

Performance of Drained and Undrained Rigid Pavements in the LTPP SPS-2 Experiment

NCHRP Project 1-34D

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We have all seen the kinds of distress that excess water in pavement structures exacerbates --

We know the details of how to calculate drainage system flow times --

But do pavements with subsurface drainage systems perform better than pavements without drainage systems?

Some research shows drainage is beneficial, some shows it is not.

***Installation costs,
maintenance hassles, and
scant evidence of benefits
are diminishing many State DOTs'
enthusiasm for subsurface drainage
systems.***

What does the new M-E Guide say?

“The current state of the art is such that conclusive remarks regarding the effectiveness of pavement subsurface drainage or the need for subsurface drainage are not possible.”

SPS-1 Experiment:

Asphalt Pavement Structural Design Factors



SPS-1 experiment design

			Drainage					
			No		Yes			
			Base Type					
			DGA	ATB	ATB/DGA	PATB/AGG	ATB/PATB	
Total Base Thickness, inches	8	Surface Thickness, inches	4	0113	0103	0105	0107	0122
			7	0101	0115	0117	0119	0110
	12	4	0102	0116	0118	0120	0111	
		7	0114	0104	0106	0108	0123	
	16	4				0121	0112	
		7				0109	0124	

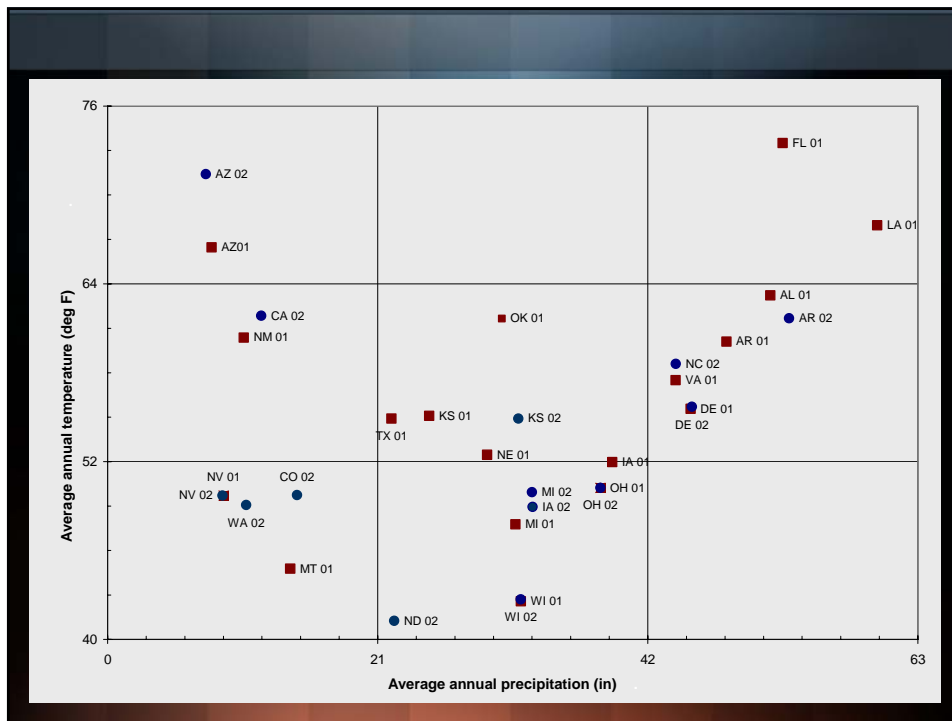
SPS-2 Experiment:

