Best Practices Guide for Manufacturing, Storing, Handling and Testing Rubber Modified Asphalt Mixtures

AUDREY COPELAND

FHWA Asphalt Mixture Expert Task Group Meeting
April 8th, 2015
Fall River, MA

NATIONAL ASPHALT PAVEMENT ASSOCIATION

Motivation

- Current National Guidance documents are outdated
  - Heitzman, M., State of the Practice – Design and Construction of Asphalt Paving Materials with Crumb Rubber Modifier, FHWA-SA-92-022, 1992
  - Epps, J. Uses of Recycled Rubber Tires in Highway, NCHRP Synthesis of Highway Practice No. 198, 1994
- GTR in pavement applications –long history starting in 1940’s, but applications/methods have evolved rapidly in past two decades
- Different techniques /technological methods addressed past problems and have demonstrated enhanced pavement performance
- Favorable environmental and economic factors promote its acceptance by industry

As a result, a best practice guide which consolidates the use of current applications and specifications related to production, handling and storage is needed

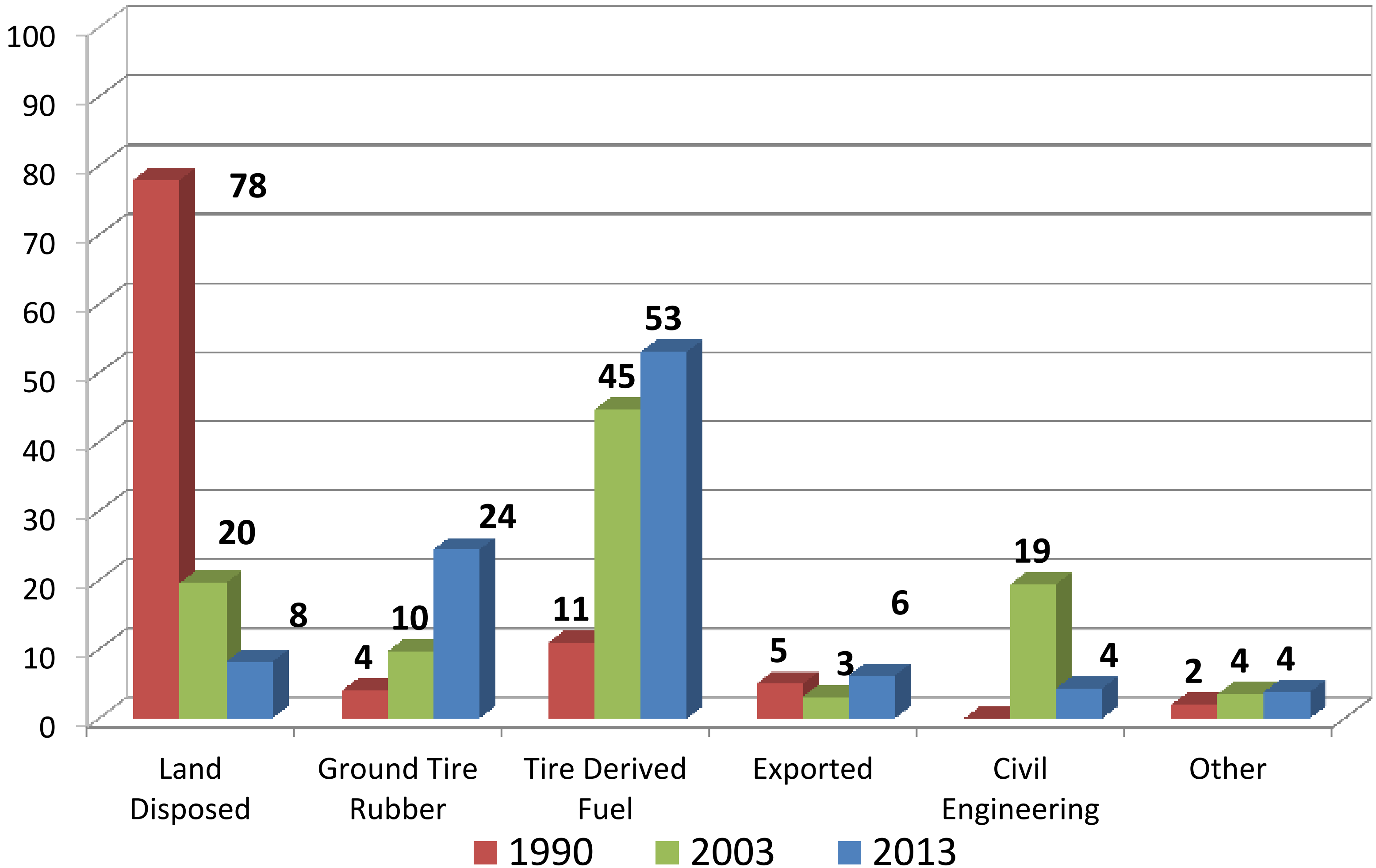
Historical Perspective

- 1940's- U.S Rubber Reclaiming Company (Vicksburg, MS) started marketing rubber as dry particle additive for HMA (Baker et al, 2003)
- 1950's- Few studies to evaluate GTR in HMA (Lewis and Welborn, 1954; Rex and Peck, 1954; Gregg and Alcoke, 1954)
- 1960-First Symposium on Rubber in Asphalt hosted by Asphalt Institute in Chicago-few papers under discussion
- 1960's-Charles McDonald worked with asphalt and rubber to develop maintenance surface patch for cracked pavements by reacting asphalt and rubber at high temperatures-earlier experiments with asphalt rubber (AR)
- 1970's-AR used for seal coats (SAM) and interlayers (SAMI) over many miles of road in AZ

Historical Perspective

- 1975-1980- Caltrans started experimenting with AR seal coats and dry process
- 1988-Definition for AR included in ASTM D8; specified later in ASTM D6114 (1997)
- 1980's-1990's –other states such as TX, FL conducted evaluations
- 1991-ISTEA required state to use minimum amount of GTR in asphalt pavements
- 1995-Mandate was lifted, but many sections were placed and national research efforts were underway

