Slag Aggregates in Hot Mix Asphalt (HMA) Paving

IRC
Industrial Resources Council
Promoting Sustainable Use
Of Industrial Materials.

November 1 – 2, 2011
Austin, TX

NSA

93rd Annual Convention of the
National Slag Association
September 26 – 29, 2011
Pensacola Beach, FL

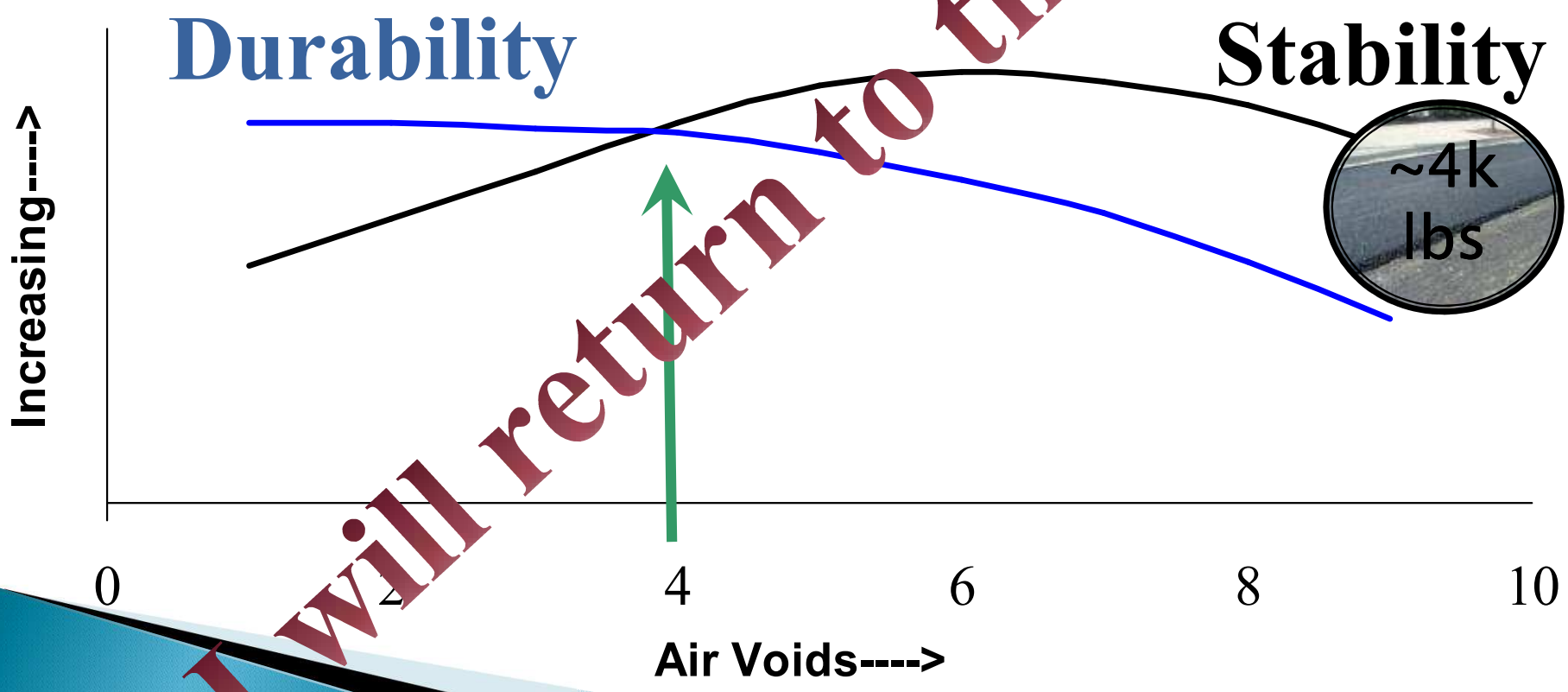
Timothy R. Murphy, P.E.
Murphy Pavement Technology, Inc.

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."

HMA Goal

Maximize performance & minimize cost!



Slag Aggregates

- Recycling
  Successes
  Opportunities
  Challenges

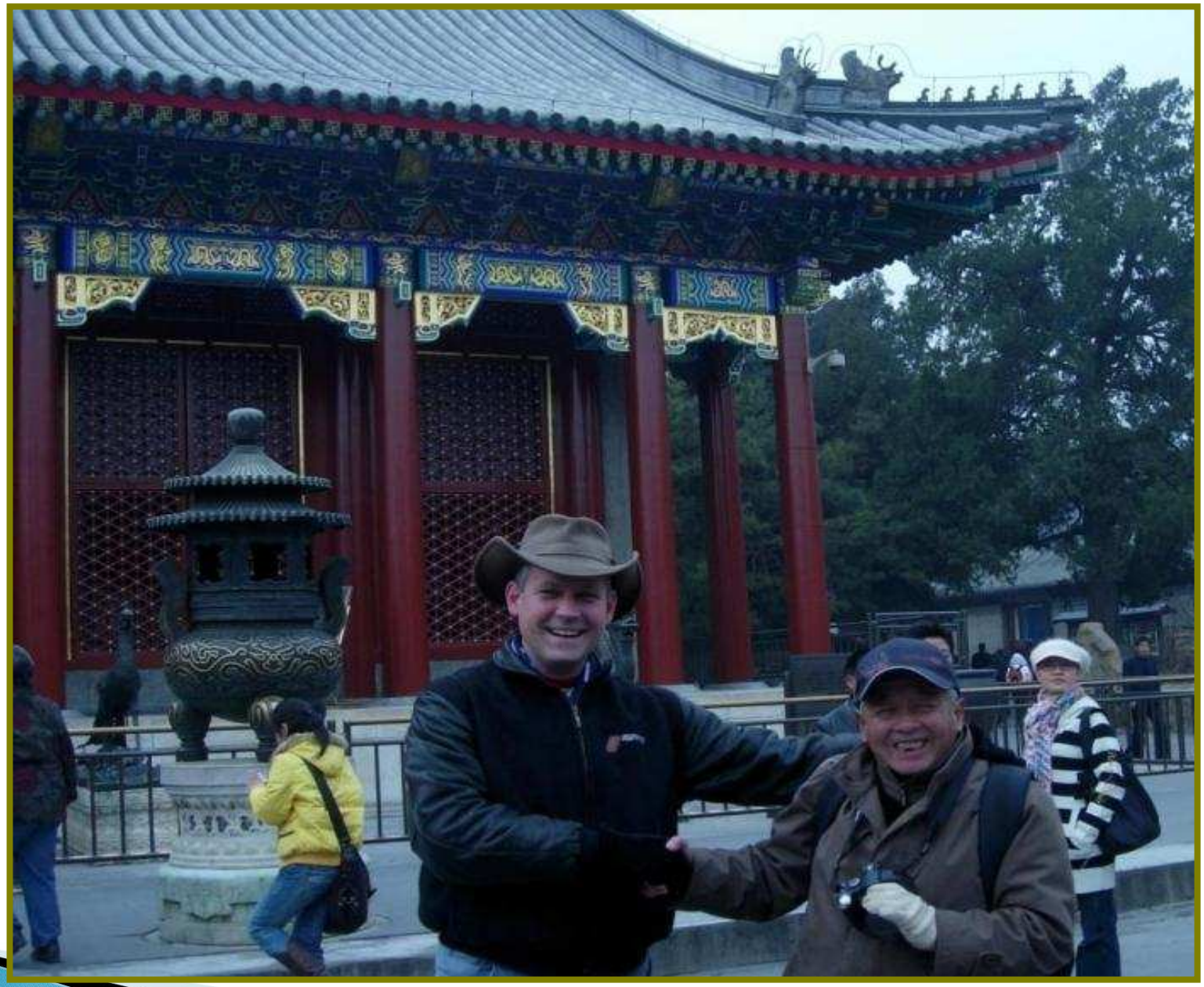
Recycling Initiative:

