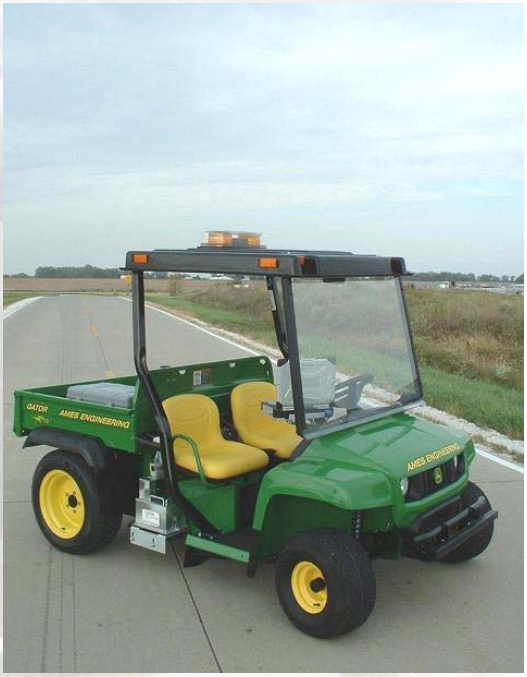
LIGHTWEIGHT INTERNAL SURFACE ANALYZER – MNROAD RIDE MEASUREMENT

General Description

John Deere Gator Utility Vehicle that automatically collects integrated road condition data by recording laser profilers of the road surface. MnROAD is using this equipment to measure ride and to collect profiles of each of its test sections.



EQUIPMENT MANUFACTURER WEBSITE

http://www.amesengineering.com/ameslisa.htm

COLLECTION FREQUENCY

MnROAD plans to collect 3 periods throughout the year for each test section. This includes routine data collection in March, July, October each year and other special tests as needed for individual studies/requests on individual test sections.

Procedure

1. Unloading the LWP from Trailer

Remove 4 straps that help hold lightweight in trailer.
Make sure cart transmission is in neutral
Start motor – Choke for engine is left of drivers seat and tucked underneath
Let motor run for several minutes before driving out of trailer. Otherwise the sudden driving could cause incalculable harm to the engine. While motor is running, attach tough-book with 2 plug-ins.

2. Calibration

Turn computer on and allow profiling program to appear. The current version of the program is 5.1. The icon is recognizable as it bears AMES 5.1
With motor running, open the smaller case at the rear of the profiler. It carries various calibration and basic tools. The Tools include:

1. A pressure gauge,
2. A flat plate measuring approximately 4 inches by 4 inches and about 50 mils thick.

3. A manual pump
4. A metal cube measuring exactly 1” by 1” by 1”
5. 4 special cones with vertical reflective strips – unused for optical trigger

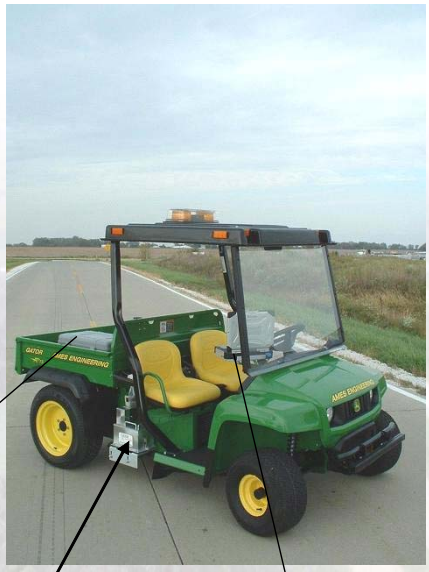


Figure 1 LWP

Please Note:

- It is important to check the tire pressure. The quarter car filter uses two sets of spring and dashpot values for the sprung and unsprung masses respectively in the vibration equation. For the unsprung mass, the tire pressure is correlated to that stiffness constant and dashpot quantity. A wrong air pressure can potentially affect the accuracy of the results.
- Check air pressure on all four tires. Tires may need to be deflated or inflated until it measures 10psi.

Open the second case Press button to turn power on to grey case in the rear of the LWP and turn the key inside case to switch on the laser. Operator should hear several beeps. There are 2 accelerometer / laser boxes that may already be mounted in place. The ODSI (single laser) is equipped with a sliding window that slides outwards to expose the laser beam but the triple laser is not equipped with such a window. The ODS2 (TRIODS triple laser) will direct 3 laser points approximately 2 inches apart onto the ground. The single laser fires only a single laser to the ground. If the laser beams are not visible, go through the process of switching on the laser, and opening the windows but now in addition, check the power connection and ensure that adequate contact is made at the accelerometer / laser box. The Optical Trigger utilizes the second connection cord along with the laser of choice.