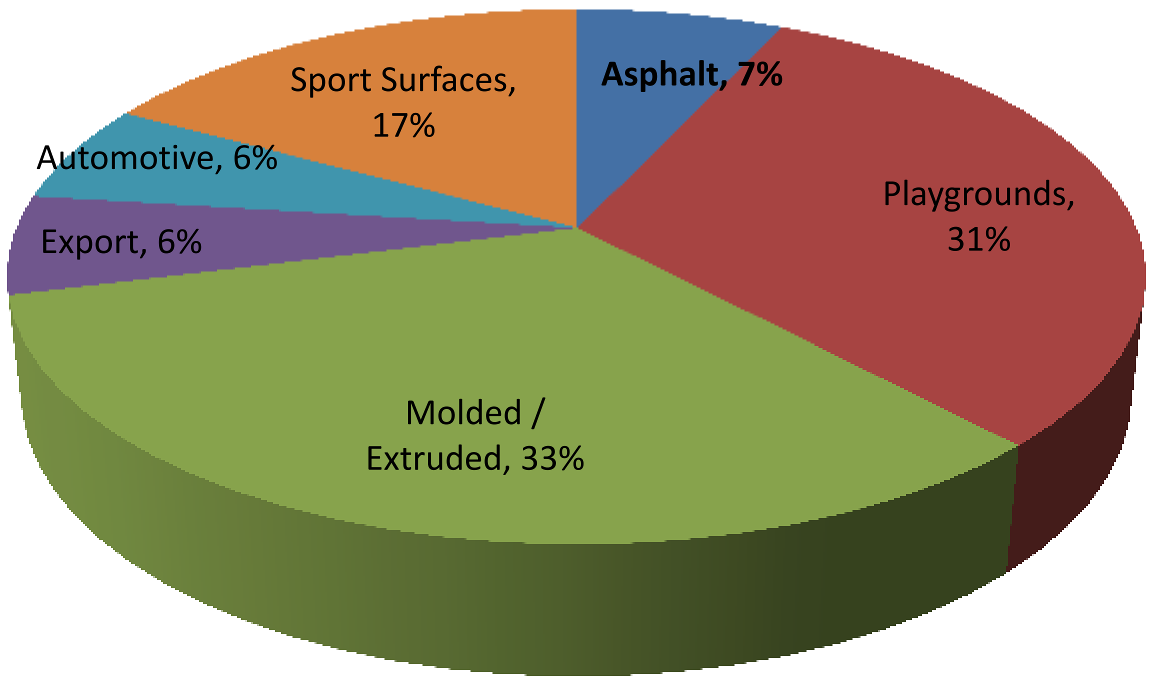
US Scrap Tire Market Trend



*Percentage of Million of Tires Generated

Source : EPA, 1991; RMA, 2003, 2014

Ground Rubber Market 2013



- ~600,000 Tons of ground tire rubber consumed in the market~60 million tires
- ~41,000 tons of GTR used in asphalt pavements

