Today decides tomorrow!!!

Applications of Waste Tire Products in Civil Engineering

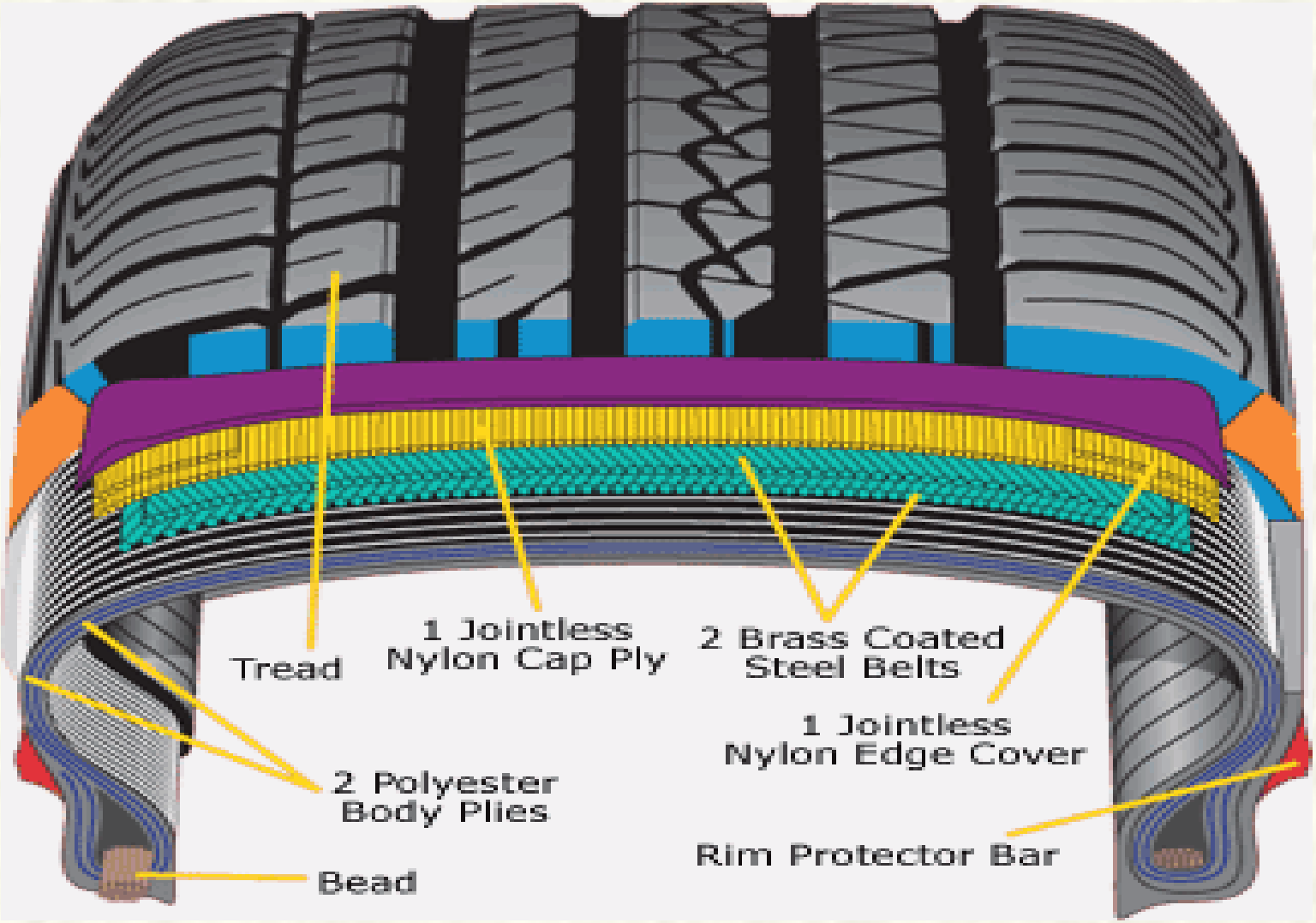
Introduction to Civil Engineering Design

CSU, Chico

Introduction

- Background
- Benefits of Using TDA
- Civil Engineering Applications
  - Lightweight Fill
  - Retaining Wall Backfill
  - Drainage Filter Material
  - Rubberized Asphalt Paving Materials
  - Others
- Challenges and Barriers
- Other Courses Related to Waste Tire Applications

Tire Composition



Problems

Millions of used tires are already piled up in huge stockpiles: both legally …

Problems

… and illegally

Environmental Issues

Environmental Issues

Tire fires release heavy metals and other hazardous compounds that run into streams and seep into shallow wells

