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Contracts Specifications and Technical Writing

ASTM INTERNATIONAL

CD² CENTER

Outline

- **Module 1:**

  ASTM International Standards

- **Module 2:**

  Specifications and Special Provisions

Module 1: Outline

- Background of ASTM
- What is ASTM
- Why we need ASTM standards
- ASTM standards for using waste tires in CE applications
- Summary

Background of ASTM

- Originally known as the American Society for Testing and Materials, now ASTM International
- The organization's headquarters is in West Conshohocken, Pennsylvania, about 5 miles northwest of Philadelphia
- A group of scientists and engineers, led by Charles Benjamin Dudley formed the *American Society for Testing and Materials* in 1898 to address the frequent rail breaks plaguing the fast-growing railroad industry

What is ASTM?

- ASTM International is one of the largest voluntary standards developing organizations in the world
- ASTM's members, representing producers, users, consumers, government, and academia from over 100 countries, develop technical documents that are a basis for manufacturing, management, procurement, codes, and regulations
- Committees develop more than 12,000 ASTM standards that can be found in the 77-volume Annual Book of ASTM Standards

ASTM Sections

1. Iron and Steel Products
2. Nonferrous Metal Products
3. Metals Test Methods and Analytical Procedures
4. Construction
5. Petroleum Products, Lubricants, and Fossil Fuels
6. Paints, Related Coatings, and Aromatics
7. Textiles
8. Plastics
9. Rubber
10. Electrical Insulation and Electronics
11. Water and Environmental Technology
12. Nuclear, Solar, and Geothermal Energy
13. Medical Devices and Services
14. General Methods and Instrumentation
15. General Products, Chemical Specialties, and End Use Products

Section 4 - Construction

- Volume 04.01 - Cement, Lime; Gypsum
- Volume 04.02 - Concrete and Aggregates
- Volume 04.03 - Road and Paving Materials; Vehicle-Pavement Systems
- Volume 04.04 - Roofing and Waterproofing
- Volume 04.05 - Roofing, Waterproofing, and Bituminous Materials
- Volume 04.06 - Thermal Insulation; Environmental Acoustics
- Volume 04.07 - Building Seals and Sealants; Fire Standards; Dimension Stone
- Volume 04.08 - Soil and Rock (I): D 420 to D 5779
- Volume 04.09 - Soil and Rock (II): D 5780 - latest; Geosynthetics
- Volume 04.10 - Wood
- Volume 04.11 - Building Construction
- Volume 04.12 - Building Constructions (II): E 1672 - latest; Property Management Systems

Section 9 - Rubber

- Volume 09.01 - Rubber, Natural and Synthetic -- General Test Methods; Carbon Black
- Volume 09.02 - Rubber Products, Industrial - Specifications and Related Test Methods: Gaskets; Tires

Why do we need ASTM?

- ASTM International has no role in requiring or enforcing compliance with its standards
- They may become mandatory when referenced by an external contract, corporation, or government

Why do we need ASTM?

- Other governments (local and worldwide) also have referenced ASTM standards
- Corporations doing international business may choose to reference an ASTM standard

ASTM Membership

- Membership in the organization is open to anyone with an interest in its activities
- Standards are developed within committees, and new committees are formed as needed, upon request of interested members
- As of 2007, there are more than 30,000 members, including over 1100 organizational members, from more than 120 countries

ASTM Spec for Waste Tires

ASTM D6270

Standard Practice for

Use of Scrap Tires in Civil Engineering Applications

Designation: D 6270 – 98 (Reapproved 2004)

ASTM D6270: Significance and Use

This Standard covers the following scrap tire products:

- tire chips or tire shreds comprised of pieces of scrap tires
- tire chip/soil mixtures
- tire sidewalls
- whole scrap tires

used in civil engineering applications

ASTM D6270: Significance and Use

Tire derived products are used in the following CE applications:

- lightweight embankment fill
- lightweight retaining wall backfill
- drainage layers
- thermal insulation layer to limit frost penetration beneath roads
- insulating backfill to limit heat loss from buildings
- replacement for soil or rock in other fill applications

ASTM D6270: Significance and Use

Uses of whole scrap tires and tire sidewalls include:

- fill when whole tires are compressed into bales
- retaining walls
- drainage culverts