Percent of total pounds of ground tire rubber consumed

RMA, 2014

What Agencies are currently using GTR in Asphalt Mixtures ?

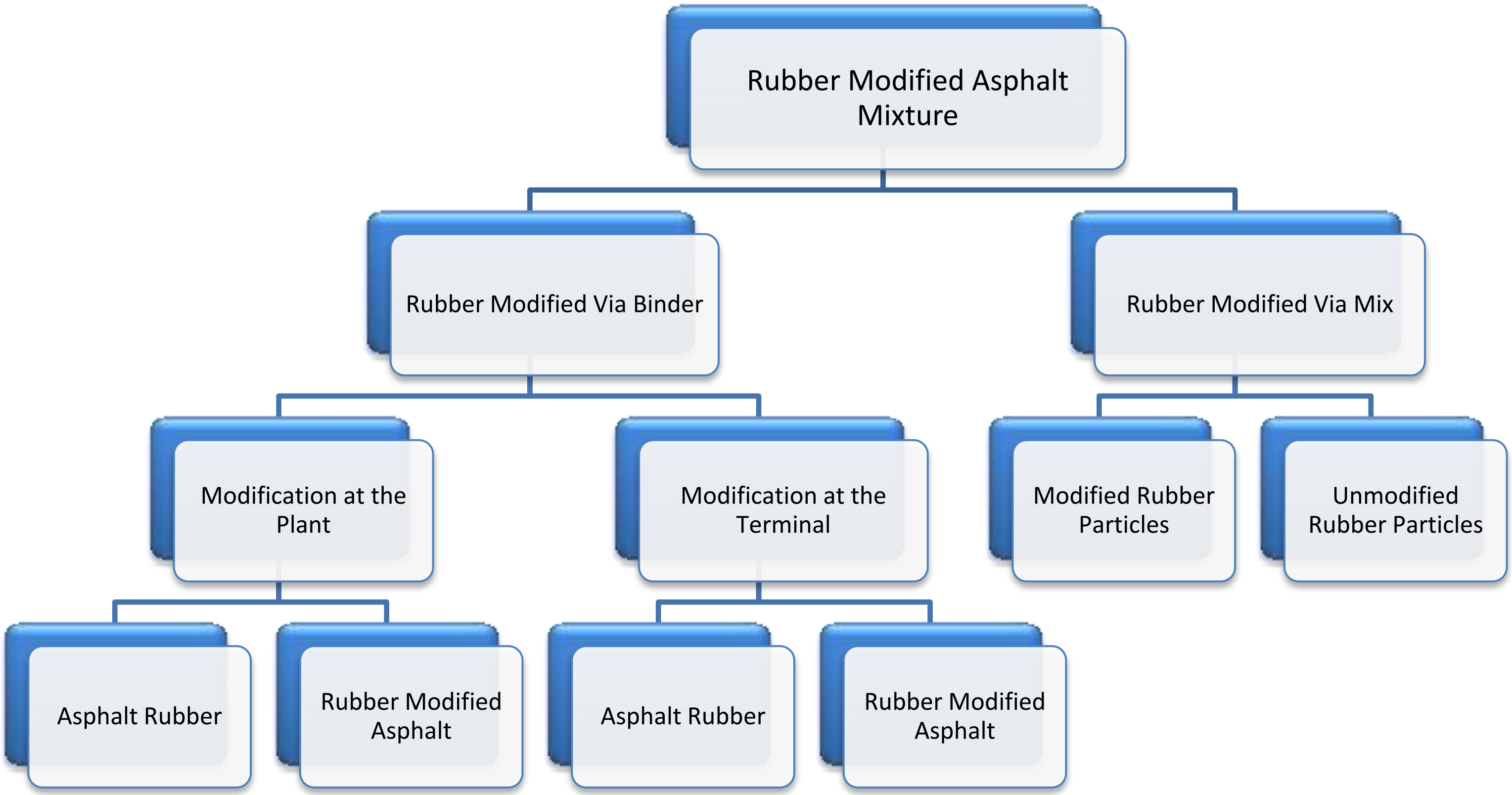
- **Arizona**
- **California**
- Delaware
- **Florida**
- Georgia
- Louisiana
- Missouri
- Nevada
- New Jersey
- Pennsylvania
- Ohio
- South Carolina
- **Texas**