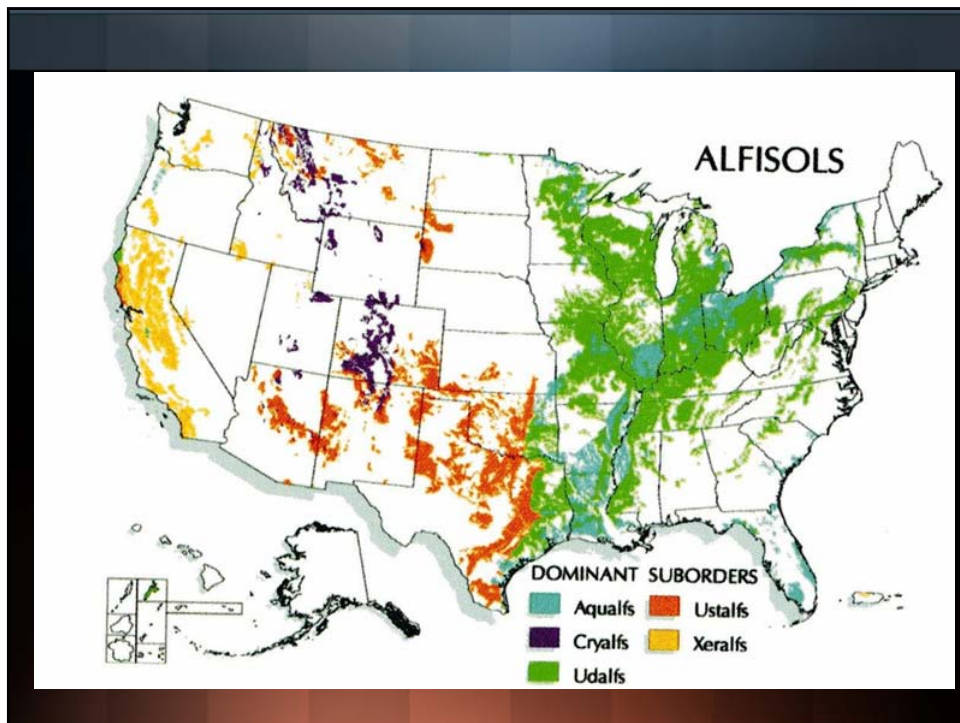
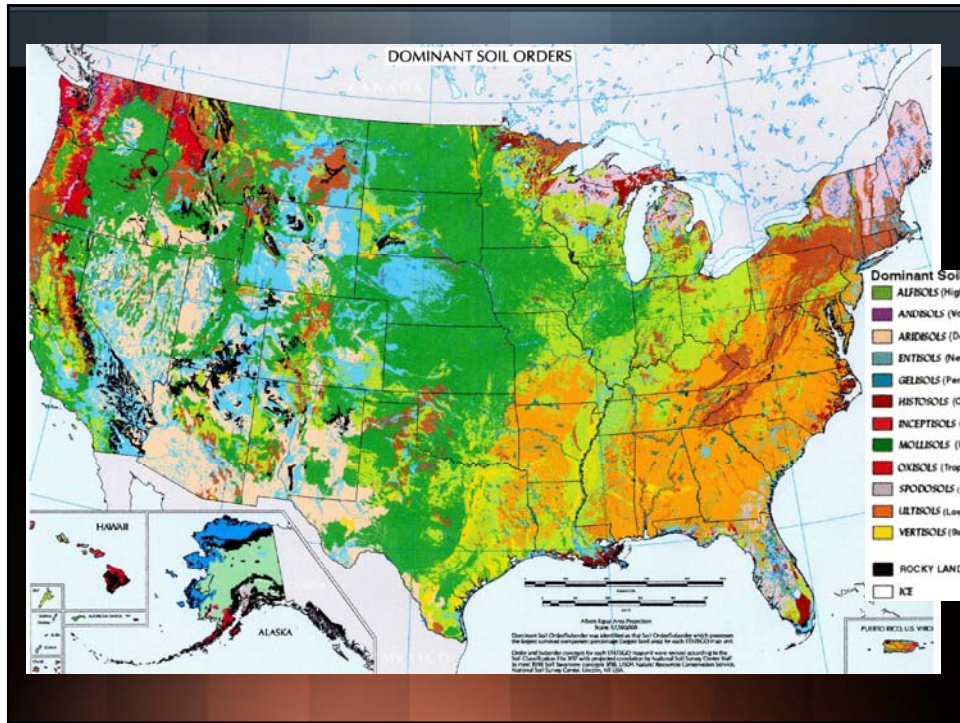
Concrete Pavement Structural Design Factors



