

**FOURTH MEETING of the
TRANSPORTATION INFRASTRUCTURE REVENUE SUBCOMMITTEE
October 5, 2015
State Capitol (Santa Fe, New Mexico)**

Future of Roads in New Mexico – Challenges and Opportunities

Maintaining the Department of Transportation as the "Best Engineering Crew" in the Southwest — Attracting Engineering Graduates to Public Work

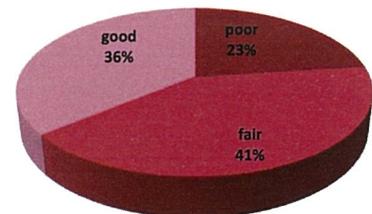
Presented by:

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New Mexico Roadway System

Key information:

- ✓ 142,863 lane miles according to FHWA data from 2012 [35,460 major]
- ✓ 23% of major roads in poor condition
- ✓ 25.6 billion vehicle miles of travel in 2012 [33.3 billion estimated by 2030]
- ✓ Pavement design follows the standard empirical method [AASHTO 1993]
- ✓ Making progress towards calibration of the MEPDG design method [advanced pavement design]
- ✓ 80% Asphalt concrete & 20% Portland cement concrete [based on national statistics]
- ✓ Typical pavement design life 20-25 years



**State of major locally and state
maintained urban roads and highways
[2014 TRIP Report]**

Challenges

Premature Pavement Failure Causes

Progressive Failure:

- Increase in the number and weight of vehicles [medium to slow]
- Aging of pavement components [medium to slow]
- Inadequate design [medium to rapid]
- Unstable subgrades 'bad dirt' [very rapid]
- Deficient construction materials [medium to rapid]

'Catastrophic' Failure:

- Natural hazards: *floods, earthquakes, fires.*
- Fires are a primary safety concern in tunnel pavements
- Fire damage to pavements typically requires resurfacing*
- Floods affect the subgrade underneath the pavement*
- Earthquakes are devastating for pavements but are rare in NM



I-40 near Kingman, AZ
PAT SCRUGGS/Courtesy



I-15 near St. George, UT

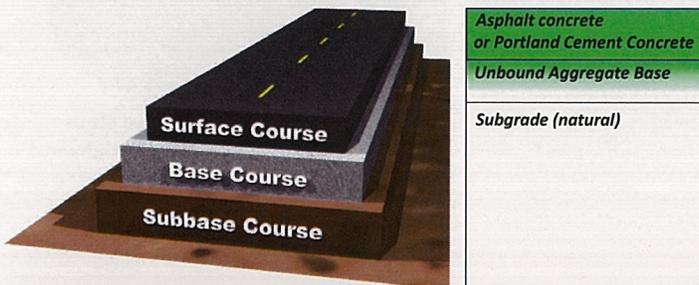


Challenges

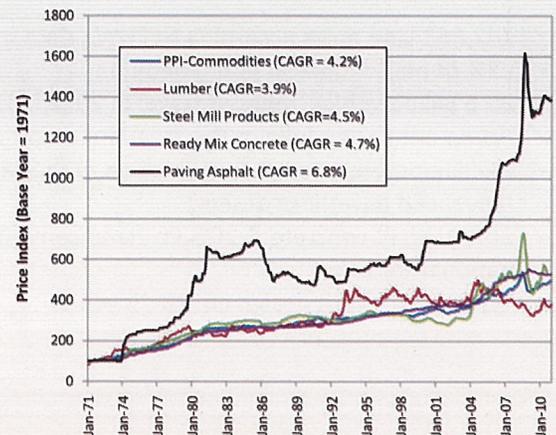
Pavement construction and maintenance costs

We have been building the same type of pavement for over a century.

All along, material costs have increased substantially. The cost of asphalt binder in particular is very volatile.



Over reliance in the surface layer leads to ever more expensive pavements.



A paradigm shift

The future of Roads in New Mexico is at the Foundation!

"The definition of insanity is doing the same thing over and over and expecting different results."

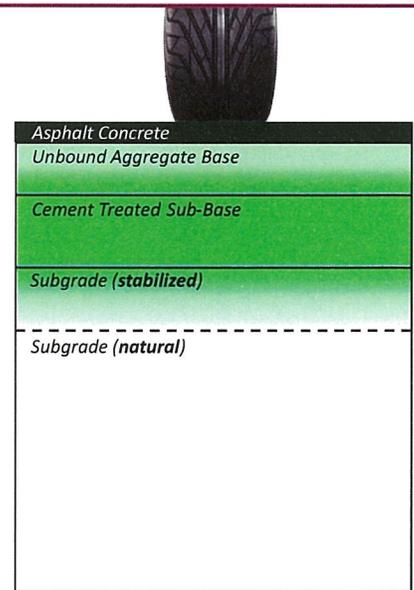
We need to challenge the very core of pavement design and shift the emphasis to the pavement foundation.

Example: Inverted Pavements

An inverted pavement structure relies more on the foundation and the unbound aggregate layers.