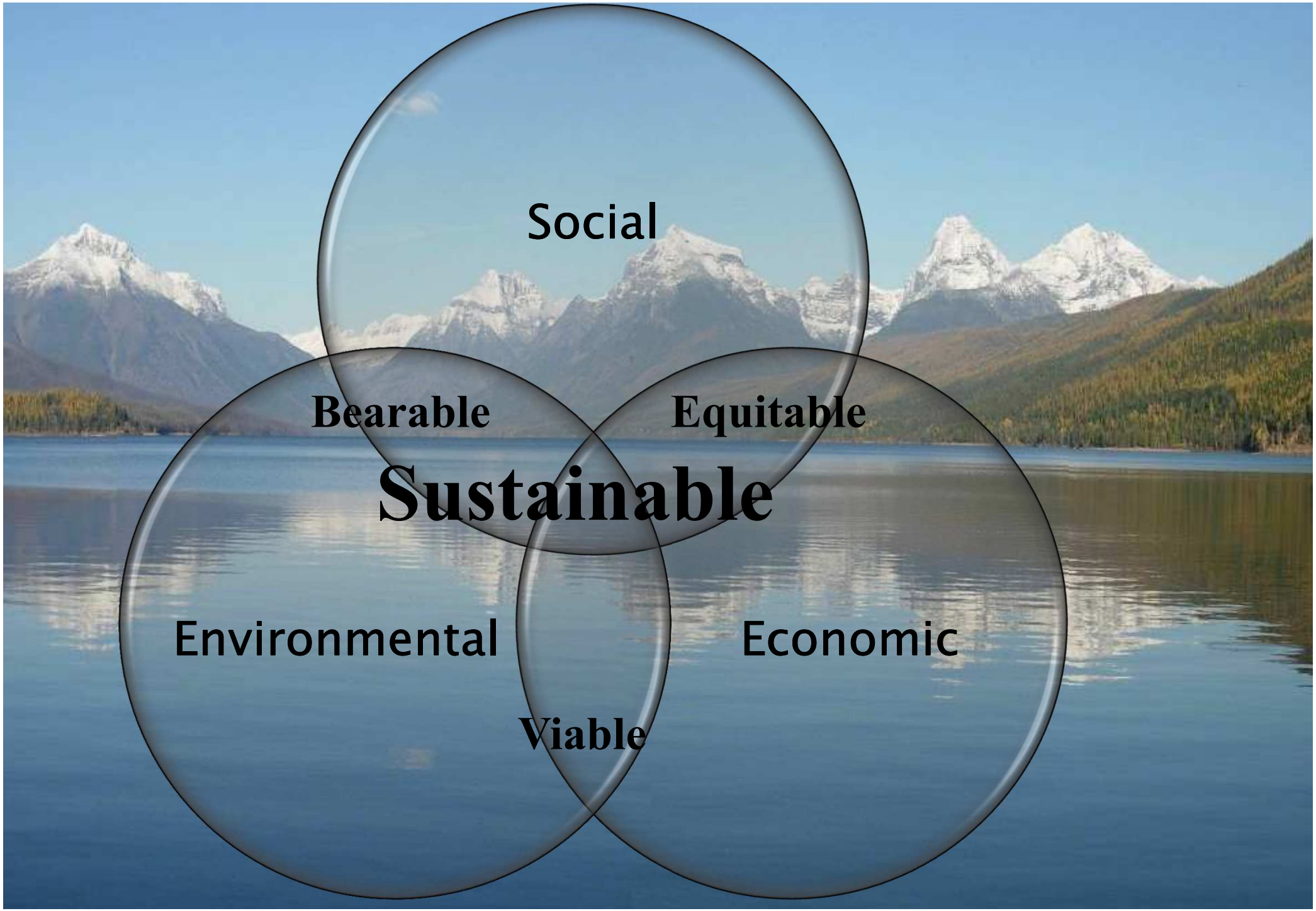
Moving Forward in Road Building, USA Style.

Several hundred million tons of Hot Mix Asphalt (HMA) are made in the USA each year. Agencies buy anywhere from 50 to 90 % / year!

Recycling is Global:
ConExpo ASIA 2007 – AEM


CARRARO
SEEMARK
KIFOR




Social
Bearable
Equitable
Sustainable
Environmental
Economic
Viable

tainable roads for a better transportatio

s a project-oriented system.

eal with planning and it does not deal with operations.

Greenroads

anning → Design & Construction → Operat

1 There are a lot of definitions for "sustainable" out there. Most are incomplete. This is what we think "sustainability" means.

Sustainability is a system characteristic which refers to the system's capacity to support natural laws and human values.

Greenroads

Table MR-4.2: Some Examples of Base and Sub-Base Assemblies (FHWA, 1997)

Assembly	Possible Recycled Materials
Granular Base and Embankment Fill	
Granular Base	Blast Furnace Slag Coal Boiler Slag Mineral Processing Wastes Municipal Solid Waste Combustor Ash Nonferrous Slags Reclaimed Asphalt Pavement Reclaimed Concrete Steel Slag Waste Glass
Embankment or Fill	Coal Fly Ash Mineral Processing Wastes Nonferrous Slags Reclaimed Asphalt Pavement Reclaimed Concrete Scrap Tires

Black Gold

Slag RAP is the BEST!

A Position to Stand For…

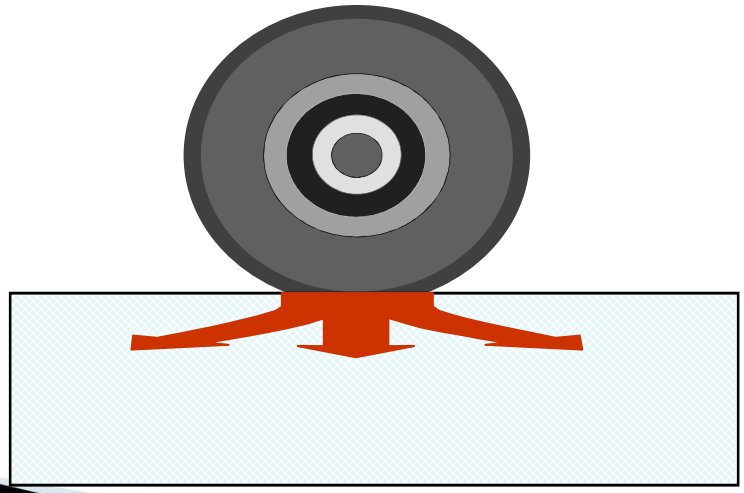
We must be dedicated to safeguarding the environment and transforming the marketplace by promoting the manufacture, purchase, and use of environmentally responsible products and services.

Heavy, Concentrated Loading

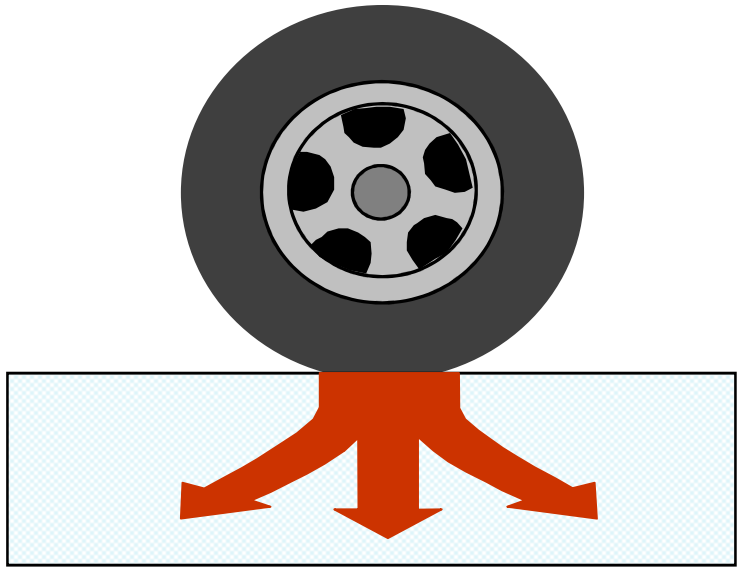
How Did We Get Here?