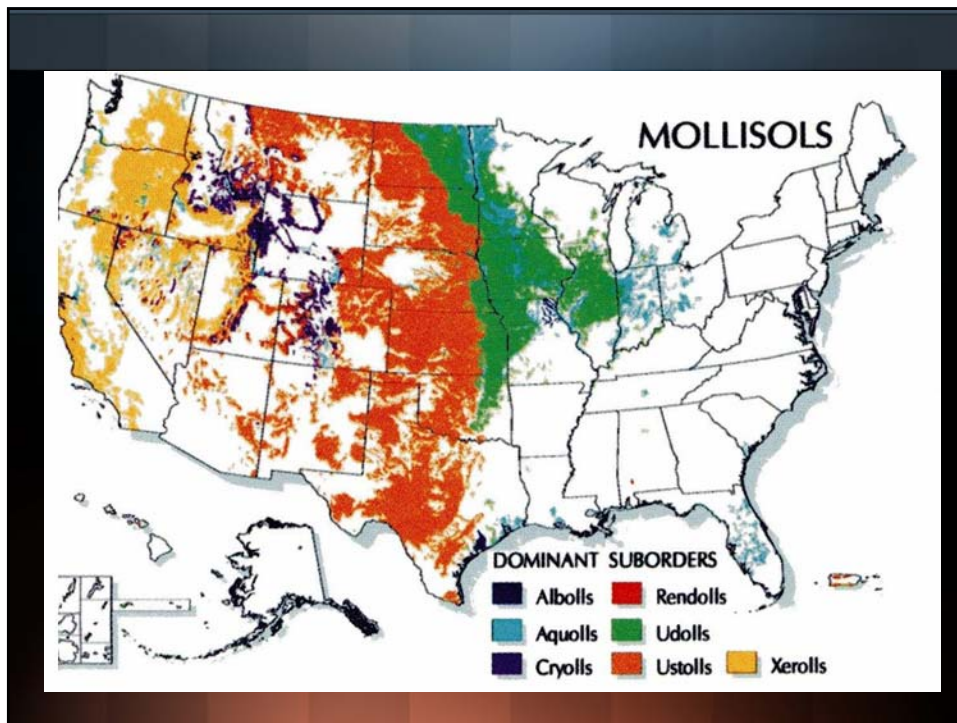
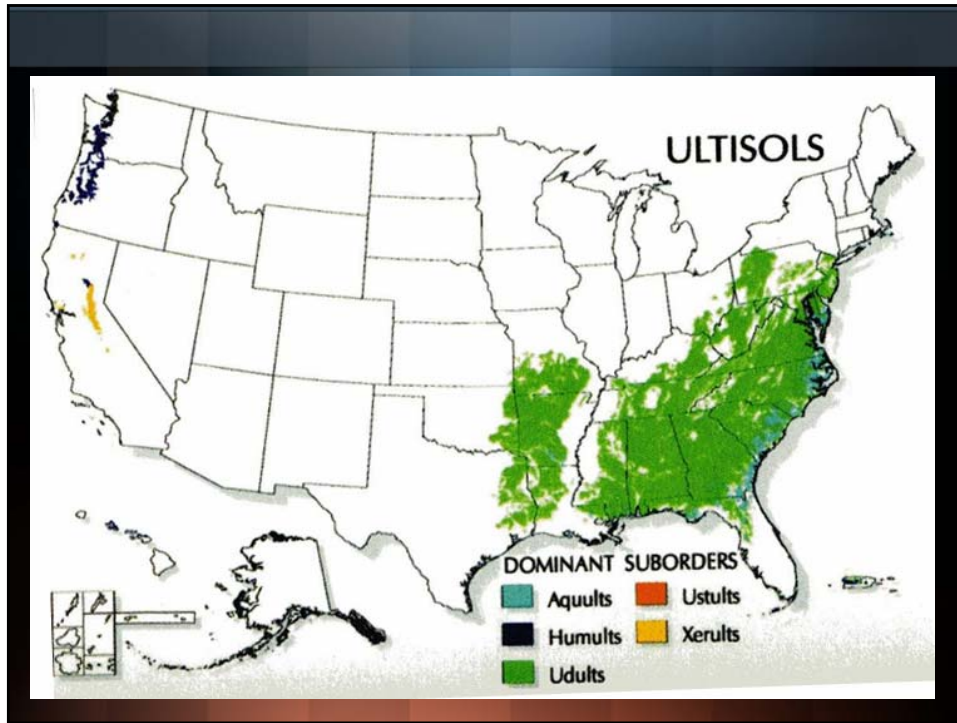
SPS-2 experiment design