Key facts:

1. The pavement works from the bottom up, so it only requires a thin asphalt concrete surface layer.
2. Main stream pavement structure in South African roads (heavy traffic)
3. At research stage in the U.S. – test sections in Georgia, Virginia, and **New Mexico!**
4. **Expertise already at NMSU!**



Positive outlook

South Lagrange Loop - Georgia

Inverted Pavement

Conventional [Portland cement concrete] and inverted pavements build for comparison

Inverted pavement: 3.5 inches of asphalt at the surface

Conventional pavement: 9.5 inches of Portland Cement Concrete

Life Cycle Cost Analysis (per lane-mile):

Event	Inverted Pavement	Concrete Pavement
Install cost	\$342,000	\$584,000
10 yr maintenance	\$101,000	-
20 yr maintenance	\$123,000	-
20-30 yr maintenance	-	\$121,000
30yr Life Cycle Cost	\$566,000	\$705,000

This project was completed in 2009 using equipment and construction methods already in use by state contractors!



Weingart (2010)

Strategic partnership

Ongoing work

NMSU is already working with NMDOT on classical subgrade stabilization to ensure that best practices are implemented and used as to prevent premature pavement failures due to 'bad dirt'.

Needs

Establish unconventional pavement test sections across the state to build up confidence on its performance under varying climates and traffic conditions. Help contractors become familiar with this new pavement.

Establish state specific design guidance for inverted pavement design and construction with an emphasis on long-term performance and construction specifications.

Implement research findings into state construction specifications [synergy between contractors, academics, and NMDOT officials]

Strategic partnership

NMSU offers:

Expertise on inverted pavements:

Our faculty have published several technical articles and reports on the subject of inverted pavements and collaborate regularly with the most prominent researchers in the field.

Expertise in making bad dirt behave:

Our faculty has a track record for work on ground improvement which includes unsaturated soils, collapsible soils, cement stabilization of high plasticity soils, recycled polymer bonding of sands, and foamed glass backfills, to list some.

Center for Bio-mediated & Bio-inspired Geotechnics (CBBG):

NMSU is now part of an NSF research center where ground improvement is a core area. In addition to classical ground improvement methods, the state will now have access to the latest technological developments in the area.

Quick Facts: Civil Engineering

- **Number of Jobs** – 272.9k (2012), 326.6k (projected in 2022, 20% or 53.7k growth); faster than the average for all occupations (11%) and engineering (9%); entry-level average salary (\$61.72k Nationwide, \$52.65k Albuquerque, \$51.5k NMSU, \$35k NMDOT)
- **Employers of Civil Engineers**
 - ✓ Architectural, engineering, and related services – 50%, \$79.47k
 - ✓ State government, excl. education and hospitals – 13%, \$74.18k
 - ✓ Local government, excl. education and hospitals – 11%, \$83.67k
 - ✓ Nonresidential building construction – 5%, \$73.74k
 - ✓ Federal government, excluding postal service – 4%, \$89.44k



“As infrastructure continues to age, civil engineers will be needed to manage projects to rebuild bridges, repair roads, and upgrade levees and dams” Source: U. S. Bureau of Labor Statistics, Employment Projections Program

Challenges and Opportunities

- **Challenges**
 - ✓ Competition for engineering graduates (market is driving salaries)
 - ✓ Growing demand for diverse STEM workforce
 - ✓ Strong demand for graduates with hands-on, real-world experience
 - ✓ Low high school graduation rates (68.5% based on NM PED 2014 data)
- **Opportunities**
 - ✓ NMSU Civil Engineering graduates have an interest in staying in NM
 - ✓ NMSU engineering enrollments have increased over past 5 years amid institutional enrollment decline
 - ✓ Long-range employment opportunities continue to grow
 - ✓ Build a strong K-12 STEM Pipeline
 - ✓ Development of a collaborative NMDOT-NMSU partnership to create competitive employee career pathway

Building the Pipeline: Recruitment Strategy

- Increase visibility of NMDOT career pathway opportunities within NMSU's civil engineering program
- Expand level of coordination between NMSU and NMDOT (as future employers of civil engineers; e.g., research, guest lectures, site visits by students, etc.)
- Enhance recruitment and retention of civil engineering students at NMSU
- Expand civil engineering activities within existing STEM outreach programs (PREP, Project Lead the Way, summer exploratory camps, NM BEST, etc.)

Source: Hubbard, B. J. and Hubbard, S. M. (2009) "Activities to Enhance Civil Engineering Recruitment and Coordination with Industry" *Transportation Research Record: Journal of the Transportation Research Board*, Washington, D. C., pp. 22-30.

