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Final Report

IN-PLACE VOIDS MONITORING OF HOT MIX ASPHALT PAVEMENTS: FOLLOW-UP

Richard Griffin

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16. Abstract

In order to validate the policy of allowing the adjustment of the asphalt cement to reduce the laboratory air voids up to one percent, cores were taken over a period of four years on 19 paving projects and tested for air voids. After being compacted by traffic over several years, the average air voids in these pavements were 3.8%. Since the design air voids are required to be between 3.5% and 4.5%, the monitoring validates the effectiveness of the policy. However, there was significant scatter in the data with most of the in-place voids falling out of this design range.

Implementation

The asphalt cement adjustment policy has been validated, but more guidance needs to be developed to reduce scatter. CDOT should consider additional guidance in making AC adjustments to achieve more consistent in-place voids. Forensic analysis of any pavement showing premature failure related to mix problems may help in developing and fine-tuning this guidance.

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EXECUTIVE SUMMARY

Based on research performed between 1995 through 2002 (Harmelink and Aschenbrener), CDOT established a new policy regarding the hot mix asphalt (HMA) mix designs. The policy allowed for adding additional asphalt cement (AC) to a mix up to a point where the design voids would be reduced one percent. (Voids are defined as the air remaining in a mix after compaction: in the laboratory (design voids) or in the field (in-place voids). This policy was based on the finding (Harmelink and Aschenbrener) that the SHRP Gyratory compactor process in the laboratory achieved a density that rolling and traffic loading in the field could not. The practice was hoped to achieve the desired in-place voids as the pavement was compacted by traffic over the subsequent three years. This research was undertaken to make sure this strategy was working. This research was composed of analyzing cores from paving projects across Colorado to determine initial and subsequent in-place voids over the years. The effort resulted in the testing of 19 paving projects placed in 2003 and 2004. The final cores were taken in early 2008 providing in-place voids trends over four to five years.

The average in-place voids achieved after traffic compaction for the 19 projects is 3.8%. Therefore, since this average is close to the center of the design range of 3.5% to 4.5%, the AC adjustment policy is working. But there seems to be significant scatter in the voids data and even aggressive AC adjustment, in some cases, does not appear to avoid high in-place voids. Conversely, several other projects end up with voids that are generally considered too low. There seem to be other factors at play that were not monitored that are affecting the in-place voids. Additional guidance regarding when and how much to adjust the AC may help in consistently reaching the proper in-place voids. All that said, in-place voids is not the only measure of a good mix. Aside from the cost for the additional AC, a mix that results in in-place voids below 3.5% may result in better long term pavement performance as long as the condition does not result in rutting, shoving, or bleeding.

Implementation

This project was undertaken to validate the AC adjustment policy and since the average in-place voids was found to be close to the center of the design range, no change to the policy is recommended. However, CDOT should consider additional guidance in making AC adjustments to achieve more consistent in-place voids. Forensic analysis of any pavement showing premature failure related to mix problems may help in developing and fine-tuning this guidance.

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INTRODUCTION

Based on research performed between 1995 through 2002 (Harmelink and Aschenbrener), CDOT established a new policy regarding the hot mix asphalt (HMA) mix designs. The policy allowed for adding additional asphalt cement (AC) to a mix up to a point where the design voids would be reduced as much as one percent. (Voids are defined as the air remaining in a mix after compaction: in the laboratory (design voids) or in the field (in-place voids).) This policy was based on the finding (Harmelink and Aschenbrener) that the SHRP Gyratory compactor process in the laboratory achieved a density that rolling and traffic loading in the field could not. The practice was hoped to achieve the desired in-place voids as the pavement was compacted by traffic over the subsequent three years. This research was undertaken to make sure this strategy was working.

Asphalt mix designing requires adjusting various components in order to meet standards. Air voids in the mix is an important standard. The target for most mixes is 4%, but an acceptable mix can have between 3.5% and 4.5% voids after compaction (CDOT, 2014, p. 3-29). Typically, based on the policy, if the original mix design resulted in 4% laboratory voids, the CDOT Engineer could require an additional amount of AC which would result in laboratory voids being as low as 3.0%. Since mix designers are required to create a graph of voids and VMA (voids in mineral aggregate) versus AC content, the Engineer can determine the amount of AC corresponding to up to one percent voids reduction without additional laboratory testing. It is also important that the AC adjustment does not cause a significant increase in the VMA. Such an increase in the VMA as AC content is increases is a sign that the AC is starting to push the aggregate particles apart preventing stone-on-stone contact resulting in stability problems.

This research was composed of analyzing cores from paving projects across Colorado to determine initial and subsequent in-place voids over the years. The effort resulted in the testing of 19 paving projects placed in 2003 and 2004. The final cores were taken in early 2008 providing in-place voids trends over four to five years.

DATA COLLECTION

Representative paving projects throughout the state were identified to evaluate the effectiveness of the new policy. Projects had to be designed on a SHRP Gyratory Compactor and had to be either an S or SX gradation. Below is the distribution of projects by Region:

Region 1 (East and Central Rural Colorado): 3
Region 2 (Southeast Colorado): 4
Region 3(Northwest Colorado): 5
Region 4(Northeast Colorado): 3
Region 5 (Southwest Colorado): 2
Region 6 (Denver Area): 2

For each project, mix samples were taken and five cores were taken shortly after the final rolling was finished. Laboratory analysis of these cores based on Rice specific gravity of the mix samples provided initial in-place voids. The average voids from these five cores are shown on the graphs in Appendix A.

The research technician returned to the site of each paving project approximately one month after paving was completed and took 15 cores. Three cores were taken transversely (left, center, and right) at five locations longitudinally (1, 2, 3, 4, and 5). The left-center-right positions were selected to encompass the location of the wheel path. Once voids are determined by laboratory analysis, one can ascertain which position was in the wheel path; the core with the lowest voids is the one in the wheel path.

One year after the paving, the research technician returned to each site and took five cores in the wheel path determined by the 15-core sampling the previous year. This procedure was repeated in 2005 and 2007 to establish a voids trend for each project. See graphs in Appendix A showing the average of the five cores for each project. For projects built in 2003, five points provided the trend and for projects built in 2004 only four points were available.

Rutting measurements were also taken each year, but were essentially zero for all the projects through 2007, and therefore, not reported.

Project records were used to ascertain parameters of the mix design including design void percentages and the laboratory void percentages expected after the AC content was increased (adjusted voids). Data from CDOT’s 2012 Statewide Roadway Condition Survey is also provided for reference in Appendix A. Finally, 20-year Equivalent Single Axle Loads (ESALs) are calculated from 2011 traffic data obtained from CDOT’s online web page (CDOT, 2013).

DATA ANALYSIS

Appendix A provides individual in-place void trend curves for each project. Generally, the in-place voids start out high (6 to 10 %) and come down significantly after the first year. After two years most projects reach their minimum, staying there for the rest of the monitoring period. Consistent with the findings of the original in-place voids study (Harmelink and Aschenbrener) there little further reduction in voids after three years. There are some exceptions to this generalization with in-place voids on some projects going up after the initial drop.

Figure 1 shows the relationship between the minimum and the initial in-place voids. The final minimum in-place voids are generally higher when the initial voids are high, but the correlation is not strong. Even if the initial in-place voids are high, roadways (especially those with heavy traffic) can experience a significant drop in voids. Since it is unreasonable to expect in-place voids to increase over time, the minimum in-place voids sometime during the monitoring period was selected as a variable for this graph as opposed to the latest value to avoid the few cases where the in-place voids went up in subsequent years. The increase in voids over time could be a reflection of the variability of the sampling methodology or the existence of an overlay unknown to the author.