- Arsenic
- Chromium
- Lead
- Manganese
- Nickel
- Mercury
- Cadmium
- Oil

Environmental Issues

Use of Waste Tires in California

- 40.2 million reusable and waste tires are generated each year and an estimated 1.5 million waste tires have been illegally dumped or stockpiled
- CE applications of waste tires in California include:
  - Tire Derived Aggregate (TDA)
  - Rubberized Hot Mix Asphalt (RHMA)
  - Others

Tire Shredding Process

ECOTIRE scrap tire recycling

Tire Derived Aggregate (TDA)

Benefits of TDA

- TDA has properties that civil engineers need:
  - Lightweight
  - Low lateral earth pressure
  - Good thermal insulation
  - Good drainage/hydraulic conductivity
  - Compressible

Benefits of TDA

Can use lots of tires!!!

- 75 tires per C.Y. of TDA fill
- 100 tires per ton
- 2000 tires per lane mile of rubberized asphalt pavement
- 662,700 tires for Dixon Landing Embankment, Milpitas, CA
- 83,700 tires for 300 ft Retaining Wall 119, Route 91, CA

Range of Civil Engineering Applications

- Rubberized Asphalt Paving Materials
- Lightweight fill for highway embankments
- Retaining wall backfill
- Vibration damping layers beneath rail lines
- Insulation layer to limit frost penetration in roadways
- Landfill and environmental application

Benefits of Rubberized Asphalt Concrete

- Improves traction
- Improves durability
- Reduces noise
- Reduces vibration
- Lowers maintenance needs
- Reduces the spray/splash when raining
- Uses waste tire chips (2000 waste tires per lane mile)

Reduced Noise and Vibration

Reduced Splash/Spray effect

Civil engineering Applications in the United States

- The fastest growing use for scrap tires
- Approximately 60 million tires per year are used in CE applications

Lightweight Fill for Highway Embankments

- Tire shreds are viable in this application due to their light weight.
- For most projects, using tire shreds as a lightweight fill material is significantly cheaper than other alternatives
- Highway embankment in Virginia used 1.7 million tires!

Retaining Wall Backfill

- The weight of the tire shreds allows construction of thinner, less expensive walls
- TDA can reduce problems with water and frost build up behind the wall, because TDA is free draining and is a good thermal insulator.

Vibration Damping Layers Beneath Rail Lines

TDA is a good way to dampen the annoying vibrations caused by passing trains

Insulation Layer to Limit Frost Penetration in Roadways

- Placing a tire shred layer under the road can prevent the subgrade soils from freezing
- In addition, the high permeability of tire shreds allows water to drain from beneath the roads, preventing damage to road surfaces.

Landfill and Environmental Application

- Daily and Intermediate Alternative Cover
- Landfill Gas Pipe Protection
- Drainage Layers in Landfill Covers
- Leachate Collection and Removal System
- Landfill Gas Extraction Trenches

Barriers to Using Recycled Materials: Civil Engineering Aspects

- Engineering properties not well established
- Lack of long term performance data
- Lack of design standards or manual
- Civil engineers are risk adverse

Barriers in Using Recycled Materials: Environmental Concerns

- Chemical composition is complex
- Long term environmental effects unknown
- Public perception – it is a waste, so it must be bad!
- Convoluted regulatory approval process
- Environmental regulators are risk adverse

Barriers to Using Recycled Materials: Construction Issues

- New procedures and equipment may be required
- Difficult to estimate “in-place” cost
- Supply is uncertain – both quantity & quality
- Sometimes more expensive than conventional construction
- Contractors are risk adverse

Overcoming Barriers

- Lab studies to determine engineering properties
- Lab studies to determine environmental impacts
- Pilot construction projects (full or nearly full scale)
- Monitor long term engineering and environmental performance
- Modify specifications, etc. as needed
- Develop national and/or regional standards
- Education – address concerns head on and focus on the benefits

