


Slide 1







Learning Outcomes

By the end of this lesson, you will be able to:

- Share best practices for aggregate production and usage
- Explain the potential effects of various emerging issues, changes in technology, shrinking aggregate resources, and industry trends
- Evaluate the benefits of emerging test methods

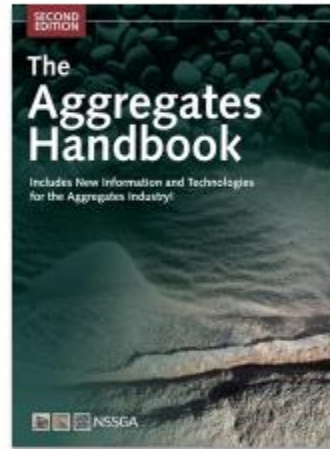
 This lesson will take approximately 1 hour to complete.

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Resources for Best Practices in Aggregate Production



- The Aggregates Handbook, Second Edition, National Stone, Sand, and Gravel Association
- Aggregate Operators Best Management Practices Handbook for British Columbia
 - Available for free download at www.th.gov.bc.ca/bchighways/contracts/Reference_Material_Tenders/23234-0001/AggOp_Best_Management_Practices.pdf



Best Practices for Aggregate Usage

- Best practices for aggregate usage depends on the intended purpose
- Important element in aggregate performance is consistency
 - Physical properties
 - Mineralogical or chemical properties
- Best practices ensure consistency through a comprehensive testing program once the desired aggregate properties are established





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Best Practices for Aggregate Usage – Properties



- Best practices
 - Means establishing and maintaining desirable and consistent properties
 - Refers to those properties that can be changed by implementing correct process control measures
- Many properties can be significantly altered by processing and handling, while others are fundamental and are not altered by production and handling
 - Mineralogical and chemical properties cannot be altered
 - Physical properties can be altered



Best Practices for Aggregate Usage – Assuring Consistent Properties



- Various sources of inconsistency can occur during loading and transport, including:
 - Segregation
 - Degradation
 - Contamination



Best practices in stockpile construction and management is one key to consistency.




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Group Discussion

- What have been your experiences with aggregate production and usage that have been a recurring problem?
- What type of modification to current practice would resolve the issue(s)?
- What are your experiences if another participant has identified a problem and you have found a solution (or an improvement)?


 What are some of the recurring problems you've encountered? What are some possible solutions for these issues?


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Emerging Technologies


- Development of characterization tests that can identify potential problems for a specific application are very important
- In order for new methodologies to “make a difference” or impact performance, consider the following questions:
 - Is the new procedure significant enough to warrant a change in practice?
 - What are the benefits and limitations of the new technology?


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Aggregate Resource Issues


- Availability, cost, and quality of aggregates are interrelated
- Difficulties in locating and opening new sources
 - Shortages are more common
 - Permitting process and public hearing requirements can make opening a new source take many years
- Increased use of recycled and manufactured aggregates
 - More widespread and cost effective

 For more information regarding aggregate production statistics, regulations, etc., visit <http://minerals.usgs.gov/minerals/pubs/commodity/aggregates/>.

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Alternative Aggregate Sources

- According to a 1996 USGS report, the US produces approximately 3 billion metric tons of aggregates each year
- A 2006 USGS report estimates the amount of aggregates used in the existing highway system in the US is about 1,500 million metric tons
- As these pavements are rehabilitated or reconstructed, this ready source of aggregates can be utilized in the new pavement in various ways
- Manufactured aggregates such as slag are also frequently incorporated into pavement systems





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Aggregate Resources Discussion

- We have discussed the need for aggregates meeting certain quality standards
 - Has your agency experienced any issues related to aggregates that meet your specifications? If so, how have these issues been resolved?
 - How has your agency implemented recycling, and to what extent?

Has your agency experience any issues related to aggregates that meet your specifications? How has your agency implemented recycling? To what extent?

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Implications of the MEPDG Adoption



- Example 1: Strength and deformation characteristics of base and subbase materials in the MEPDG are characterized by their resilient modulus
 - Resilient modulus is much more sensitive to moisture, relative confinement, particle interaction, and other test variables than the older characterization methods (k value, CBR, unconfined compressive strength)
- Examples 2: Aggregates used in PCC and their effect on the coefficient of thermal expansion (CTE) of the PCC
 - High CTE aggregates, such as siliceous rock, can have a significant effect on required slab thickness, joint spacing, and potential curling (ride quality), thereby potentially impacting aggregate selection

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- ☐ ☐ ☐
- ☐ ☐ ☐

Are you aware of any pending changes to aggregate selection or specifications based on adoption of the MEPDG in your agency?

Implications of New and Emerging Test Methods




- Example: Reliable data acquisition systems facilitated development of the current resilient modulus test protocols for fine and coarse aggregates
 - Performance impacts must be determined
 - Need to incorporate the test protocol and range of acceptable values into the specifications
- Overall result is to produce a higher quality product that:
 - Lasts longer
 - Requires less maintenance
 - Costs less



Aggregate Soundness

- Can be assessed by soaking in either a sodium sulfate or magnesium sulfate solution to simulate rapid deterioration similar to multiple freeze/thaw cycles
 - Sulfate soundness is specified in the AASHTO T 104 (ASTM C88)
- Prior to development and refinement of this test, the only practical method for determining soundness was to actually subject samples to multiple freeze/thaw cycles



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Automated Aggregate Grading

- Aggregate grading is performed according to the AASHTO T-27 protocol, commonly termed a sieve analysis
- The aggregate sample is dry sieved with the amount of material retained on each sieve determined by automated weighing
- The primary advantages of this equipment include the speed at which the analysis can be performed, especially in high production labs





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Aggregate Shape, Angularity, and Texture



- Particle interaction
 - Extremely important element in the load carrying capacity of HMA
 - Dependent on the shape, angularity and texture as well as gradation
- The Aggregate Imaging Measurement System (AIMS) was developed in an effort to eliminate the subjective determination of particle shape and texture




What are the benefits of the AIMS and how does it impact performance?



Remote Elemental Analysis

- By identifying the specific aggregate remotely, the properties are assumed to be equivalent, thereby reducing or eliminating the need for what is essentially duplicate testing
- NCHRP Report 150, Automated Laser Spectrographic Pattern Matching For Aggregate Identification, details the technology, potential applications, and advantages
 - NCHRP Report 150 is available for download at:
http://onlinepubs.trb.org/Onlinepubs/IDEA/FinalReports/Highway/NCHRP150_Final_Report.pdf

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Laboratory Determination of Anisotropic Aggregate Resilient Moduli Using an Innovative Test Device



- Isotropic behavior is normally assumed for aggregates used in unbound bases and subbases
- The importance of anisotropic aggregate behavior is presently not considered in material characterization for pavement design because of the lack of proper laboratory equipment and testing capabilities
- A study conducted at the University of Illinois presents a methodology to assess this behavior



For details of this procedure, please refer to
<http://trb.metapress.com/content/g5353443117h7n20/>.




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Additional Developments

- Test procedures frequently are developed or evolve in response to a specific need
 - Example: performance-based specifications that clearly define the relationship to a specific material characteristic can drive innovation
- Adoption of the MEPDG and its more robust aggregate characterization requirements can drive innovation in terms of rapid assessment



What types of aggregate tests or refinements to existing tests do you feel are needed?

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Learning Outcomes Review

You are now able to:

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