*Based on limited data from Surveys: NAPA, 2014; Cheng and Hicks, 2012
*GTR use may include pavement preservation treatments e.g chip seals, interlayers

Challenges Developing this Guide

- Define common terminology
  - Wet process, rubberized asphalt concrete?
  - Asphalt rubber, terminal blend?
  - Wet process- high viscosity, wet process -no agitation?
  - What about hybrids?

Rubber Modified Asphalt Mixtures-Family Tree



Asphalt Mix Modified via Binder (GTR added to binder) or via Mix (GTR added to aggregate during the mixing process)

Best Practice Guide Content

A total of nine chapters, the topics to be covered include:

- **Chapter 1-Introduction to Rubber Modified Asphalt and Mixtures**
  - History, Background, Benefits and Challenges; Terminology
- **Chapter 2-GTR Production**
  - Production methods, quality control
- **Chapter 3-Methodologies**
  - Rubber Modified Asphalt Mixtures via Binder
  - Rubber Modified Mixtures via Mix
- **Chapter 4-Applications**
  - Asphalt Mixtures
  - Pavement Preservation

Best Practice Guide Content

- **Chapter 5-Design**
  - Binder Design and Mix Design
- **Chapter 6- Quality Control**
  - Binder Quality Control
  - Mix Quality Control
- **Chapter 7-Acceptance Testing**
  - Possible performance tests
- **Chapter 8-Construction Practices**
  - Blending, storage, placement and compaction
- **Chapter 9-Case Studies**
  - Performance, life cycle cost, noise, emissions

Potential Benefits

- Improved performance and durability
- Competitive with polymer modified binders (terminal)
- Possible noise improvement
- Improved resistance to cracking
- Possible reduction in paving thickness (Asphalt Rubber)
- Improve driving safety
- Energy and environmental savings with reuse of waste tires

Challenges

- Lack of Industry Experience
- Lack of national standards
- Limited paving window
- Weather restrictions (not recommended during cold or rainy weather with temperature below 10°C)
- Lack of available processing facilities / mobilization cost for asphalt rubber production equipment

Chapter 2- Ground Tire Rubber Production

- Processing Systems
  - Ambient Systems
  - Cryogenic Systems
- Quality Control
  - Standards
  - Particle size requirement
  - Industry Practice

