

FSAE TIRE TEST CONSTORTIUM DVD

From: Edward M. Kasprzak, FSAE TTC Co-Director
To: FSAE TTC members
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This document describes the contents of the DVD, provides a guide to the tests and acknowledges the people and organizations who have made this effort possible.

I. Acknowledgements

The FSAE Tire Test Consortium (FSAE TTC) has been founded, organized and lead by three Co-Directors:

Edward M. Kasprzak, University at Buffalo
Dr. Bob Woods, University of Texas, Arlington
Denny Trimble, University of Washington

My personal thanks to my co-directors for all their time and hard work.

The FSAE TTC received support from the following people and organizations:

Doug Milliken—FSAE Judge and Vice President of Milliken Research Associates. Doug Milliken continues to independently oversee the FSAE TTC finances and has contributed considerable time and effort to the consortium—above and beyond the call of duty. He has also donated a model of the data (MRA Nondimensional Tire Model), which is included on this DVD.

Mike Stackpole—Stackpole Engineering Services. Mike Stackpole has donated a Pacejka '96 model of the data, included on this DVD.

The Goodyear Tire and Rubber Company donated 6 tires of each construction and shipped them to Calspan at no cost to the FSAE TTC.

Hoosier Racing Tire also donated 6 tires of each construction and shipped them to Calspan at no cost to the FSAE TTC.

Calspan Tire Research Facility (TIRF). Thanks to Dave Gentz, George Tapia, Sam Pugliese and everyone at Calspan for making this tire test possible. Calspan entered this project with a “What can we do for the Formula SAE students?” attitude. They were easy to negotiate with and gave the consortium a substantial price break (they didn’t turn a profit on this project). Everyone worked just as hard on this

project as they do with their corporate and professional racing customers, and the staff went out of their way to accommodate FSAE students who attended the test. The Calspan Tire Research Facility is a top-notch operation—display your Calspan decal with pride.

II. Guide to the Tests

The FSAE TTC tests at the end of July 2005 were given Calspan TIRF project number “1051”. You will see this number throughout the data files.

Most of the data on this DVD is referenced by “run number”. Each time a new tire or test sequence is started on the testing machine at Calspan TIRF a run number is assigned, starting with “1” at the beginning of a project. Our project includes runs 1-21. Runs 1, 2 and 11 do not have data supplied since they were either tests to check the equipment or tests where a mistake was made in running the test.

As a result, a typical output file might be named “1051run3.dat”, which is the third run (test) of our project.

The following table relates run numbers to the tires tested:

Test	Tire	Test Type
Run 3	Goodyear 20x7-13 -- Tire 19	Lateral Force I
Run 4	Hoosier 20x6-13 -- Tire 7	Lateral Force I
Run 5	Hoosier 20x7-13 -- Tire 13	Lateral Force I
Run 6	Goodyear 20x6.5-13 -- Tire 25	Lateral Force I
Run 7	Goodyear 20x7-13 -- Tire 20	Lateral Force II
Run 8	Hoosier 20x6-13 -- Tire 8	Lateral Force II
Run 9	Hoosier 20x7-13 -- Tire 14	Lateral Force II
Run 10	Goodyear 20x6.5-13 -- Tire 26	Lateral Force II
Run 12	Hoosier 20x6-10 -- Tire 3	Lateral Force II
Run 13	Hoosier 20x6-10 -- Tire 4	Lateral Force I
Run 14	Goodyear 20x6.5-13 -- Tire 27	Longitudinal Force, 12 psi
Run 15	Goodyear 20x6.5-13 -- Tire 27	Longitudinal Force, 8 psi
Run 16	Hoosier 20x6-13 -- Tire 9	Longitudinal Force, 12 psi
Run 17	Hoosier 20x6-13 -- Tire 9	Longitudinal Force, 8 psi
Run 18	Hoosier 20x7-13 -- Tire 15	Longitudinal Force, 12 psi
Run 19	Hoosier 20x7-13 -- Tire 15	Longitudinal Force, 8 psi
Run 20	Goodyear 20x7-13 -- Tire 21	Longitudinal Force, 12 psi
Run 21	Goodyear 20x7-13 -- Tire 21	Longitudinal Force, 8 psi

Note: We had planned to test seven constructions. Goodyear did not have any of their 10” tires in stock and did not plan on producing any for the next few months. We tried to obtain tires from Avon, but they were not as easy to work with as Goodyear and Hoosier. We still have one day of testing remaining on our contract with Calspan TIRF. Our hope is to test these tires sometime in the fall, bringing the total to 7 constructions. Of course, you will receive the data when the final day of testing occurs.