2.1 Vertical Test

With the laser on, start the AMES software and select the Calibration button. The aim of the vertical test is to minimize errors caused by the laser inadvertently misinterpreting depth of profiles. To detect such an anomaly, a known relative height should be measured with the laser. With motor running – perform vertical height test with both base plate and one inch block. Place base plate under laser and begin vertical test. Use extensive test in menu on the screen. (There are many options, however, the extensive test is deemed adequate for our work). Place the 4" by 4" plate under the laser, ensuring that it is concentric with the laser beam. Press enter and the screen will show some height values for the plate. Zero the laser to zero the plate. Next place the 1 inch block on the plate ensuring that it is concentric with the beam and the plate. The table should read approximately one inch. A residual of .05 of an inch is tolerable. Examine the mounting plate for damage or you need to call the manufacturers if residuals exceed .05 of an inch.

Caution!!! Remove the cubical box and plate from beneath the laser before driving away. If the vehicle runs over it will need replacement due to inaccuracy.

2.2 Bounce Test

The bounce test is not really a calibration process but a priming process. It is a test that is performed until the equipment passes. In this test, the operator subjects the equipment to a vertical acceleration with their self-weight plus a "RHUMBA DANCE" covered below. It has a dual advantage of freeing the accelerometer from any impediments to smooth operation and the operator from job-related tension.

- With motor running – perform bounce test to check accelerometer. Not uncommon for this test to fail several times before getting a pass. Leave 4" plate in place for test.
- Press the Bounce test icon.
- Stand as close to the vehicle center line as possible. Hold onto the frame, press start and rock the vehicle back and forth, up and down. Bounce vehicle from back to front (in direction of travel) – not side to side.
- A trace appears on the screen and continues till a beep is heard. The screen shows pass or fail. If it fails, repeat the test until it passes.

2.3 Distance Check

Perform distance check. This is to ensure that distance being measured is accurate. Should be within one foot for one-thousand feet of distance. At MnROAD, there are markings of known distances in the profiler certification strip.

- Switch on the distance check set the laser at the beginning and run the distance moving at a speed between 10 and 12 miles per hour.
- Check that the distance is measured correctly.
- Repeatability of distance measurement is as important as the actual ride measurement because will correctly interpret event markers such as joints, bumps and dips that may show up in the spectral density analysis.

3.0 Measurement

The current version of the software, as well as the Toughbook, allows a touch screen process that facilitates the procedure. There are settings that must be done.

3.1: Profiler Setting

Set to IRI. We do not encourage the collection of texture data with the LWP as experience has shown that it is not repeatable and like the secondary product of any process, the quality is not comparable to the primary product. The use of PI is obsolete otherwise that will require filter (Blanking band setting) the Operator should not worry about that.

There are preset manufacturer defaults. These cannot be changed unless with a pass code. The pass code resides with manufacturer. We do not anticipate the need to use those codes except the notebook doubles for a high-speed profiler as well as the lightweight profiler. Should MnROAD acquire a high-speed profiler, a dedicated strong-book is also advisable. Under Settings, grey areas for these settings should read 0.30 Radians for Analog Filter, Anti-Aliasing Filters set to 24 Hertz.

Switch on the various pods by checking the boxes on display. Ensure that the equipment is set to auto start. Arrange the vertical striped cones at the prescribed start and stop points.

3.2: File Creation and Management

Very easily the files if poorly coded lose identity due to similarity. A file appears and a cursor blinks around it. This is likely to be the last file used. The single laser will add a leading 1 to the file name and the triple laser will add a leading 2.

TABLE 1 – SUGGESTED FILE NOMENCLATURE FOR PROFLE RUN

1	Location	2	3	0	8	3	2	T	D	D	L	0	2
Profiler 1 or 2 entered by equipment	Mainline, LVR or THxxx	Month	Day	Year		Cell or Direction NB/SB WB/EB		Texture Wheel-path LWP or RWP		Driving Lane or Passing Lane		Run 1,2,3…	

The above example is the 2nd run on Cell 32 on February 3rd 2008 . TD = Turf Drag The operator may choose what is prominent on the cell such as ND for no dowels instead of TD, or CO / BI for concrete or BITUMINOUS, if the doweled profilograms are compared with those from an undoweled segment. If this run is done by a triple laser, a leading 2 would appear instead of 1.

3.3: The Profile Runs

Once input file is completed, you are ready to profile

The software asks series of questions to describe the segment. These include Operator name, direction, surface type etc. When these are entered, the equipment is ready for the first run.

