

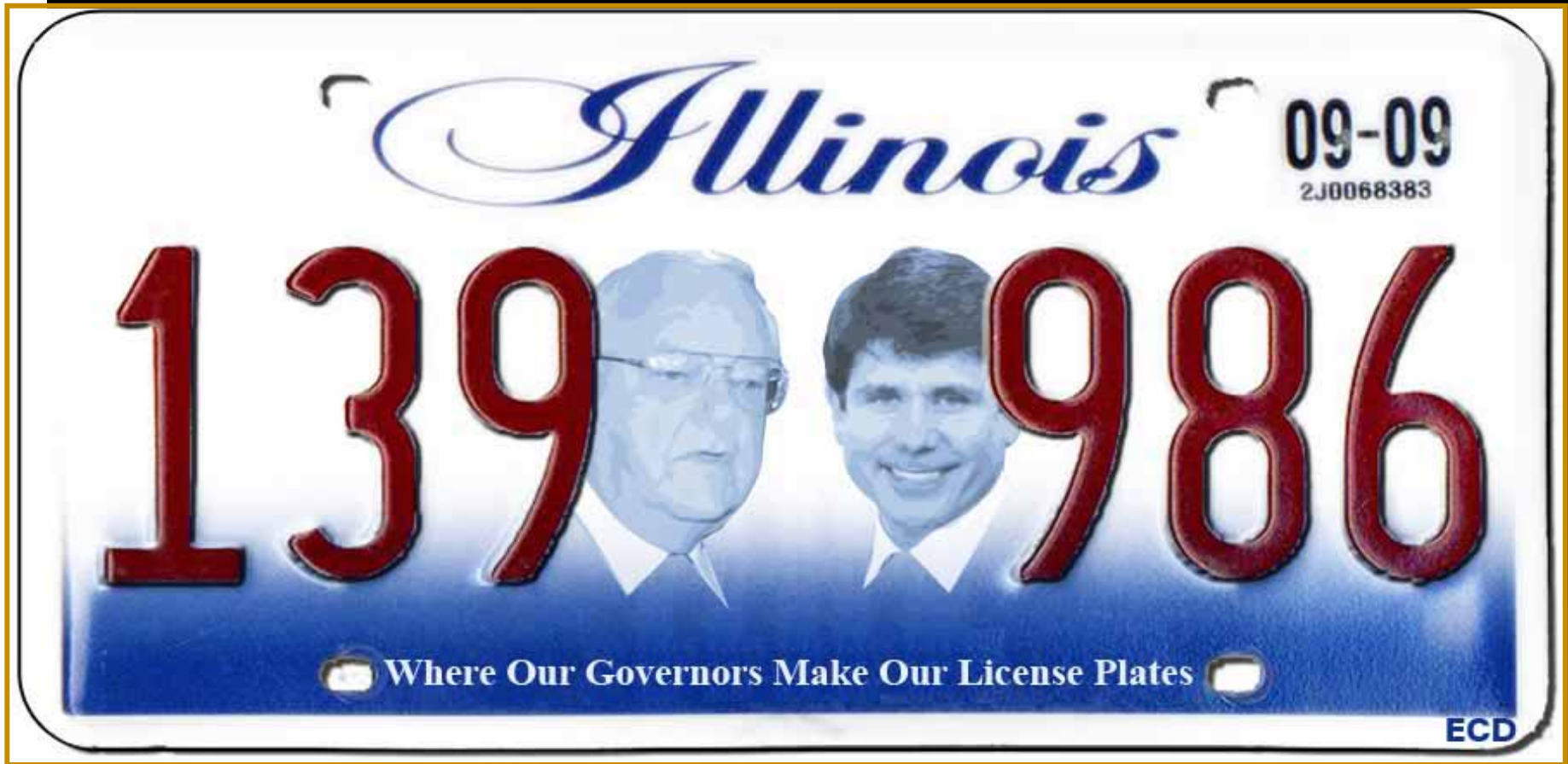
Stone Matrix Asphalt and Perpetual Pavements



Timothy R. Murphy, P.E.