Figure 1
Minimum vs Initial In-Place Voids

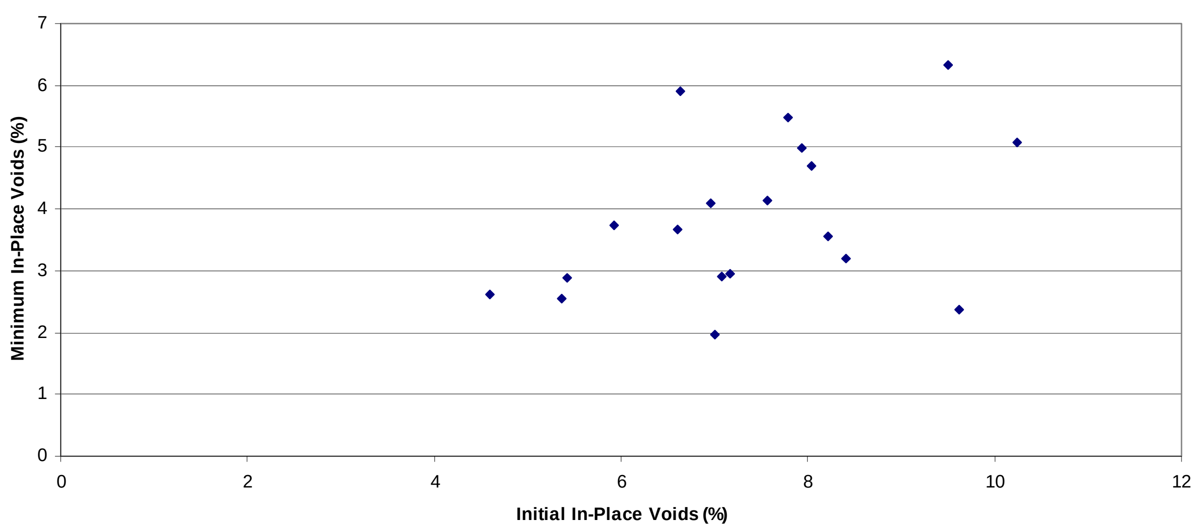
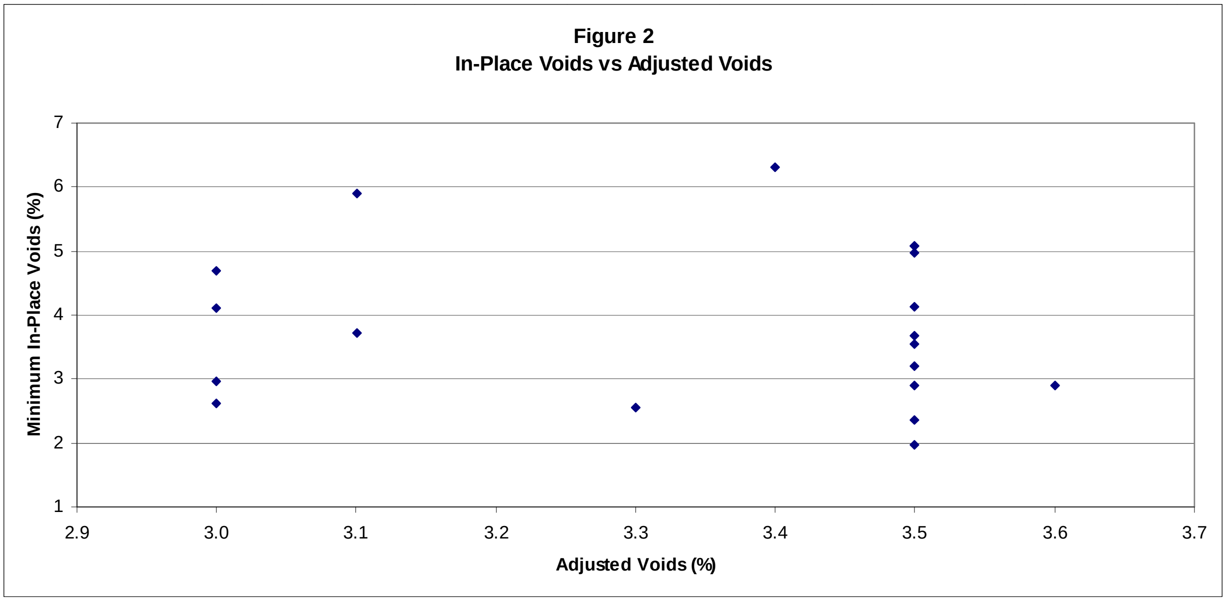
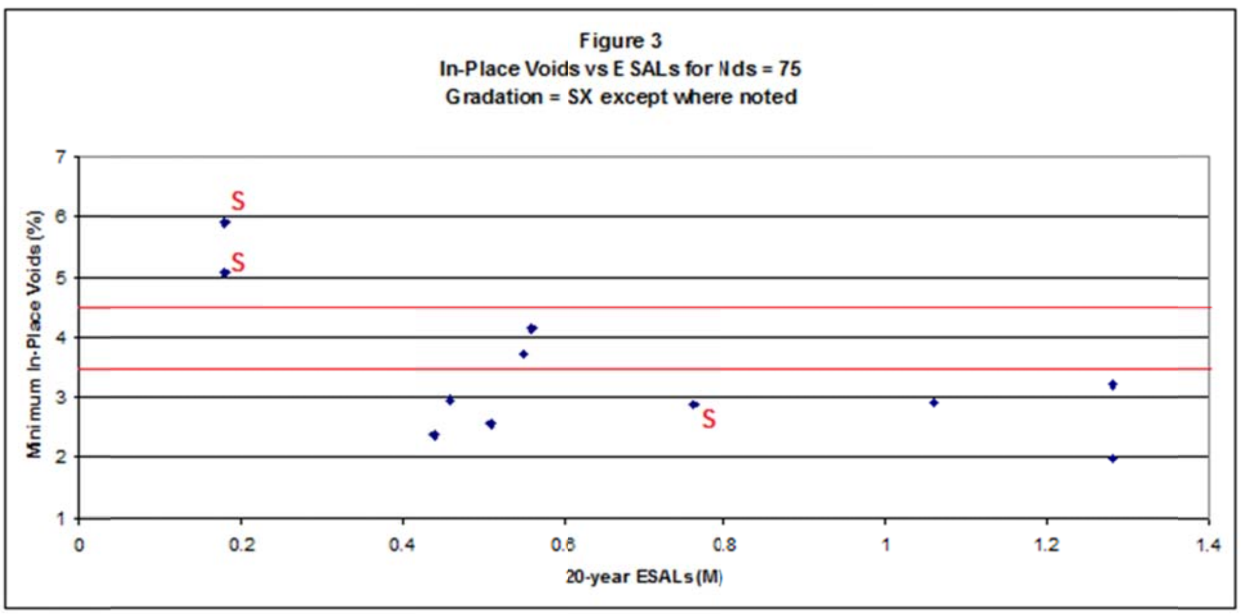
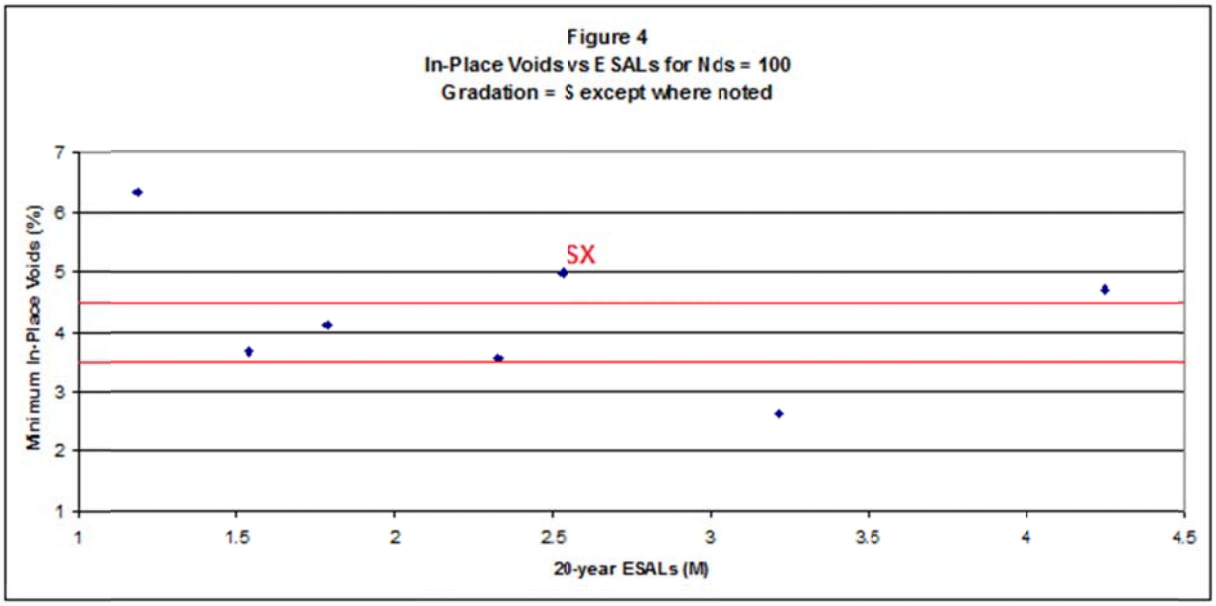


Figure 2 shows the relationship between in-place voids and adjusted voids. All but one of the projects were built with an adjusted voids of 3.0 to 3.1 percent or 3.4 to 3.6 percent. In either case, a broad range of in-place voids resulted. Within the range normally used, there does not seem to any correlation between in-place voids and adjusted voids.



The following two graphs show the relationship between in-place voids and pavement loading. Figure 3 shows the data for projects that used a medium compaction effort (N_{ds} = 75) for the mix design and Figure 4 shows the data for those projects that used a high compaction effort (N_{ds} = 100) for the mix design. Gradation was also noted on these graphs to explore whether it is an issue in achieving appropriate in-place voids.





For the N_{ds}-75 projects, in-place voids generally go down with higher traffic loading. For the two pavements with the light traffic, the in-place voids remained above 5.5%. Because of the low traffic, this is probably not a problem, but the pavement could be subject to weathering and raveling. On the other extreme, the one pavement with high traffic loading had in-place voids go below 2% and because of the heavy traffic, may be subject to rutting, shoving, and bleeding. All but three of these N_{ds}-75 projects used a grading SX. Two of the three projects that used grading S had in-place voids that were too high, while the third had in-place voids that were too low. These 11 projects had average in-place voids of 3.4 %, which is slightly below the design range of 3.5% to 4.5%. Further only two of the 11 projects had in-place voids within the laboratory design range.

The graph of N_{ds}-100 projects does not seem to reveal any correlation between in-place voids and traffic loading (ESALs). Three of the projects had minimum in-place voids above the design range (3.5% to 4.5%), three of the projects were about right (in the design range), and one project had low in-place voids (2.6%). However, the average in-place voids of these seven projects was 4.3%, within the design range.

When all 19 projects are averaged together (including the N_{ds}-50 project not shown on the above two graphs), you get a value of 3.8% in-place voids, close to the center of the design.

CONCLUSIONS

The average in-place voids achieved after traffic compaction for the 19 projects is 3.8%. Therefore, since this average is close to the center of the design range of 3.5% to 4.5%, the AC adjustment policy is working. But there seems to be significant scatter in the voids data and even aggressive AC adjustment, in some cases, does not seem to avoid high in-place voids. Conversely, several other projects wound up with voids that are generally considered too low. There seem to be other factors at play that were not monitored that are affecting the in-place voids. Additional guidance regarding when and how much to adjust the AC may help in consistently reaching the proper in-place voids. All that said, in-place voids is not the only measure of a good mix. Aside from the cost for the additional AC, a mix that results in in-place voids below 3.5% may result in better long term pavement performance as long as the condition does not result in rutting, shoving, or bleeding. But per the Asphalt Institute (2013) "… when the void content drops to 2% or less, the mix becomes plastic and unstable."

REFERENCES

Harmelink and Aschenbrener. "In-Place Voids Monitoring of Hot Mix Asphalt Pavements", Colorado Department of Transportation, September 2002, CDOT-DTD-R-2002-11.

CDOT, 2014. "2014 Pavement Design Manual", Colorado Department of Transportation.

CDOT, 2013. "Online Transportation Information System (OTIS) Traffic Explorer", http://dtdapps.coloradodot.info/Otis/TrafficData

Asphalt Institute, 2013. "Asphalt Pavement Thickness and Mix Design FAQs", http://www.asphaltinstitute.org/public/engineering/design/asphalt-pavement-thickness-and-mix-design-faqs.dot

APPENDIX A: DATA BY PROJECT

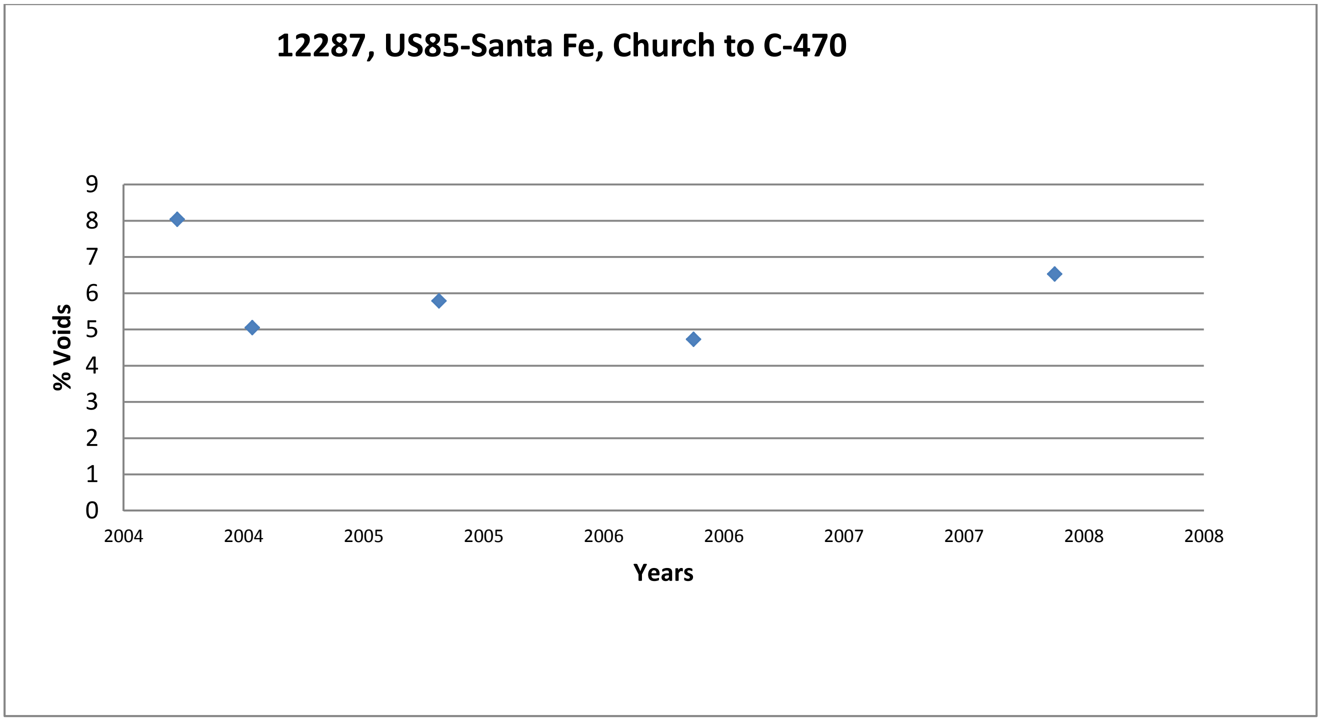
Void trends are shown on the following 19 pages for each of the projects tracked. Below each of the graphs is a table listing data items that may have relevance to the in-place voids and how they impacted the performance of the pavement over time. The first six lines in each table relate to the mix design.

