

Low-Volume Roads

LOW-VOLUME ROADWAYS are often unappreciated and under-researched by pavement engineers when held alongside their high-volume interstate and highway counterparts.

But MnROAD, a key element in TERRA's comprehensive road research strategy, has established itself as a national leader in the study of low-volume road research and construction techniques. In fact, no other test track gives researchers the ability to investigate low-volume roads to the extent of MnROAD. Extensive experiments and continuous data collection on test sections of the MnROAD low-volume road (LVR) have produced a number of benefits to Minnesota roadways and to the larger pavement community.

Following are some highlights based on the 2007 report *MnROAD Lessons Learned*.

Project Highlights

- **Low-Volume Road Design**—Researchers, using years of LVR data, recommended that the Soil Factor and R-Value design procedures for low-volume roads be reconsidered. This conclusion is significant for local agencies, most of which use one of these procedures in planning their roadways. As an alternative, MnPave, a mechanistic-empirical design software program, was developed using MnROAD performance data and, to a lesser extent, data from Minnesota highway sections.

- **Aggregate roads**—The subgrade under aggregate sections froze days sooner and took weeks longer to thaw than hot-mix asphalt (HMA) sections at MnROAD. In addition, researchers found a strong

relationship between washboarding and the number of truck passes. They also found that the use of the chip seal reduced the likelihood of washboarding. Furthermore, researchers noted that aggregate gradations are not reliable predictors of performance in an aggregate road.

- **Oil Gravel**—Three test sections in the LVR were built with material unique to test tracks—emulsified oil gravel—which consists of a softer binder than a typical HMA mix. Use of oil gravel resulted from a long-lasting partnership with the Finnish National Road Administration (FINNRA), which has been building roads with oil gravel since the late 1950s. The resulting flexible, thin surface has

Implementation/Application

- The **flexible slurry system**—a mixture of emulsified asphalt, high-quality crushed aggregate, and water that is constructed using a microsurfacing machine—has produced 30 percent short-term ride improvement on normally rutted sections and more than 50 percent improvement on severely rutted sections on the MnROAD low-volume road. Flexible slurry was also used as an overlay preparation on McLeod County State Aid Road 15, north of Glencoe, Minnesota.

- LVR Cell 32, a **5-inch concrete pavement** with no dowels, is performing well after seven years. This thinner concrete pavement is being studied for use in cer-

tain lower-volume roads not expected to exceed LVR testing parameters for load configuration and volume.

- The typical recommended minimum standard **6-inch concrete pavement** has performed so well on the MnROAD LVR and other Minnesota low-volume roads that it is often referred to as a “bullet-proof” pavement for more heavily loaded applications.

- **Taconite aggregates**, used in LVR Cell 31 (HMA) and LVR Cell 54 (PCC) since their construction in 2004, have performed well and demonstrate the high quality needed to expand their use



Quick Facts

- **Facilities**—The 2.5-mile, two-lane, closed-loop LVR has 21 500-foot test sections, each built according to specifications for a particular research focus using a variety of materials.
- **Load Testing**—A five-axle tractor-semi trailer, rigged with two different load configurations (80,000 and 102,000 lb), provides controlled weight and traffic volume on the LVR to simulate conditions on rural roads.
- **Data**—MnROAD continuously monitors the LVR test sections in the ground with hundreds of embedded sensors collecting data and regularly assessing pavement and environmental conditions.

typically exhibited a long life and a low amount of cracking in Finland. Two of the original three oil-gravel LVR sections remain at MnROAD and have resisted thermal cracking entirely.

around Minnesota. Taconite aggregates, already used extensively in roads around the state, have proven to be strong and durable when used as subgrade and base material and in bituminous pavements.

- Mn/DOT's experience with **oil gravel** at the MnROAD facility and on roads throughout the state has helped to educate municipal and county engineers about oil gravel. This new pavement technology for road rehabilitation would have gone unexplored had it not been for MnROAD's partnership with the Finnish National Road Administration (FINNRA).

Research Benefits

- Knowledge of road-building materials is increased. For instance, research has resulted in a better understanding of performance grading (PG) and its use to select appropriate asphalt binder for the job.
- Familiarity and depth of knowledge of MnROAD test sections exceeds that of any other full-scale facility due to the amount and quality of data collected and stored. The most noteworthy projects to benefit from the wealth of low-volume

road data were those involving mechanistic-empirical design, which first used the LVR data in a rigorous way.

- Regular, controlled loading distinguishes the MnROAD low-volume road from other full-scale pavement facilities.
- Local design and maintenance practices are improved.
- Local roadway improvement costs are minimized.



Partners

- Minnesota Local Road Research Board (LRRB)
- Federal Highway Administration (FHWA)
- Transportation Research Board (TRB)
- Strategic Highway Research Program (SHRP)
- U.S. Army Cold Regions Research and

- Engineering Laboratory (CRREL)
- Finnish National Road Administration (FINNRA)
- Manitoba Ministry of Transportation
- Industry representatives, including contractors and material providers.

For More Information

For more information about this research, please contact:

- Timothy R. Clyne, P.E., MnROAD Forensic Engineer, Office of Materials, Minnesota Department of Transportation, 651-366-5473, tim.clyne@dot.state.mn.us

For more about TERRA, please contact:

- Laurie McGinnis, Associate Director, Center for Transportation Studies, University of Minnesota 612-625-3019, mcgin001@cts.umn.edu
- Maureen Jensen, Manager, Road Research Section, Office of Materials, Minnesota Department of Transportation, 651-366-5507, maureen.jensen@dot.state.mn.us

About TERRA

The Transportation Engineering and Road Research Alliance, or TERRA, brings together government, industry, and academia in a dynamic partnership to advance innovations in road engineering and construction, including issues related to cold climates. More about TERRA is online at www.TerraRoadAlliance.org.

For Further Reading

- *MnROAD Lessons Learned* (Mn/DOT Report MN-RC-2007-06)
- *Minnesota Low Volume Road Design 1998* (Mn/DOT Report MN-RC-1999-34)
- *An Evaluation of Aggregate and Chip Seal Surfaced Roads at MnROAD* (Mn/DOT Report MN-RC-1998-24)
- *Evaluation of Aggregate Sections at MnROAD* (MnROAD Report 2000-29)
- *Best Practices for the Design and Construction of Low-Volume Roads*. (Mn/DOT Report MN-RC-2002-17REV)
- *Historical Use of Taconite Byproducts as Construction Aggregate Materials in Minnesota: A Progress Report* (NRRI-RI-2006-02)

Links to these publications are on the TERRA Web site at

www.TerraRoadAlliance.org