Murphy Pavement Technology

In Illinois we Perpetually
Recycle our Politicians



I-84: Garrity to Ten Mile Rd. in Meridian, ID



Transportation Research Board's Report 202

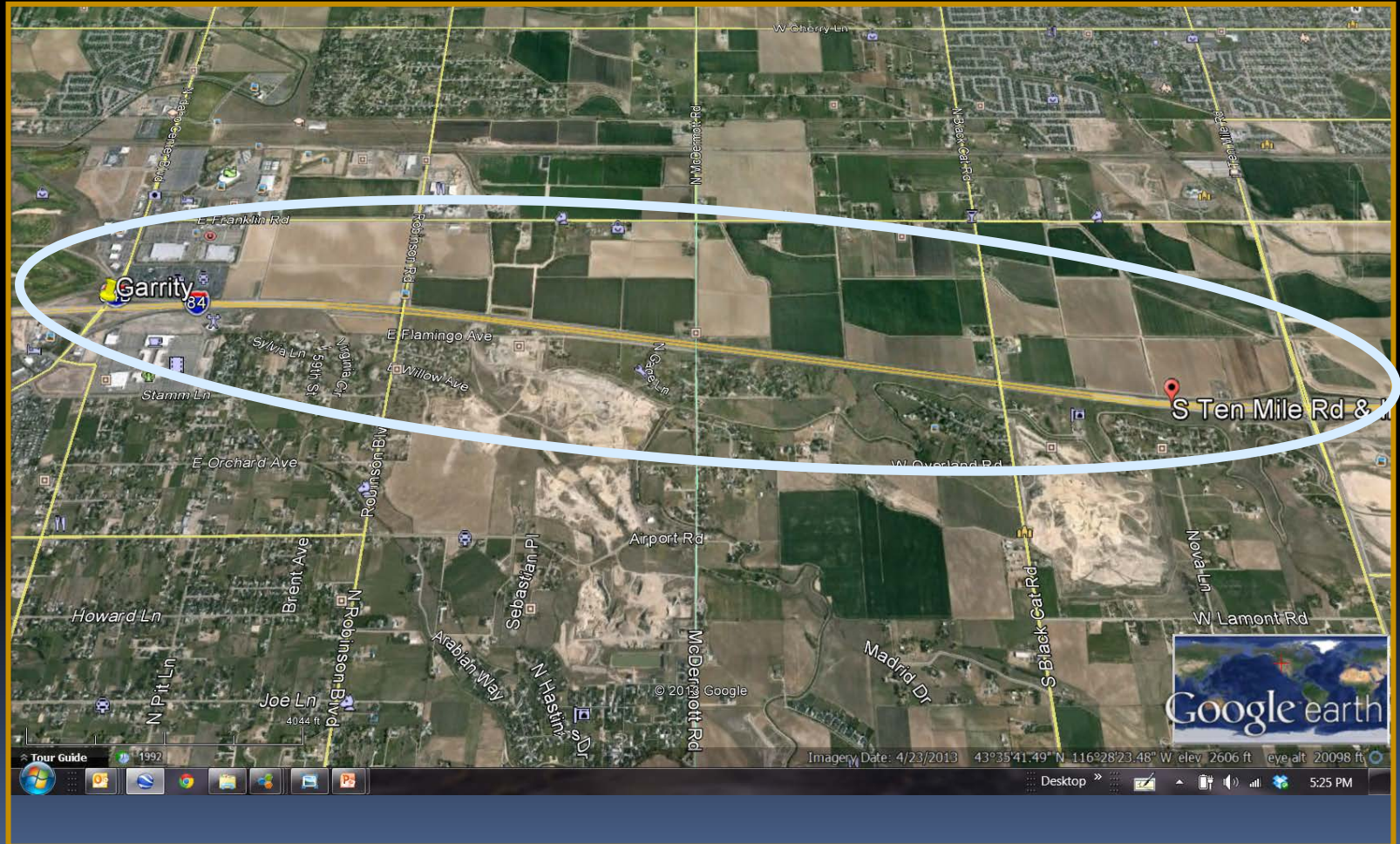


"Asphalt, more than any other single product, sustains the nation's highway system and facilitates the flow of commerce."

AGGREGATE AND ASPHALT



I-84: Garrity to Ten Mile Rd. in Meridian, ID



West bound near E0J



Independent Assurance Audit


Goal is to bring
People and Ideas
Together in an
effort to
implement a
successful
asphalt system.





Why Audit?

Continue to:

- **Advance the success rate of producing hot mix asphalt.**
 - **Improve asphalt in-use performance for the tax payers of Idaho.**
- 



Perpetual Pavement Defined

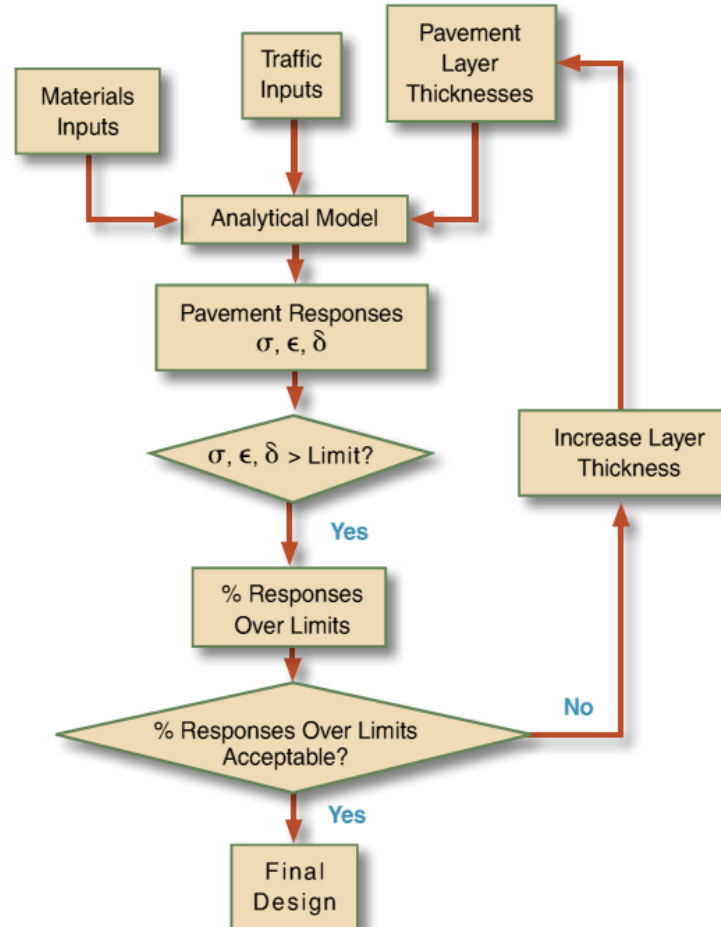
Asphalt pavement designed and built to last longer than 50 years without requiring major structural rehabilitation or reconstruction, and needing only periodic surface renewal in response to distresses confined to the top of the pavement.