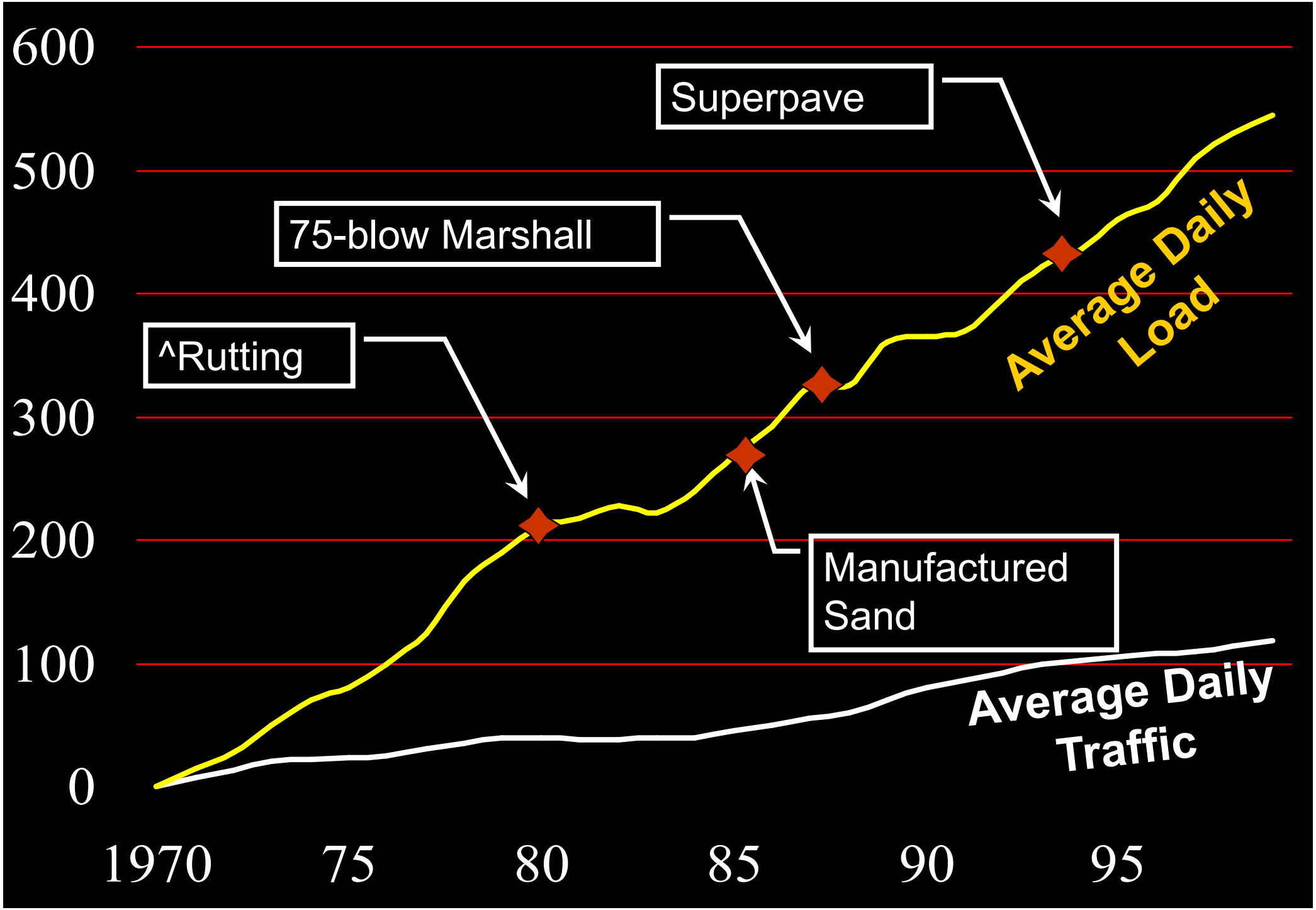
Truck tire footprint changed drastically!

75 psi, 2-ply



105 psi, radial



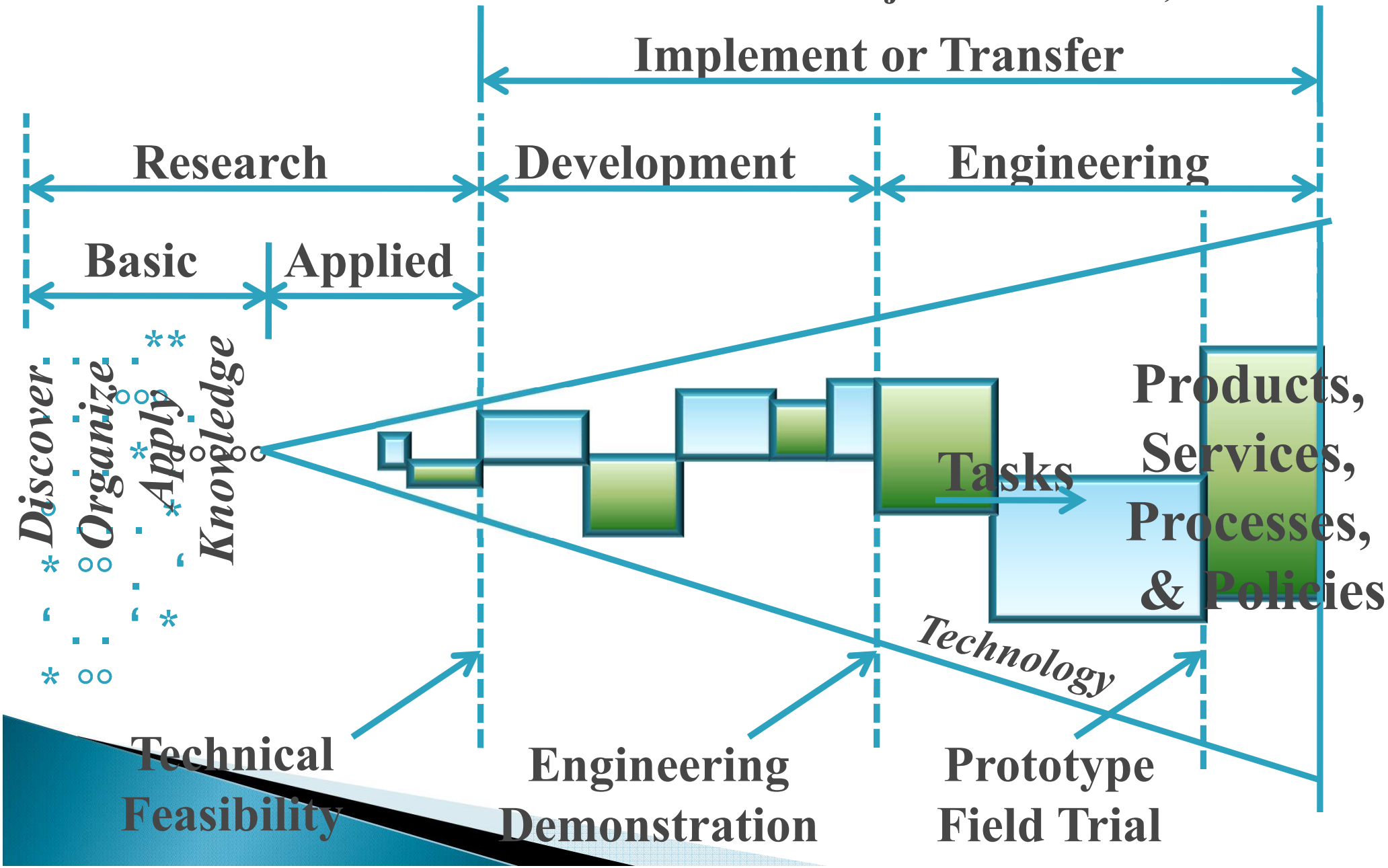

600
500
400
300
200
100
0
1970
75
80
85
90
95
Superpave
75-blow Marshall
^Rutting
Manufactured Sand
Average Daily Load
Average Daily Traffic

Research Done (Needs?)