					Drainage			
					No	Yes		
					Base type			
					AGG	LCB	PATB	
Slab thickness, inches	8	Flexural strength, psi	550	Lane width, ft	12	0201	0205	0209
					14	0213	0217	0221
			12		0214	0218	0222	
	11		900		14	0202	0206	0210
					12	0215	0219	0223
			550		14	0203	0207	0211
900	12	0204		0208	0212			
			14	0216	0220	0224		

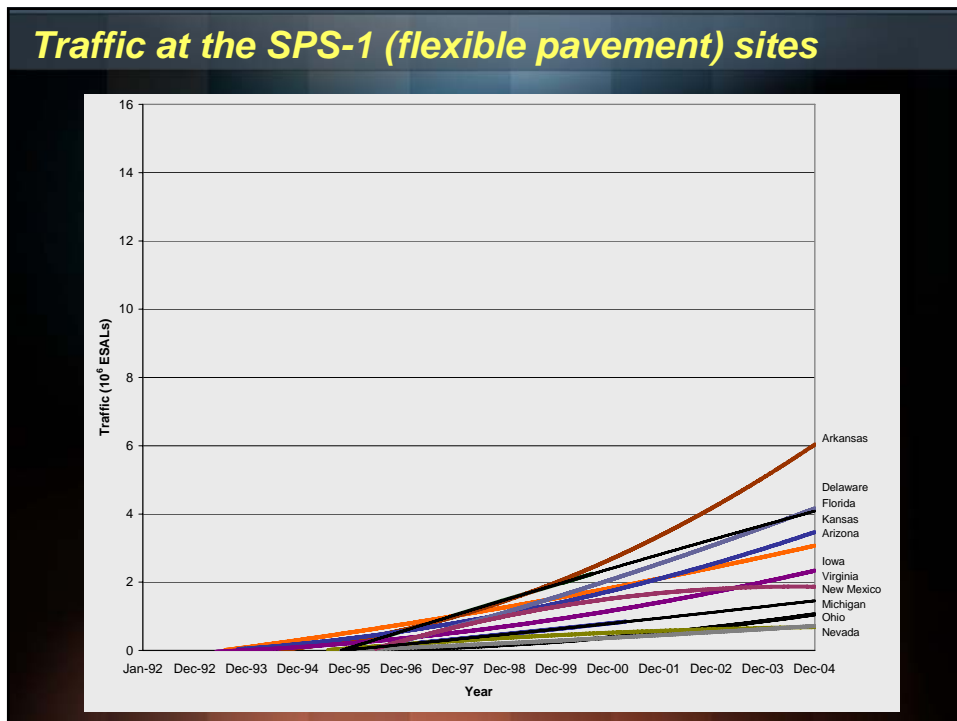
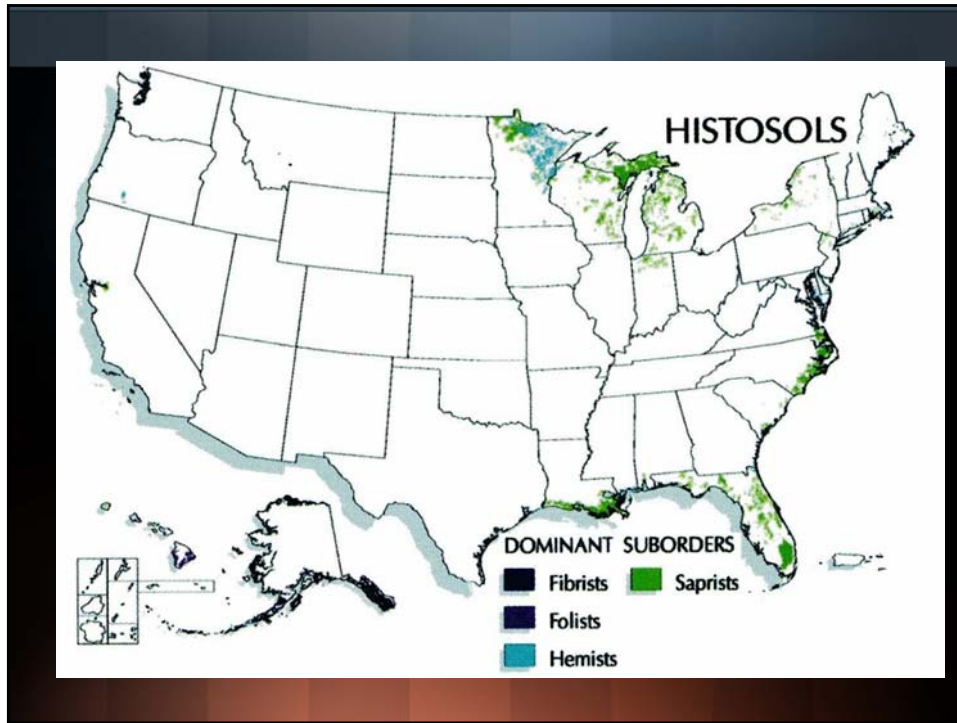