Chapter 3-Methodologies

Two broad categories:

a) **Rubber Modified Mixtures via Binder** (Wet)

GTR combined with binder before mixing with aggregate, rubber is wet

- Asphalt Rubber (Wet Process with Agitation)
- Terminal blends (Wet Process no Agitation)
  - Hybrids

b) **Rubber Modified Mixtures via Mix** (Dry)

GTR is used to replace a fraction of aggregate within HMA, rubber is dry

- Dry Process

GTR-Binder Interaction Mechanism

- Reaction at high temperature (160-220°C) includes two processes:
  - Partial digestion of rubber into asphalt
  - Rubber absorption of aromatics that cause swelling
- After extended interaction or higher temperature, swelling continues until depolymerization/ devulcanization
- If depolymerization continues modifications of binder is lost

GTR-Binder Interaction Mechanisms

Depends on the following key factors that govern modification process:

- **Blending variables:** Temperature, time and blending units (applied shear stress)
- **Base binder properties**: binder source, type
- **GTR Properties**: rubber source, processing method, particle size and content

Rubber Modified Mixture via Binder

Most Common processes: Asphalt Rubber and Terminal Blend

	Asphalt Rubber	Terminal Blend
GTR size	10-20 mesh	40-80 mesh
GTR content	>15%	Typically <10%; up to 15% (few products)
Blending and digestion	Tanker-Rubber reacts with binder	Terminal-Rubber dissolves
Tank storage agitation	high	Low or none
PG Grading	no	yes
Performance history	1960s	1990s

Rubber Modified Mixture via Binder

Asphalt Rubber		Terminal Blend
	Dense graded	Y
Y	Gap graded	Y
Y	Open graded	Y
Y	Preservation Treatments	Y

Rubber Modified Mixture via Binder

Different technologies, if design and construct properly enhance performance

Chapter 4- Applications

Discussion of applications within following categories

1. Asphalt Mixtures (Dense Graded, Gap Graded, Open Graded, SMA)
2. Pavement Preservation (Interlayers, seal coats, crack sealants)

Chapter 5-Design

- Discussion of Binder Design, Mix Design
  - GTR requirements, design gradations, binder test methods and mix design procedures used by agencies

Chapter 6-Quality Control

- Focus of this chapter will be GTR binder testing
  - Traditional testing methods
  - Viscosity testing
  - Performance grade
    - Variations of PG standard (example: Florida)
    - 1 mm vs 2 mm gap
  - Cup and bob testing

Chapter 7-Acceptance Testing

- Whether the mix is modified via the binder or the mix, ultimately it is the mixture performance which matters
- How do we determine if mixture will perform?
  - Rutting
  - Low temperature cracking
  - Top down cracking
  - Fatigue cracking
  - Moisture susceptibility