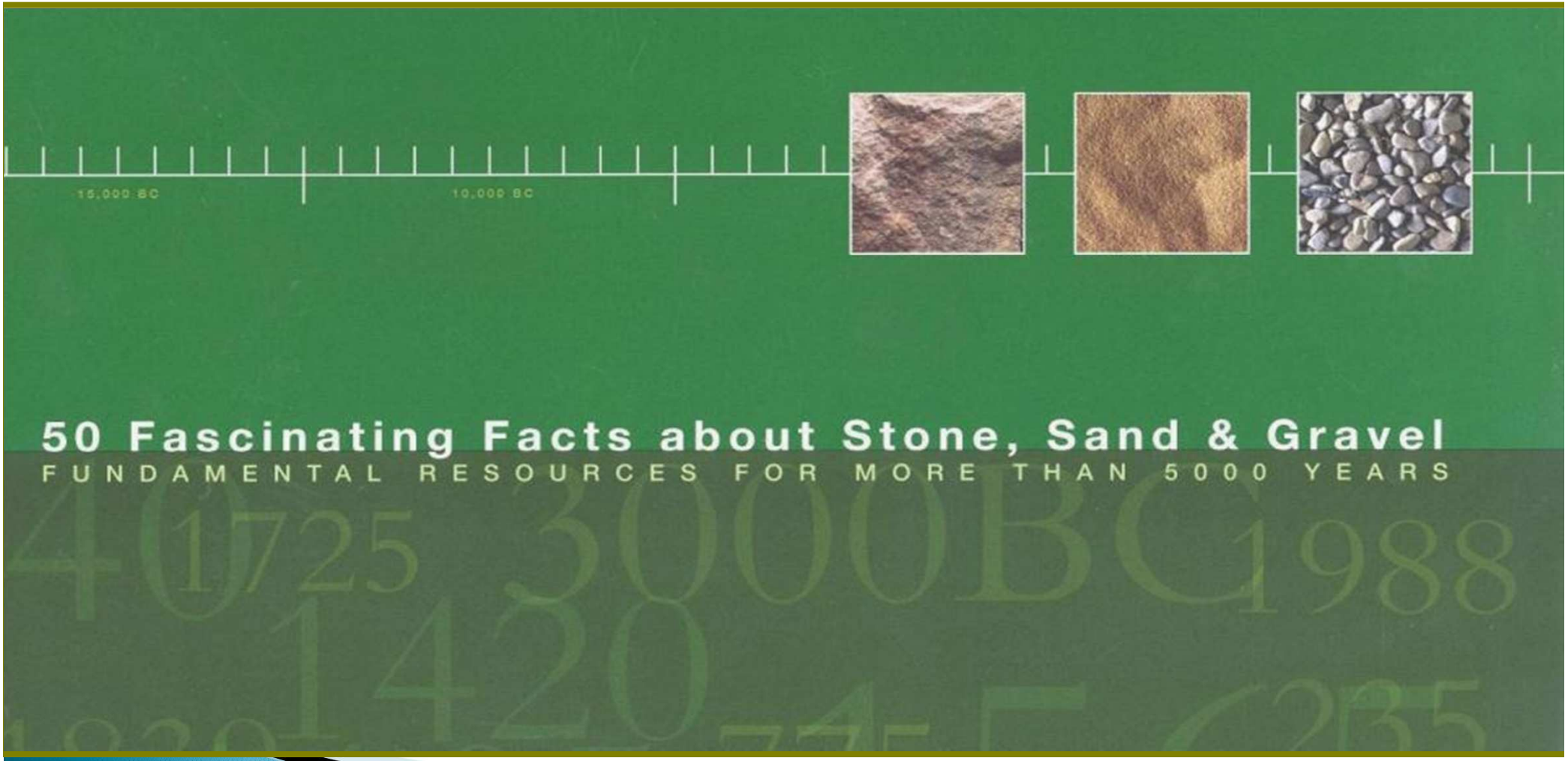
- Performance test for evaluating Slag
- Best practices manual
- Method to characterize Slag
- Field performance of Slag mixes
- Replicating plant production in lab

MODEL OF DEVELOPMENT OF TECHNOLOGY

- Oujian and Carne, 1987

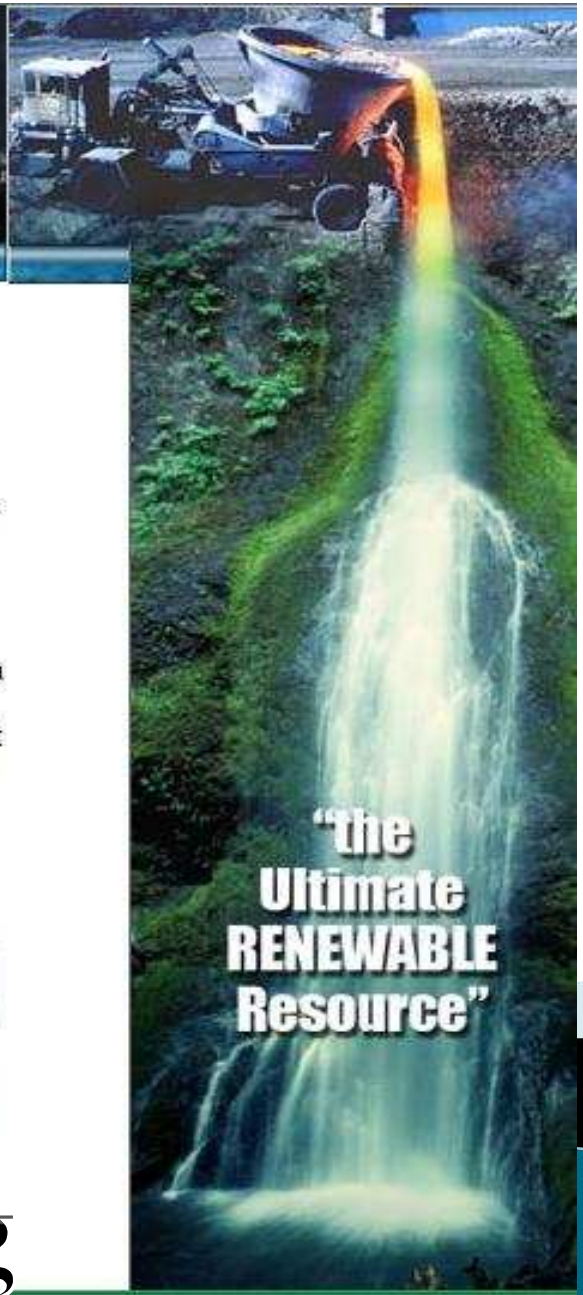


We can applaud others efforts



National Slag Association

Founded in 1918



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Environmentally friendly aggregate changes the skyline of Ontario

Scotia Plaza
Toronto, Ontario, Canada.

Slag products (air-cooled, pelletized, ground granulated) used in the poured concrete and lightweight masonry units for durability, light weight, fire resistance and aesthetic quality.

From byproduct to co-product.

Since 1918, The NSA has promoted the use of Blast Furnace and Steel Furnace Slag. Blast Furnace slag has been called the "All-Purpose Aggregate" as it can be used in all construction applications as either a normal weight or lightweight (expanded or pelletized) aggregate depending on how it was formed and processed. Blast Furnace Slag is also quickly quenched by water or air to produce Granulated Blast Furnace Slag. When ground to cement fineness, GGBS (ground granulated blast slag) has been used extensively as a Portland cement replacement in concrete. Steel Furnace slag has been used in many construction applications and as a raw ingredient in Portland cement manufacture, but its primary use is as premium asphalt aggregate. These types of slag and the uses are covered extensively in numerous online documents and the applications matrix.

Slags are produced in many metallurgical operations throughout the world and are considered a co-product of the production of iron and steel. Slag is an environmentally sound material that has been used to aid in the remediation of many environmentally damaged areas such as Acid Mine Discharge. A copy of the Risk Assessment report is available in the environmental section of this website. Protect the environment. Think re-use and use slag, a renewable resource, in your next Green project.

www.nationalslag.org

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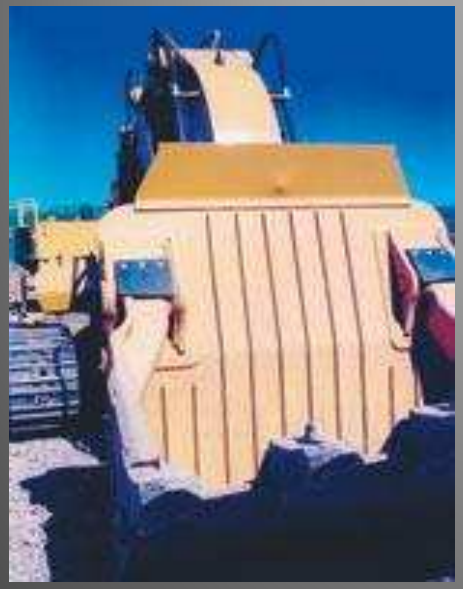
ASTM D-8
Standard Terminology Relating to Materials for Roads and Pavements