- "Grading" relates to the gradation specification for the mix, per CDOT Specification 703.04.
- "Compaction" is the number of gyrations N_{ds} used to compact the mix in the SHRP Gyratory compactor.
- "Original Design Voids" is the percent voids achieved with N_{ds} gyrations with the original design mix. For cases where the original mix design was not available "[4.0]" was entered since the goal of the designer is to provide a mix design close to 4.0 % voids.
- "Adjusted Voids" is the percent laboratory air voids expected (based on the original design mix curves) when AC content of the mix is increased.
- "Stability" is the HVEEM stability value expected based on original design mix curves using the adjusted AC content.
- "20-year ESAL (M)" is a rough estimate of the equivalent millions of single axle loads over 20-years based on 2011 traffic data. (The formula used is: 0.003 * annual average daily passenger cars and light trucks + 0.249 * single unit trucks + 1.087 * combination trucks. (CDOT, 2014 (Table 1.2)).

The last four lines in the table provide rutting and cracking information collected from the annual state wide survey from a representative section within the project limits for the year indicated.

- "Rutting" is the average rut in the wheel path in inches.
- "Longitudinal Cracking" is the linear feet of longitudinal cracking in a tenth mile section.
- "Transverse Cracking" is the number of transverse cracks in a tenth mile section.
- "Fatigue Cracking" is the square feet of alligator cracking in a tenth mile section.

A qualitative discussion was provided at the bottom of each page attempting to assess how the in-place voids behaved over time and how they related to pavement performance. Although in-place voids can have an impact on rutting, transverse, and fatigue cracking, the condition of the substrate also plays a role. Therefore, lacking comprehensive evaluations of the pavements before the overlays, a quantitative assessment of this relationship is not possible.



Grading	S
Compaction (N_{ds})	100
Original Design Voids (%)	[4.0]
Adjusted Voids (%)	3.0
Stability	30
20-year ESALs (M)	4.25
2012 Condition per 0.1 mi.	
Rutting (in.)	0.20
Longitudinal Cracking (ft.)	266
Transverse Cracking (#)	23
Fatigue Cracking (sq. ft.)	57

Comments:

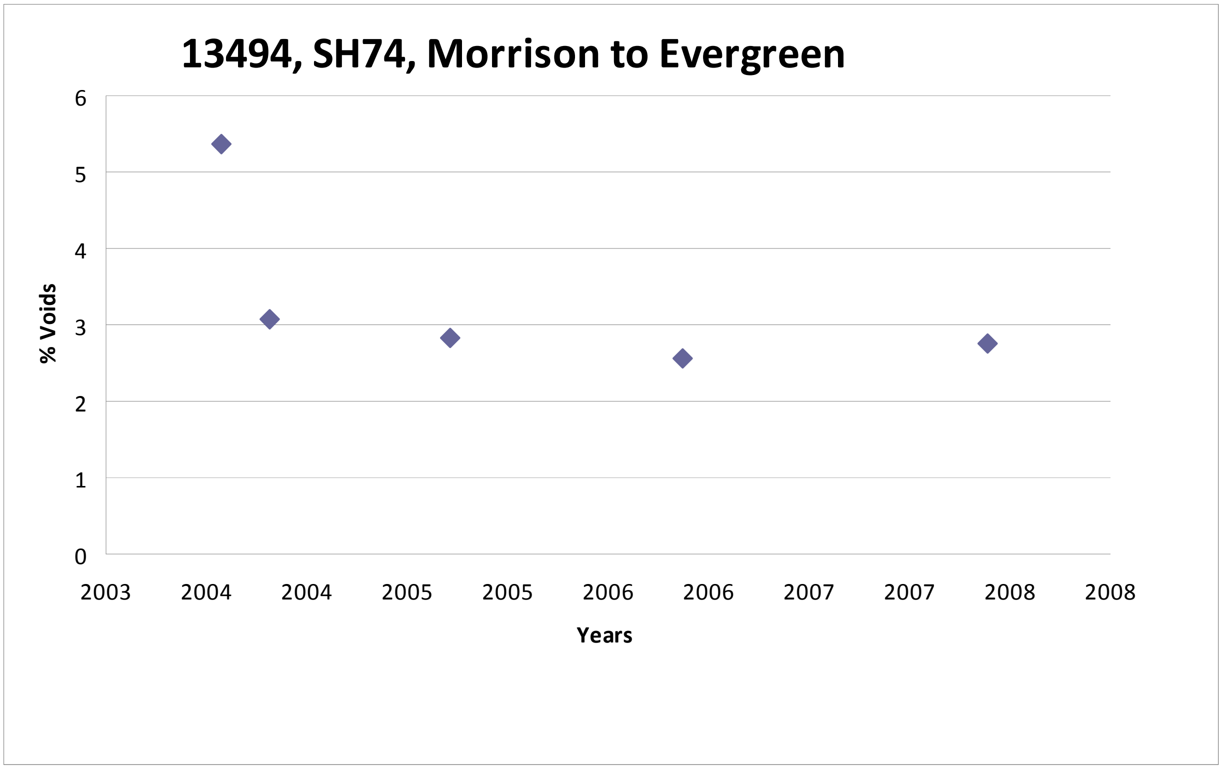
The in-place voids went down during the first year to around 5.0% due to substantial traffic loading (daily ESAL = 4.25M), but never got down below 4.5% (the maximum allowed for a mix design). This could be due to the voids in the overlay starting out high (8 %) combined with the aggressive compaction effort (Nds = 100) used in the design. In 2008 the in-place voids went up to 6.5% which is probably due to some undocumented overlay between 2006 and 2008. Due to this overlay, the rutting and cracking data are probably not relevant to the original overlay in 2003.

Grading	S
Compaction (N_{ds})	75
Original Design Voids (%)	3.9
Adjusted Voids (%)	3.5
Stability	28
20-year ESALs (M)	0.18
2012 Condition per 0.1 mi.	
Rutting (in.)	0.09
Longitudinal Cracking (ft.)	15
Transverse Cracking (#)	1
Fatigue Cracking (sq. ft.)	0

Comments:

Aside from the 2004 data point, the in-place voids appear to go down over time in a uniform way. The fact that it took five years to reach final in-place voids is probably due to the low traffic loading.

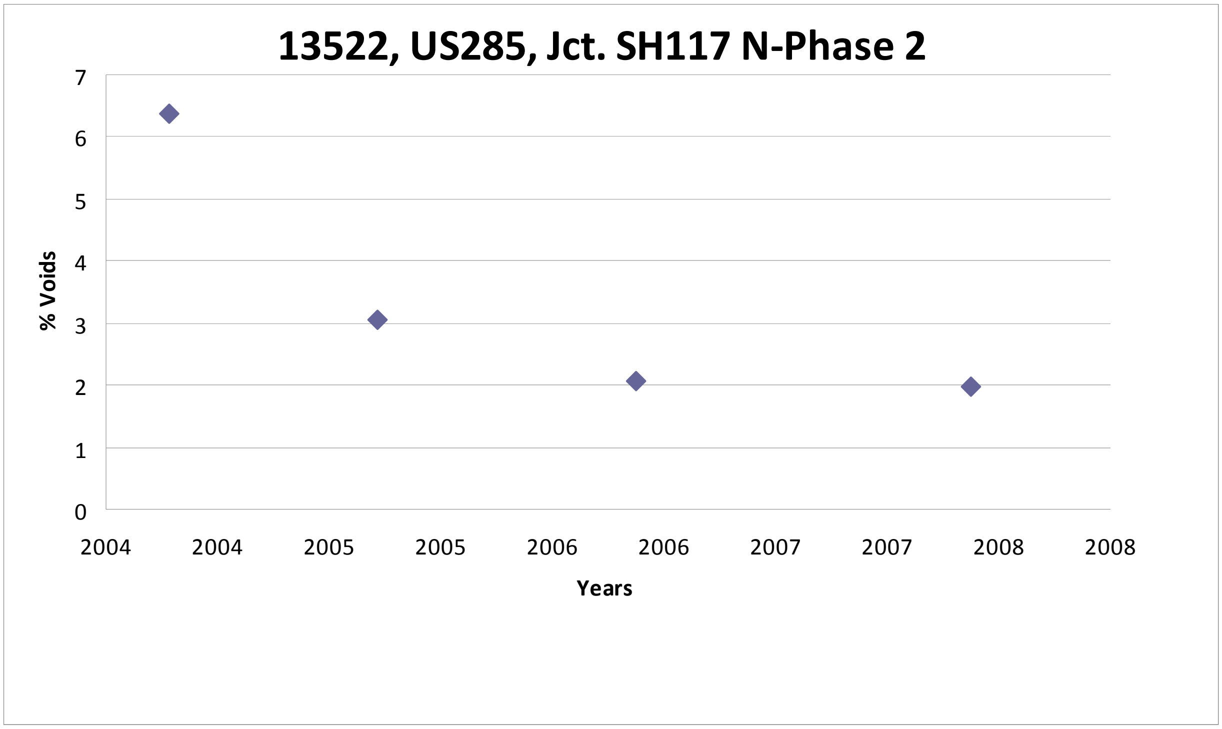
Since there appears to be a problem with the 2004 data point, the 2008 data point was used as the “minimum in-place voids” for this project.