Perpetual Pavement Defined



Perpetual Design

Figure 2. Simplified Flowchart of Perpetual Pavement Design



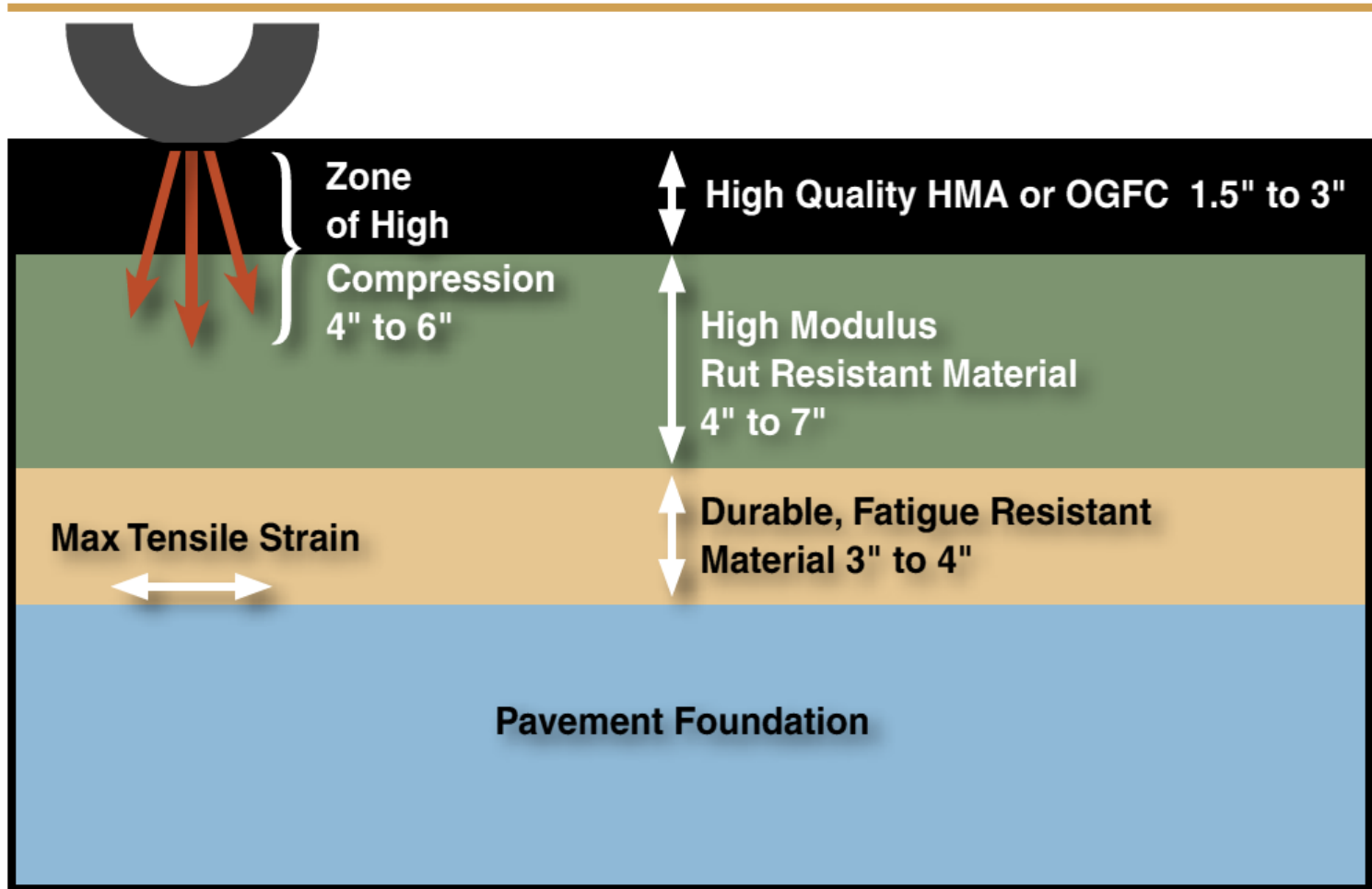
M-E Design

- Seasonal pavement moduli and annual variation (COV),
- Seasonal resilient moduli of materials and annual COV,
- Thickness of bound materials and COV,
- Thickness of unbound materials,
- Load spectrum for traffic,
- Location for pavement response analysis,
- Magnitude of limiting pavement responses, and
- Transfer functions for pavement responses exceeding the user specified level for accumulating damage.

Thank You, Dr. VonQuintus

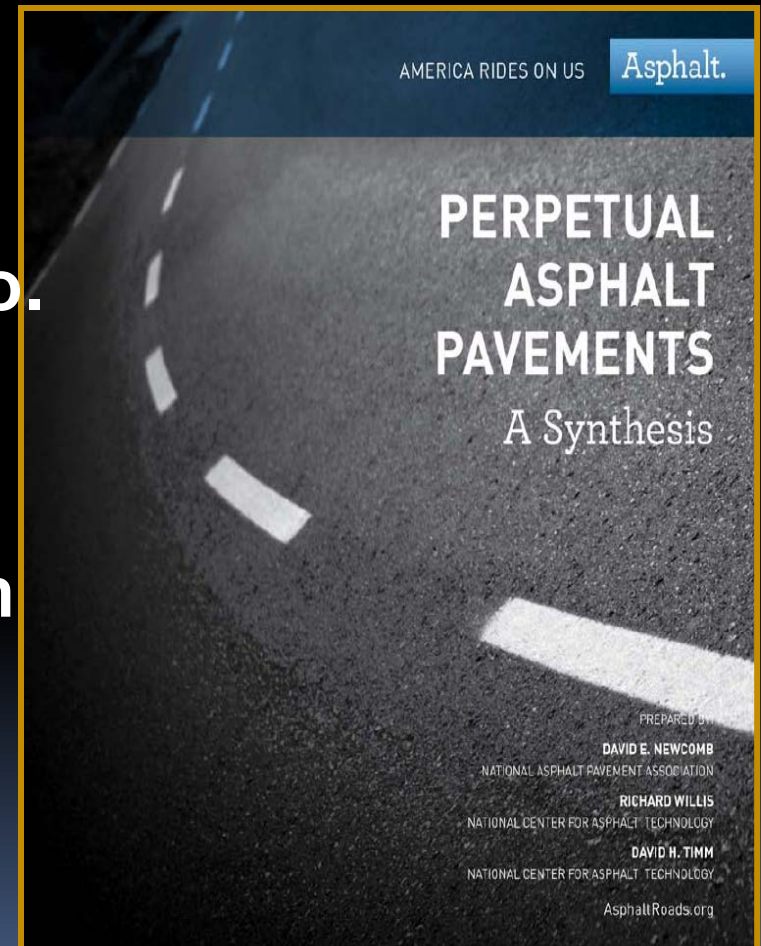
Figure 3. Perpetual Pavement Design Concept

(Newcomb et al, 2000)




Why Audit?