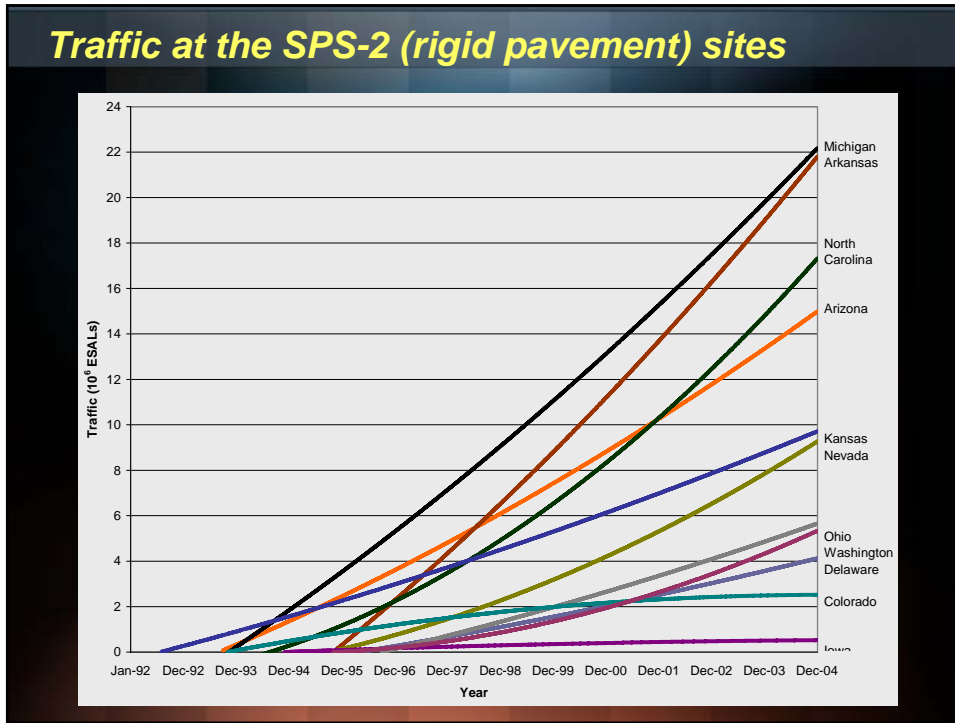


Does Drainage Matter -Performance of Drained & Undrained Pavements (Hall)



Does Drainage Matter -Performance of Drained & Undrained Pavements (Hall)