ASTM D6270: Apparatus

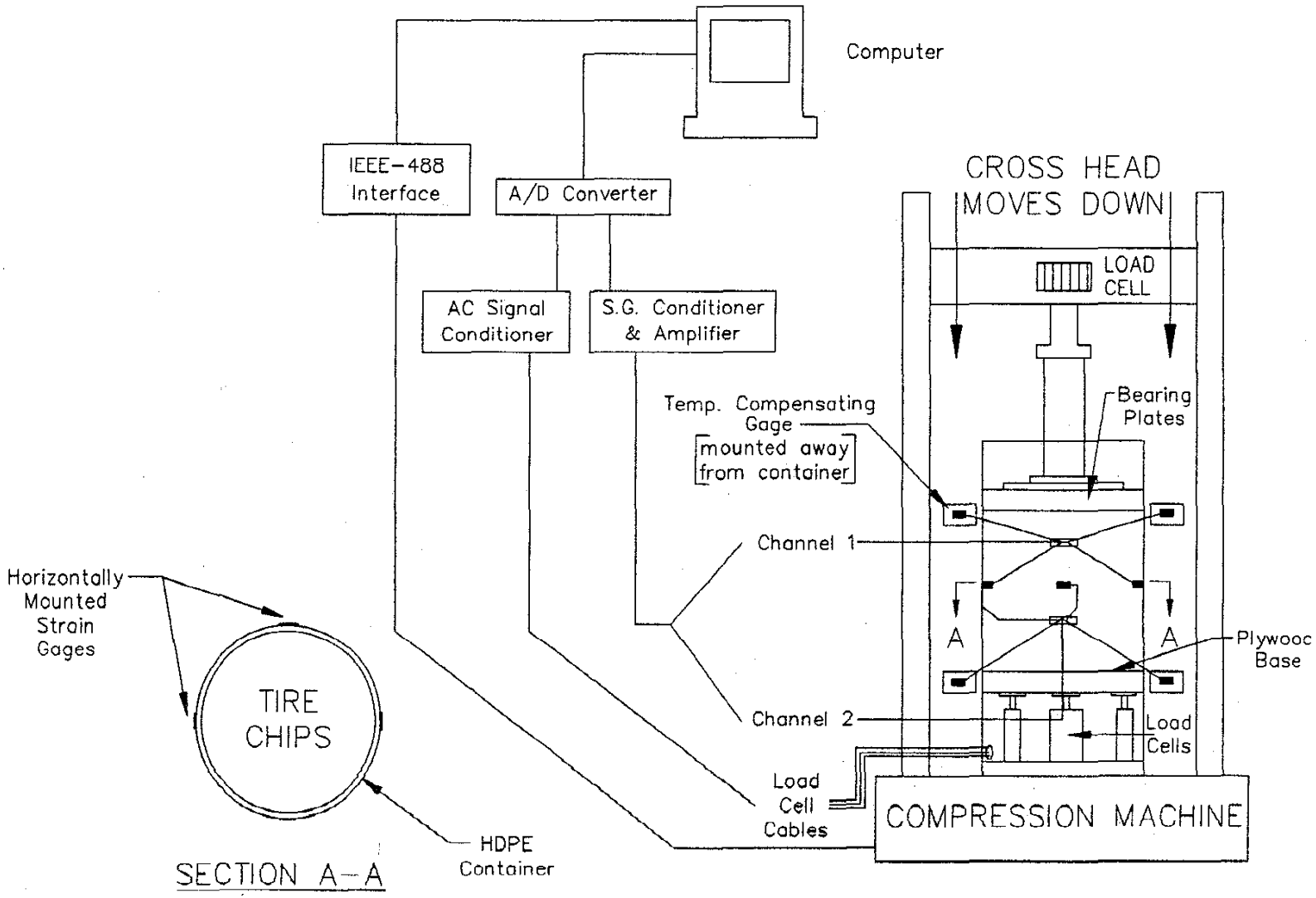


FIG. 1 Compressibility Apparatus for Tire Shreds Designed to Measured Lateral Stress and the Portion of the Vertical Load Transferred by Friction from Tire Shreds to Container (8)

ASTM D6270: Apparatus

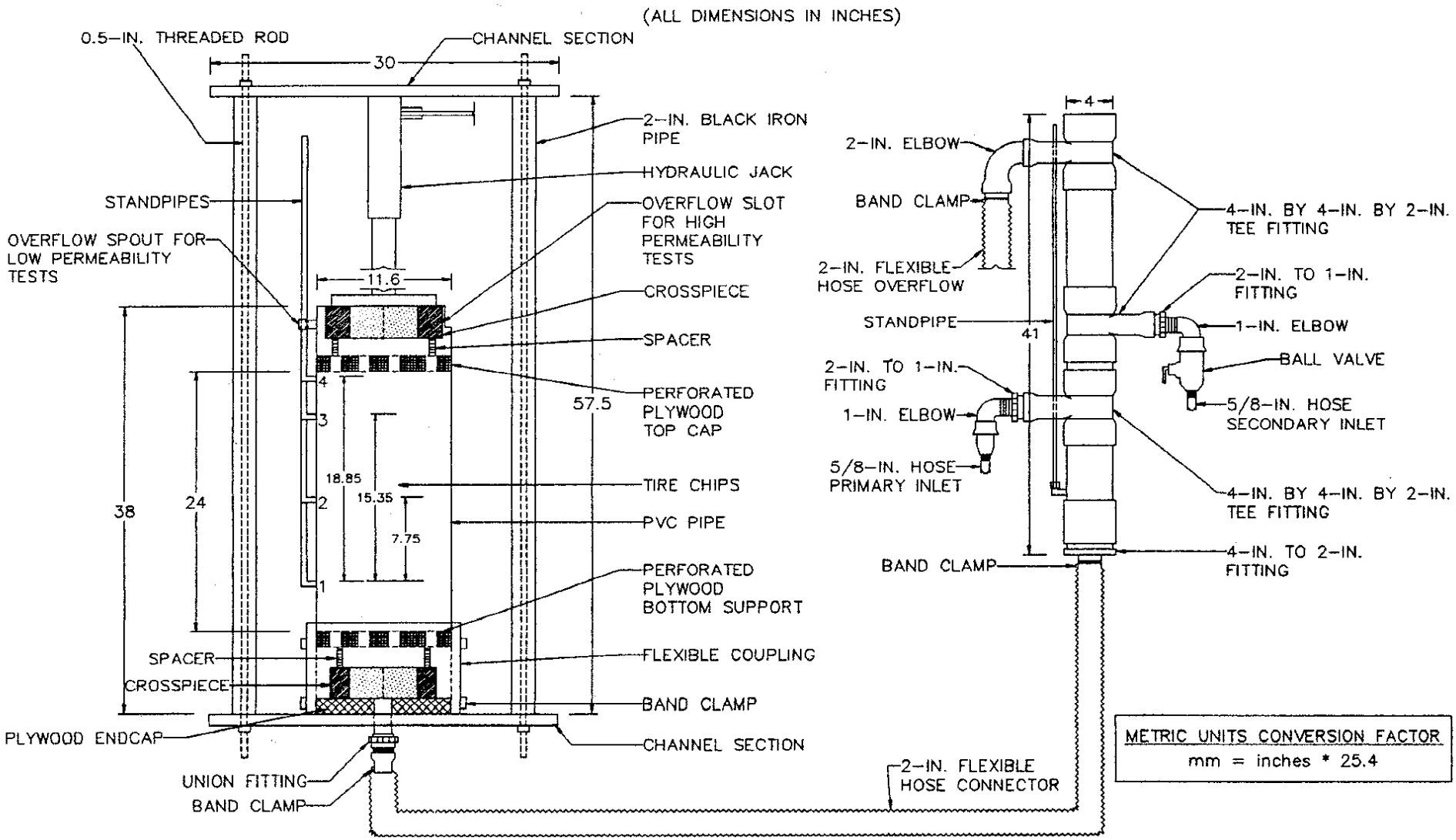


FIG. 2 Hydraulic Conductivity Apparatus for Tire Shreds with Provisions for Application of Vertical Stress (10)

ASTM D6270: Benefits

- 1/3 to 1/2 of the dry density of typical soil
- 8 times greater thermal resistivity than typical soil
- Lateral earth pressures reduced by 50%
- High hydraulic conductivity

ASTM D6270: Construction Uses

- Two different sizes are commonly used (Type A: <3in, Type B: <12in)
- Large tire shreds should be compacted by a tracked bulldozer, sheepsfoot roller, or smooth drum vibratory roller
- Should be covered with a sufficient thickness of soil
- Where pavement will be placed over the tire shreds and in drainage applications, the tire shreds should be wrapped completely by a geotextile material

ASTM D6270: Calculations

Density of tire shred solids $\rho_s = S_a(\rho_w)$ (1)

where:
S_a = apparent specific gravity, and
ρ_w = density of water.

Resilient modulus $M_R = A\Theta^B$ (2)

where:
Θ = first invariant of stress (sum of the three principal stresses),
A = experimentally determined parameter, and
B = experimentally determined parameter.

Coefficient of lateral earth pressure at rest $K_O = \sigma_h / \sigma_v$ (3)

Poisson's ratio $\mu = K_O / (1 + K_O)$ (4)

where:
σ_h = measured horizontal stress, and
σ_v = measured vertical stress.

