

Use of Waste Materials in Highway Construction- Challenges and Economical Opportunities



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RESEARCH PORTFOLIO

- No. of Proposal Funded: 44
- Total Funds Received: US \$3,656,574; (external: US \$3,631,708; internal: US \$24,866)
- No. of Proposal in the Pipeline: 2; Expected Funding Amount: US \$279,000
- No. of Graduate Students Supervised: 25 (21 MS Theses and 4 Ph.D. Dissertations)
- No. of Undergraduate Student Researchers advised: 20
- No. of Undergraduate Senior Design Projects Advised: 14 (23 students)
- Engineering students field trips organized: 38
- No. of peer-reviewed Book Chapters/Journal Articles authored: 83
- No. of peer-reviewed conference papers authored and presented: 50
- No. technical presentations delivered: 179
- No. of technical report authored: 24
- No. of radio podcast delivered: 3
- No. of workshop/webinar conducted: 7
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- Google scholar profile: <https://scholar.google.com/citations?user=Qs4TAykAAAAJ&hl=en>
Citations: 1451; h-index: 22; i10-index: 39
- Researchgate: https://www.researchgate.net/profile/Zahid_Hossain6; RG Score: 25.66
- ORCID: <https://orcid.org/0000-0003-3395-564X>
- Scopus: <https://www.scopus.com/authid/detail.uri?authorId=26641259700>

Background

Reclaimed Asphalt Pavement (RAP)

- Nationwide, RAP usage in asphalt over 21%; AR used only 13%

Used Automobile Tire

- Over 280M waste tires/year are generated in the US
- Most of 3.3M waste tires in AR goes in landfills or burnt
- Fire hazards, breeding grounds for mosquitos



Rice Husk Ash (RHA)

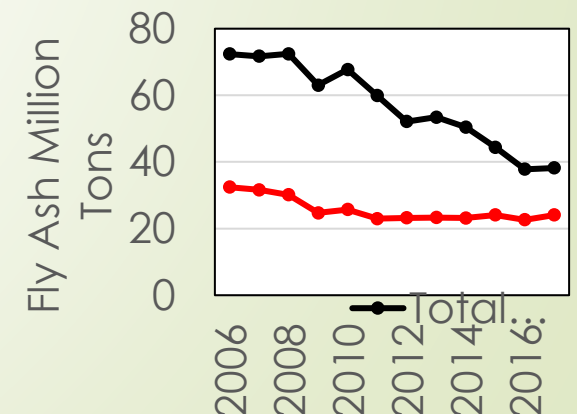
- ~230M tons of rice produced in the US; 20% is Rice Hull (RH)
- AR produced over 5.6M tons of rice (farmer-owned)
- Storage problems and environmental hazards, but RHA is cementitious



Class C Fly Ash Issues:

- Decline (~20% by 2050) of coal-fired power generation in the U.S.
- Jeopardizes the availability of fly ash for concrete production

Need to find alternative cementitious materials (SCMs)

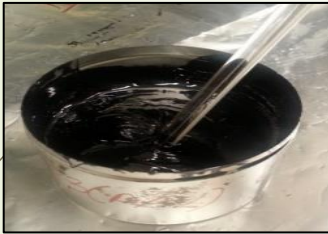


Recently Completed Projects (Example)

Effectiveness of Softening Agents for Asphalt Mixes with High RAP Contents

- 3 binders from 2 crude sources (Canadian and Middle-East)
- 3 softeners (Waste Cooking Oil-WCO, Engine Bottom Oil-OBO, and EvoFlex)
- 2 RAP samples: RAP1 and RAP2

Manual Blending of RAP Binder



WCO



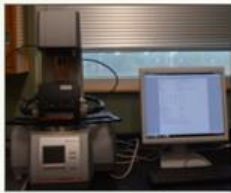
EBO



EVF



Rotational Viscosity (RV)



Dynamic Shear Rheometer (DSR)



Bending Beam Rheometer (BBR)



Rolling Thin Film Oven (RTFO)



Pressure Aging Vessel (PAV)



Penetration Device



Centrifuge Extractor



Binder Recovery using the Rotary Evaporation Method



pH Measurement

- Rejuvenated binders become softer than RAP binders
- Production temperatures reduced => saving fuel costs
- 10% WCO/EBO was effective in 25% RAP-blended binders in surface mixes.

Industry Partner: Atlas Asphalt Co.

Resource: Two faculty members and two students (One Ph.D. and one BS)

Recently Completed Projects (Example)

Evaluation of Alternative Supplementary Cementitious Materials (SCMs) for Concrete

- 4 SCMs: Class F Fly Ash (FA), Ground Bottom Ash, Reclaimed Fly Ash (RFA), Metakaolin
 - Performed laboratory tests and implemented through field demonstration
- SCMs reduced shrinkage up to 49% compared to Control without SCM.
 - SCMs reduced ASR expansion.

