

SOLUTIONS



RESEARCH PROGRAMS SUMMER 2007

IN THIS ISSUE

PROJECT HIGHLIGHTS

Mechanistic-Empirical Pavement Design
Guide Flexible Pavement Performance
Prediction Models for Montana

[Fish Passage in Culverts Research
Projects Recently Completed](#)

[LIBRARY CORNER](#)

[DID YOU KNOW?](#)

[NEW RESEARCH PROJECTS](#)

[CALENDAR OF EVENTS](#)

[NEW RESEARCH REPORTS](#)

[CONTACT US](#)

PROJECT HIGHLIGHTS

MECHANISTIC-EMPIRICAL PAVEMENT DESIGN GUIDE FLEXIBLE PAVEMENT PERFORMANCE PREDICTION MODELS FOR MONTANA

http://www.mdt.mt.gov/research/projects/pave/pave_model.shtml

U. S. pavement design has been based on road tests conducted by the American Association of State Highway Officials (AASHTO) in the 1950's. These designs were empirical, that is, based on equations and observations from the original tests.

As early as the 1970's, it was recognized that a huge increase in truck traffic along with increased vehicle weights were rapidly making the empirical design method obsolete. AASHTO test data was very limited. It was based on one climatic location and subgrade type; 1950's construction practices, vehicle weights, and suspensions; and higher than normal construction quality. A better method of pavement design was needed.

In 1996, the American Association of State Highway and Transportation Officials (AASHTO) Joint Task Force on Pavements (JTTF) laid the foundation for a new mechanistic-empirical (M-E) pavement design method, which adds a more scientific approach to pavement design. Based on laboratory pavement material properties, mathematical models are used to predict stresses and strains within the pavement when subjected to wheel loadings. Another set of mathematical models uses the stresses and strains to predict pavement performance.

As a result of decisions made by the AASHTO JTTF, a new Mechanistic-Empirical Design Guide (MEPDG) was developed under [NCHRP project 1-37A](#), including both a user's guide and a software package.

The software requires detailed inputs on distress limits, reliability, traffic, climate, and materials. This design guide is much more complex than the old AASHTO 1993 design method. However, additional accuracy, and better communication among disciplines will allow for much better pavement designs. Strengths of this design method lie in six areas:



- Use of site-specific data on materials, pavement thickness, and the environment for custom pavement design;
- The ability to calibrate the pavement distress models to local conditions;
- The ability to review old or failed designs and look at ways to improve them;
- Flexible use for new designs, rehabilitation, or maintenance;
- Associating key distress types with critical pavement responses; and
- Prediction of when key distresses will reach unacceptable levels.

Currently the pavement performance models within the M-E Design Guide software are calibrated based on a nationwide database. Montana is a lead state in the implementation of the new Design Guide.

In 1998, the Pavement Analysis Section of MDT began exploring testing methods to support a more mechanistic design method. In anticipation of the new Design Guide, the current research project was begun in 2000 to calibrate the models for local pavement conditions in Montana.

The final report was presented in three parts:

- Research Summary,
- Reference Manual, and
- Field Guide.

MDT will continue to monitor pavement performance and periodically update calibration coefficients. The new Design Guide will allow more efficient design of roadways in Montana and keep this state in the forefront of pavement design technology. The final report can be viewed at the link above.

Contact Sue Sillick at 406.444.7693, ssillick@mt.gov for more information.





FISH PASSAGE IN CULVERTS RESEARCH PROJECTS RECENTLY COMPLETED

http://www.mdt.mt.gov/research/projects/env/fish_passage.shtml

http://www.mdt.mt.gov/research/projects/env/fish_passage_warm.shtml

Fish passage through culverts is an issue that has been in the forefront in recent years. We all want healthy Montana fisheries, but at the same time we recognize that limited budgets can force some tough decisions when it comes to balancing aquatic habitat with transportation needs. Two MDT research projects have just been completed that shed significant light on this issue

One project was a follow-up to the [MDT research project previously conducted in the Seeley Lake area](#). The Phase II project specifically examined passage as a probabilistic occurrence, and observed the probabilities of fish moving through successive points in a drainage, between culverts and through them.

The project team instrumented a tributary to the Yellowstone River near Gardiner to demonstrate a strong statistical relationship between the probability of fish passing through a culvert and the water velocity in the culvert. This is a significant finding and deviates from previous studies that proposed a simple pass/no pass velocity.

The project also demonstrated that the probability of fish passing through a series of culverts can be adequately expressed as the cumulative probability of fish passing individual culverts. These cumulative probabilities should be considered in combination with estimates of upstream habitat quality and availability, and should be weighed against available funds for culvert installation or replacement projects.



The second project focused on warm water fish species that are found in the settings of Eastern Montana. Prior to this project, there was only a small amount of anecdotal information about the mobility tendencies of prairie fish and their physical capacity to traverse the barriers that can be imposed by a culvert. This project, conducted on tributaries to the Yellowstone River near Glendive, demonstrated that a large number of species were well distributed in reaches with culverts.