Grading	SX
Compaction (N_{ds})	75
Original Design Voids (%)	4.0
Adjusted Voids (%)	3.3
Stability	28
20-year ESALs (M)	0.51
2012 Condition per 0.1 mi.	
Rutting (in.)	0.15
Longitudinal Cracking (ft.)	0
Transverse Cracking (#)	13
Fatigue Cracking (sq. ft.)	116

Comments:

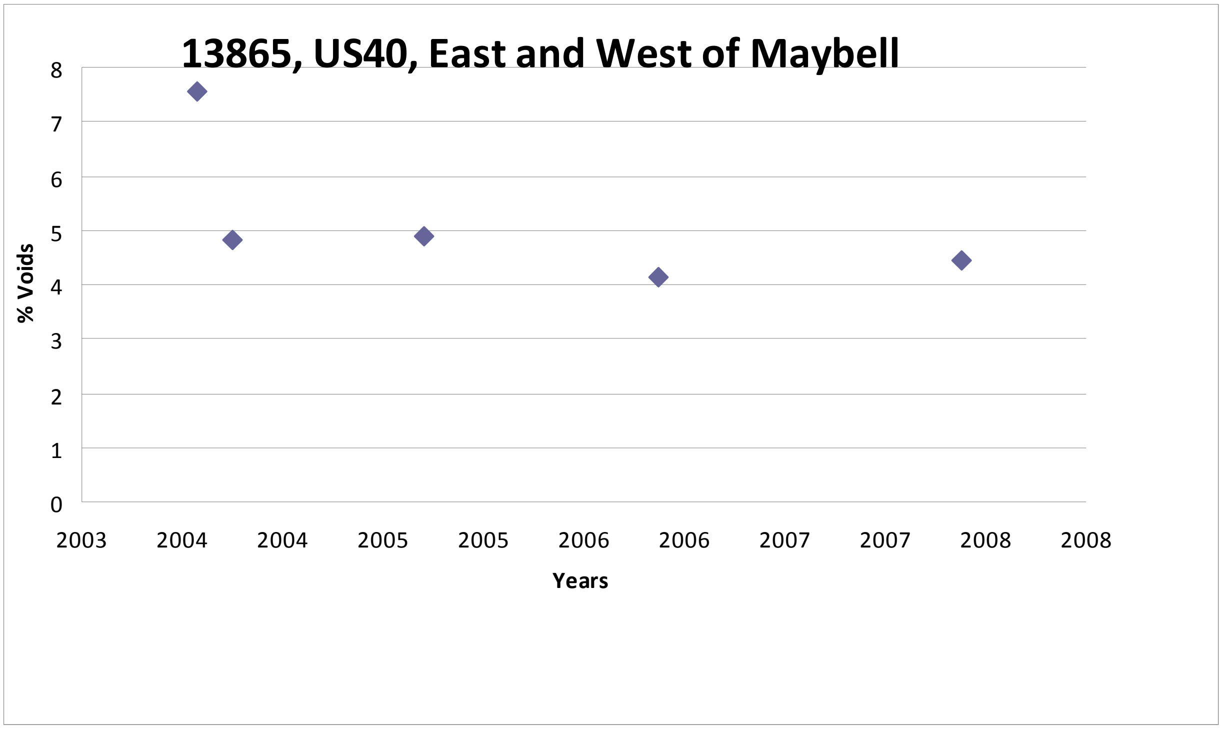
The pavement was constructed with in-place voids of 5.3% and pavement traffic loading after one year brought it down to just above 3% and on down to 2.6%.



Grading	SX
Compaction (N_{ds})	75
Original Design Voids (%)	[4.0]
Adjusted Voids (%)	3.5
Stability	28
20-year ESALs (M)	1.28
2012 Condition per 0.1 mi.	
Rutting (in.)	0.13
Longitudinal Cracking (ft.)	n/a
Transverse Cracking (#)	n/a
Fatigue Cracking (sq. ft.)	n/a

Comments:

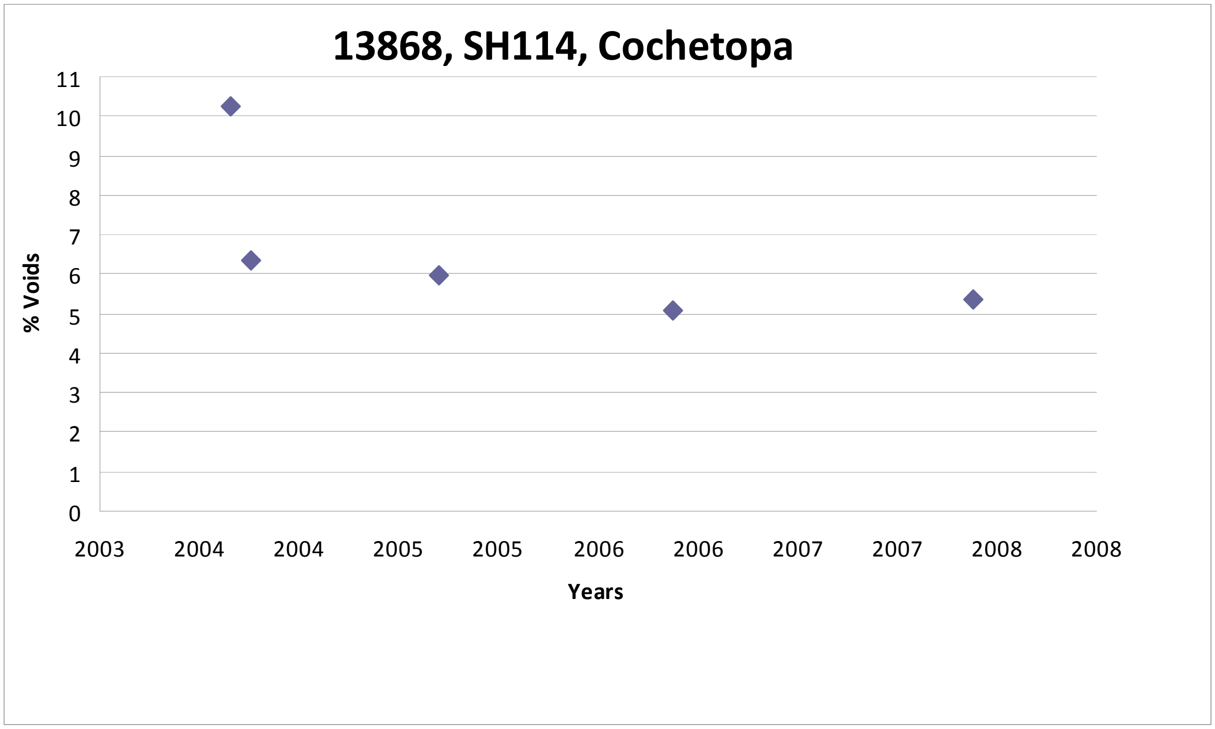
The in-place voids went down after the first year to around 3.0% due to traffic loading (daily ESAL = 1.28M). However, in-place voids went down further to 2.0% in 2006. But based on the modest rutting (0.13 in.), it appears that there is no rutting or shoving problem typically related to low voids.



Grading	SX
Compaction (N_{ds})	75
Original Design Voids (%)	[4.0]
Adjusted Voids (%)	3.5
Stability	28
20-year ESALs (M)	0.56
Rutting (in.)	0.34
Longitudinal Cracking (ft.)	21
Transverse Cracking (#)	18
Fatigue Cracking (sq. ft.)	33

Comments:

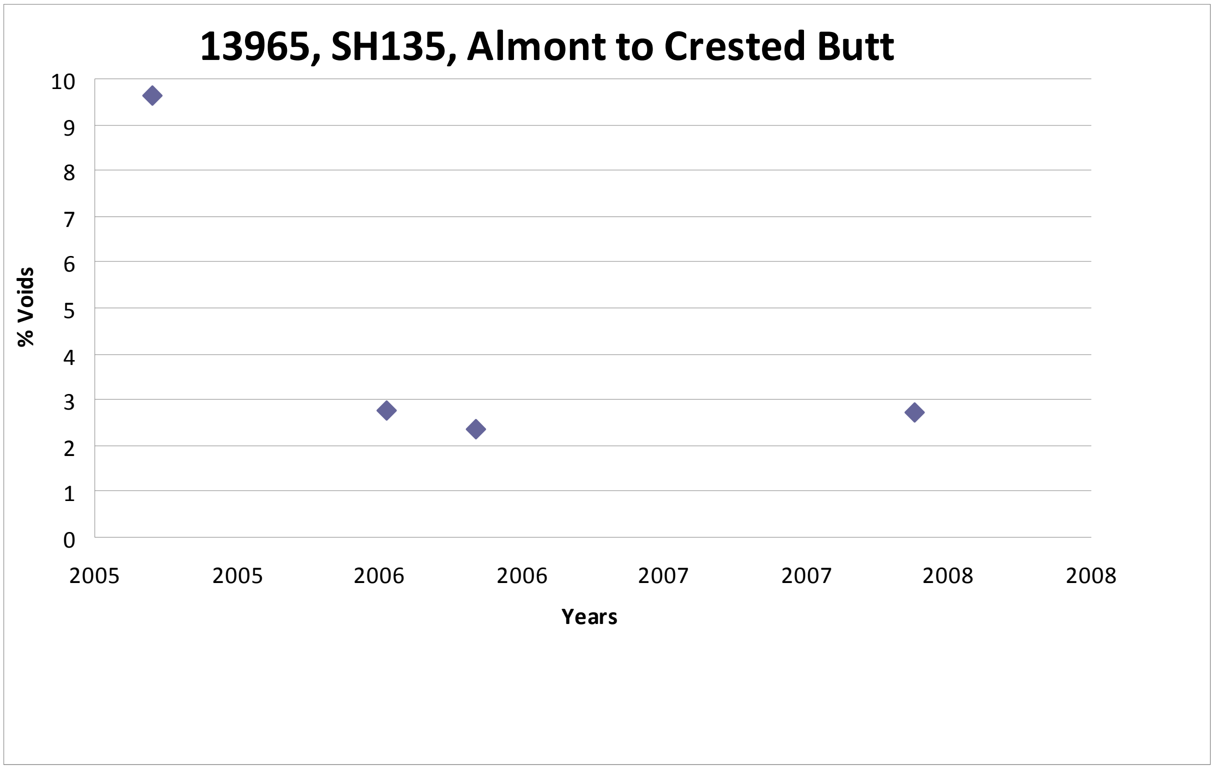
The pavement was constructed with in-place voids of 7.6% and dropped to just under 5.0% after a year of traffic. Long-term traffic compacted the pavement down to 4.4% in-place voids, the high end of the mix design requirement in the laboratory.