Timeline

Best Practice Guide is expected to be completed by Fall 2015

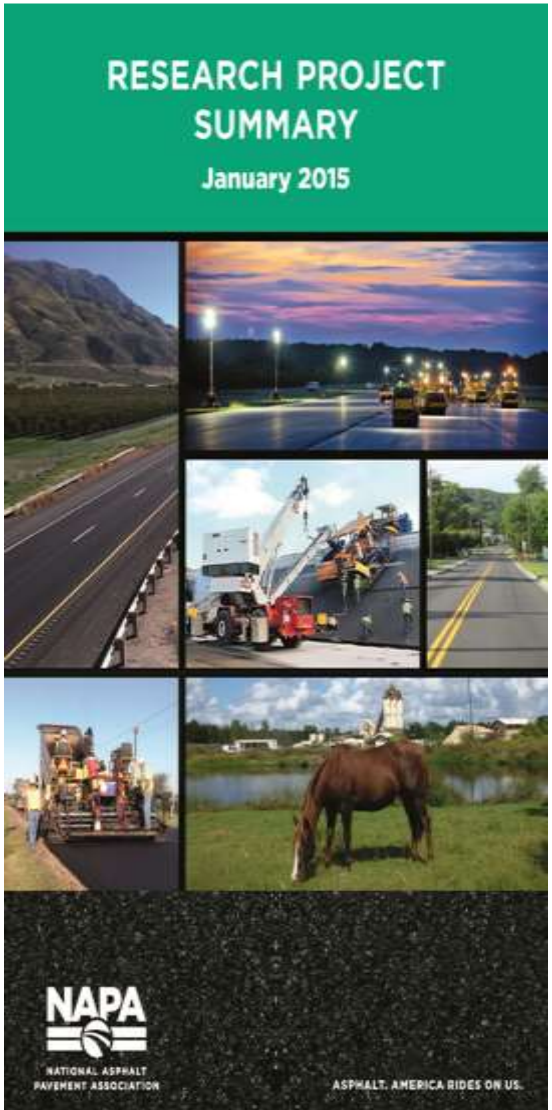
- **Chapter 1-Introduction to Rubber Modified Asphalt and Mixtures APRIL 30**
- **Chapter 2-GTR Production APRIL 30**
- **Chapter 3-Methodologies MAY 15**
- **Chapter 4-Applications MAY 15**
- **Chapter 5-Design JUNE 15**
- **Chapter 6- Quality Control MAY 15**
- **Chapter 7-Acceptance Testing APRIL 30**
- **Chapter 8-Construction Practices JULY 15**
- **Chapter 9-Case Studies JULY 30**

Review Process and Implementation

- **Review**
  - NAPA Technical Committees
  - Asphalt Pavement Alliance – Asphalt Institute and SAPAs
  - Rubber Pavement Association and other rubber associations
  - Expert Task Groups
- **Implementation**
  - Tech Brief(s)
  - Webinar Series
  - Regional Workshops?

Industry Research &Development

Pavement Economics Committee



PaveXpress

THINLAY

SAFE. SMOOTH. DURABLE.