WASHINGTON - SPS-2

Station		Section	Design with Drains	Drain Inspected	Lane Width (feet)	Strength (psi)	Layers		Layer Thicknesses (inches)	
(feet)	(m)									
0	0	530259					PCC	HMAC	10.3	2.8
500	152	Sup								
705	215									
		530203	N		14	550	PCC	AGGI	11.1	6.9
1,205	367									
1,515	462									
		530202	N		14	900	PCC	AGGI	8.3	6.5
2,015	614									
2,295	700									
		530210	Y		14	900	PCC	PATB	8.3	3.8
2,795	852									
3,000	914									
		530211	Y		14	550	PCC	PATB	11.8	3.9
3,500	1,067									
3,690	1,125									
		530209	Y		12	550	PCC	PATB	9.0	3.9
4,190	1,277									
4,380	1,335									
		530212	Y		12	900	PCC	PATB	11.3	3.5
4,880	1,487									

Drainage flow time testing

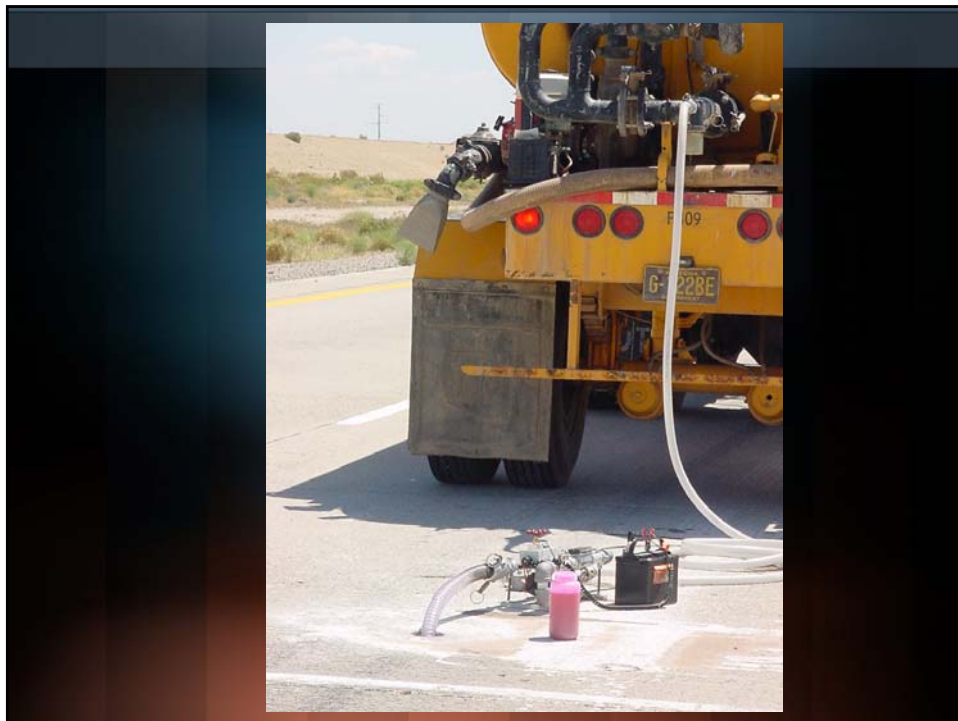
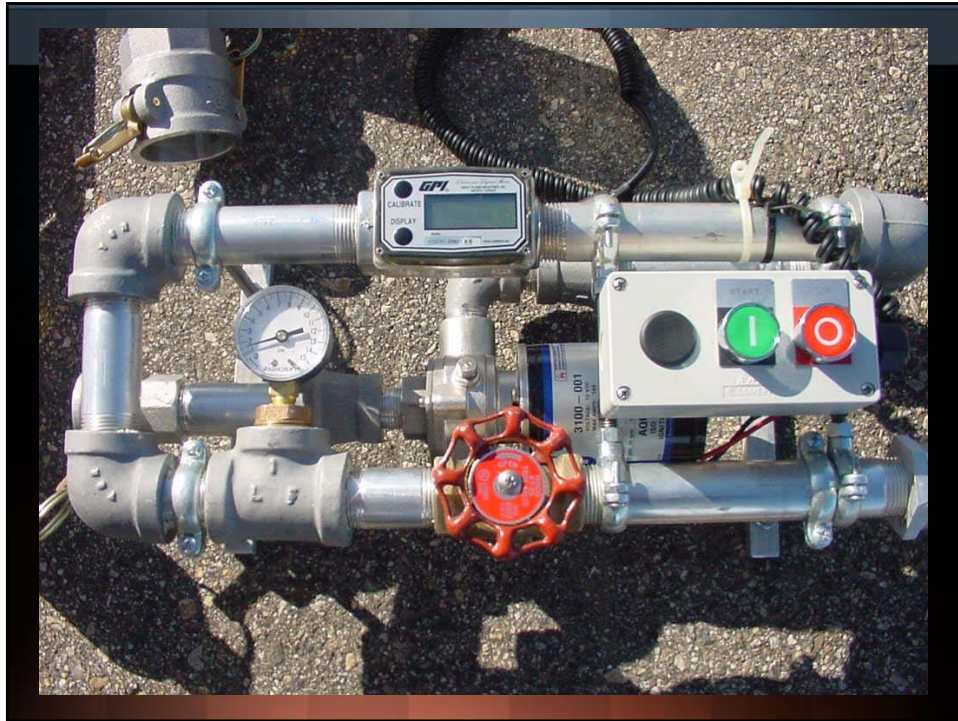
Testing conducted in drained test sections at all SPS-1 and SPS-2 sites