Grading	SX
Compaction (N_{ds})	50
Original Design Voids (%)	4.0
Adjusted Voids (%)	3.5
Stability	28
20-year ESALs (M)	0.17
2012 Condition per 0.1 mi.	
Rutting (in.)	0.12
Longitudinal Cracking (ft.)	754
Transverse Cracking (#)	2
Fatigue Cracking (sq. ft.)	373

Comments:

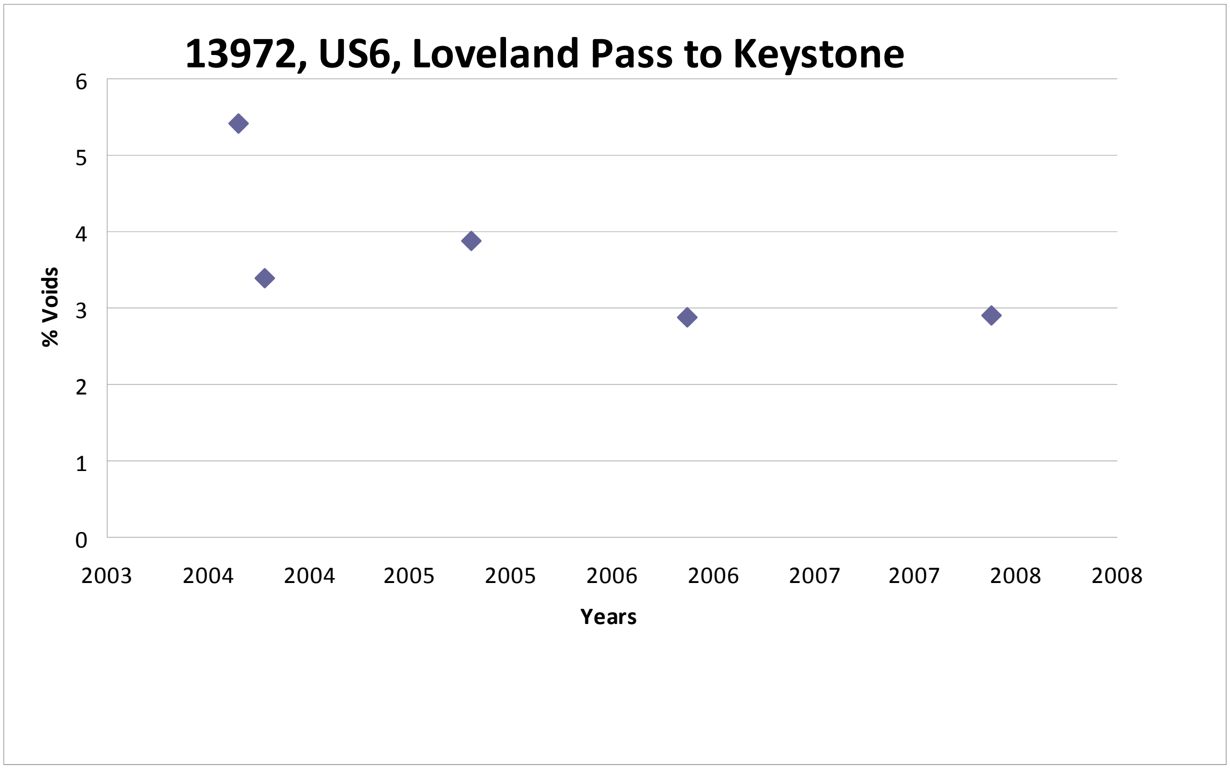
The pavement was constructed with in-place voids of 10.2% even though the AC content was increased to reduce the target in-place voids by 0.5%. The light traffic was able to compact the pavement to 6.0% in two years. Traffic compaction continued in later years but only resulted in in-place voids of about 5%. While rutting remains low after nine years, fatigue cracking appears to be becoming a problem. For this project, the flexibility for the Engineer to adjust the AC appears to be highly important. Maintaining the AC content corresponding to the higher design target voids would probably have resulted in early failure of the pavement.



Grading	SX
Compaction (N_{ds})	75
Original Design Voids (%)	[4.0]
Adjusted Voids (%)	3.5
Stability	28
20-year ESALs (M)	0.44
2012 Condition per 0.1 mi.	
Rutting (in.)	0.15
Longitudinal Cracking (ft.)	116
Transverse Cracking (#)	0
Fatigue Cracking (sq. ft.)	39

Comments:

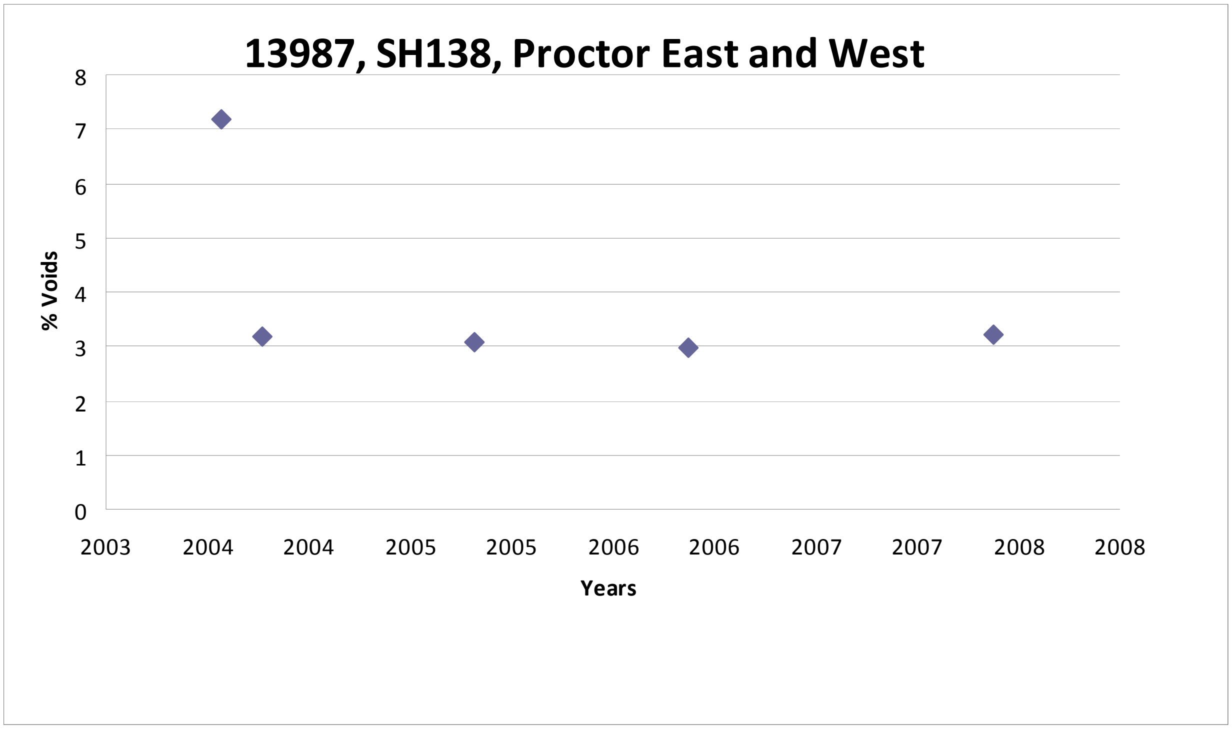
The in-place voids went down in the first year from 9.6% to around 3.0 % while the laboratory target value is 3.5%. It is not clear why the in-place voids over time went down to almost 2% with only light pavement loading. However, the condition did not seem to have an impact on pavement performance since the rutting was only 0.15 inches after nine years of service.



Grading	SX
Compaction (N_{ds})	75
Original Design Voids (%)	4.0
Adjusted Voids (%)	3.6
Stability	28
20-year ESALs (M)	0.79
2012 Condition per 0.1 mi.	
Rutting (in.)	0.11
Longitudinal Cracking (ft.)	317
Transverse Cracking (#)	6
Fatigue Cracking (sq. ft.)	14

Comments:

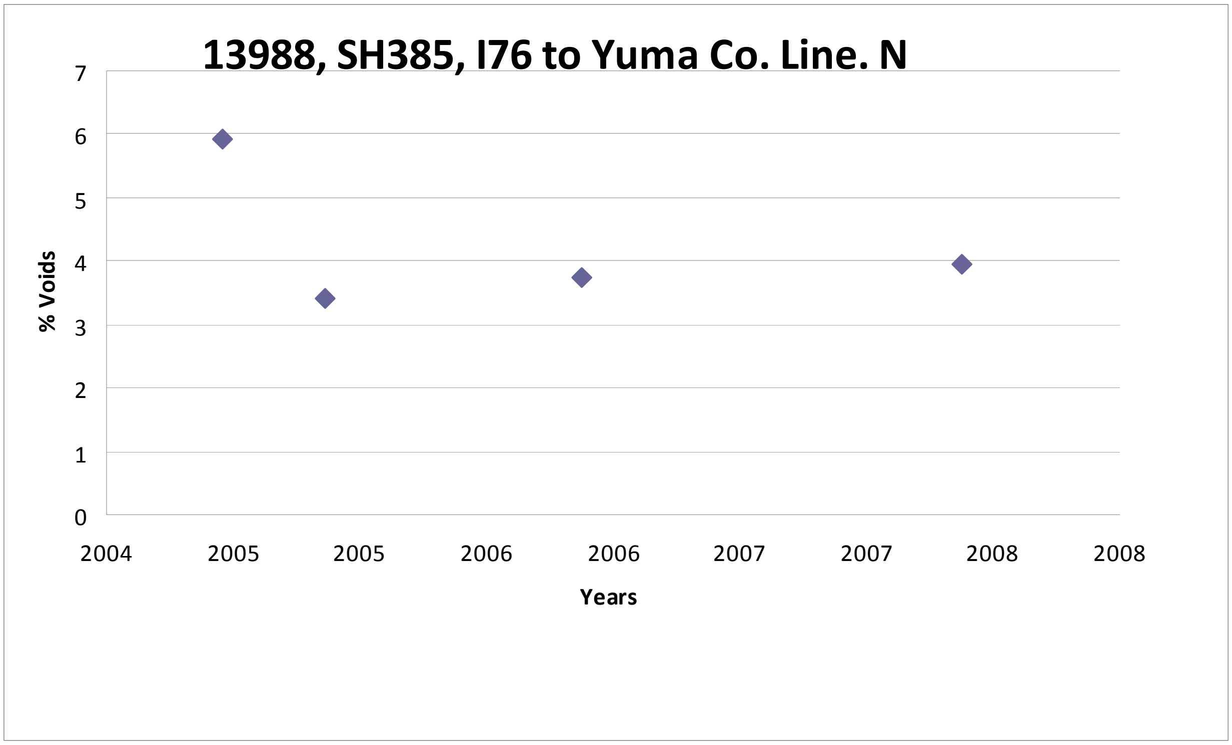
The pavement was constructed with in-place voids of 5.4% and pavement traffic loading over the years brought it down between 3 and 4%.