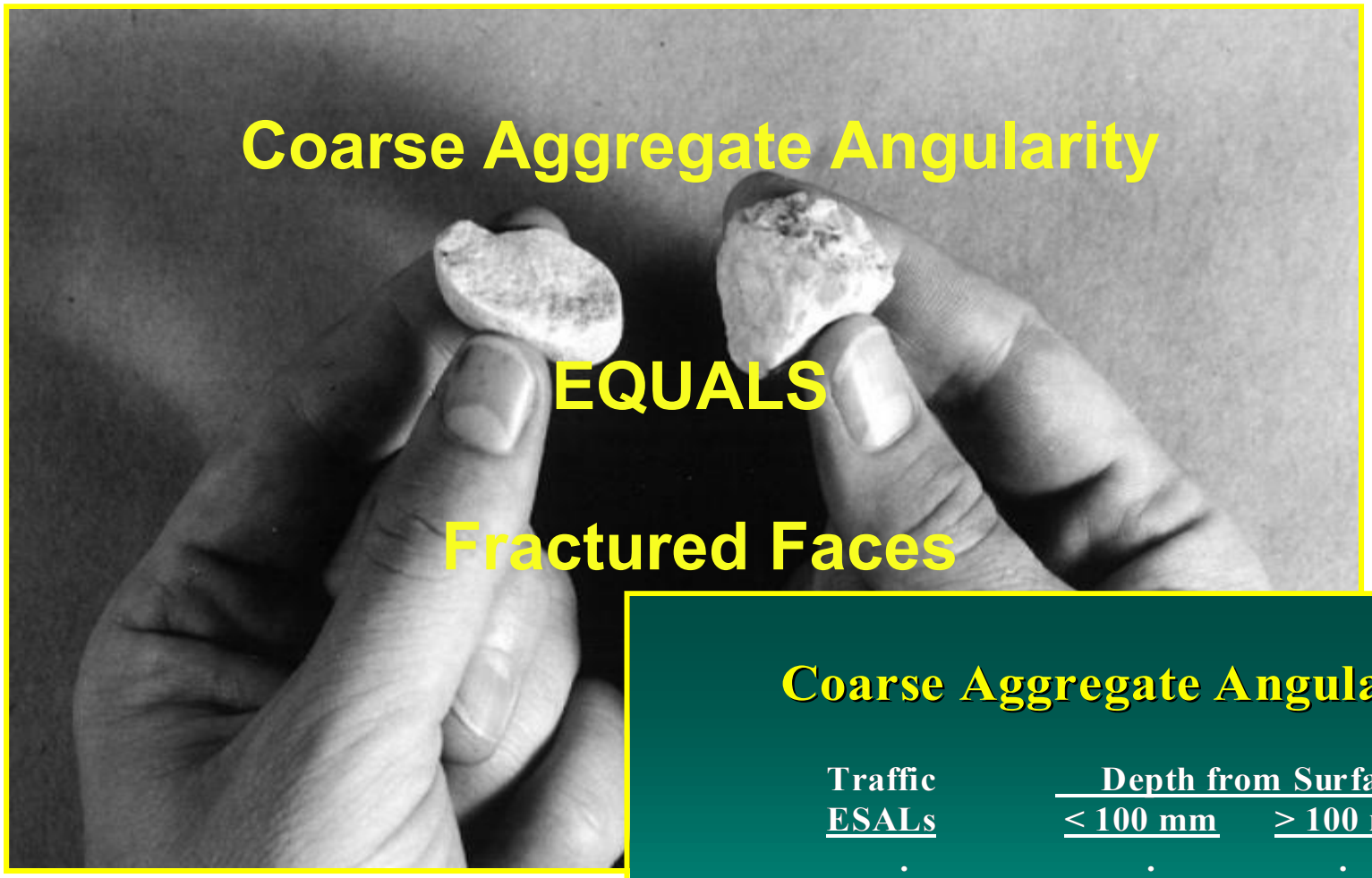
- *Steel Slag (SS), and*
- *Air-cooled Blast Furnace (ACBF)*

Input for crusher

Selecting Aggregate Crushers



Processing Slag



Coarse Aggregate Angularity

Traffic ESALs	Depth from Surface < 100 mm	Depth from Surface > 100 mm	
10 - 30 million	95/90	80/75	Minimum

95% one fractured face

90% two+ fractured faces

Output from crusher

Sieve	Percent Passing
½”	100
3/8”	85 – 100
#4	10 – 30
#8	0 – 10
#16	0 – 5
G_{sb} = 3.100	Abs. = 2+

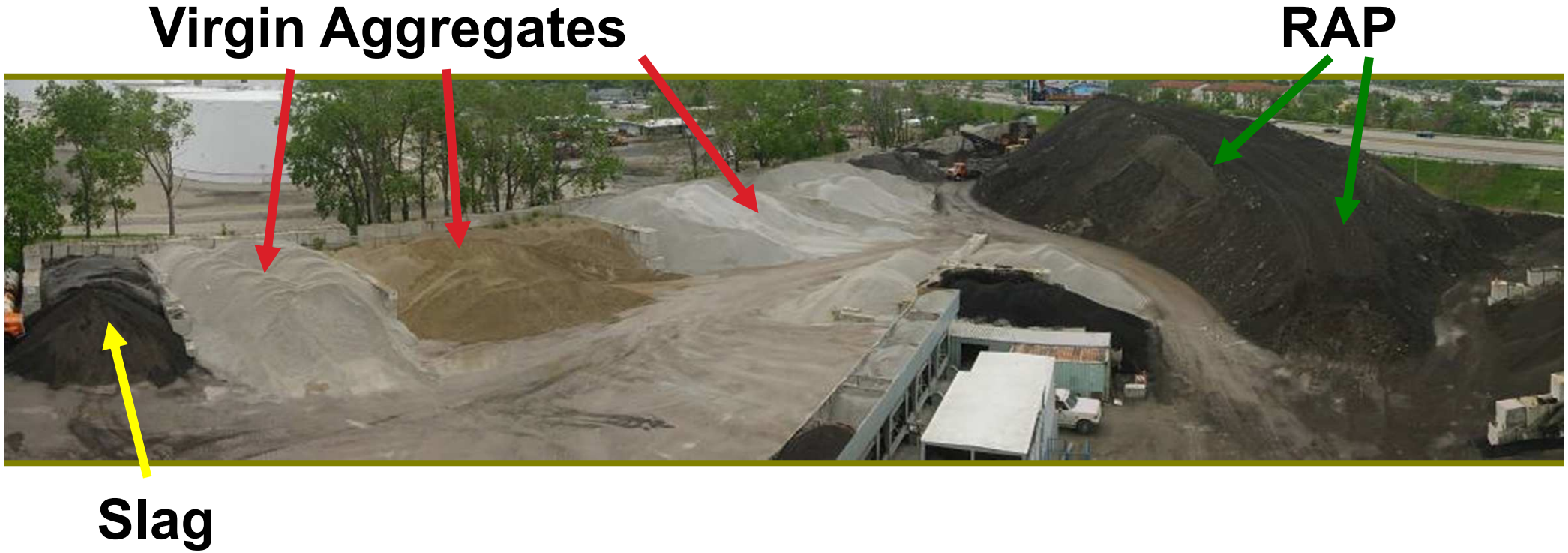
Coarse Aggregate Properties

Aggregate	G_{SB}	Water Abs
Steel Slag	3.10 – 3.53	1.9 – 3.5%
Dolomite	2.62 – 2.64	2.1 – 2.3%
ACBF Slag	2.33 – 2.38	2.4 – 4.6%