ASTM D6270: Use of Scrap Tires in Civil Engineering Applications

D 6270 – 98 (2004)

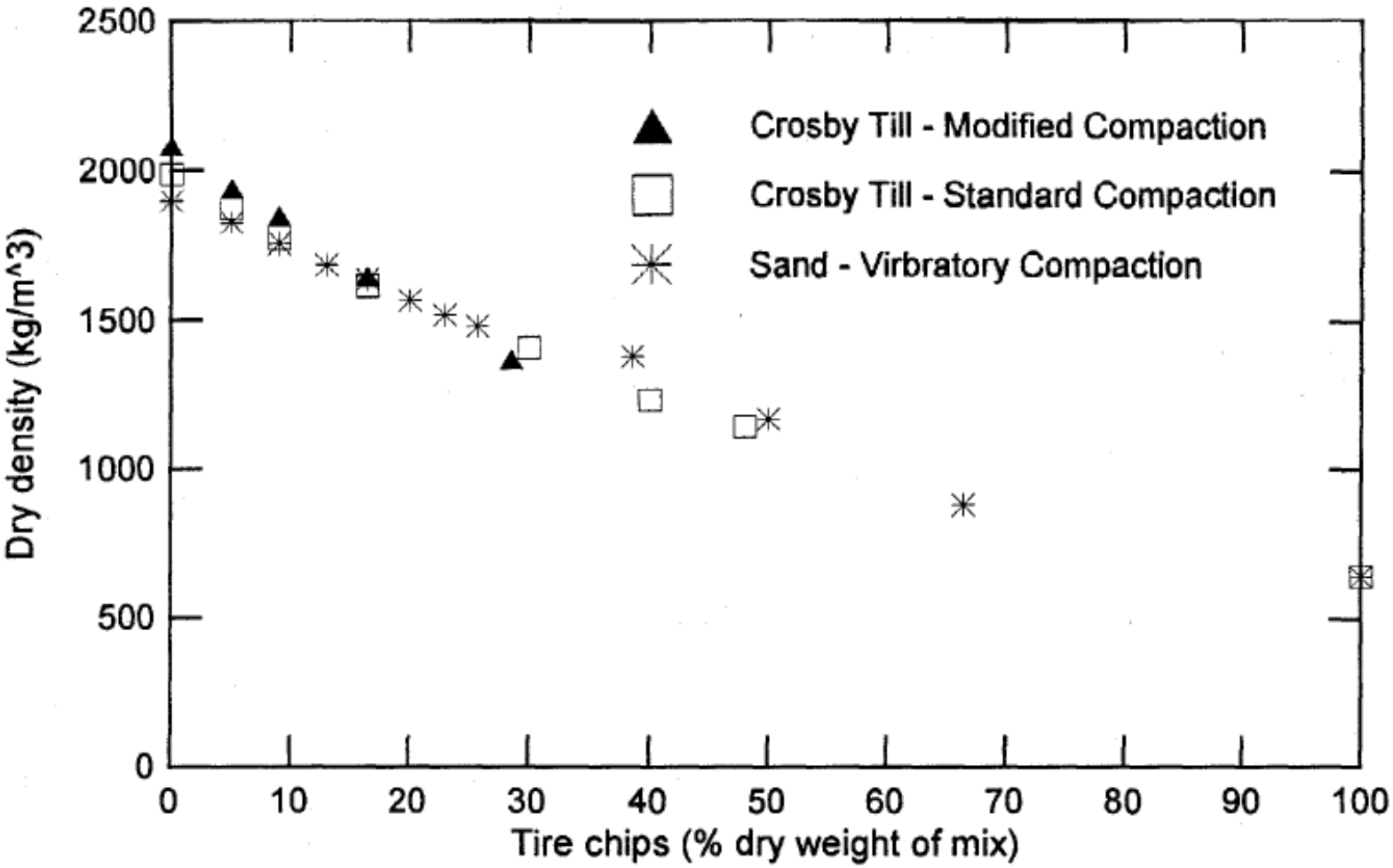


FIG. X1.1 Comparison of Compacted Dry-Density of Mixtures of Tire Shreds with Ottawa Sand and Crosby Till (5)

ASTM D6270: Use of Scrap Tires in Civil Engineering Applications

TABLE X1.3 Compressibility on Initial Loading

Particle Size Range (mm)	Tire Shred Type	Tire Shred Source	Initial Dry Density (kg/m³)	Vertical Strain (%) at Indicated Vertical Stress (kPa)				
				10	25	50	100	200
2 to 75	Mixed	Palmer	Compacted	7 to 11	16 to 21	23 to 27	30 to 34	38 to 41
2 to 51	Mixed	Pine State	Compacted	8 to 14	15 to 20	21 to 26	27 to 32	33 to 37
2 to 25	Glass	F and B	Compacted	5 to 10	11 to 16	18 to 22	26 to 28	33 to 35
2 to 51	Mixed	Sawyer	Compacted	5 to 10	13 to 18	17 to 23	22 to 30	29 to 37
	Mixed		Compacted	4 to 5	8 to 11	13 to 16	18 to 23	27
75 max	Mixed	Pine State	510 to 670	12 to 20	18 to 28	- - - -	- - - -	- - - -
2 to 51	Mixed	Pine State	Loose	18	34	41	46	52
2 to 25	Mixed	F and B	Loose	8	18	28	37	45
	- - - -		Loose	9	12 to 17	17 to 24	24 to 31	30 to 38