Grading	S
Compaction (N_{ds})	75
Original Design Voids (%)	[4.0]
Adjusted Voids (%)	3.0
Stability	28
20-year ESALs (M)	0.46
2012 Condition per 0.1 mi.	
Rutting (in.)	0.12
Longitudinal Cracking (ft.)	0
Transverse Cracking (#)	82.5
Fatigue Cracking (sq. ft.)	0

Comments:

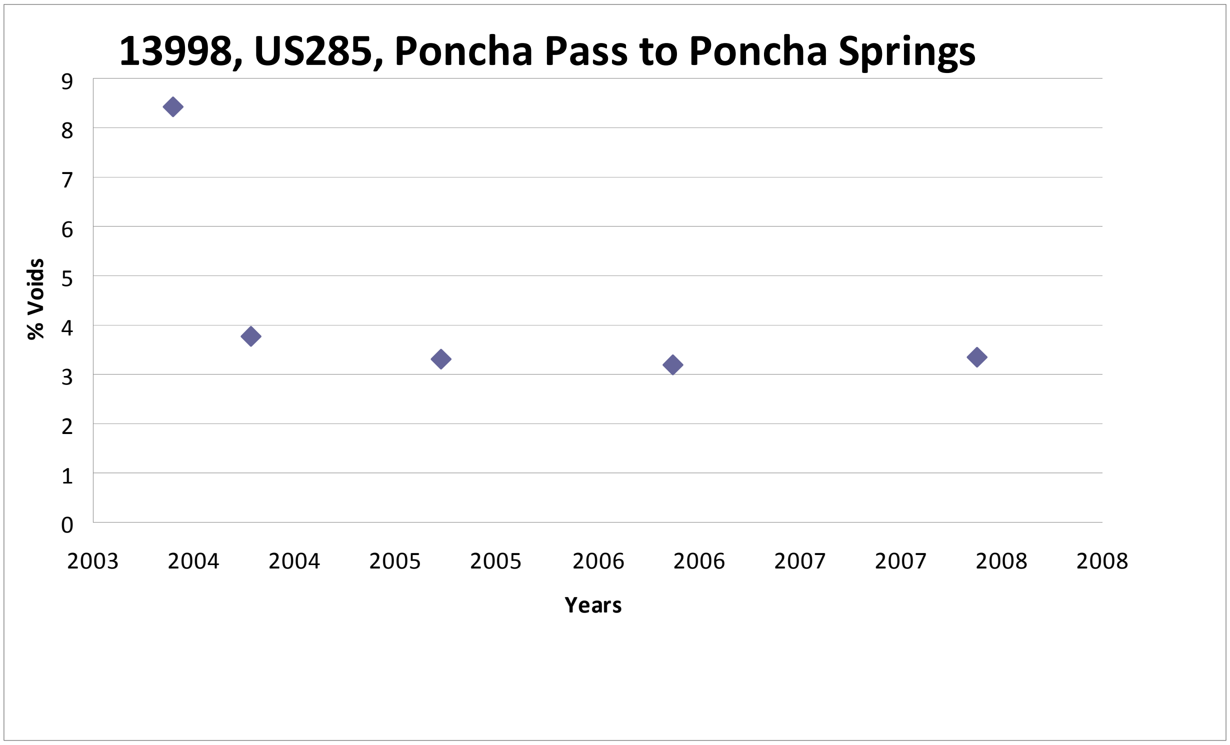
The in-place voids went down in the first year from 7.1% to close to the laboratory target value of 3.1% and remained stable. In this case, if the AC was not adjusted, the long-term in-place voids may have been closer to the ideal 4.0%



Grading	SX
Grading	SX
Compaction (N_{ds})	75
Original Design Voids (%)	[4.0]
Adjusted Voids (%)	3.1
Stability	28
20-year ESALs (M)	0.55
2012 Condition per 0.1 mi.	
Rutting (in.)	0.17
Longitudinal Cracking (ft.)	n/a
Transverse Cracking (#)	n/a
Fatigue Cracking (sq. ft.)	n/a

Comments:

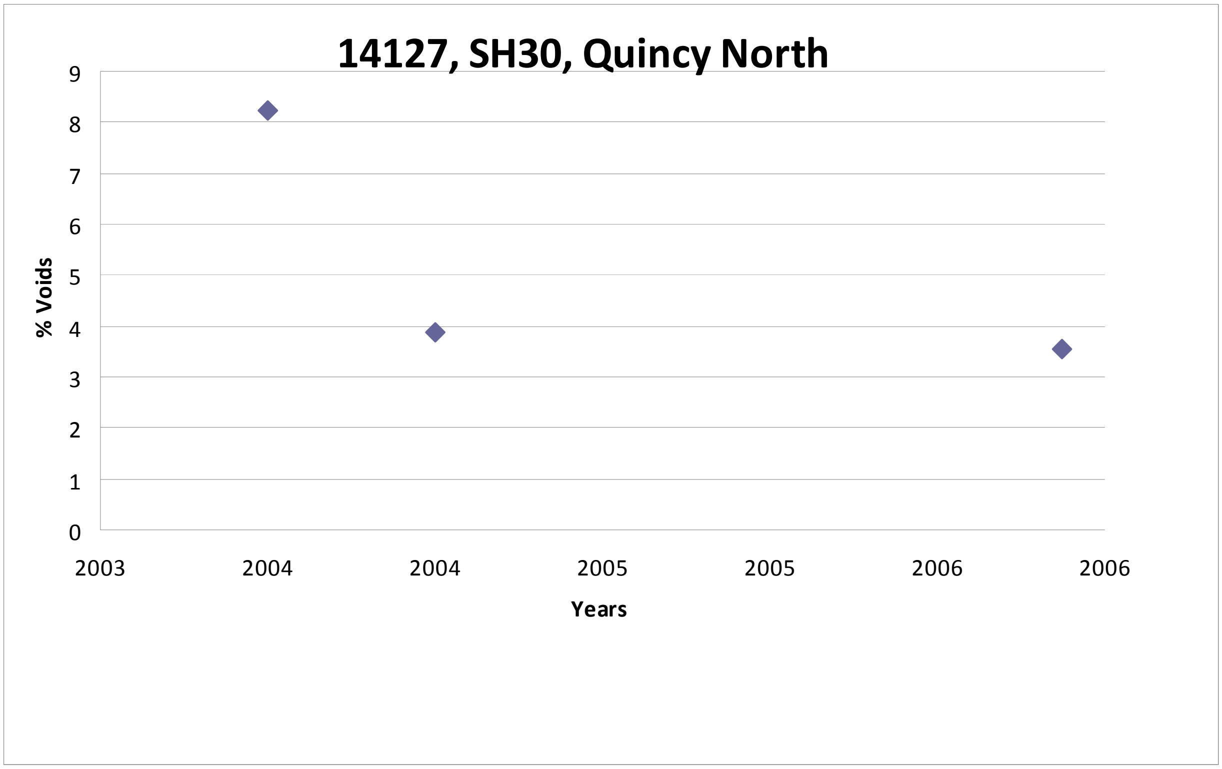
The in-place voids went down in the first year from 5.9% to within the laboratory design range of 3.5 to 4.5%. The pavement appears to have the ideal AC content.



Grading	SX
Compaction (N_{ds})	75
Original Design Voids (%)	4.1
Adjusted Voids (%)	3.5
Stability	28
20-year ESALs (M)	1.28
2012 Condition per 0.1 mi.	
Rutting (in.)	n/a
Longitudinal Cracking (ft.)	n/a
Transverse Cracking (#)	n/a
Fatigue Cracking(sq. ft.)	n/a

Comments:

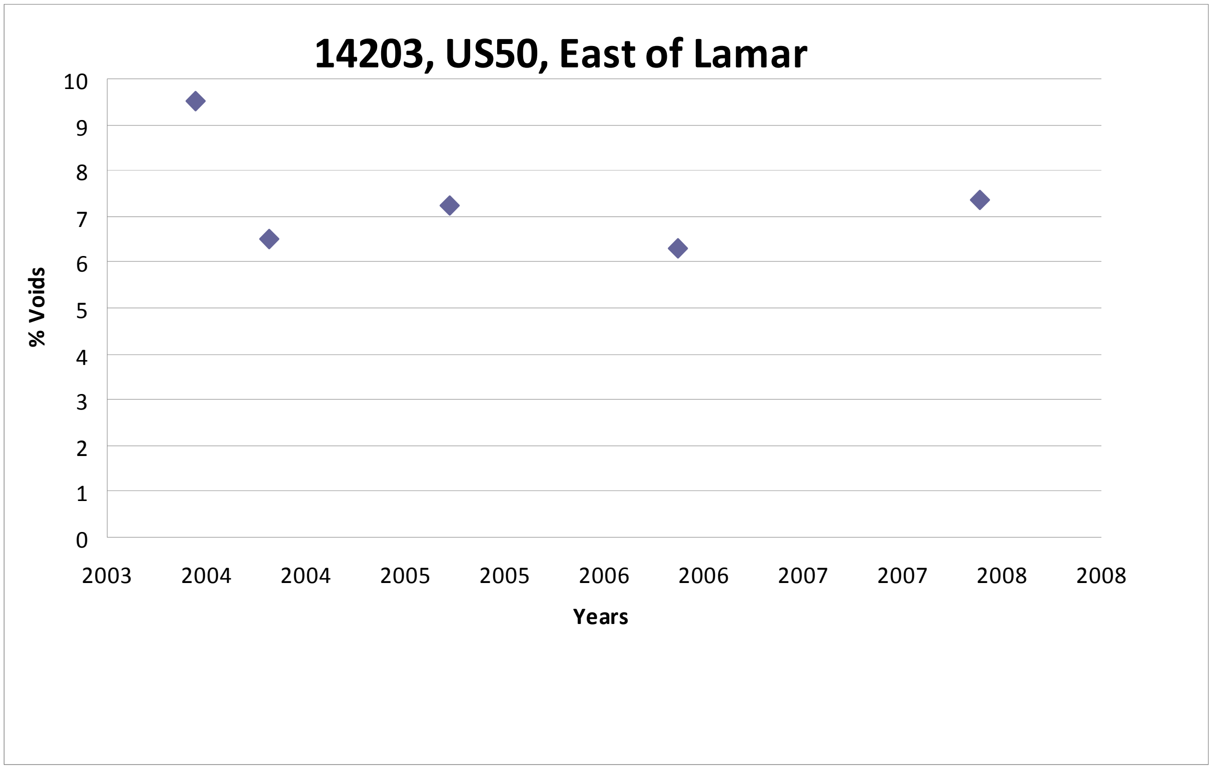
The in-place voids went down after to the first year to just below 4.0% and stayed above 3.0%. This is slightly below the design range (3.5% to 4.5%). But it should not be a problem and may be beneficial in the high-altitude environment.