For all species but one (Longnose Dace), the culverts in the study were not a significant barrier to upstream fish passage. This can be attributed in part to the fact that the culverts in the study closely mimicked the habitats and low gradient of the streams, by having



streambed material and similar stream velocities in the culvert barrel, and small outlet drops compared to culverts often seen in steeper mountainous drainages.

Overall this study reinforces the notion that culverts should mimic the aquatic habitats and hydraulic conditions of streams with a fishery resource, while still meeting the hydraulic, hydrologic, safety, maintenance, and road bearing needs of the system.

In both projects, analyses were undertaken demonstrating the software FishXing, the contemporary tool of choice for many culvert experts, can be a valuable design tool for new culverts. FishXing also tends to do a good job of

identifying existing culverts that are passable to many Montana fish species. Findings from both studies indicated that the model does not perform as well at identifying existing culverts that are potential barriers to fish passage, as fish passage was observed at a significant proportion of culverts classified as barriers by the model.

So when the model indicates that a culvert is a barrier, more detailed studies of the culvert should be undertaken. Finally, a recommended design procedure is also presented in these reports, which can be viewed at the above links.

For more information, contact Sue Sillick at 406.444.7693 or ssillick@mt.gov.





LIBRARY CORNER

TRANSPORTATION-RELATED JOURNALS

Almost all engineering and transportation-related journals have online editions that allow access to the same information in the paper edition. If you subscribe to a monthly journal, you usually also get access to the journal's web site edition. However, some journals have prices for online editions that are separate and distinct from paper subscriptions.

In addition, some journals allow all or some articles in each issue to be available in full if the research was funded by government grants and sources, such as the *Journal of Public Transportation*, which is published at The University of South Florida's Center for Urban Transportation Research.



Other electronic journals, such as the *Electronic Journal of Structural Engineering*, are freely available to the engineering community and have no paper edition. This international journal, based in Australia, is peer-reviewed and disseminates news from conferences and workshops in structural engineering.

Many journals are available to employees and the public through [Montana State Library \(MSL\)](#). Full articles from *Journal of Structural Engineering* can be accessed through the MDT Library's Infotrac journal databases. MSL also carries *Journal of Transportation Engineering* and *Journal of the American Planning Association* to name a few among thousands of journals that are available through the vendor, Thomson Gale.

Many trade journals, however, fall into a category of providing some or all of the articles free in their past issues or archives. If you click on each journal link, you will find all past issues included in each volume; however, some require a paid subscription to find full articles.

The following are examples of journals that have past issues available:

- ACRP Research Results Digest*
- Asphalt Contractor*
- Better Roads*
- Construction (& Construction Bulletin)*
- Government Technology*
- ITE Journal*
- ITS Journal*
- Journal of Transportation & Statistics*
- NCHRP Research Results Digest*
- Pacific Builder & Engineer*
- Public Roads*
- Roads and Bridges*
- TCRP Research Results Digest*
- World Highways*

Contact Lisa Autio at 406.444.6125 or lautio@mt.gov for more information.



DID YOU KNOW?

Site Analysis Report Records Visitors to Research Web Site

The Research office receives a quarterly Site Analysis Report from the Information Services Division, which sums up statistics about internet visitors to the Research web site during that time. The latest report covers the period from April 1 to June 30, 2007.

A number of interesting facts are evident from viewing the report. It is possible to see where visitors to the web site originate, the duration of visits, the total hits, unique visitors, the number of visitor sessions, most popular hours of the day for visits, and most popular pages viewed.

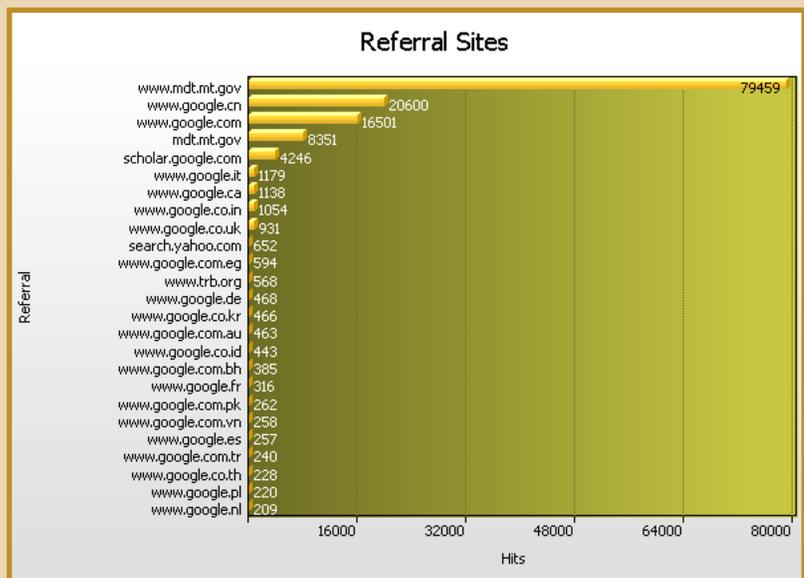
Not surprisingly, by far the most visits to the web site are from employees of the Montana Department of Transportation (79,500, up from 43,900 six months ago).