ASTM D6270: Use of Scrap Tires in Civil Engineering Applications

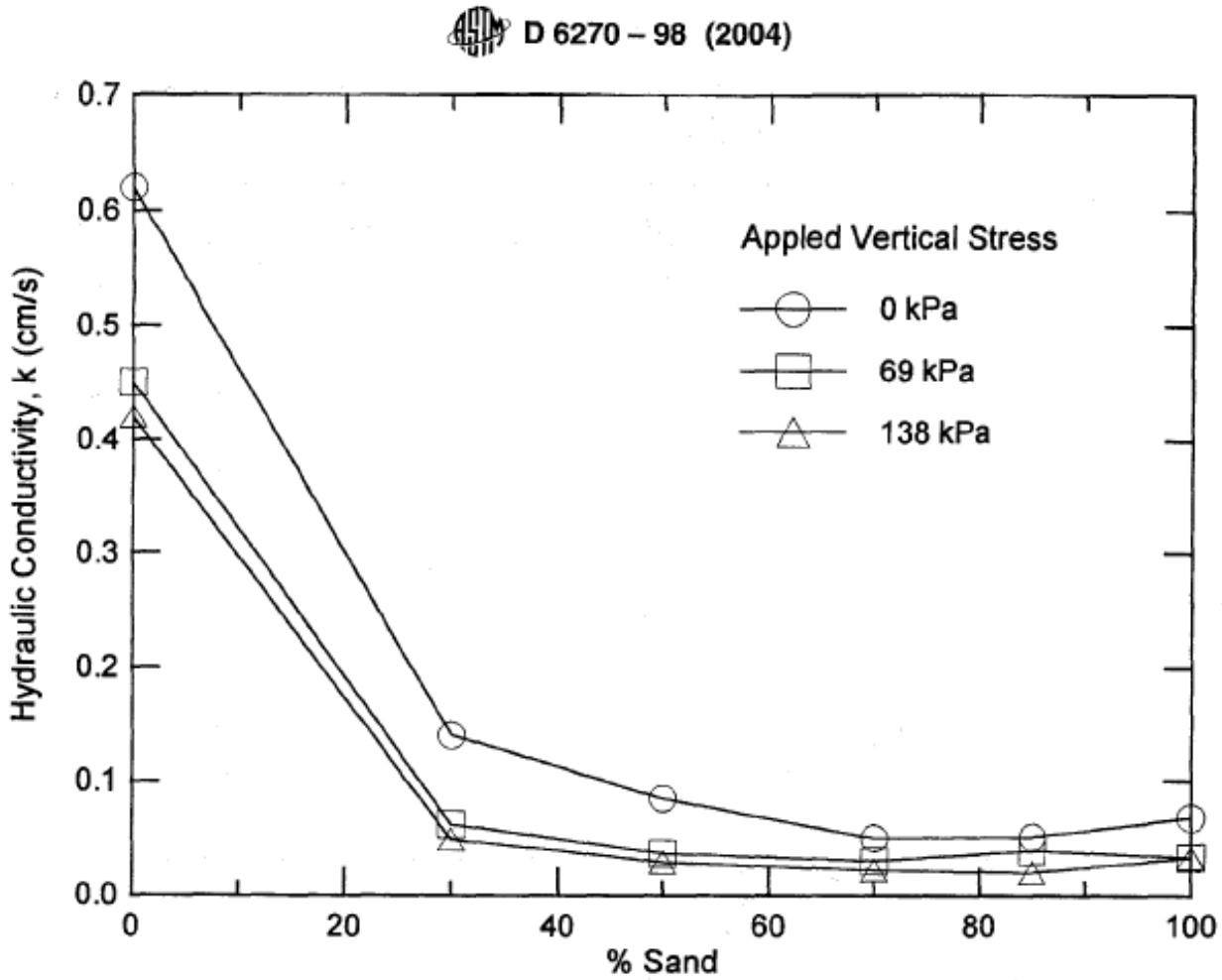


FIG. X1.4 Hydraulic Conductivities of Mixtures of Tire Shreds and Clean Sand (4)

ASTM D6270: Embankment Fill- Introduction

- Shredding of scrap tires produces chunks of rubber ranging in size from large shreds to smaller chips
- Tire shreds and tire chips have both been used as lightweight fill materials for roadway embankments and backfills behind retaining walls
- The shreds or chips can both be used by themselves or blended with soil

ASTM D6270: Embankment Fill- Introduction

- Tire shreds normally range in size from 12 in to 3 in
- Tire chips are usually sized from a maximum of 3 in down to a minimum of 1/2 in

ASTM D6270: Embankment Fill-Application

Embankments containing tire shreds or chips are constructed by completely surrounding the shreds or chips with a geotextile fabric and placing at least 3 ft of natural soil between the top of the scrap tires and the roadway.

ASTM D6270: Embankment Fill-Performance Record

- At least 15 states have utilized scrap tire shreds or chips as a lightweight fill material for the construction of embankments or backfills
- Some projects have used tire shreds or chips as embankment material, while other projects have blended tire chips with soil
- In 2004, more than 70 successful projects have been constructed on state, local, or private roads

ASTM D6270: Embankment Fill-Performance Record

- Aside from problems with puncturing of rubber tires on haul vehicles by the exposed steel in tire chips or shreds, there have been no other construction-related problems on scrap tire embankment projects
- Adequate compaction, which is always a prime concern on any embankment project, is of even greater concern on a tire shred or chip embankment project, where it is known that some consolidation will occur
- Some cracking of the roadway above a tire shred or chip embankment is possible because of long-term settlement or differential settlement

ASTM D6270: Embankment Fill- Performance Record

As of 2004, at least 15 states had completed scrap tire embankment projects, only six states (North Carolina, Oregon, Vermont, Virginia, Wisconsin, and Maine) had prepared specifications or some provisions for this use

ASTM D6270: Material Characteristics

- Specific Gravity
- Water Absorption Capacity
- Gradation
- Compacted Dry Density
- Compressibility
- Resilient Modulus
- Coefficient of Lateral Earth Pressure
- Poisson's Ratio
- Shear Strength
- Hydraulic Conductivity
- Thermal Conductivity

ASTM D6270: Embankment Fill- Properties

- Specific Gravity: 1.1 to 1.3
- Compacted Unit Weight: 20 lb/ft^3 to 45 lb/ft^3
- Friction Angle: 19° to 25°
- Cohesion value: 160 lb/ft^2 to 240 lb/ft^2
- Young's Modulus: 112 lb/in^2 to 181 lb/in^2
- Permeability: 1.5 to 15 cm/sec

ASTM D6270: Embankment Fill- Mix Design

- Tire chips can be mixed or blended with soil
- As the percentage of soil is increased, the unit weight of the blend increases
- Mix ratios are usually prepared on a volumetric basis
- A maximum 50:50 tire chip to soil ratio is suggested so that tire chip usage is not reduced too greatly
- If the unit weight of the fill is not a concern, then even small percentages (10 to 25 percent) of tire chips can be blended into the soil. This could improve the compactibility of the fill

ASTM D6270: Construction Practices and their Characteristics

- Lightweight Embankment Fill: Low-Compacted Dry Density
- Insulating Layer: Thermal Resistance
- Retaining Wall Backfill: Low-Compacted Dry Density, High-Hydraulic Conductivity, Low-Thermal Conductivity
- Drainage Application: High-Hydraulic Conductivity

ASTM D6270: Embankment Fill- Construction Procedures, Material Handling:

- The number of tires to be processed into shreds or chips is directly related to the intended volume of the tire chip portion of the embankment
- It is estimated that every cubic yard of volume will require about 75 automobile tires that have been shredded into shreds or chips and compacted into an embankment

ASTM D6270: Embankment Fill- Construction Procedures, Site Preparation:

- The site of the embankment should be prepared in essentially the same manner as though common earth were being used for fill material
- If there is a high water table or swampy area that will be at the base of the embankment, it may be advisable to construct a drainage blanket
- If there is a natural flow of runoff through the area where the embankment is to be constructed, provisions should be made to pipe the runoff beneath the embankment

ASTM D6270: Embankment Fill- Construction Procedures, Mixing:

- When tire shreds or chips are to be blended or mixed with soil, the mixing should be performed volumetrically, using bucket loads from a front end loader and blending the materials together as well as possible with the bucket
- As another option to the mixing of tire shreds or chips and soil, alternate layers of the tire shreds or chips and the soil can be constructed

ASTM D6270: Embankment Fill- Construction Procedures, Placing

- Tire chips should be spread across a geotextile blanket using a tracked bulldozer
- A minimum 2 foot layer or lift should be spread out over the geotextile
- A recommended maximum 3 foot lift thickness can still be spread and compacted

ASTM D6270: Embankment Fill- Construction Procedures, Compaction:

- Compaction may be achieved by at least three passes of the tracked bulldozer over the layer of tire chips
- The chip particles align themselves with each other and settle fairly readily
- The weight of the bulldozer passing over the tire chips is enough to readily compact the layer of chips
- For larger chips or thicker layers, as many as 15 passes of a bulldozer may be required to achieve compaction

ASTM D6270: Embankment Fill- Construction Procedures

- The top layer of a tire chip embankment should be kept at least 3 ft below the base or subbase layer of the pavement that will be on top of the embankment
- Each layer of a tire chip embankment must be fully compacted before the next layer is placed
- When the top layer of tire chips has been fully compacted, the sides and top of the tire chips should be fully wrapped and enclosed by the geotextile

ASTM D6270: Embankment Fill- Construction Procedures

- A minimum of 3 ft of compacted soil should be placed on top of the geotextile and tire chips
- The soil should be compacted in thinner layers 6 in. to 12 in. in thickness
- The tire chip embankment will experience further deflection during placement and compaction of the soil cover

ASTM D6270: Embankment Fill- Unresolved Issues

- The first and most pressing unresolved issue is to determine the cause or causes of the exothermic reactions that resulted in three scrap tire embankment fires that occurred during 1995
- Other tire shred or tire chip embankment projects, especially the thick fills, including those that have caught on fire, should be more closely monitored, possibly by installing temperature probes and gas sampling wells

ASTM D6270: Embankment Fill- Unresolved Issues

- The pH of any water leaching from scrap tire fills should be measured
- Laboratory investigations should also be undertaken under varying conditions and temperatures to pinpoint under which conditions exothermic reactions may be initiated

Some ASTM Standards Relevant to Waste Tires in CE Applications

- ASTM D422: Particle Size Analysis of Soils
- ASTM D575: Test Methods for Rubber Properties in Compression
- ASTM D698: Test Methods for Compaction Characteristics of Soil Using Standard Effort
- ASTM D5084: Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter
- ASTM D3080: Direct Shear Test of Soils Under Consolidated Drained Conditions

ASTM D422: Particle Size Analysis of Soils

The following is the quantitative determination of the distribution of particle sizes in soils:

- Distribution of particle sizes larger than 75 μm is determined by sieving
- Distribution of particle sizes smaller than 75 μm is determined by a sedimentation process, using a hydrometer to secure the necessary data.

ASTM D575: Test Methods for Rubber Properties in Compression

- Covers two test methods that are useful in comparing stiffness of rubber materials in compression
- Can be used by rubber technologists to aid in development of materials for compressive applications
- Compression Test of Specified Deflection: The force required to cause a specified deflection is determined
- Compression Test of Specified Force: A specified mass or compressive force is placed on the specimen and the resulting deflection is measured

ASTM D698: Test Methods for Compaction Characteristics of Soil Using Standard Effort

- A soil at a selected water content is placed in three layers into a mold of given dimensions
- Each layer is compacted by blows of a rammer dropped from one foot high
- The resulting dry unit weight is determined
- The procedure is repeated for a sufficient number of water contents to establish a relationship between the dry unit weight and the water content for the soil
- When plotted the data represents a relationship known as the compaction curve
- The values of optimum water content and standard maximum dry unit weight are determined from the curve.

ASTM D5084: Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter

- Apply to one-dimensional, laminar flow of water within porous materials such as soil and rock
- Hydraulic conductivity of porous materials generally decreases with an increasing amount of air in the pores of the material
- Assume that Darcy's law is valid and that the hydraulic conductivity is unaffected by hydraulic gradient

ASTM D5084: Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter

- Validity of Darcy's law may be evaluated by measuring the hydraulic conductivity of the specimen at three hydraulic gradients; if all measured values are similar (within about 25%), then Darcy's law may be taken as valid
- When the hydraulic gradient acting on a test specimen is changed, the state of stress will also change, and, if the specimen is compressible, the volume of the specimen will change

ASTM D3080: Direct Shear Test of Soils Under Consolidated Drained Conditions

Ding

- Test method consists of placing the test specimen in the direct shear device
- Predetermined normal stress is applied
- Measures the shearing force and horizontal displacements as the specimen is sheared

Slide 49

Ding3 Put a direct shear picture

DingXin Cheng, 7/22/2008

Summary

- Discussed the origin, background, and purposes of ASTM standards
- Reviewed ASTM standards for use of waste tires in civil engineering applications
- Discussed the application of TDA in embankment fill according to ASTM D6270

Questions ?

The Beginning

Keeping roads good with asphalt rubber paving materials

http://www.cp2info.org/center

Today decides tomorrow!!!