- Update the perpetual pavement specification currently in use in Idaho.
- Develop a “How to design and build perpetual pavements in Idaho” manual.





Independent Assurance Audit

- **Specifications**
 - **Mix Designs**
 - **Process Control**
 - **IA and Verification Testing**
 - **Site Visit**
- 

TEAM Approach

- Meeting with all parties involved (ITD, J-U-B Engineers, Inc., and Idaho Sand & Gravel).
- Reviewing engineering reports available, including:
 - ESAL determination (M. Dehlin),
 - Thickness design and typical section (M. Dehlin, HDR, and Terracon),
 - Mix selection (Terracon, M. Dehlin, and T. Murphy),

(Cont'd.)

TEAM Approach

- **Reviewing engineering reports available, including:**
 - **Specification writing (M. Dehlin),**
 - **Mix design verification versus Acceptance Test strips versus Production (ITD HQ, and GeoTek),**
 - **Paving equipment requirements versus actual (JUB and ITD D3), and**
 - **Job specific variations for materials, machinery, and methods, particularly the impact of change orders and construction issues (JUB and ITD D3).**



Loading

Equivalent Single Axle Loadings (ESAL's) and thickness design was performed using PerRoad . PerRoad uses the mechanistic-empirical (M-E) design philosophy.

Pavement Design Findings


- Consideration should be given to the inclusion of Stone Matrix Asphalt thickness and corresponding Poisson Ratios for the total thickness design.
- Investigation by ITD specific to traffic volumes and typical truck load factors is appropriate as values used for double and triple trailers significantly influence the ultimate thickness required.

Building the Roadway





I-84 Field Review of 2010

- Site review reveals acceptable ride, lane configuration, and performance to date.
 - Allow use of any acceptable material transfer device provided that volumetric measures and smoothness are achieved.
- 