However, the next largest group is from Google China, www.google.cn (20,600 visits). This is an unexpected source of traffic, but may be attributed to the large number of digital reports that are posted to the Research site. Google is the third largest source of hits, followed by Google Scholar, Google Italy, Google Canada, Google India, Google United Kingdom, Yahoo, Google Egypt, and the Transportation Research Board. Further down the list are large numbers of visitors from Germany, Korea, Australia, Indonesia, and Bahrain.

This indicates that the Research web page is being viewed and files being downloaded from all over the world. The most common file accessed is a portable document file (pdf), and the most accessed

and downloaded report is *Wildlife-Highway Crossing Mitigation Measures and Associated Costs/Benefits: a Toolbox for Montana Department of Transportation*.

Most visits are for a minute or less, but a surprising number of visitors (854) have stayed online for an hour or more. The most common level of loyal, returning visits is between 50 and 99 sessions. There were 29,062 unique visitors.



In terms of traffic, over 6,000 files were downloaded, 787 pages were viewed daily, and 380 megabytes downloaded daily as pages. For some reason, the most popular day to visit the Research web site was June 13 and the hour with the most visitors is 3:00-4:00 p.m. on any given day.

For more information, contact Lisa Autio at 406.444.6125 or lautio@mt.gov.



NEW RESEARCH PROJECTS

Highway Project Cost Estimating and Management

http://www.mdt.mt.gov/research/projects/const/project_cost.shtml

Investigation of Various Impacts of Allowing Canadian B-Trains at Full Alberta Weights to Operate on the I-15 Corridor North of Great Falls, MT

<http://www.mdt.mt.gov/research/projects/planning/btrains.shtml>

Noise Compatible Planning

http://www.mdt.mt.gov/research/projects/env/noise_plan.shtml

Research in Support of Container on Flatcar (COFC) and Trailer on Flatcar (TOFC) in Intermodal Service on Montana's Railway Mainlines

<http://www.mdt.mt.gov/research/projects/admin/flatcars.shtml>

Find all past and current research projects at

http://www.mdt.mt.gov/research/projects/sub_listing.shtml

CALENDAR OF EVENTS

September

- AASHTO Annual Meeting (9/28-10/2)
- AASHTO International Scanning Program
Proposals Due 9/28
- ACRP Panel Nominations Due 9/17
- MDT RRC Meeting (9/25)
- NCFRP Solicitation for Problem Statements
Due 9/26
- NCHRP Problem Statements Due 9/14
- SPR Annual Work Plan Due

October

- ACRP Synthesis Topics Due 10/12
- MDT RRC Meeting (10/30)
- TRB Annual Meeting Preliminary Announcement
Distributed

November

- AASHTO SCOR Meeting (11/1-11/2)
- MDT Research Project Solicitation
- NCHRP Problem Submitters' Responses to
Evaluations Due
- NCHRP Synthesis Topic Solicitation

December

- FHWA Annual Accomplishments Report Due
- MDT RRC Meeting (12/11)
- NCHRP Ballot, New Projects Distributed to SCOR
and RAC

January

- MDT RRC Meeting –
Solicitation Research
Ideas to be Ranked
(1/29)
- NCHRP Synthesis Topics
Due
- RAC/SCOR Meeting
(1/13)
- TRB Annual Meeting
(1/13-1/17)

February

- MDT RRC Meeting (2/26)
- NCHRP Ballots on New
Problem Statements
Due





NEW RESEARCH REPORTS

Evaluation of Wildlife Crossing Structures on US Highway 93 Evaro to Polson
http://www.mdt.mt.gov/research/projects/env/wildlife_crossing.shtml

Experimental Assessment of Aggregate Surfacing Materials
http://www.mdt.mt.gov/research/docs/research_proj/exp_assess/final_report.pdf

Fish Passage at Road Crossings in Montana Watersheds Providing Bull and Cutthroat Trout Habitat
http://www.mdt.mt.gov/research/projects/env/fish_passage.shtml

Mechanistic-Empirical Pavement Design Guide Flexible Pavement Performance Prediction Models for Montana
http://www.mdt.mt.gov/research/projects/pave/pave_model.shtml

OJT Program Evaluation
<http://www.mdt.mt.gov/research/projects/admin/ojt.shtml>

Warm Water Species Fish Passage in Eastern Montana Culverts
http://www.mdt.mt.gov/research/projects/env/fish_passage_warm.shtml

Find all past and current research projects at
http://www.mdt.mt.gov/research/projects/sub_listing.shtml

REMINDER

Information on research services and products, such as research and experimental project processes and reports, and technology transfer services, including our library catalog can be found on the Research web site at www.mdt.mt.gov/research.

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