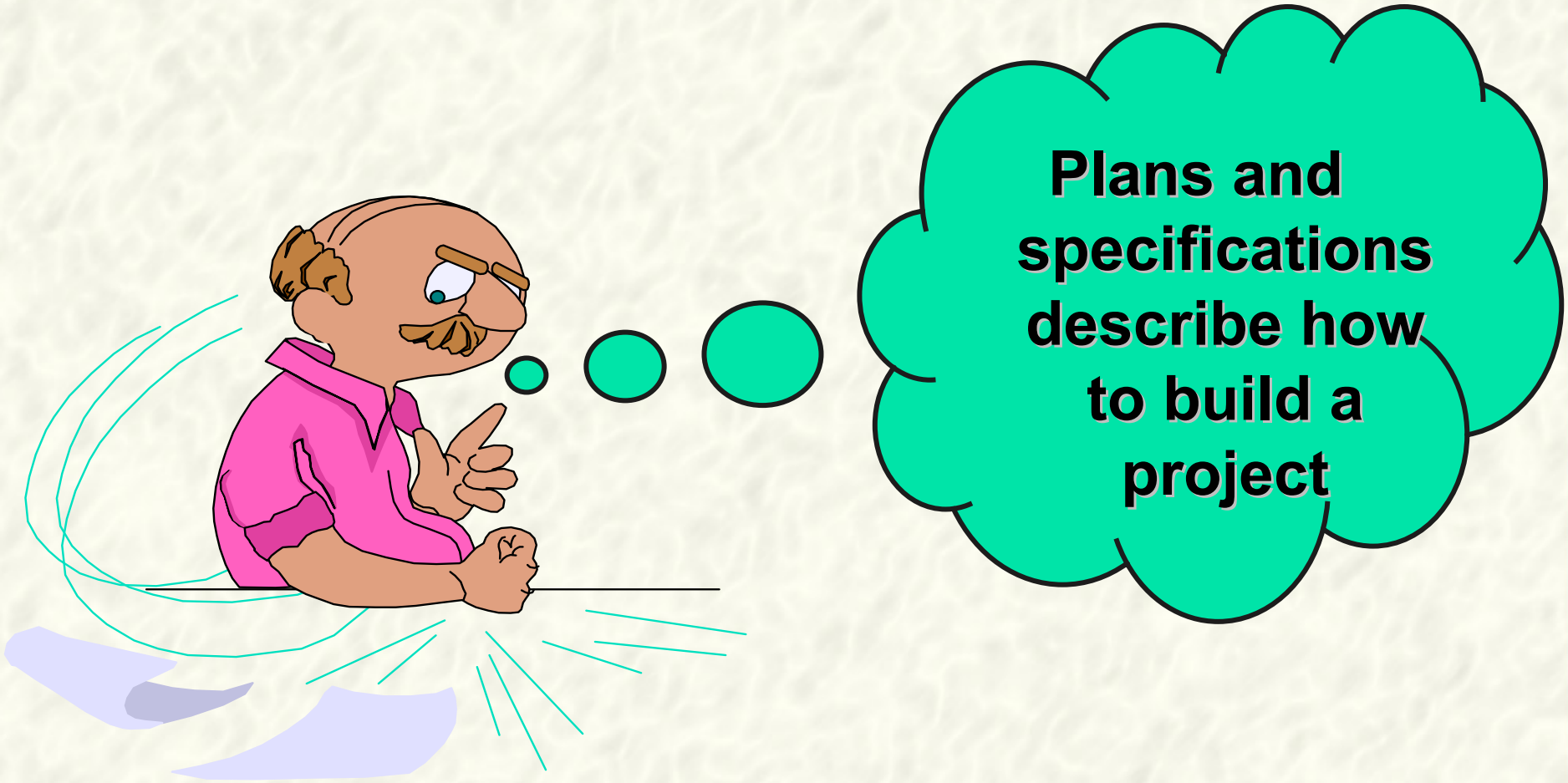
CIVL 402 Contract Spec and Technical Writing

Rubberized Hot Mix Asphalt

Module 2: Outline

- Standard Specifications
- Standard Special Provisions
- Asphalt rubber definitions
- Asphalt rubber binder
- Asphalt rubber binder design
- Types of mixes
- Cautions

Plans and Specifications



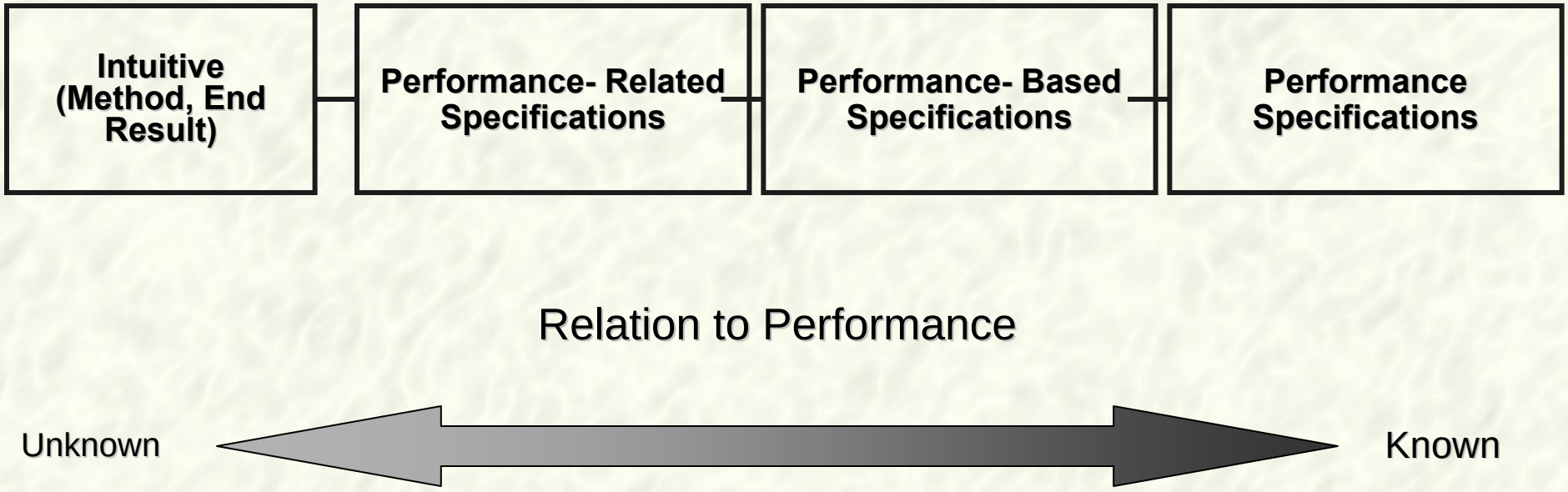
Plans and Specifications

- Plans
  - Provide layout and dimensions
- Specifications
  - Describe project specific requirements for:
    - Materials
    - Workmanship
    - General & special provisions

Types of Specifications

- Proprietary
- Method
- QC/QA
- End Result
- Performance-Related (PRS)
- Performance-Based (PBS)
- Performance (e.g., Warranty/Guarantees)
- Design/Build
- Design/Build/Operate

Specifications



Statistical Methods in Specifications

These can be statistically based:

- **Method**
- **QC/QA**
- **End Result**
- **PRS and PBS**

Proprietary Specifications

- Brand/Product/Process/Manufacturer Specific
  - (e.g., Patented Products or Processes)
- Difficult to use in Competitive Bidding Process
  - “or equivalent” commonly used

Method Specifications

- Detailed description of materials and procedures to be used to construct final product
- Procedural
- Prescriptive
- Require continuous on-site inspection
- Historically, most commonly used method

QC/QA Specifications

- 35 states
- Commonly used
- Falls between method and end result specifications

Elements of QC/QA Specifications

- Definitions
- Materials
- Construction Process
- Construction Equipment
- Mix Design
- Acceptance:
  - Lot and Sublot
  - Sampling
  - Testing
- Pay Factors / Method of Payment
- Training, Certification, and Accreditation

End Result Specifications

- Specify minimum in-place material properties (e.g., density)
- Do NOT specify construction methods - *Contractor freedom and Innovation*
- May or may not include material specifications
- Gaining popularity (use)

Statistically Based End Result Specifications

- Consider BOTH Agency or Owner and Producer or Contractor risk
- Require both QC and QA
- Third party - Independent Assurance?
- Very common today

Performance-Related and Performance-Based Specifications

- Commonly used in equipment and machinery manufacturing industries
- Being introduced to construction as well as other Industries
- FHWA strongly supporting development of performance-related specs
  - HMA - WesTrack
  - PCC - ERES/Illinois

Performance-Related and Performance-Based Specifications

- Require functional spec's for materials and in-place properties
- Tight quality control/quality assurance (QC/QA) required
- Must have dependable relationships between material properties and actual pavement performance - KEY!

