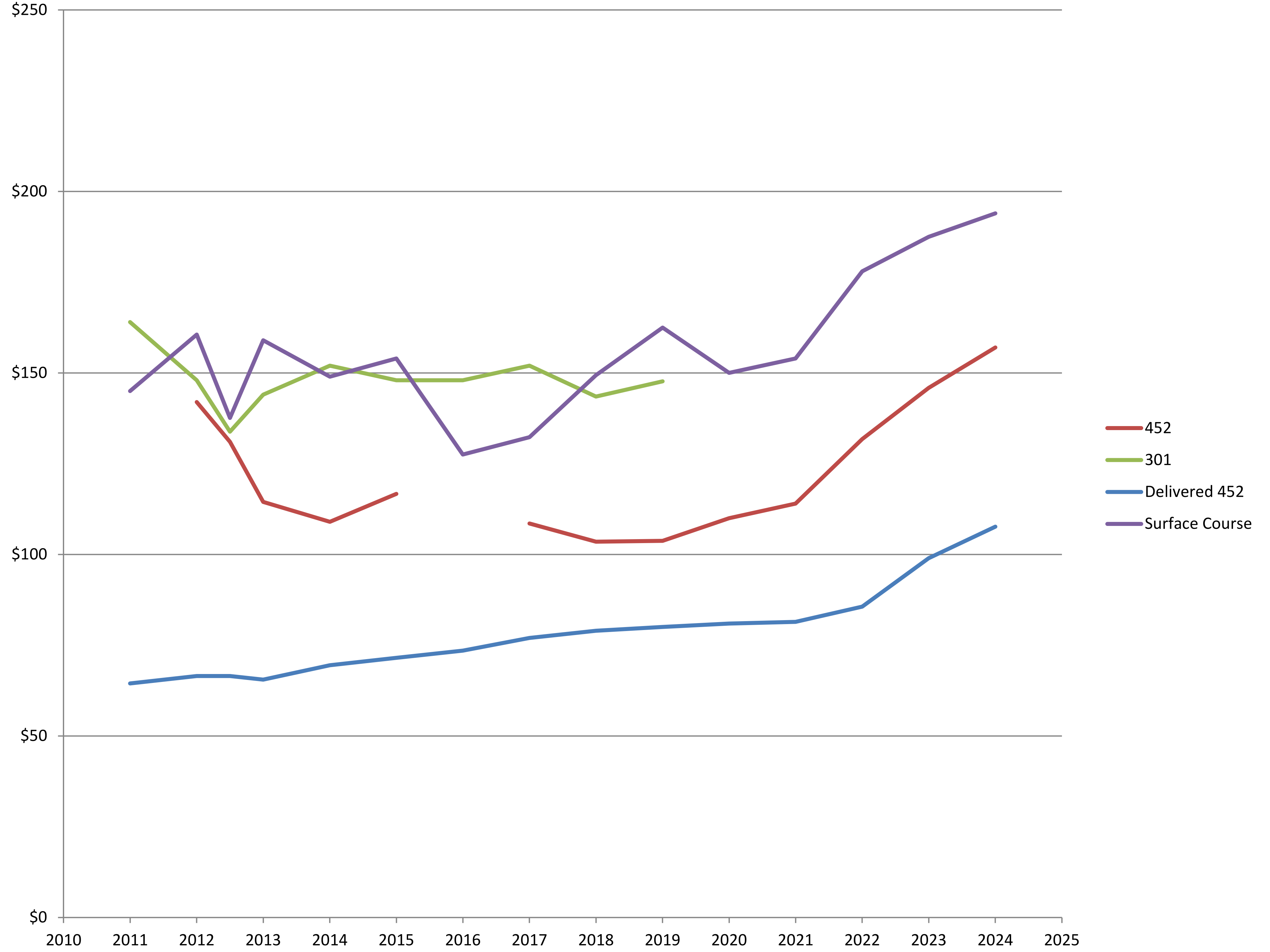
Placement so far

- Thicknessess ¼” to 12”
- Widths 2’ to 12’
- Handfinishing
- Widening box
- Custom tooling

Bidding as an alternate to ODOT 301
Prices are in place

		Savings
2011 Paving 1483 CY		
301 $82 per Ton	Gerken Paving	
2012 Paving 1754 CY		
301 $74 per Ton	Gerken Paving	
452 $142 per CY	RG Zachrich	
2012 Krouse Road 1711 CY		$38,588
301 $66.90 per Ton	Gerken Paving	
452 $131 per CY	RG Zachrich	
2013 Paving 2133 CY		$56,463
301 $72 per Ton	Gerken Paving	
452 $114.5 per CY	Gerken Paving	
2014 Paving 2736 CY		
301 $76 per Ton	Gerken Paving	$105,584
452 $109 per CY	RG Zachrich	
2015 Paving 560 CY		
301 $74 per Ton	Gerken Paving	$150,480
452 $116.5 per CY	RG Zachrich	
2016 Paving		
301 $74 per Ton	Gerken Paving	$106,704
301 $88.5 per CY	Defiance County	
2017 Paving 3780 CY		
301 $76 per Ton	Gerken Paving	$164,430
452 $108.5 per CY		
2018 Paving 6524 CY		
301 $76 per Ton	Gerken Paving	$260,960
452 $103.5 per CY	Vernon Nagel	
2018 CR424 3056 CY		$152,800
452 $102 per CY	RG Zachrich	
2019 Paving 5195 CY		$247,800
301 $73.85 per Ton	Gerken Paving	
452 $103.75 per CY	RG Zachrich	

Cumulative to Date
$1,283,809


$250
$200
$150
$100
$50
$0
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
452
301
Delivered 452
Surface Course

If I want to try it??

LOCAL REDIMIX COOPERATION AND INTEREST IS ESSENTIAL

TRY IT – PLACING, MILLING, REMOVING, RADIUS IMPROVEMENT

STAY TUNED

What is next?

- Use is spreading slowly
- ORIL research
- Fiberglass fiber is a new possibility
- Finding ways to use it in larger paving applications

Questions?

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