Time to steady-state flow measured

Length of flow path determined from geometry

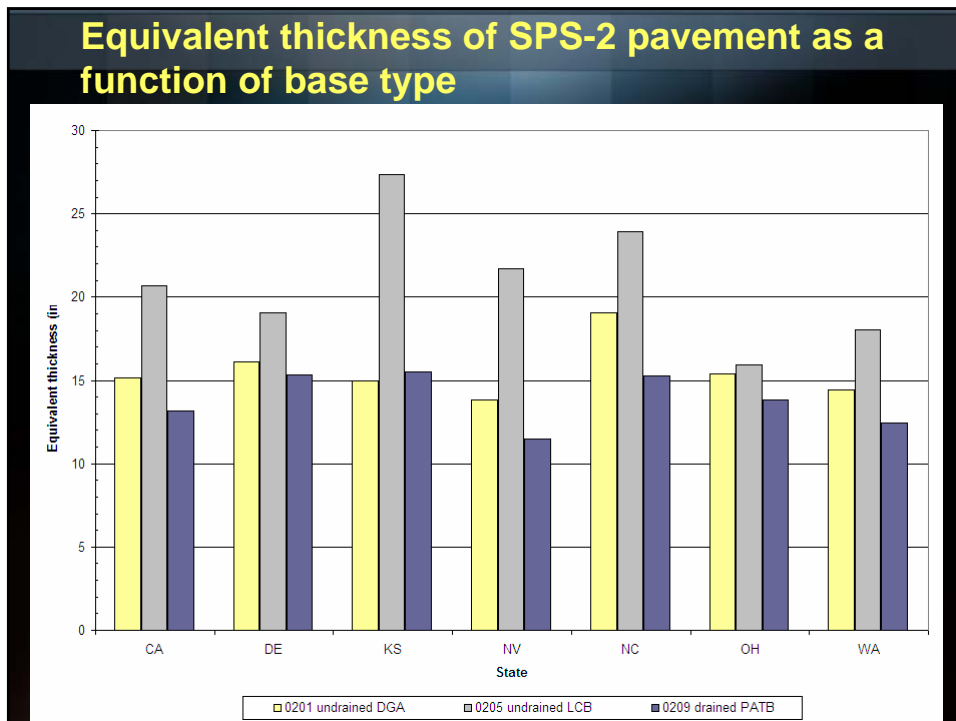
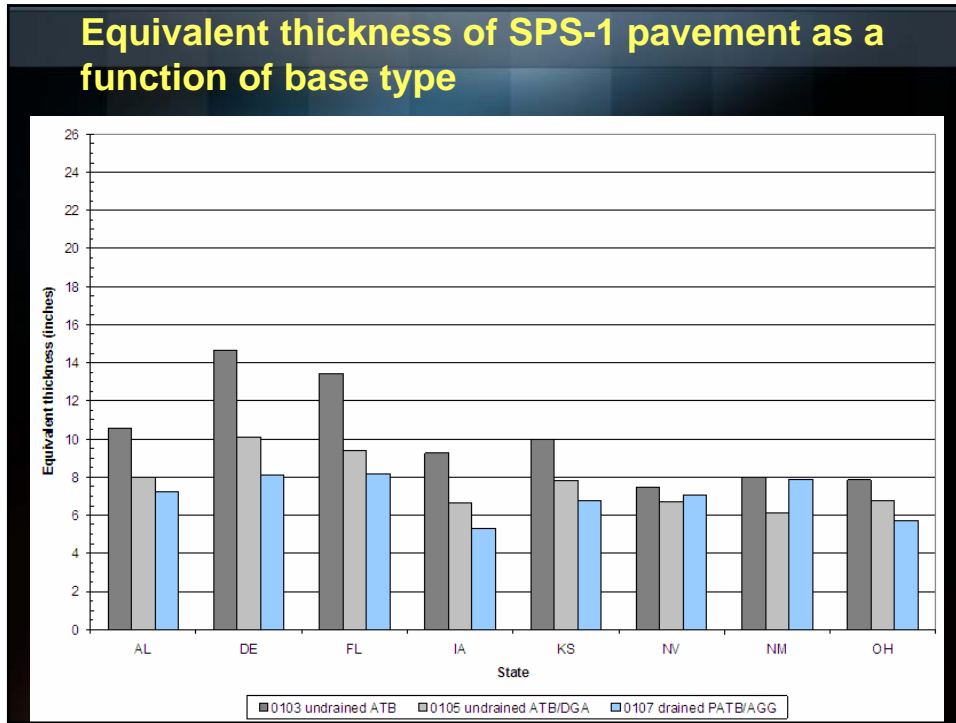
Flow rate of subdrainage system (PATB → edge drain → outlet) determined