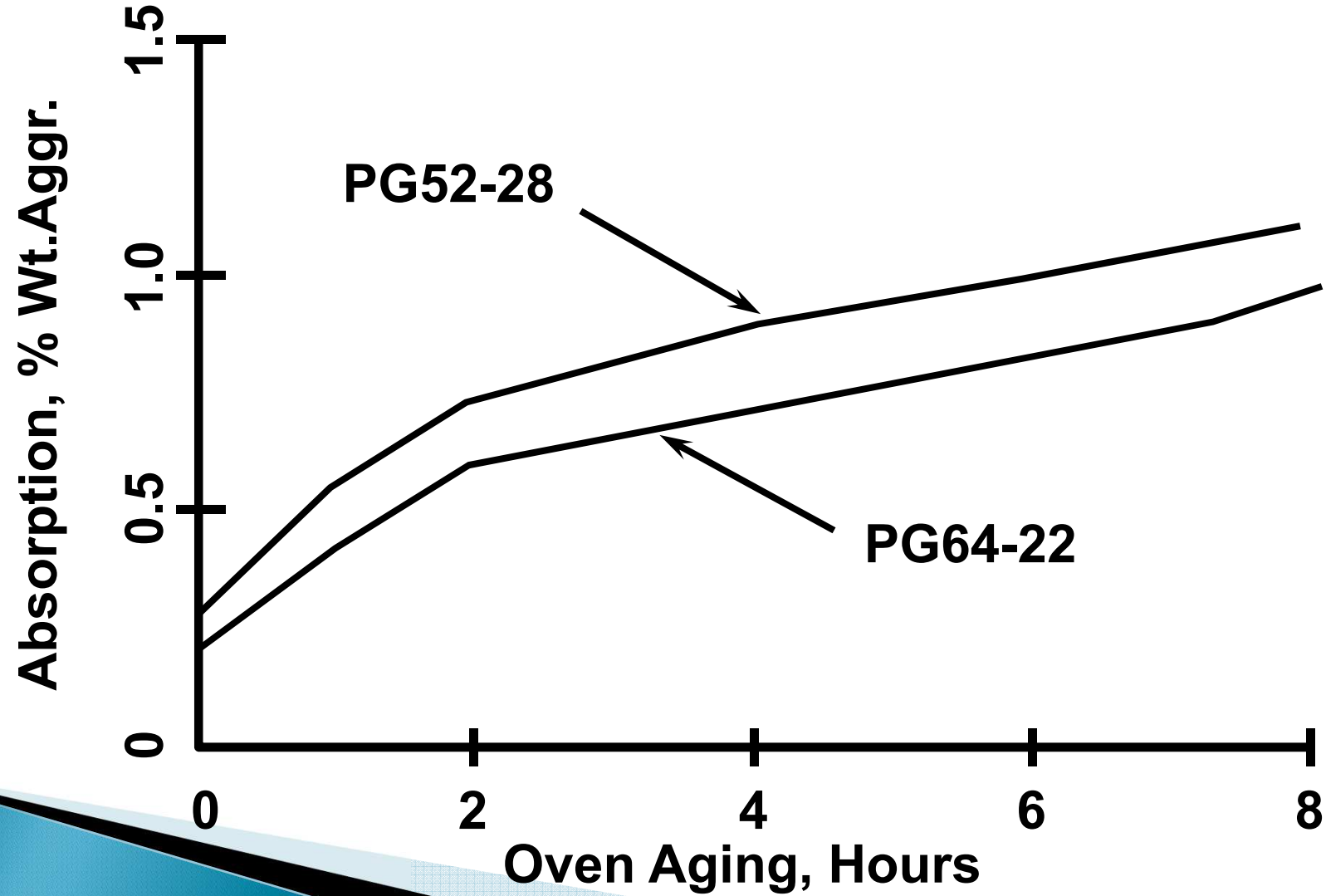
Aggregate and Asphalt

Blending & Batching

Asphalt plant quality inputs



Effect of Absorption



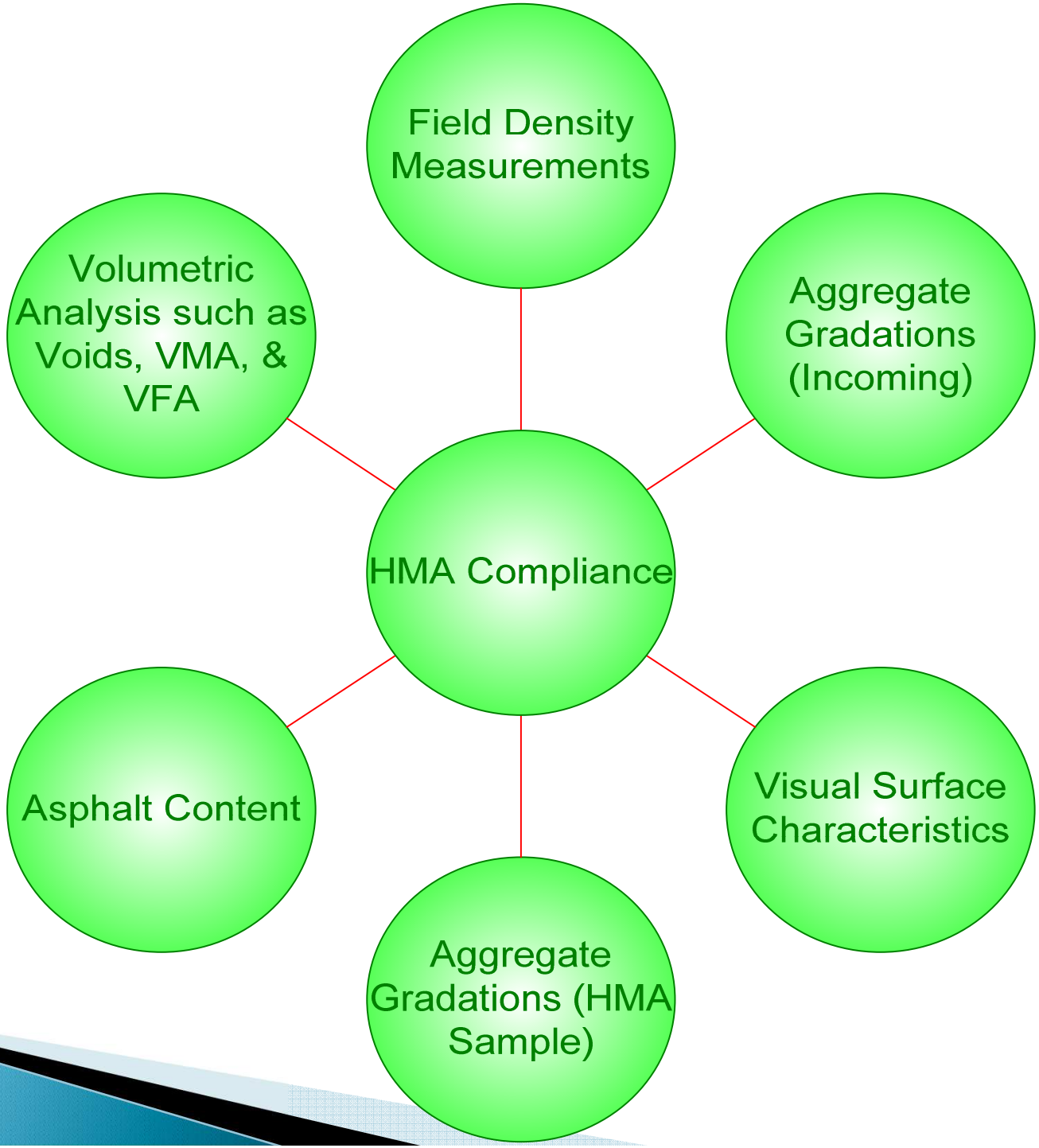
Volumetrics 100

$$V_a = \left(\frac{G_{mm} - G_{mb}}{G_{mm}} \right) \times 100$$

$$VMA = 100 - \left(\frac{G_{mb} \times P_s}{G_{sb}} \right)$$

$$VFA = \left(\frac{VMA - V_a}{VMA} \right) \times 100$$

Effective Volume of Asphalt = VMA – V_a


Field Density Measurements
Volumetric Analysis such as Voids, VMA, & VFA
Aggregate Gradations (Incoming)
HMA Compliance
Asphalt Content
Visual Surface Characteristics
Aggregate Gradations (HMA Sample)