Elements of the "Ideal" Performance Based Specification

- Reproducible test methods
- Well defined construction variability
- Existence of robust relationships between tests (measured properties) and pavement performance
- Definable and measurable pavement performance

Performance Specifications

- Specify minimum level of performance over a specified period
- Examples:
  - Less than 5% fatigue cracking after 10 years of service
  - Rut depths less than 13 mm (1/2 in) after 15 years of service
- Warranties

AR Definitions

Asphalt Rubber Definition: ASTM D8

A blend of asphalt cement, reclaimed tire rubber and certain additives in which the rubber component is at least 15% by weight of the total blend and has reacted in the hot asphalt cement sufficiently to cause swelling of the rubber particles.

Definitions

Related Specification: ASTM D 6114

Standard Specification for Asphalt Rubber Binder

High viscosity material (usually field-blended) that typically requires agitation to keep CRM particles dispersed.

Asphalt Rubber Binder

Components:

- Crumb Rubber Modifier (CRM)
  - Scrap Tire Rubber
  - High Natural Rubber Content Scrap Rubber
- Asphalt Cement
- Extender oil - Caltrans

Caltrans Specifications for High Viscosity (Field Blend) AR Binders

- Asphalt modifier: Extender oil at 1 to 6% by mass of asphalt (For chip seal binders, CT may continue to require minimum 2.5% extender oil)
- Asphalt + extender oil: 78-82% by total mass of AR binder
- Total CRM: 18-22% by total mass of AR binder, of which:
  - Scrap tire CRM = 73-77% of total CRM
  - High natural CRM = 23-27% of total CRM

Crumb Rubber Modifier (CRM)

- CRM is produced from grinding whole scrap tires, tread buffings, and other waste rubber products. CRM comes in a variety of grades and size designations from various suppliers and/or sources
- CRM gradation and content affects not only AR binder properties, but also influences the voids structure of RHMA-G mixes
- Gradation limits used by Caltrans and ADOT are broad and allow considerable variation; changes are being considered
- Check project special provisions to verify CRM gradation limits in effect for specific projects

Crumb Rubber Modifier (CRM)

Crumb Rubber Modifier (CRM)

- High natural rubber CRM is used to improve adhesion and flexibility, chip seal aggregate retention, and to compatibilize asphalt and CRM interactions
- It has a high natural rubber content (40-48% by mass) and may be made from scrap tires or other non-tire sources
- Caltrans also requires that “high natural” be used in binders for RHMA mixes

Asphalt Cements

- Asphalt cements come in a variety of grades and designations
- AR-4000 was used to make asphalt rubber in the past
- Caltrans adopted the Performance Graded (PG) system in 2006
- Do not use modified asphalts as the base asphalt cement for CRM modification

PG Asphalt Cements

- For high mountain and high desert areas, use PG 58-22 as the base asphalt
- For other areas (coastal, inland valleys, low and south mountain, and desert) use PG 64-16 as base asphalt

Additives

- Extender oils: aid in the interaction of the crumb rubber and asphalt by providing aromatics which are absorbed by the rubber, and help with dispersion by chemically suspending the rubber in the asphalt. Required by Caltrans

- Anti-stripping agents: used to improve adhesion of binder to aggregate

Asphalt Rubber Blend Design Submittals

- Supplier and identification (or type) of scrap tire and high natural CRM
- Typical gradation of each type of CRM material used in the asphalt rubber binder design
- Percentage of scrap tire and high natural CRM by total mass of the asphalt-rubber blend
- If CRM from more than one supplier is used, info will be required for each CRM supplier used
- Laboratory test results for test parameters shown in the special provisions

Asphalt Rubber Blend Design Submittals

- Base asphalt PG binder grade, supplier, and Certificate of Compliance
- Percentage of the combined blend of asphalt and asphalt modifier by total mass of asphalt rubber binder
- Asphalt modifier type, supplier, identification, and test results demonstrating conformance to specs
- Percentage of asphalt modifier by mass of asphalt
- Design profile
- Minimum interaction time and temperature
- Material Safety Data Sheets for everything

Asphalt Rubber Blend Design Profile

- A design profile is developed to evaluate the compatibility between materials used, compliance of component interaction properties, and to check for stability of the AR blend over time
- A 24-hour design profile will be required for each project, for hot mix and spray applications
- Previous AR blend designs may be validated with currently available materials and may be submitted for more than one project

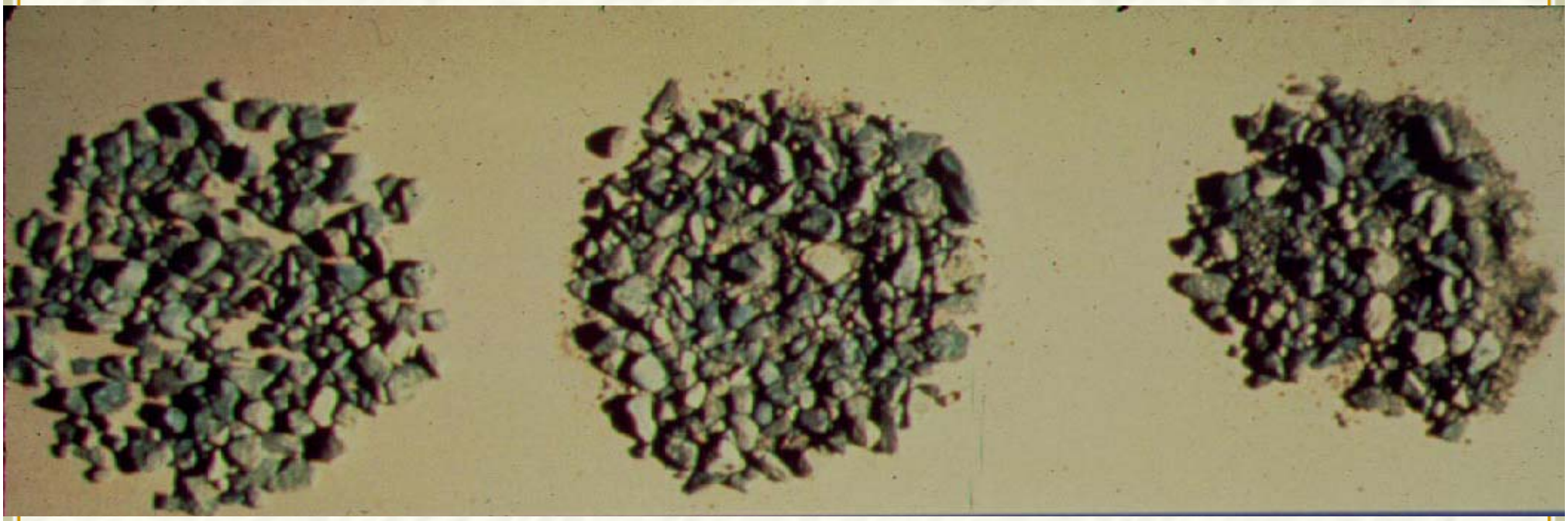
Asphalt Rubber Blend Design
Example Design Profile