The Test Types are as follows:

Lateral Force I:

- Static (non-rolling) spring rate test on brand new tire
- Dynamic (rolling) spring rate test on brand new tire. Speed at 25 mph for the rest of the test.
- Tire Break-in. Oscillation in slip angle and inclination angle for appx. 3 minutes.
- Conditioning Sweeps. Two steers to large slip angles at 250 lb. load to finish tire break-in.
- Dynamic spring rate test on tire after break-in.
- Slip angle sweeps at various loads and inclination angles, 12 psi., 0 slip ratio.
 - Inclination angles: 0, 1, 2, 3, 4 deg.
 - Loads: 350, 250, 150, 50, 450 lb.
- Post-test dynamic spring rate (worn tire).

Lateral Force II:

- Static (non-rolling) spring rate test on brand new tire
- Dynamic (rolling) spring rate test on brand new tire. Speed at 25 mph for the rest of the test.
- Tire Break-in. Oscillation in slip angle and inclination angle for appx. 3 minutes.
- Conditioning Sweeps. Two steers to large slip angles at 250 lb. load to finish tire break-in.
- Dynamic spring rate test on tire after break-in.
- Slip angle sweeps at various loads and pressures, 0 deg. inclination angle, 0 slip ratio.
 - Pressures: 8, 10, 12, 14, 16 psi.
 - Loads: 350, 250, 150, 50, 450 lb.
- Dynamic spring rate test for every pressure performed between slip angle sweeps
- Post-test dynamic spring rate (worn tire).

Longitudinal Force:

- Tire Break-in. Oscillation in slip angle and inclination angle for appx. 3 minutes.
- Conditioning Sweeps. Two cycles to large slip angles at 250 lb. load to finish tire break-in.
- Slip ratio sweeps at various loads, 12 psi, 0 slip angle
 - Loads: 350, 250, 150, lb.
 - Inclination Angles: 0, 2, 4 psi
- Slip ratio sweeps at various loads, 8 psi, 0 slip angle

- Loads: 350, 250, 150, lb.
- Inclination Angles: 0, 2, 4 psi
- Slip ratio sweep at 250 lb. to very large \pm slip ratio (almost locked, spinning)

III. DVD Contents

The contents of the DVD are now listed. This list is arranged according to the folders on the DVD.

Top Level

- PDF describing the contents of the DVD
- PDF containing the text of the FSAE TTC website as it stood when you registered
- PDF stating the terms of use of this DVD's contents. *Read this document carefully.*
- Excel spreadsheet of summary tables provided by Calspan

The “Summary Tables” spreadsheet is provided by Calspan. It contains a list of the runs, run conditions and tires used for the tests. Tables of “reduced parameters”, including tire spring rates and cornering stiffnesses, are provided. Tire carcass temperature measurements, taken with a probe immediately following the end of each test, are reported. Tread depth measurements are also provided—the tires showed little wear during testing.

fromCalspan

- A cover letter describing what was provided to the FSAE TTC (all contents appear on this DVD)
- Calspan TIRF logos (to make your own decals)
- Command files for the tests
- The TIRF website
- Reference documents on TIRF capabilities

Currently the TIRF website is being absorbed into a reworked Calspan website and is not available on the internet. The website included still shows the logos of their previous name, Veridian.

fromMillikenResearchAssociates

- A cover letter describing the contents provided by MRA—please read this for more information
- Five .mat (Matlab) files containing MRA Nondimensional Tire Model coefficients
- Two .p (Matlab) files containing the MRA Nondimensional Tire Model expansion
- One .m file which shows how to call the expansion routines

fromStackpoleEngineeringServices

- A single PDF containing the coefficients for Pacejka '96 models of the measured data, a statement of model equations and a discussion of the raw data.

RawData_____

Four folders, each containing raw data files in the following formats:

- ASCII (plain text, space delimited), Metric
- ASCII (plain text, space delimited), USCS
- ASCII (plain text, space delimited), Mixed ...used by Stackpole Engineering Services
- Matlab (.mat format), USCS

TestVideos

Video of each run is provided. Files are labeled by their run number. Run 3 contains the entire warm-up sequence. Subsequent videos begin near the end of the warm-up sequence, just before the conditioning sweeps. For the longitudinal (drive/brake) runs the video starts at the conclusion of the conditioning sweeps.

Used Tire Photos

Two photos were taken of each tire after it came off the tire testing machine, one head-on and the other at 3/4 view. While the file names are not descriptive, the tire number is visible in each photo.

IV. Questions/Comments

Please direct your questions/comments to Edward M. Kasprzak, kasprzak@localnet.com