Does Drainage Matter -Performance of Drained & Undrained Pavements (Hall)





Long-term change in roughness – SPS-2 (rigid pavements)

- most** *undrained aggregate base*
undrained lean concrete base
- middle** *drained permeable asphalt-treated base*
- least** *undrained hot-mix asphalt base*
undrained cement-aggregate mix base

Faulting – SPS-2 (rigid pavements)

- most** *undowelled, any base type*
- middle** *dowelled undrained aggregate*
- least** *dowelled undrained lean concrete base*
dowelled drained permeable asphalt base

Cracking – SPS-2 (rigid pavements)

- most** *undrained lean concrete base*

- middle** *undrained aggregate base*
 drained permeable asphalt base

- least** *undrained hot-mix asphalt base*
 undrained cement-aggregate mix base

Long-term roughness – SPS-1 (flexible pavements)

- most** *undrained aggregate base*

- middle** *drained permeable asphalt base*

- least** *undrained asphalt-treated base*

Also, backcalculated equivalent thickness was the most significant factor in the regression for long-term roughness in flexible pavements

Rutting – SPS-1 (flexible pavements)

most *undrained aggregate base*

less *all other base types of greater stiffness
(backcalculated equivalent thickness),
drained or undrained*

Cracking – SPS-1 (flexible pavements)

most *undrained aggregate base*

less *all other base types of greater stiffness
(backcalculated equivalent thickness),
drained or undrained*

Conclusions

For asphalt pavements, base stiffness matters more than drainage – the stiffer the base, the better

For concrete pavements, base stiffness matters more than drainage – the ideal concrete pavement base is neither too weak nor too stiff

Conclusions

It is true that excess moisture and inadequate drainage was detrimental to performance of many pavements built in the past

Pavements built in the United States today are much less vulnerable to moisture effects: they have thicker surfaces, thicker bases, stabilized bases, and dowelled joints

Conclusions

Some pavements in some places may still need subsurface drainage

- *at locations with high Thornthwaite Moisture Index values*
- *where county soil reports show soils with poor natural drainage*
- *with thinner pavement surfaces, thinner and weaker bases*

But, it is far less true than it was twenty years ago that most pavements in most places need subsurface drainage