	Minutes of Reaction					Spec. Limits @ 45 minutes (Caltrans 12/2005)
TEST	45	90	240	360	1,440	
Viscosity, cP Haake@ 190ºC	2400	2800	2800	2800	2100	1500 - 4000
Resilience@ 25ºC (% Rebound) (ASTM D 5329)	27	--	33	--	23	18 Minimum
R & B Softening Pt., ºC (ASTM D36)	59.0	59.5	59.5	60.0	58.5	52 – 74 (125-165ºF)
Cone Pen @ 25ºC (ASTM D217)	39	--	46	--	50	25 – 70

Types of Rubberized Asphalt Concrete (RHMA) Hot Mixes

- Dense-graded (limited usage by Caltrans)
- Gap-graded
- Open-graded
- Open-graded (High Binder, HB)

Aggregate Gradation Comparison



Open Graded **Gap Graded** **Dense Graded**

Dense-Graded Mixes (RHMA-D)

- Early use
  - Limited performance improvements vs. cost
  - Inadequate void space to accommodate sufficient AR binder to modify mix behavior
- Discontinued use with high viscosity (field blend) binders
- Suitable for use with no agitation CRM-modified binders (terminal blend) such as MB

Gap-Graded Mixes (RHMA-G)

RHMA-G is the most commonly used RHMA mix type

Purpose – Structural mix that provides increased resistance to:

- Rutting
- Fatigue
- Reflective cracking
- Oxidative aging

Gap-Graded Mixes (RHMA-G)

Standard Special Provisions for RHMA-G with high viscosity (field blend) AR binder are currently being updated to address PG binder implementation.

Revisions include:

- Remove test methods from body of SSP, develop corresponding CT Lab Procedures for CRM sieve analysis and measuring rotational viscosity of AR binder
- Format SSP for inclusion in Section 39 of Caltrans Standard Specifications

Gap-Graded Mixes (RHMA-G)

- Adjustments to Hveem Mix Design Method (CT 367), including:
  - Modify (coarsen) aggregate gradation requirements, particularly for 600 µm sieve, to facilitate achieving minimum VMA (18%)
  - Add maximum VMA limit of 23%
  - Test 3 briquettes at each binder content, use average values for calculations and plots

Gap-Graded Mixes (RHMA-G)

- Adjustments to Hveem Mix Design Method, cont'd
  - Design air voids content may range from 3 to 5% based on traffic index and climate, and as designated by the Engineer in project special provisions
  - Still requires minimum AR binder content of 7.0% by weight of dry aggregate to provide durability (Must have sufficient binder content to provide expected performance benefits)

Gap-Graded Mixes (RHMA-G)

Adjustments to Hveem Mix Design Method, cont'd

- Use Caltrans Laboratory Procedures LP-1 through LP-4 for volumetric calculations
- Report Voids Filled with Asphalt (VFA) and Dust Proportion for information only
- Plot average unit weight, stability, % air voids, VMA, and VFA, versus asphalt rubber binder content

Open-Graded Mixes (RHMA-O, RHMA-O-HB)

- Standard Special Provisions for RHMA-O and RHMA-O-HB are also currently being updated to incorporate PG binder implementation
- Changes are similar to those for RHMA-G, but with less impact on mix design method
- Effects of CRM gradation and content in binder have relatively little effect on voids structure of open-graded mixes

Open-Graded Mixes (RHMA-O)

- RHMA-O is designed to provide a free-draining surface (reduced splash, spray, and hydroplaning) that maintains good frictional characteristics in wet or dry conditions
- Such mixes are not considered to be structural elements and no thickness reduction applies
- RHMA-O is typically placed in thin lifts, nominally 24 to 30 mm thick

Open-Graded Mixes (RHMA-O)

- Do not use open-graded mixes where there is a significant amount of stop and go traffic or turning vehicles, such as city streets or in parking lots
- These porous low modulus pavements are susceptible to tire scuffs from simultaneous braking and turning motions, and to damage from leaking vehicle fluids
- Caltrans does not use RHMA-O in snow country

RHMA-O Mix Design

- RHMA-O mixture design is performed according to California Test 368, with asphalt rubber binder content set at 1.2 times the optimum bitumen content for the designated PG binder grade
- A check test is used to verify that binder drain down is not excessive
- If long hauls are anticipated, drain down should also be checked in the laboratory for the expected haul time

Open-Graded Mixes (RHMA-O-HB)

- RHMA-O-HB mixes have higher binder contents (1.6 times demand for PG asphalt instead of 1.2)
- HB provides improved friction course durability and performance due to thicker AR binder films
- Drain down check is more critical for high binder mixes
- RHMA-O-HB does not drain as freely as RHMA-O due to higher binder content, but still drains more freely than DGAC

SSP – Standard Special Provisions

- Standardized language used with construction contracts to amend, supplement, and incorporate the Caltrans Standard Specifications
- Standard Special Provisions are always being created and updated to reflect new understanding of materials, workmanship, and new products or procedures.

Open-Graded Mixes

- RHMA-O and RHMA-O-HB provide safety benefits, and also have proved to:
  - Provide smooth ride
  - Significantly reduce tire noise
- Joint Caltrans/ADOT/FHWA studies are in progress to measure and document noise reduction over a ten-year period

SSP – RHMA-O

1. General
2. Materials
3. Proportioning and mix design
4. Review of RHMA mix design
5. Contractor QC, sampling, and testing

SSP – RHMA-O

6. Equipment for production of asphalt-rubber binder
7. Proportioning of binder, aggregates
8. Spreading and compacting
9. Measurement and payment

Caution

- The specifications and mix design methods discussed in this presentation apply to use of high viscosity asphalt rubber binders (field blend) in gap- and open-graded RHMA mixes
- No agitation binders (low viscosity, terminal blend) should never be directly substituted for high viscosity binders in any RHMA mix
- The two different types of CRM-modified binders have very different viscosity ranges and behave very differently from each other in asphalt concrete hot mixes

Summary

- Introduction of plans and specifications for construction projects
- Caltrans specifications for RHMA-G, RHMA-O, and RHMA-O-HB
- Caltrans SSPs

Questions ?

The Beginning

Keeping roads good with asphalt rubber paving materials

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