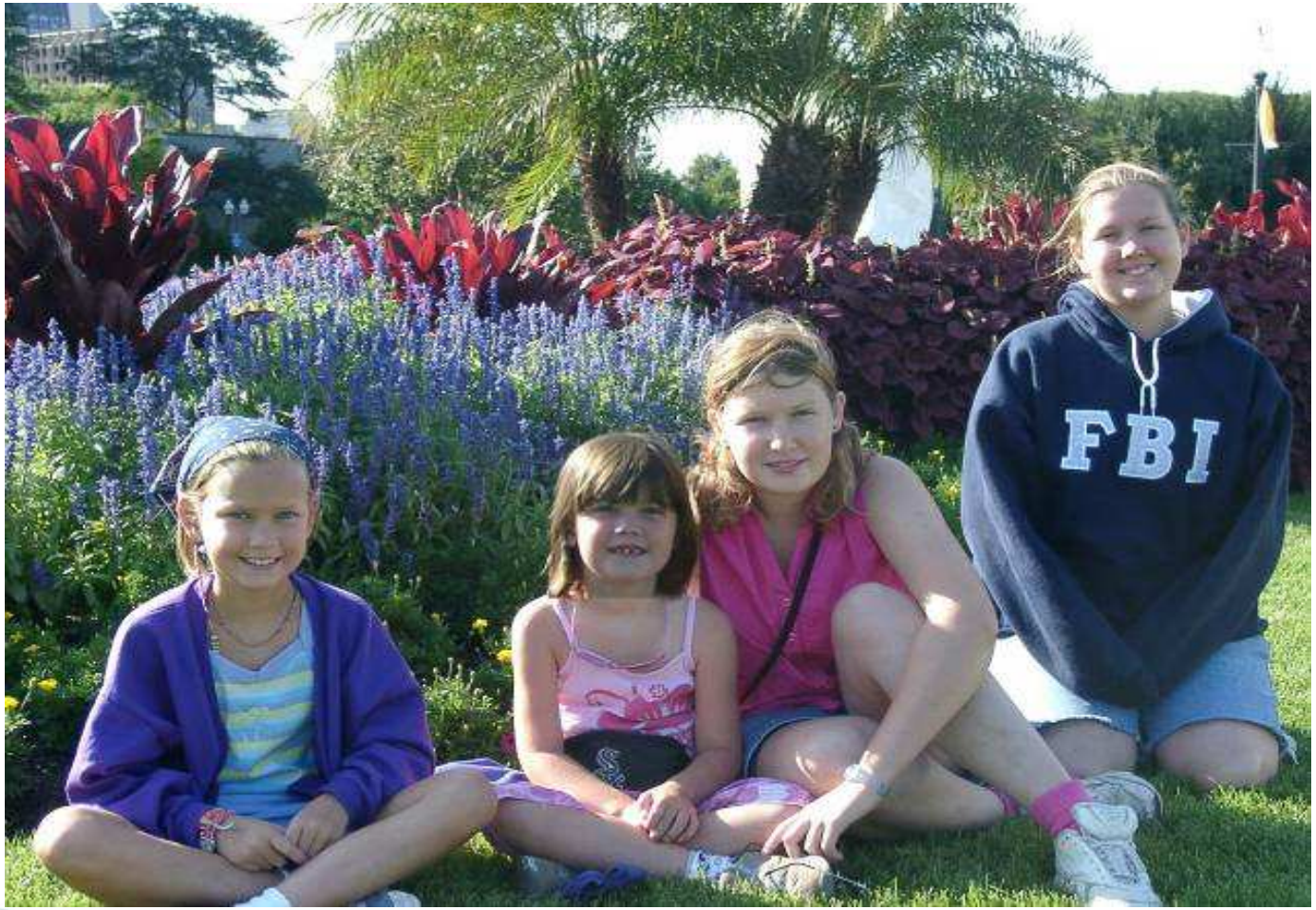
Safety Benefits of Steel Slag in Asphalt Pavements

- Coarse Aggregate
  Friction Policy
  Police Reports

Coarse Aggregate Quality

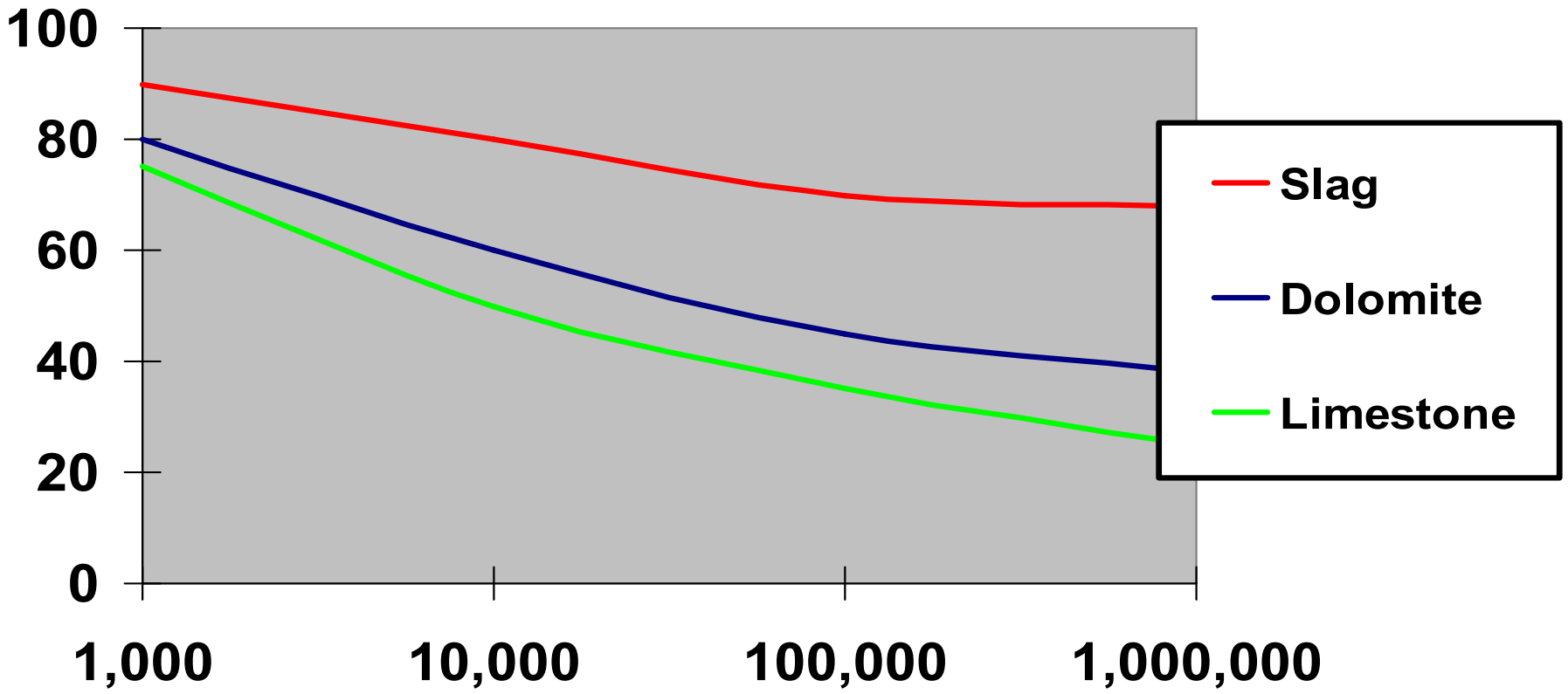
Meets agency specifications.

Coarse Aggregate Type = Safety




WEAR TRACK

Slag's Frictional Characteristics vs. Other Products



What's Your Friction Policy?

Opportunity is from Agency knowledge on measuring performance with Academia and from Contractor knowledge of their operations.

OPPORTUNITY FOCUSED SPECIFICATION

Selecting Aggregate Gradation

- Dense-Graded
- Gap-Graded (Stone Matrix Asphalt, SMA)
- Open-Graded Friction Course (OGFC)
- Asphalt Treated Permeable Base (ATPB)

Intersections need special attention

Pavement designers and contractors realize that heavy, slow-moving vehicles that are stopping, turning, or accelerating expose intersections to some of the highest stress levels found on pavements.