- Stationing can be used by entering station without + symbol. Denote direction increase/decrease below.
- Before starting make sure of the lead distance and observe the green black and red buttons from left to right of the LWP dash. The green is held down about 10 ft before the start cone and released immediately after a beep indicates that the auto start triggers. The black button is held down to exempt a section, such as stop bar rumble strips. The red button is held down 10 ft before the stop cone and released. A beep will note the stop cone has been triggered.
- To make a run, ensure a lead distance of 200ft. Press start.
- If everything checks, you are now ready to input file data prior to profiling.
- Start 200 feet or so before where you want profiling to start.

The graphics may show as though the profiler is collecting data but note that these are black checkered graphics and is not part of the profile. Yellow graphics will only show when the auto trigger is armed and data is collected.

- Start from the lead distance and press "**arm auto trigger**". Maintain a speed between 10 and 12 mph.
- Press the green button 10 ft before the start cone and release 10ft after or when a beep is heard.
- Observe yellow graphics showing true data collection
- Depress the red button to end the run as described above.
- Use PK nails or permanent stop & start marks.

That run is completed. You may choose to go back and analyze the file. Press analyze file, select that file and analyze it. The first analysis generates, excel, ASCII and ERD files for that run. In summary gives an IRI value. Depending on the initial print setting, it will print out a report showing bumps and dips as well as the IRI summary. The LPT printer is situated at the rear box beside the laser key switch. This printer is triggered by the analyze file command. No MnROAD profiles are printed, but are required for QA/QC paving profiling activities.

Very likely the next run is on the same stretch and the only change in the file name is the next higher number at the extreme right of the file name. That can be change while moving back to make the next run.
Repeat the motion for subsequent runs.

By default the files are stored in a job file in the D-drive or C-drive. It is required to create sub-folders for projects because the files soon become overwhelming and unwieldy.

4: Data Retrieval

The LWP stores 3 sets of files namely an excel summary, an ASCII file and an ERD file. The most robust of these is the ERD files. It is not necessary to use any extra software to retrieve the ASCII and EXCEL files generated. Depending on the level of research, users may request data in any of these 3 forms. However the ERD files are the best representation of the ride information. The ERD files can be managed with various software including ROADRUF, PROVAL, WAVELET etc. PROVAL loaded on the Toughbook for file review in the field.

However as long as the identity of the file runs are preserved by a good nomenclature, any tool with which the ERDs can be stored at least as an iconic model in the data base at will be useful. The Ride summaries are only useful for quick data comparison but detection of hot spots and causative features are enhanced with ERD files. The software is equipped with a cropping tool that can extract subsets for analysis. Since this feature is found in PROVAL only, it is advisable to profile each cell separately and minimize errors implicit in cropping.

> The PROVAL software is available free from FHWA and can be downloaded from the web. If any one needs a 1 hour crash course on power usage of PROVAL please call Bernard Izevbekhai at (651) 366-5454.

Data Processing

PROGRAM USED: PROVAL software

MnROAD will enter this data though a loader using the spreadsheet developed using PROVAL to enter in the IRI summary data. The actual ERD profile data (each measurement) will also be stored offline in the R:\MnROAD\Data Collection\Light Weight Profiler (LISA) directory under the date it was tested.

Database Tables

DISTRESS_RIDE_LISA	Format	Example	Description
CELL	Number 3.0	19	MnROAD cell number
DAY	Date	11/19/2008	Date of test
LANE	Text 25	ML-Driving	Lane being tested (ML-Driving, ML-Passing, ML-Driving Shoulder, ML-Passing Shoulder, LVR-Inside, LVR-Outside, Farm-North, Farm-South)
WHEELPATH	Text 6	LWP	Location in the lane while tested in the same direction of traffic. Note the LVR inside lane will be tested in a clockwise location with traffic and the LVR outside lane will be tested in a counterclockwise direction. LWP, RWP is determined to the testing. SHLDR is measured 2 feet offset from the driving lanes.
OPERATOR1	Text 30	Eddie Johnson	Name
OPERATOR2	Text 30	John Pantelis	Name
COLLECTION_METHOD	Text 15	Continuous	"Continuous" (cells split out from event markers in the file) or "Individual" (cell data collected only for that location in the file)
RUN_NO	Number 2.0	1	Number of runs from 1-99
IRI_RUN(M-KM)	Number 2.2	*0.86*	Number from .01 to 99.99 in meters/kilometer
COMMENT	Text 50	Tested in the rain	Comment on the testing or data extraction for this data

For more information:

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