Grading	S
Compaction (N_{ds})	100
Original Design Voids (%)	[4.0]
Adjusted Voids (%)	3.5
Stability	30
20-year ESALs (M)	2.33
2012 Condition per 0.1 mi.	
Rutting (in.)	0.21
Longitudinal Cracking (ft.)	n/a
Transverse Cracking (#)	n/a
Fatigue Cracking (sq. ft.)	n/a

Comments:

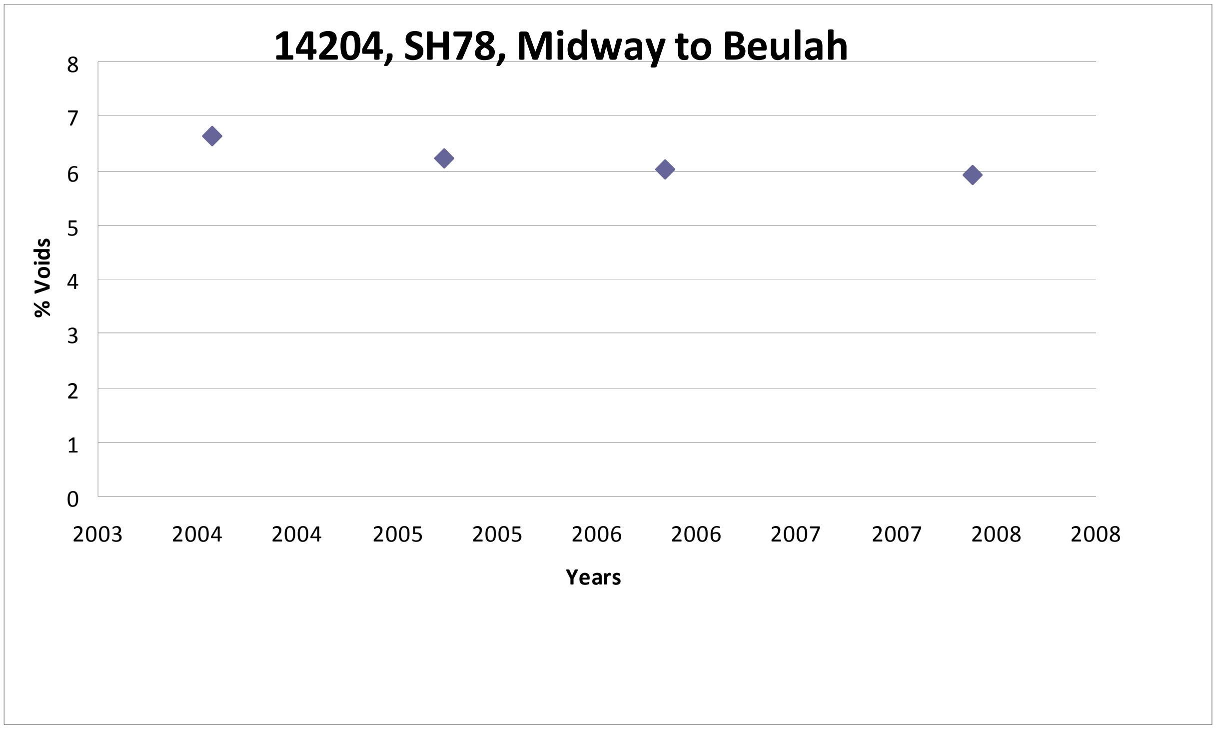
The pavement was constructed with in-place voids of 8.2% and dropped to below 4 % in one year. The AC content to reduce laboratory voids by 0.6% appears to have worked well, bringing the in-place voids within the design range (3.5% to 4.5%).



Grading	S
Compaction (N_{ds})	100
Original Design Voids (%)	4.0
Adjusted Voids (%)	3.4
Stability	28
20-year ESALs (M)	1.19
2012 Condition per 0.1 mi.	
Rutting (in.)	0.20
Longitudinal Cracking (ft.)	0
Transverse Cracking (#)	10
Fatigue Cracking (sq. ft.)	0

Comments:

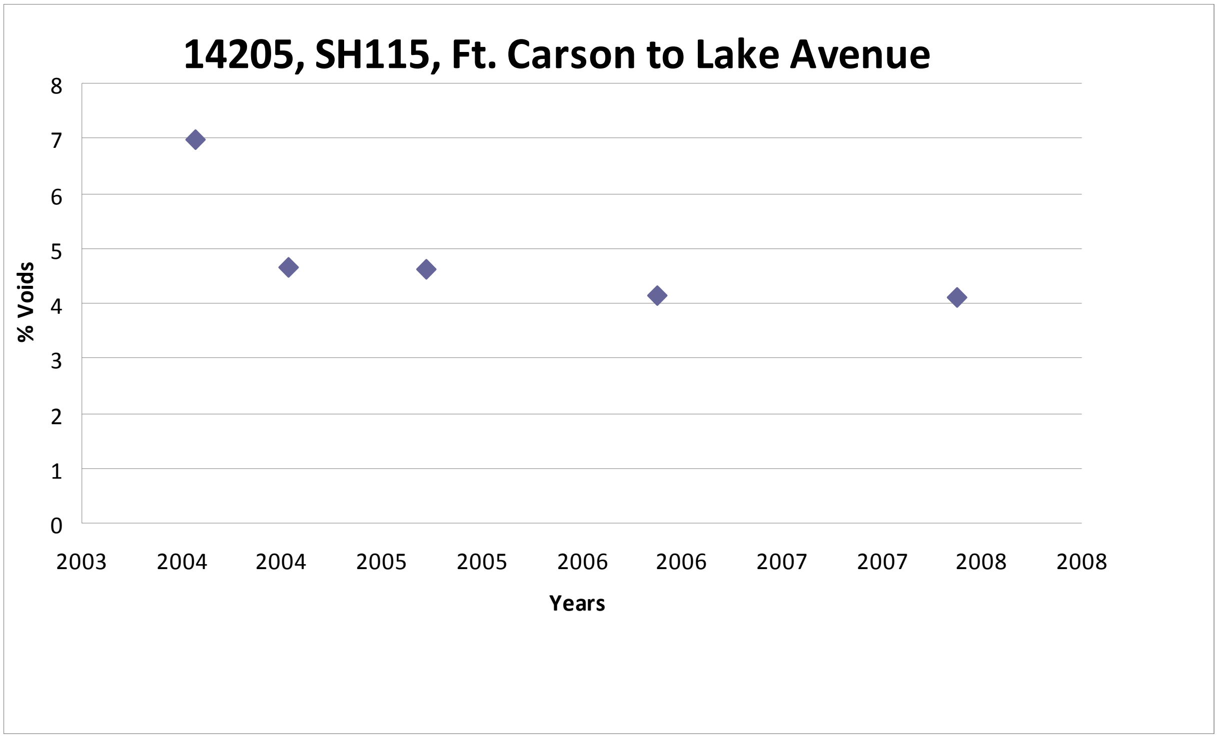
The pavement was constructed with in-place voids of 9.5% even though the AC content was increased to reduce the target in-place voids by 0.6%. The moderate pavement traffic was unable to reduce the in-place voids much below 6.0%. With a design based on a high compaction effort (N_{ds} = 100) the moderate pavement loading (daily ESALs = 1.19) could not bring the in-place voids closer to the target value.



Grading	S
Compaction (N_{ds})	75
Original Design Voids (%)	[4.0]
Adjusted Voids (%)	3.1
Stability	28
20-year ESALs (M)	0.18
2012 Condition per 0.1 mi.	
Rutting (in.)	0.14
Longitudinal Cracking (ft.)	n/a
Transverse Cracking (#)	n/a
Fatigue Cracking (sq. ft.)	n/a

Comments:

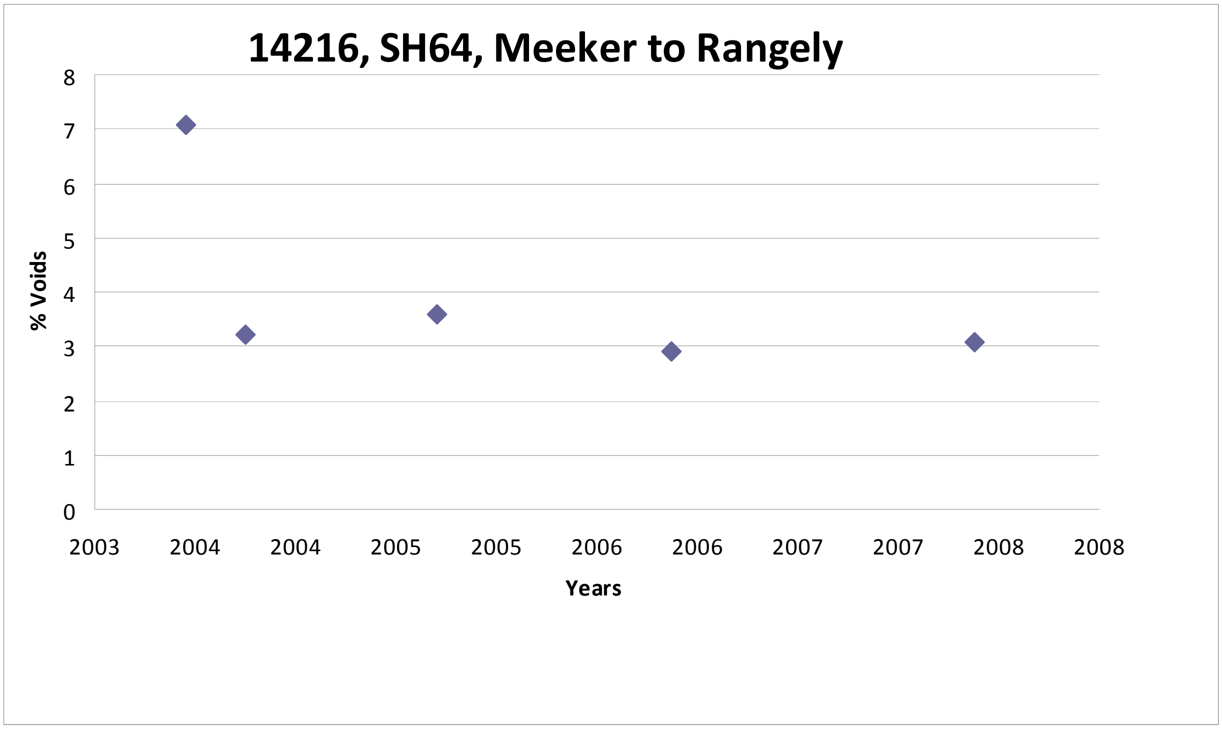
The pavement was constructed with in-place voids of 6.6% and the light traffic was unable to reduce the in-place voids much below 6.0%.