I-84 Field Review of 2010



The Job Mix Formula

Voids, VMA, and VFA; The Building Blocks of Hot Mix Asphalt



Laboratory Mix Designs vs. Plant - Produced Mixture



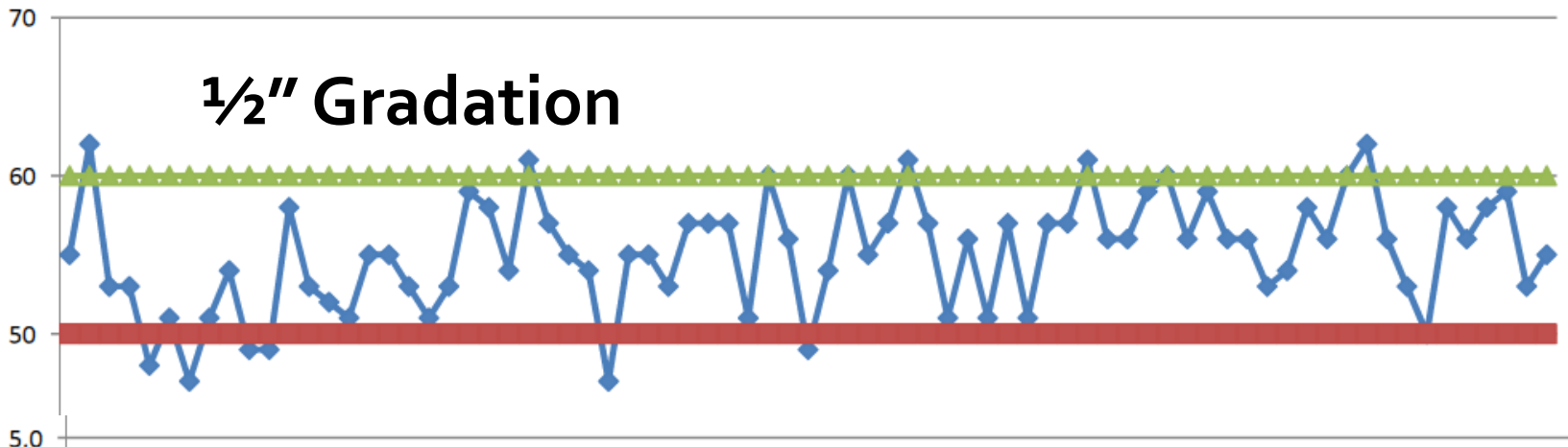
Measure Volumetrics



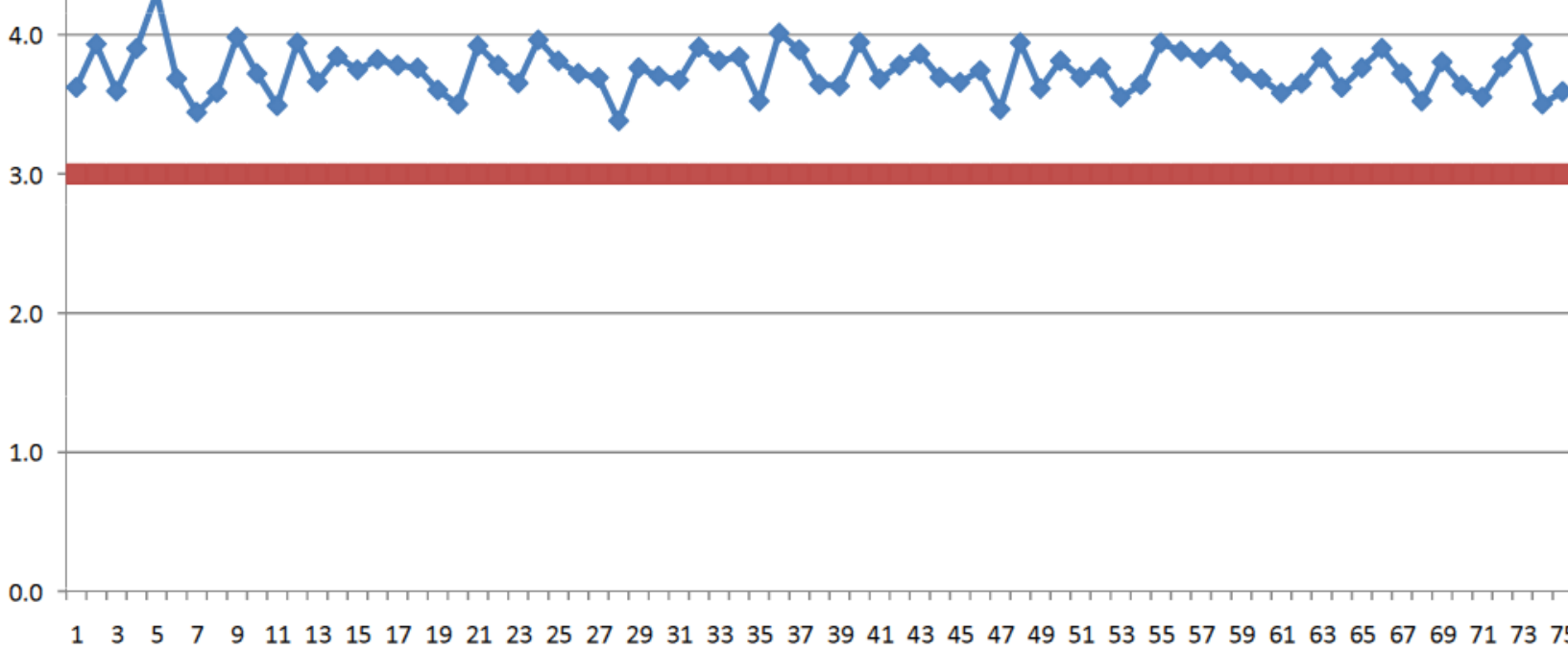
Rich Bottom Base

- 1.5" top size.
 - Variable test results.
- 

1/2" Gradation

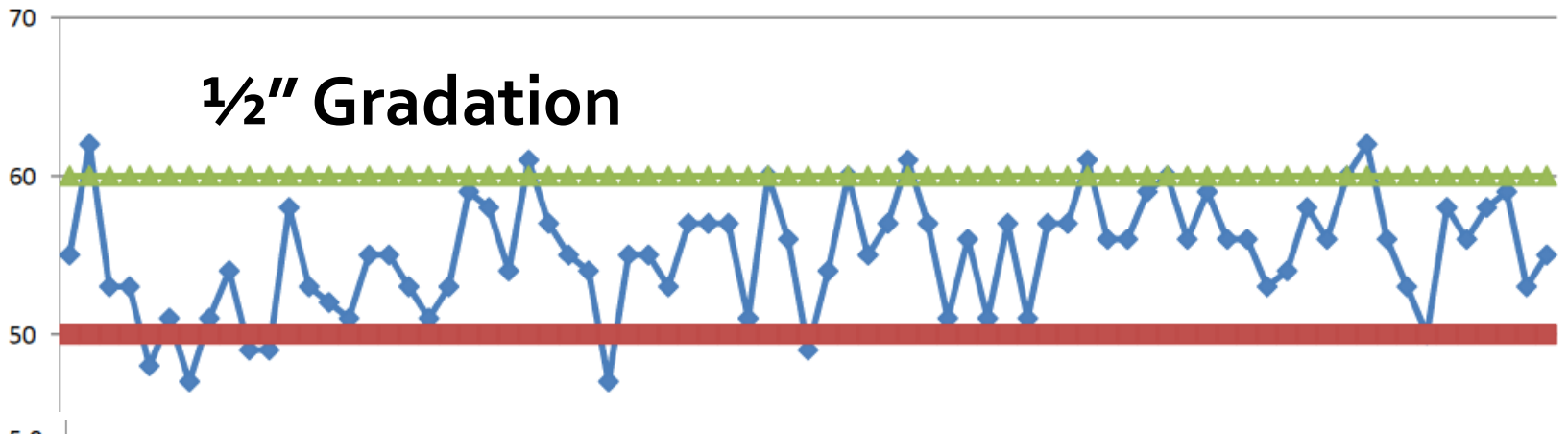


Asphalt Content

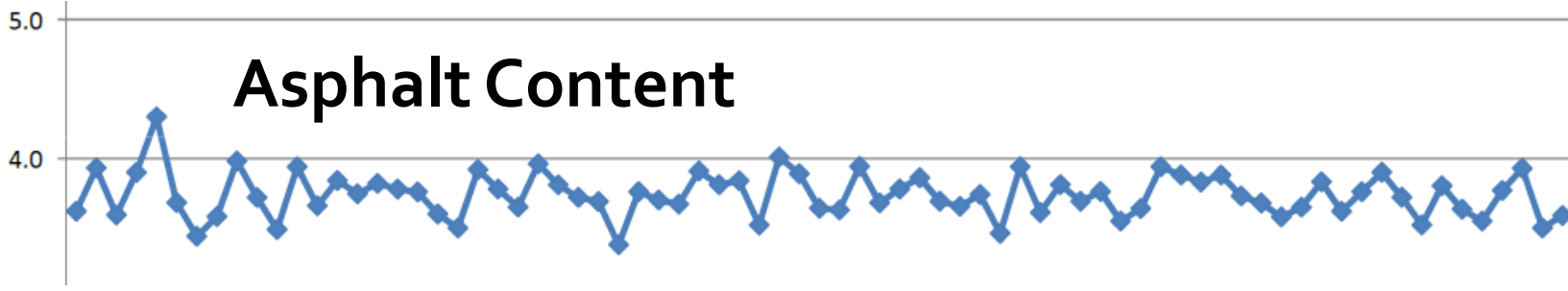


- AC Per.
-
- +

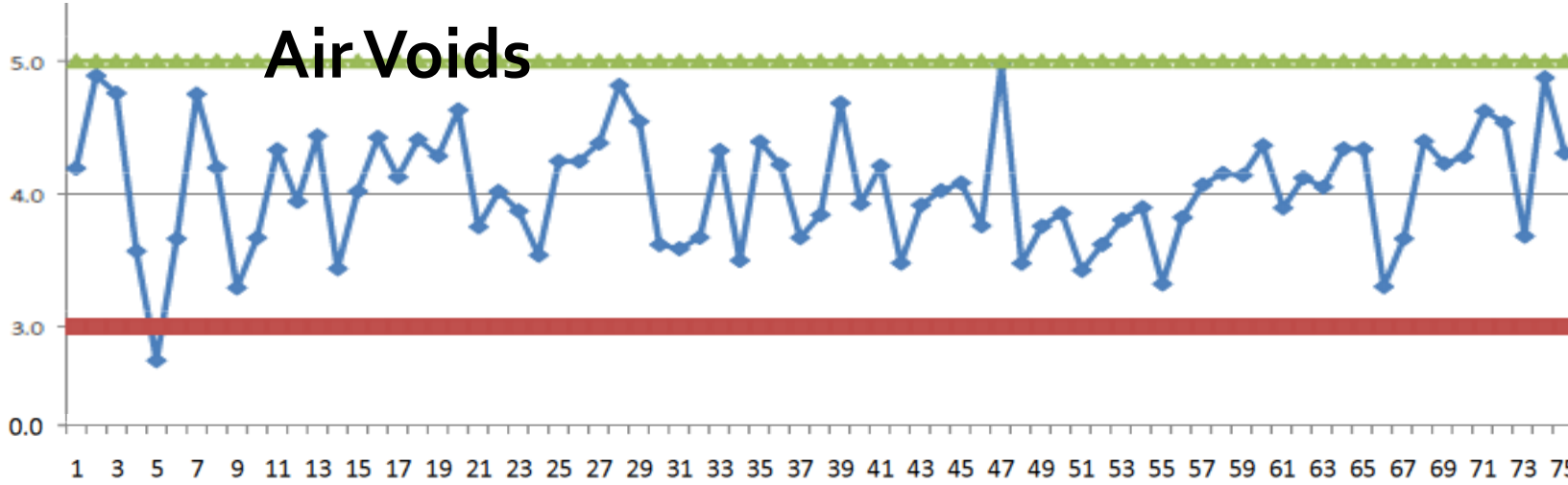
1/2" Gradation



Asphalt Content



Air Voids



AC Per.
-
+

Va
-
+

Potential Solutions

- Eliminate the 37.5-mm mix,
- Specify that all 37.5-mm mixtures will be fine graded (i.e. above the maximum density line on the #4 and #8 sieves),
- Revisit sampling and splitting techniques.

What Surface Mixture to Use?

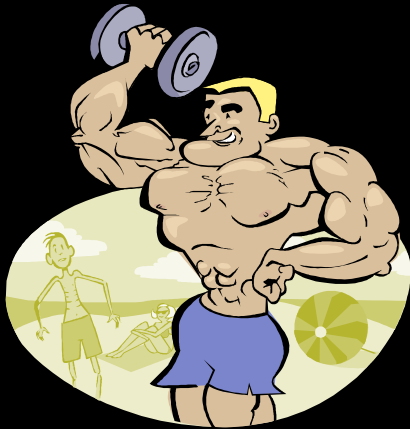




Strategy consists of four steps:

- **Assess the opportunity**
- **Ensure structural adequacy**
- **Select high-performance materials and confirm the mixture design**
- **Use proper construction techniques**

Strong



Use aggregates with:

- High crush
- Hard particles
- Consistent gradation (clean) and gravity
- Proper Quality Control (QC)