IRI Explorer

Environmental Product Declaration

NAPA CERTIFIED

Green Codes & LCA

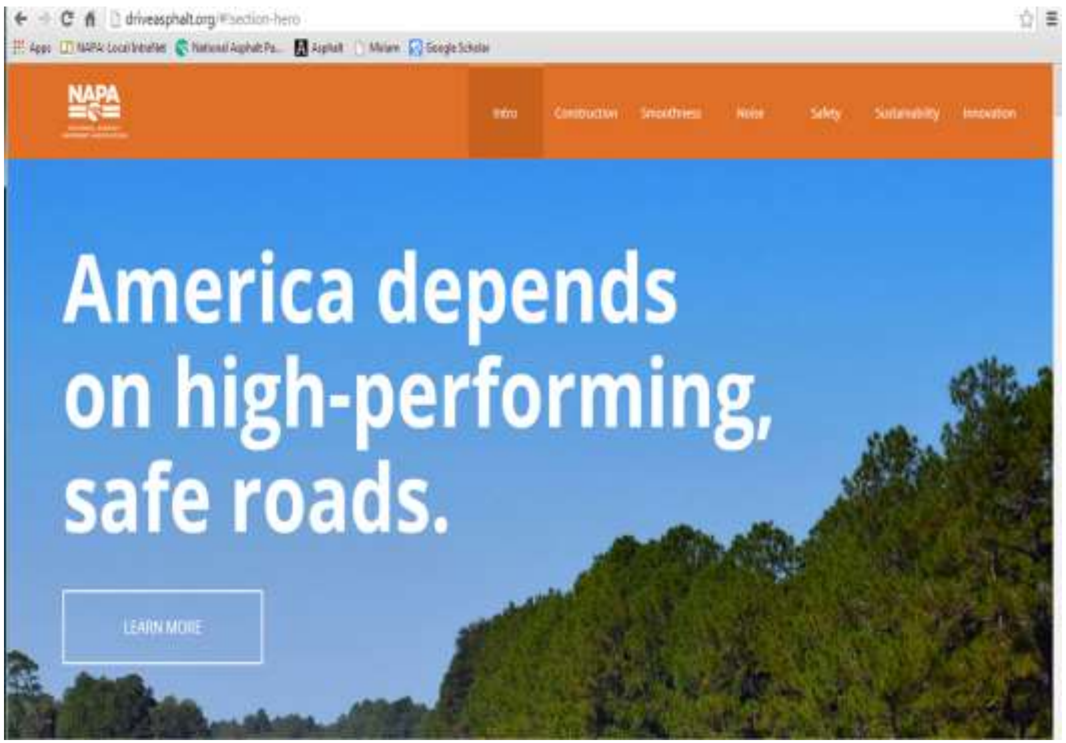
Pavement Economics Committee

- Affecting product selection decisions now …and more into the future
- NAPA working to dispel myths and promote real science
- Life cycle assessment (LCA) & Environmental Product Declarations (EPDs)
- Heather Dylla, Dir. Sustainable Engineering

Spreading the Message & Science

Go To Market

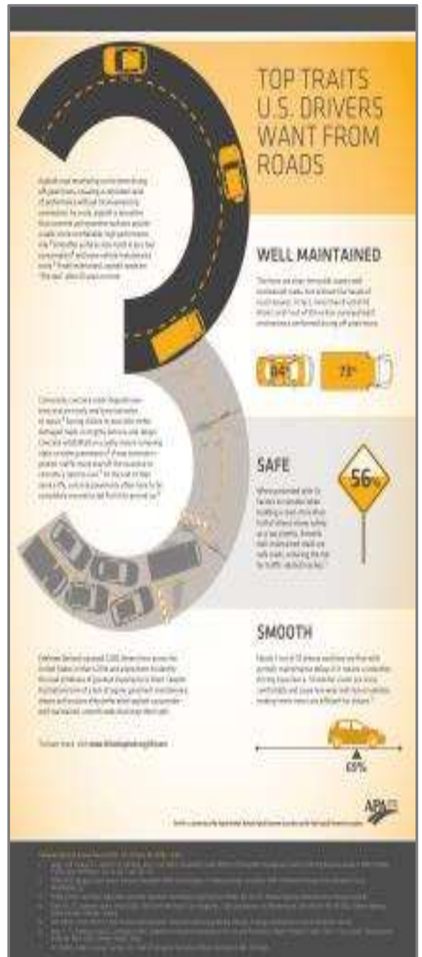
- Website & Advertisements



Spreading the Message & Science

Go To Market

- Infographics



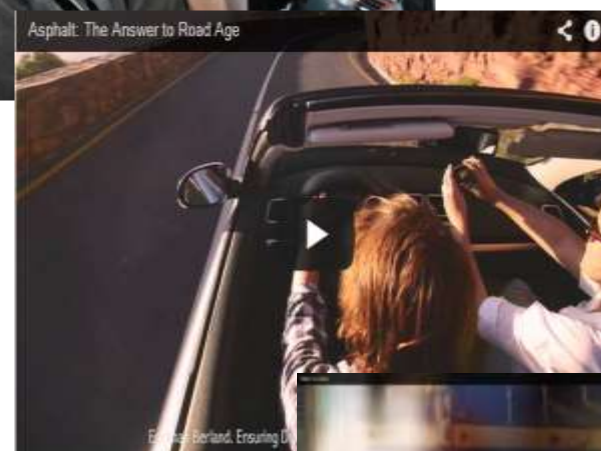
Spreading the Message & Science

Go To Market

- Videos

  "Place to be…"

  "Road age…"



  "While you were…"

Industry High RAP Tour of Japan

We’re adding to NAPA’s team of industry leaders!

http://www.asphaltpavement.org/PDFs/jobdescr-dir-pavement%20innovation_20150327.pdf.

NATIONAL ASPHALT
PAVEMENT ASSOCIATION