TDA Sizing and Applications

Type A (Less than 3 inches) - drainage, insulation, vibration damping

Type B (Less than 12 inches) - lightweight fill

Types of Rubberized Hot Mix Asphalt

RHMA-O – Open Graded Asphalt Concrete

RHMA-G – Gap Graded Asphalt Concrete

RHMA-D – Dense Graded Asphalt Concrete

RHMA-O **RHMA-G** **RHMA-D**

Guidelines Available

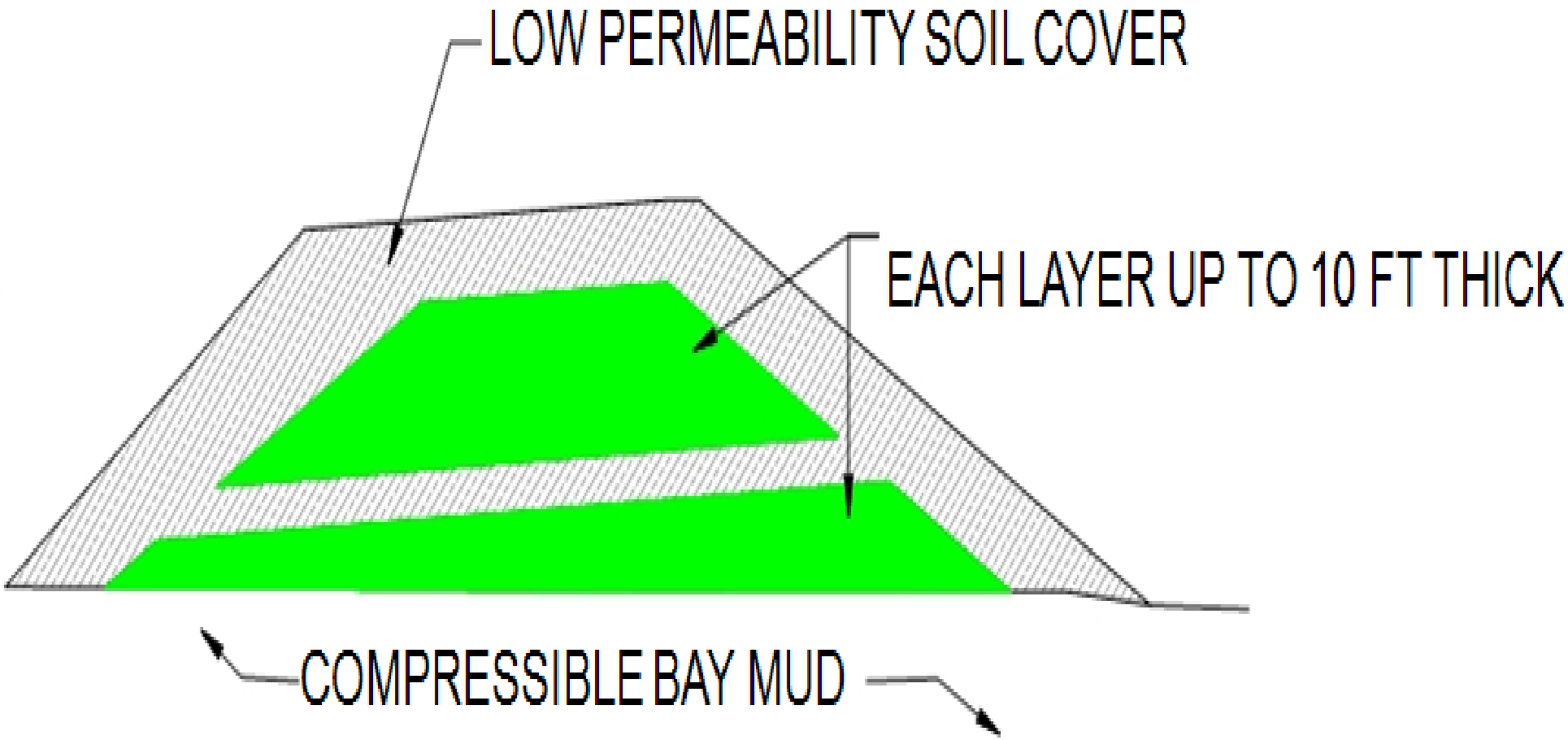
- ASTM D6270 “Civil Engineering Applications of Scrap Tires”
- FHWA guidelines to limit heating in fills
- EPA studies on environmental impacts

Successful TDA Embankment Project

Dixon Landing Interchange

- PROBLEM: Embankment Constructed on Bay Mud
- SOLUTION: Use TDA for the core of the embankment
- CHEAPEST SOLUTION: saved $230,000

Typical Cross Section



Preventing Embankment Heating

- No TDA contaminated with gasoline, oil, grease, etc.
- Limit fine sized TDA
- Max TDA layer thickness is 3 meters (10 ft)
- Minimize access of fill to water & air

Unloading TDA

Spreading with Bulldozer

Compacting with 10-ton Roller

Unit Costs

- Placement costs of TDA (including geotextile) = $3.74/yd^3
- Purchase & delivery costs of TDA = $23.66/yd^3
- In-place cost for TDA = $27/yd3
- In-place cost for lightweight aggregate = $50/yd^3