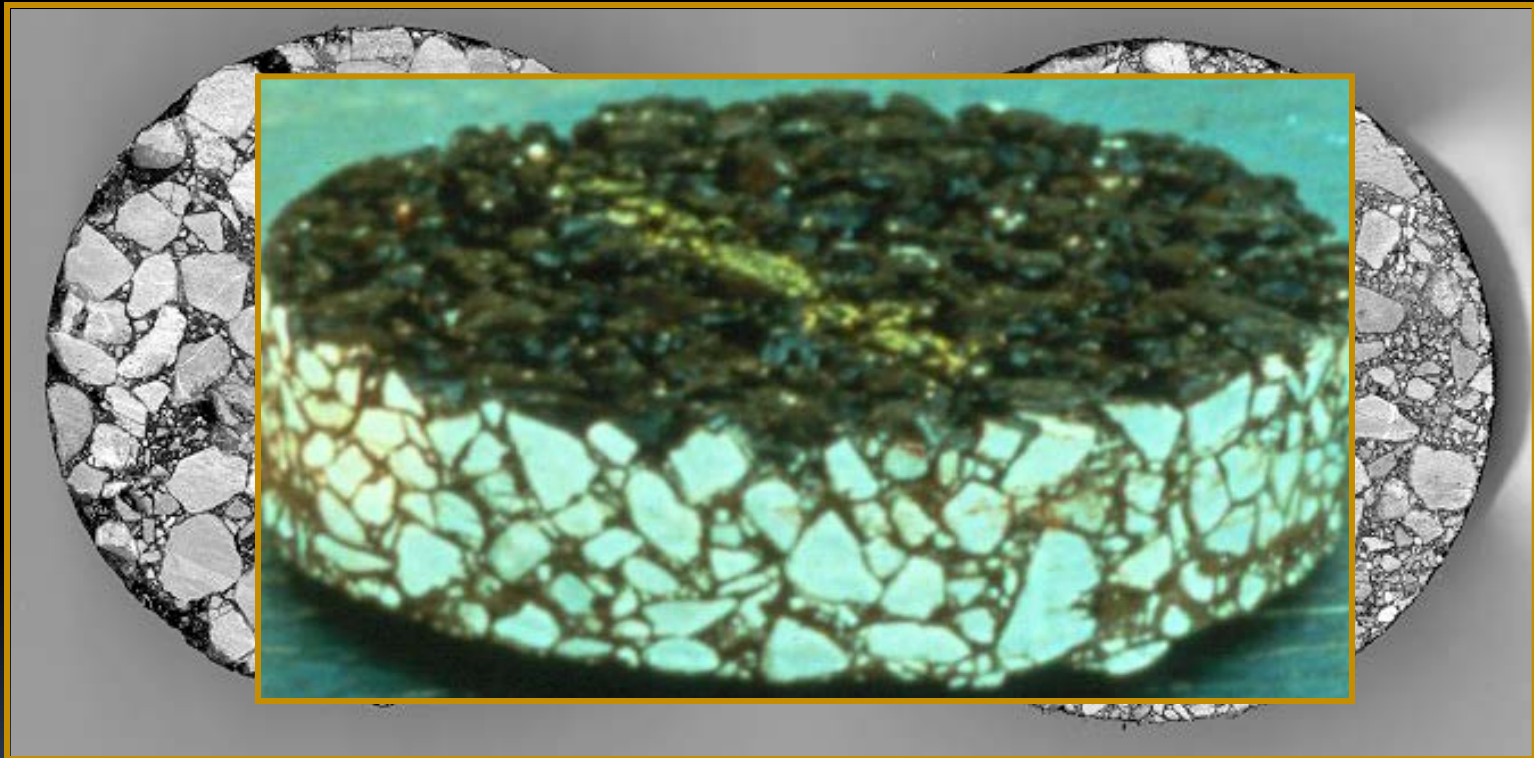
BUILT IN 1997



World's Strongest Intersection

(Williams & Margaret in Thornton, IL)

Comparison SMA vs. Dense-Graded



Stone Matrix Asphalt

Dense-graded Asphalt

Mix Properties, Job-Mix Formula

Mixture Composition

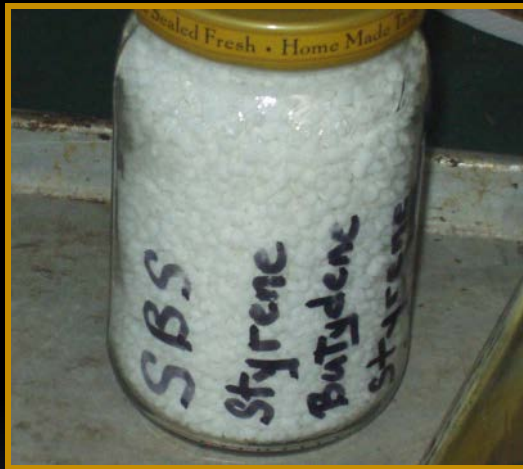
<i>Sieve</i>	<i>Lower</i>	<i>Upper</i>
3/4" (19.0 mm)		100
1/2" (12.5 mm)	90	99
3/8" (9.5 mm)	50	85
#4 (4.75 mm)	20	40
#8 (2.36 mm)	16	28
#200 (0.075 mm)	8	12

Typically +6% Polymerized AC

SMA vs. Dense-Graded




Resilient Asphalt with Polymers



**Polymers plus
Asphalt Binder**







World's Strongest Intersection Conclusion

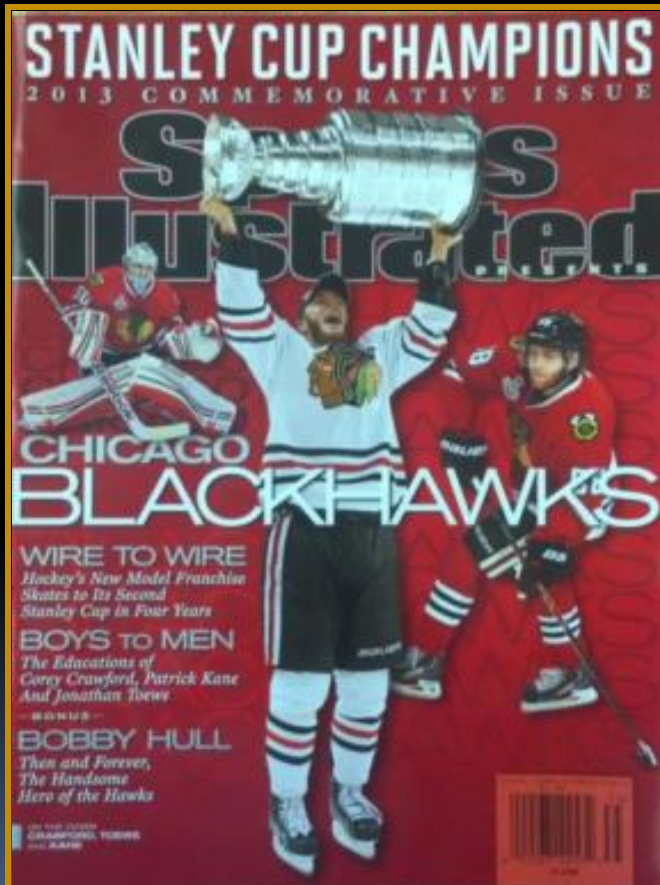
An evaluation of the 1997 pavement fix was performed in 2013. After 16 years, and the application of almost 16+ million equivalent single axle loads (ESALs), the intersection of Williams and Margaret streets has required no essentially no maintenance and quietly continues its amazing performance as “the world’s strongest intersection”.

STRONG + DURABLE = SUSTAINABLE



Idaho Said, "YES!"

STRONG + DURABLE = SUSTAINABLE



Rolling Pattern on I-84



Ballast Rollers



Utilize Three Wheel Rollers



Findings

- SMA surface mixture voids did not trend about the target of 4.0% for the entire project.
- Voids actually average close to 5.0%, the upper limit for voids.
- Density was difficult to achieve.