World's Strongest Intersection: Williams & Margaret in Thornton, IL

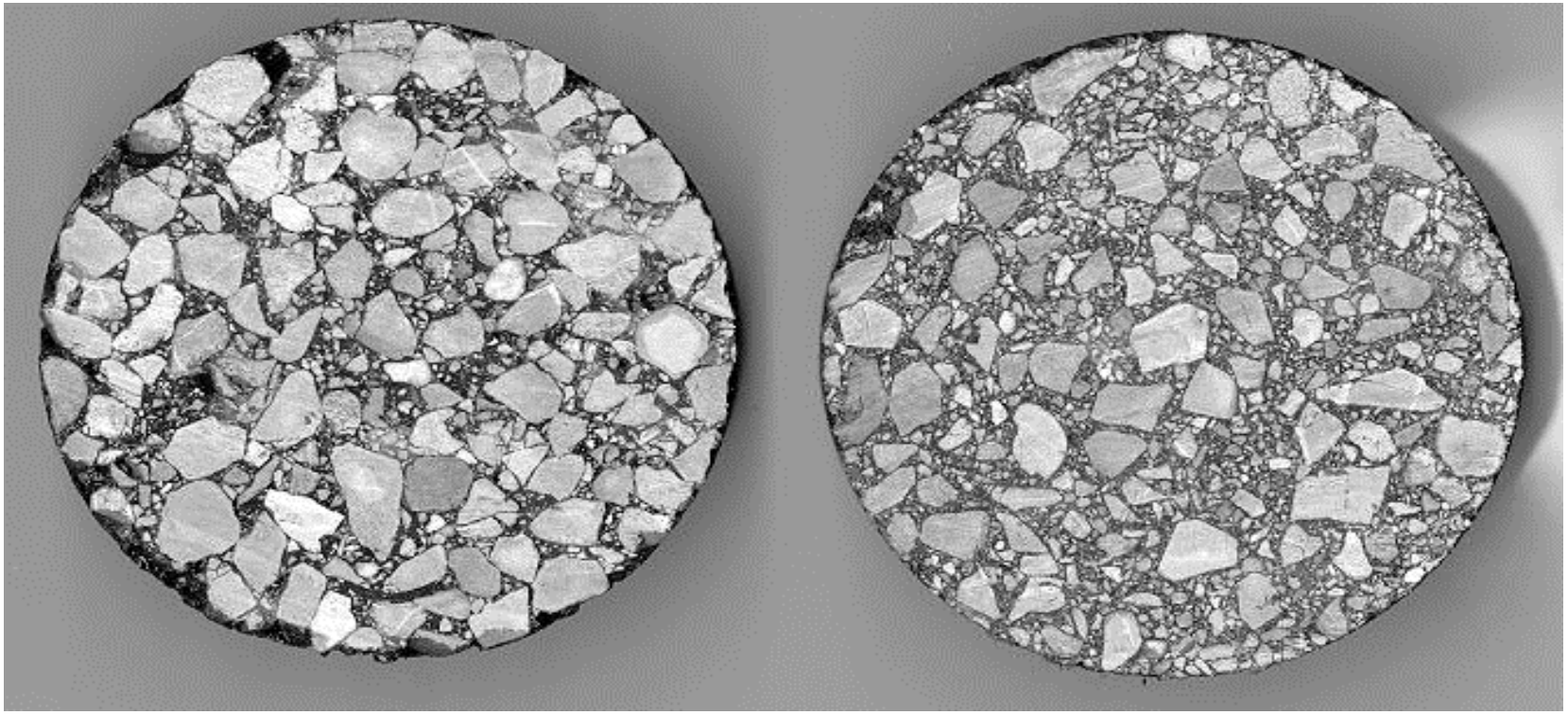
Intersection strategy consists of four steps:

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

Tough Mix Team

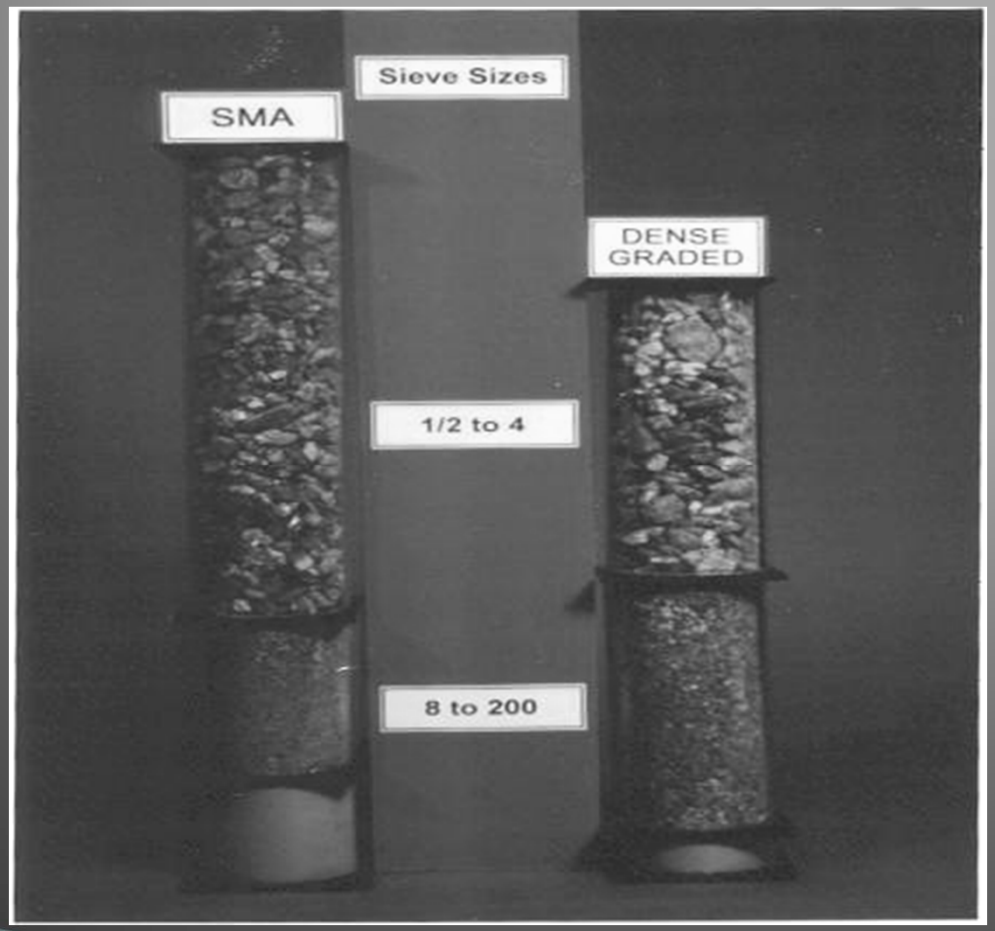
Asphalt Institute,
Chicago Testing Laboratory,
Gallagher Asphalt,
IDOT,
Seneca Petroleum,
Slag Suppliers

Comparison
SMA vs. Dense-Graded



Stone Matrix Asphalt

SMA (aka Gap) vs. Dense-Graded



World's Strongest Intersection Conclusion

An evaluation of the 1998 pavement fix was performed in 2011. After 13 years, and the application of almost 10 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".

Today Slag is the standard that all other materials are measured against.

How to (US)e Slag in HMA Successfully

People Working Together to Form

Alliances in Action

Academia - Agency - Association - Consultant - Contractor - Supplier

Build a team to work through the details

slag Successes

News and Information about the Iron and Steel Slag Industry

MEMBER PROCESSORS

AMSI, INC.

AUSTRALIAN STEEL MILL SERVICES

BEELMAN TRUCK CO.

BLUE CIRCLE CEMENT

BROKEN HILL PROPRIETARY, LTD.

C.J. LANGENFELDER & SON, INC.

CLUGSTON GROUP LTD.

DOFASCO INC.

EDW. C. LEVY CO.

GAGNERAUD INDUSTRIES

HECKETT MULTISERV

HOLNAM INC.

IMS WAYLITE

INTERNATIONAL MILL SERVICE

LAFARGE CANADA

LAFARGE CORP.

Largest Stone Matrix Asphalt project in USA spans 6 lanes for 8 miles

THE LEVY COMPANY of Portage, Indiana, supplied the steel slag for busy I-94, Bishop Ford Expressway, and its heavy loads

I-94, Bishop Ford Expressway, Chicago

When the Illinois Department of

Other high-stress locations

High-stress locations also include climbing lanes, truck weigh stations, rest areas, and other slow-speed areas. Giving special attention to these areas can ensure that high-stress areas deliver the same outstanding performance as other asphalt pavements.

Opportunities!

What will you *really* remember most about today?

Thoughts?

- Slag is stable.
- Slag provides friction.
- Slag meets Superpave CAA requirements.
- Slag requires QC like any other aggregate.
- Slag is in your backyard.


america (18)
american (38)
banks (12)
bring (7)
budget (13)
businesses (7)
care (18)
children (10)
college (10)
confidence (7)
congress (10)
cost (15)
country (12)
crisis (11)
deficit (9)
depend (8)
dollars (8)
don (10)
economic (8)
economy (22)
education (14)
energy (14)
ensure (8)
family (12)
future (10)
government (7)
health (20)
help (12)
invest (11)
jobs (19)
lending (8)
meet (7)
money (10)
Slag is 100% Made in North America!
created at TagCrowd.com

Time fo(u)r questions