Field Demonstration:

Pavement section on the campus (near Student Union)

50 ft x 12 ft x 5-inch slab

Two sections side by side: FA and RFA

<https://fb.watch/d3WXgOFAHh/>



(a)



(b)



(c)



(d)



(a)



(b)

Industry Partners: NEAR Concrete, Arkansas Concrete Pavement Association, Boral Resources

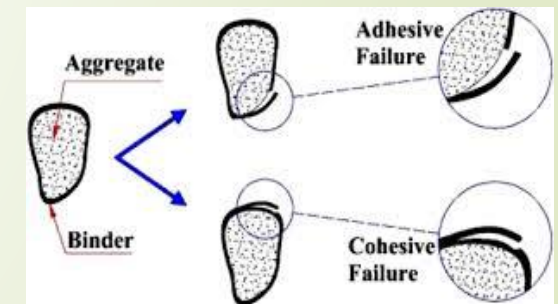
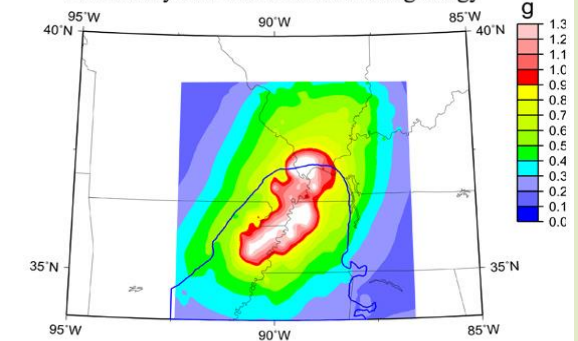
Resource: One faculty; Two students (One MS, one BS)

IN PROGRESS- PROJECTS

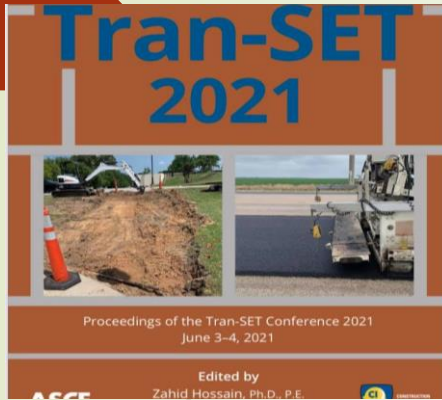
- ❑ Use of RHA as Stabilizing Agent for Poor Subgrade Soils
 - Collaborative with Oklahoma State University
- ❑ Seismic Hazard Analysis within Northeast Arkansas
- ❑ A New Generation of Dense-graded Asphalt With Superior Performance Against Moisture Damage
 - Collaborative with Louisiana State University
- ❑ Aggregate and Binder Compatibility in Asphalt Concrete
 - Collaborative with University of Arkansas
- ❑ Use of Ground Tire Rubber in Concrete Pavement
- ❑ 2022 Transportation Summit- to be held September 2022 (Hybrid mode)



2005 Embayment PGA Hazard Map
2% in 50 years with effects of site geology



EDUCATION, TRAINING, AND COMMUNITY OUTREACH

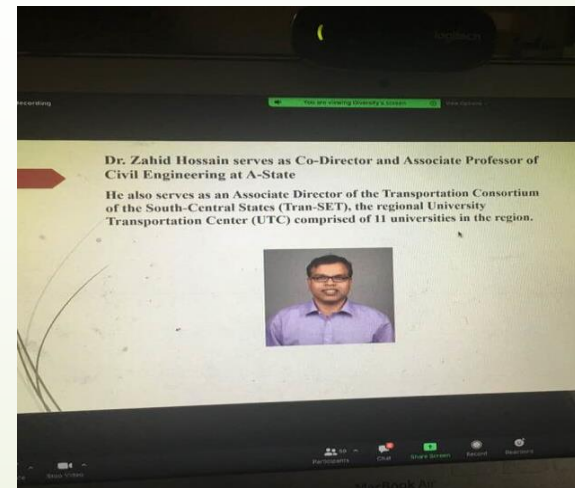


- Hosted 2021 Tran-SET Conference (200 participants)
- Trained & supported 11 students (6 grad+5 undergrad)
- Organized field trips for 66 engineering students: Atlas Asphalt Plant (21 participants), NEAR Concrete (23 participants), AR-18 BNSF Overpass (22 participants)
- Assisted safety training for 50 Ready Mix Plant staff
- Provided internship or 6 High School students
- Contributed to NEA Regional Science Fair, Career Fair, and Robotics Contests
- Participated in Art & Eng. Retreat, Pack Preview, etc.



AWARDS AND RECOGNITIONS

- Dr. Hossain received 2021 A-State Champions in Diversity Award and 2021 Faculty Award for Professional Services
- Ms. Bagchi received Outstanding Graduate Student Researcher Award; accepted Ph.D. fellowship at Purdue Univ.
- 6 research-funded students graduated
 - One Ph.D.: Started post-doc at Purdue University
 - Two MS: Accepted jobs from private industries
 - Three BS: Accepted jobs from private industries



ECONOMICAL BENEFITS

- Consumption of waste products => reduce environmental and financial burden
- Make waste (RHA) as saleable products => economical sustainability for farmers
- Using waste, reduction of Highway Construction Material cost by 25%
- Processing plants of local GTR, RHA, etc. will create new jobs
- Develop transportation workforce for the 21st century
- Support graduate and undergraduate students through research
- Employ/engage senior and junior faculty members
- Recruit/train high school students in STEM education
- Invest in K-12 education through community engagements

ACKNOWLEDGEMENTS

- **Major Sponsors:** Tran-SET, US Department of Transportation, ARDOT, and National Science Foundation
- **Industry Partners:** Nucor Steel, Boral Resources, Ergon, Paragon Technical Services, NEAR Concrete, Arkansas Ready Mix Association, Arkansas Concrete Pavement Association, Arkansas Asphalt Pavement Association Members, A-State Facility Department
- **Research Collaborators:** Colleagues from A-State, University of Arkansas, University of Oklahoma, Oklahoma State University, Louisiana State University, Louisiana Tech University, University of Texas-Austin, Texas A&M University, and Michigan Tech University
- Graduate and Undergraduate students
- The Arkansas Legislative Council Higher Education Subcommittee
- Mr. Shane Broadway and the others

THANK YOU!