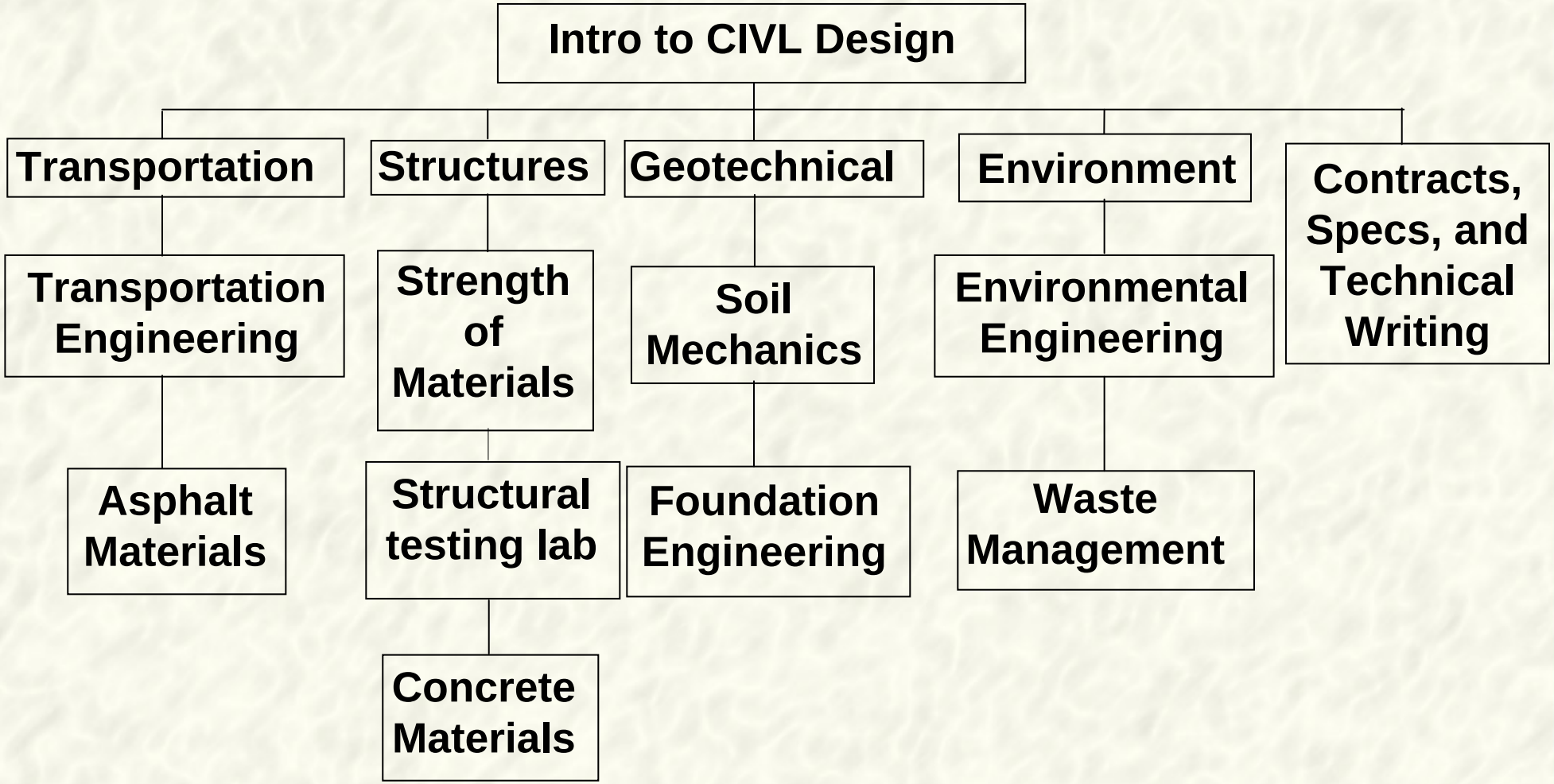
Cost Savings

- Cost savings to CALTRANS with TDA provided at no cost by CIWMB = $477,000
- Cost savings to state less purchase price of TDA = $230,000

Sample Problems

- If we need 5000 yd^3 of the Compacted Fill, what is the TDA volume that is needed from the borrowing pit? The expansion factor is 1.5 for this problem.

Roadmap for CIVL Curricula Related to Waste Tire Applications



Conclusions

- Barriers to using recycled materials can be overcome
- TDA has properties that engineers need
- Civil engineering applications are the fastest growing use for scrap tires in U.S.
- Certain specifications and guidelines are available
- Manageable Environmental effects

THANK YOU

QUESTIONS?