Grading	S
Compaction (N_{ds})	100
Original Design Voids (%)	4.0
Adjusted Voids (%)	3.0
Stability	30
20-year ESALs (M)	1.79
2012 Condition per 0.1 mi.	
Rutting (in.)	0.13
Longitudinal Cracking (ft.)	0
Transverse Cracking (#)	9
Fatigue Cracking (sq. ft.)	0

Comments:

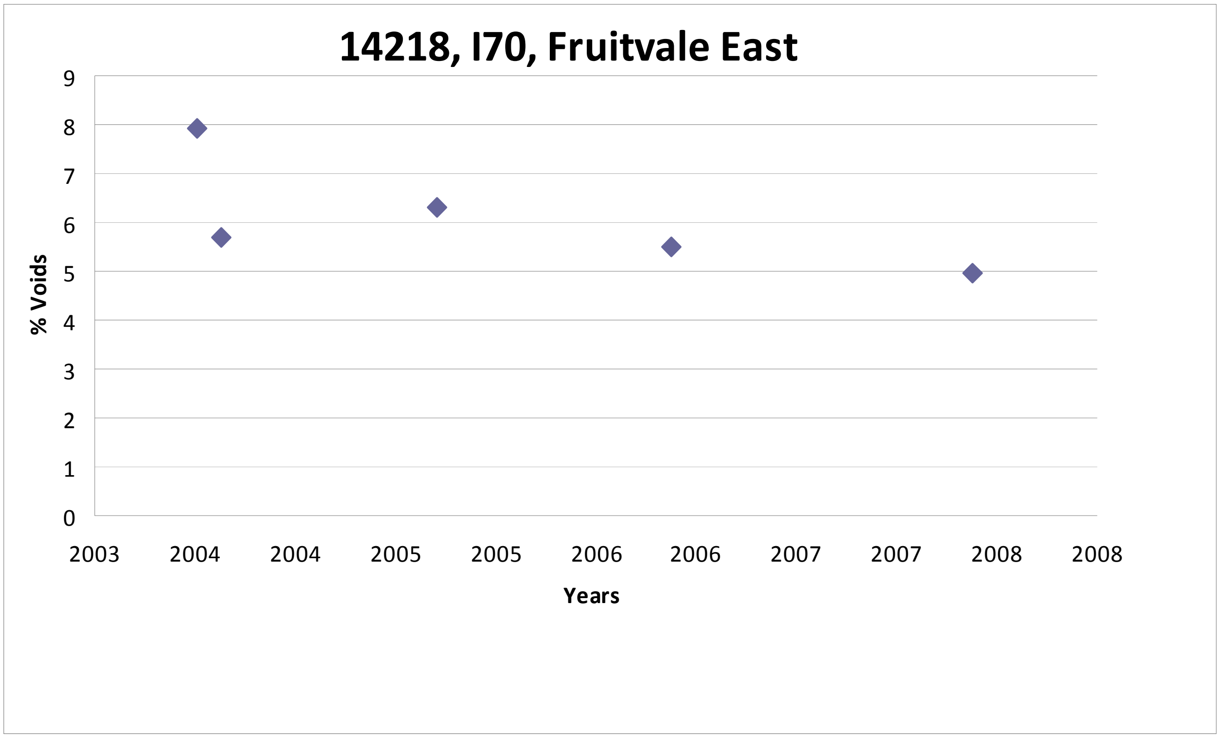
The pavement was constructed with in-place voids of 7.0% and pavement traffic loading and brought it down to 4.2% close to the center of the laboratory design range.



Grading	SX
Compaction (N_{ds})	75
Original Design Voids (%)	[4.0]
Adjusted Voids (%)	3.5
Stability	28
20-year ESALs (M)	1.06
2012 Condition per 0.1 mi.	
Rutting (in.)	0.14
Longitudinal Cracking (ft.)	0
Transverse Cracking (#)	10
Fatigue Cracking (sq. ft.)	43

Comments:

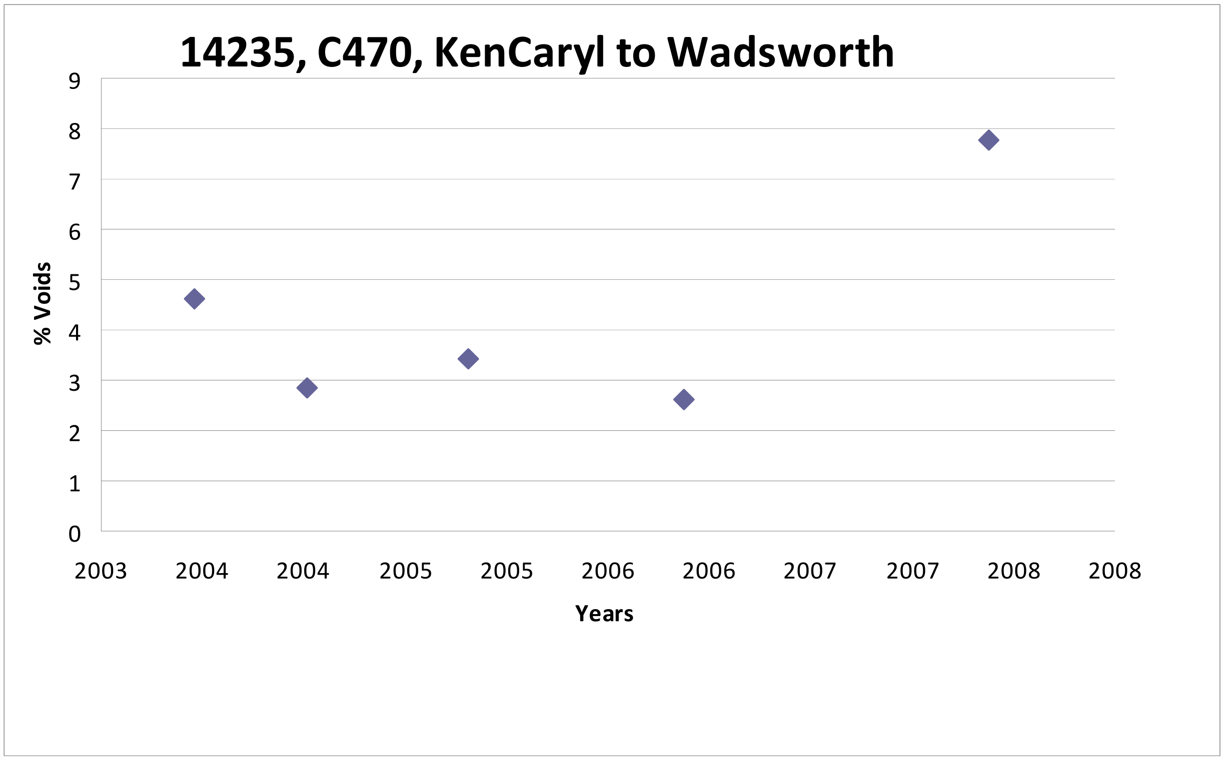
The in-place voids went down in the first year from 7.1% to around about 3.0%. Even though it is below the laboratory design range, the pavement appears to be performing well over the last 9 years with only 0.14 inches of rutting and low cracking.



Grading	SX
Compaction (N_{ds})	100
Original Design Voids (%)	[4.0]
Adjusted Voids (%)	3.5
Stability	30
20-year ESALs (M)	2.53
Before 2011 Chip Seal per 0.1 mi.	
Rutting (in.)	0.12
Longitudinal Cracking (ft.)	754
Transverse Cracking (#)	2
Fatigue Cracking (sq. ft.)	373

Comments:

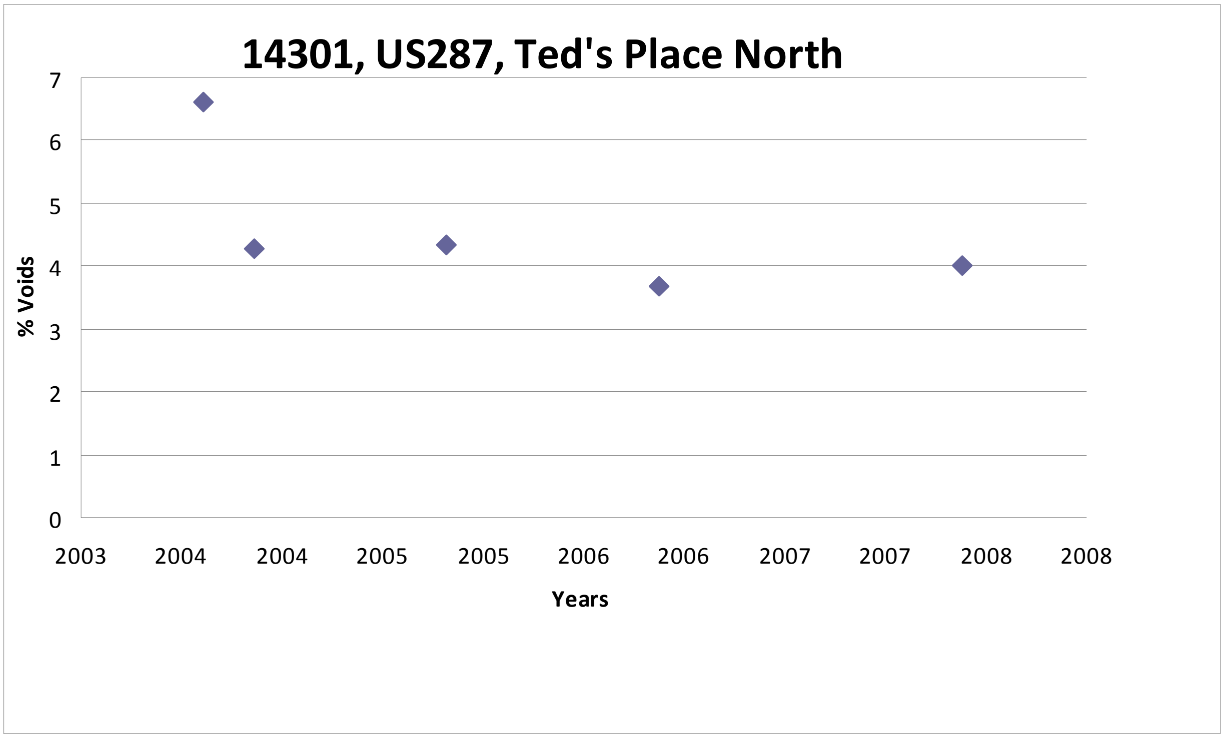
The pavement was placed at an in-place voids level of 7.9%. But fairly high traffic loading (ESALs = 2.53M) only brought it down to around 6% and it wasn't until 2008 that the in-place voids reach 5%.The inability of the pavement to meet the target voids of 4.0% may be due to the high compaction effort (N_{sd} = 100) used in the design and that the AC content was not increased enough at construction time. A higher AC content may have reduced the fatigue cracking and possibly eliminated the need for a chip seal in 2011.



Grading	S
Compaction (N_{ds})	100
Original Design Voids (%)	[4.0]
Adjusted Voids (%)	3.0
Stability	30
20-year ESALs (M)	3.22
2012 Condition per 0.1 mi.	
Rutting (in.)	0.31
Longitudinal Cracking (ft.)	44
Transverse Cracking (#)	7
Fatigue Cracking (sq. ft.)	0

Comments:

The in-place voids went down after the first year to around 3.0% due to substantial traffic loading (ESAL = 3.22M) reaching 2.6% in 2006. However, in 2008 the in-place voids went up to 7.8% which is probably due to some undocumented overlay between 2006 and 2008. Due to this overlay, the rutting and cracking data are probably not relevant to the original overlay in 2003.



Grading	S
Compaction (N_{ds})	100
Original Design Voids (%)	[4.0]
Adjusted Voids (%)	3.5
Stability	30
20-year ESALs (M)	1.54
2012 Condition per 0.1 mi.	
Rutting (in.)	0.12
Longitudinal Cracking (ft.)	27
Transverse Cracking (#)	4
Fatigue Cracking (sq. ft.)	0

Comments:

The in-place voids went down in the first year from 6.6% to around 4.0 % right in the center of the design range.