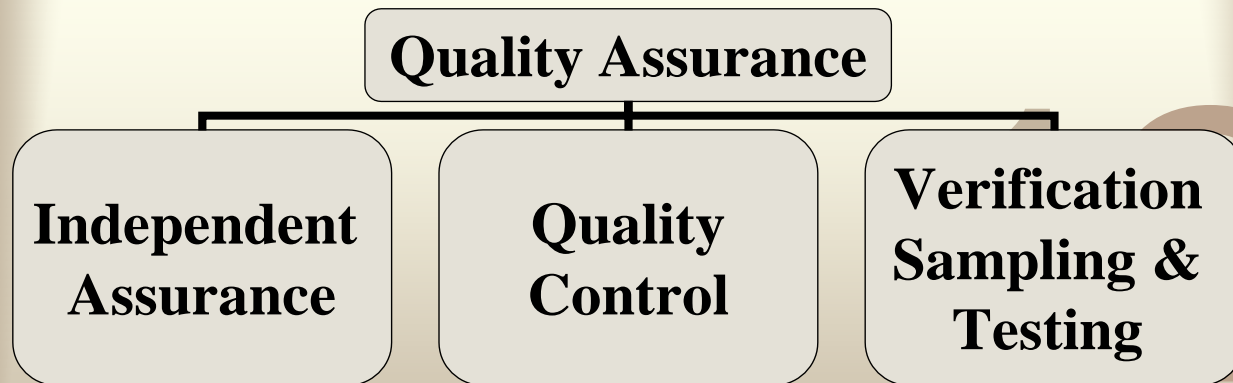
Recommended

Higher VMA and Lower Voids = More AC

Acceptance by AMRL Laboratory is Required

FHWA Acceptance Program

0011



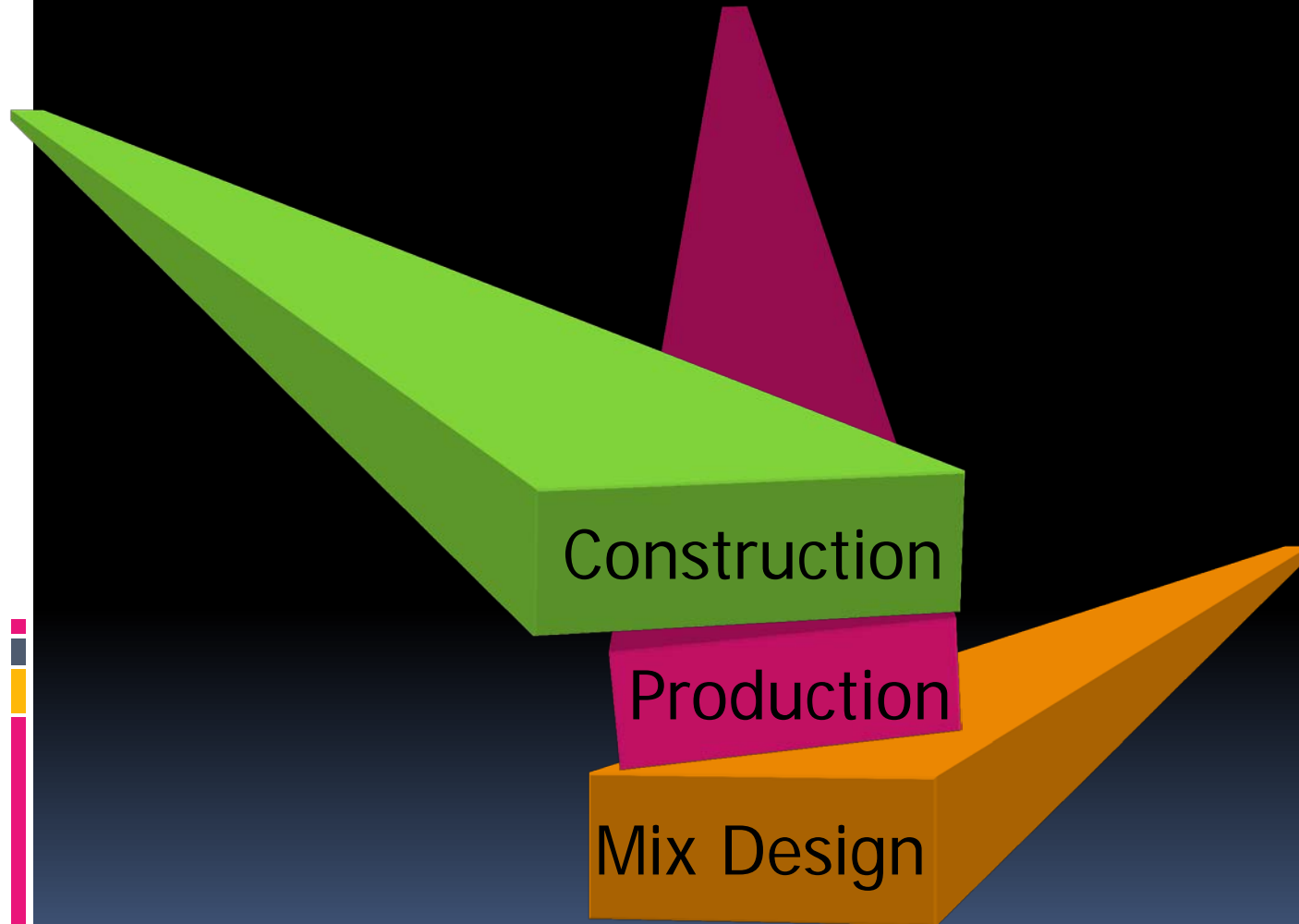
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Sound Specifications

- **Scientifically and mathematically sound,**
- **Related to performance,**
- **Easy to understand and apply,**
- **Provide strong incentives to produce good quality,**
- **Provide strong disincentives for poor quality, and**
- **Take into account construction phases.**

Successful HMA QA



Workmanship Items





Dense-graded = Mat - 2%

SMA = 92.0%+

Echelon Paving, Part I



Bonus / Penalty on Joints

Echelon Paving, Part II



Be Determined in

Ac



It Takes Teamwork!!!

Time fo(u)r questions



Timothy R. Murphy, Murphy Pavement Technology