Visibility of Civil Engineering as a Career Choice

- "Introduction to Civil Engineering" course at NMSU – revamp to include more hands-on activities (e.g., balsa wood bridge), field trips (e.g., construction projects), and career counseling (e.g., internship opportunities)
- Aggie Innovation Space – increase offerings of civil engineering design challenges, pop-up workshops, and "design thinking"
- Summer Internships – typically aimed at sophomores or juniors (could expand to freshmen to identify top talent of incoming class and start connection early in student's college career)
- Career Fair – opportunity to increase visibility of NMDOT among engineering students (e.g., permanent hires, co-op and internship positions); NMDOT employees serve as ambassadors

NMDOT – NMSU Collaborative Partnership

- **Point Source for Communication** – may be administrator, staff, or faculty member in Department of Civil Engineering (ensures inquiries are answered quickly)
- **Collaborative Partnership with NMDOT** – web-based system (post information, view student resumes, schedule interviews); capitalize on events that brings NMDOT to Las Cruces (guest lectures, Career Fair, Resumania, Homecoming, Transportation Engineering Conference); recruitment and retention funds (continuing scholarships); site visits by students (blend academic learning with real-world application)
- **Student Employment** – create opportunities for student internships and co-ops (e.g., Bridge Engineering Program), and research projects (e.g., CBBG)

Creation of Education Partnership Agreement

Recruitment and Retention

- **Student Recruitment** – revise and update the materials used in recruiting (should reflect the breadth of topics associated with a civil engineering career with the NMDOT) **Keep NMDOT Visible**
- **Student and Alumni Ambassadors** – students previously or currently employed as interns or part-time by NMDOT; alumni currently employed by NMDOT **Serve as Champions of NMDOT**
- **Support of Ongoing Activities** – informational sessions of current projects via student organizations (American Society of Civil Engineers, Engineers without Boundaries, Associated General Contractors); advisors / mentors for technical electives and capstone projects **Share Professional Experience**
- **Employee Retention** – create professional development opportunities to support retention and career advancement of civil engineers at NMDOT (e.g., short courses and workshops offered at NMSU, P.E. refresher course, etc.)

NMSU Bridge Engineering Program

- **Bridge Inspection** – sophomore, junior, and senior undergraduate students; six-month co-op assignments (two-member teams under PE supervision); involves travel throughout NM to inspect 100-150 bridges (including Rio Grande Gorge Bridge, Taos, NM)
- **Bridge Rating** – undergraduate senior and MS students; 10-20 hr/wk assignments (two-member teams under PE supervision); involves load rating of approximately 50 bridges per year (also includes evaluation of bridges w/o plans using advanced techniques developed through research supported by NMDOT)

NOTE: many graduates have continued as civil engineers in NM working with local / state / federal government agencies and private companies in the field of bridge engineering. Graduates include several NMDOT employees.

NSF Center for Bio-Mediated and Bio-Inspired Geotechnics (CBBG)

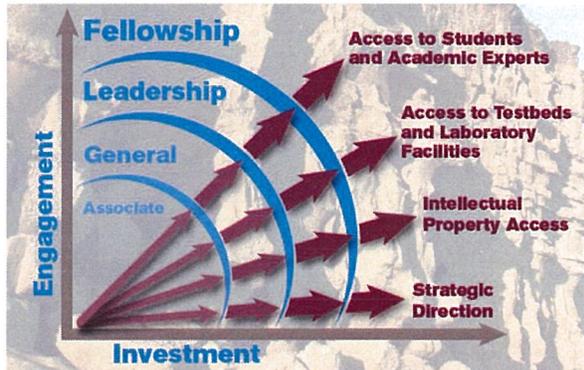
- **University Partners** – ASU (lead), UC Davis, Georgia Institute of Technology, NMSU
- **Center Goal** – develop biologically based designs to promote sustainability in
 - ✓ environmental protection and restoration (ASU)
 - ✓ hazard mitigation (UC Davis)
 - ✓ resilient and sustainable infrastructure construction (NMSU)
 - ✓ resource recovery (George Institute of Technology)
- **NMSU Focus Area** (PI: Dr. Paola Bandini, Associate Professor, Civil Engineering)
 - ✓ develop more efficient foundations through mimicry of root systems
 - ✓ protect, repair, and remediate existing infrastructure, including foundations and earthen structures
 - ✓ reduce CO₂ emissions and develop sustainable construction materials
 - ✓ develop bio-inspired and bio-mediated ground improvement technologies

NSF Center for Bio-Mediated and Bio-Inspired Geotechnics (CBBG)

CBBG Partner Program – develop solutions to address challenging geotechnical problems in a sustainable, cost-effective and environmentally sensitive manner.

- Participation in Strategic Direction
- Preferred Access to Students
- Access to Exceptional Team
- Early Exposure to Innovation
- Participation in Annual Meeting
- Access to Industry Network
- State-of-the-Art Research Facilities

GOAL – Foster Industrial Development



Overall Philosophy of NMDOT / NMSU Collaboration

Facilitate connections between

- NMSU Department of Civil Engineering & students (potential NMDOT employee)
- NMDOT employment opportunities & NMSU student interests
- NMSU Department of Civil Engineering & NMDOT
- NMDOT student interns & NMSU students
- NMDOT and NMSU STEM network (K-12)