THE DRAG SLED VERSUS NEW TECHNOLOGY: A VALUABLE INVESTIGATIVE TOOL, OR A DINOSAUR THAT HAS MET ITS TIME?

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Introduction

Palm Beach County is the largest of the sixty-seven counties in the state of Florida, the largest county east of the Mississippi. A geographical area of some two thousand square miles with a rising population of better than one million, Palm Beach County has recently earned a dark distinction as an area ranking third in the nation for traffic fatalities. As such, Palm Beach County consistently scores better than two hundred traffic fatalities per year.

Law enforcement agencies within incorporated (city) areas of Palm Beach County have traffic homicide units tasked with the investigation and reconstruction of fatal traffic crashes that occur within their respective jurisdictions, as does the Florida Highway Patrol for Interstate 95, the Florida Turnpike and other county locations. The Palm Beach County Sheriff's Office has an eight-member traffic homicide unit responsible for the biggest piece of the pie, the unincorporated areas of the county.

Sergeant Kerry Fleming and Investigators Matthew King and David Rander, the authors, are either former or current members of the sheriff's office traffic homicide unit. During a three year period, we conducted a series of tests at a number of Palm Beach County collision sites. The intent of this writing is to share with the reader the results of the authors' study, the methodology and reasoning behind the testing, and conclusions and suggestions on the use of the drag sled as a result of the study.

The Dilemma

On February 7, 2003, a group of renowned accident reconstruction experts, Wade Bartlett, Al Baxter, Ed Livesay and Bill Wright, conducted drag sled testing in Palm Beach County. The test subjects were comprised of law enforcement traffic investigators and two assistant state attorneys from the traffic homicide division.

Students were teamed in groups of two or three. The students were given instruction as to drag sled pull technique. Each team was assigned a drag sled. Each team member rotated his or her turn between five pulls of a sled and the reading and recording of team member pulls. Values were obtained from a number of site locations and surfaces (i.e., asphalt, wet asphalt and concrete). Accelerometer values via a G-Analyst or Vericom 3000 or both were obtained at each site.
The conclusion of the test efforts were disappointing.

A disparaging range of test values coupled with the test scenarios selected by the organizers failed to validate, or invalidate, the use of the drag sled. Specifically, the issue of proper training versus equipment prevailed as the dilemma at day's end.

The History of the Drag Sled

The determination of a drag factor is one of the most critical issues of a traffic crash investigation and/or reconstruction. Test skidding had been the accepted method of obtaining a drag factor for many years but, was not without accuracy problems.

Primarily, the determination of the speed of the test vehicle at the instant the braking system locked the vehicle's wheels. Additionally, determination of the actual distance traveled by the test vehicle's center of mass is also problematic.

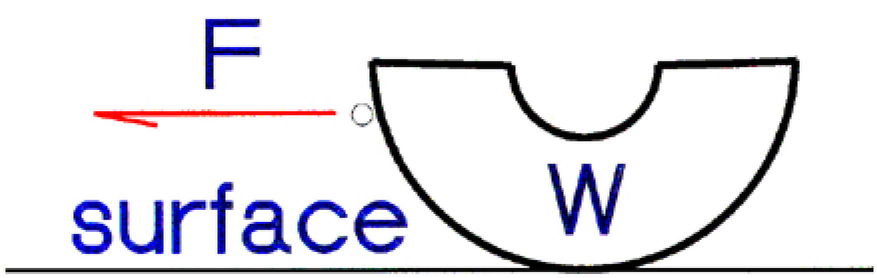
The drag sled was first introduced as a patent in 1965 by Hartwig Kummer, a Penn State University physicist. The drag sled offers traffic crash investigators a safe and convenient method of estimating drag factors in the field. It can be used on a variety of surfaces. The drag sled is constructed from materials which are commonly available to the investigator. Considerations must be given to materials utilized in the assembly of a drag sled. Several articles have been published over the years concerning construction of drag sleds/ drag tires.

The primary expense is the cost of a scale from which the static weight of the drag sled and the force (pounds of pull) is measured. The drag sled should always be weighed and pulled with the same scale. The scale can be certified for accuracy but, this is not a necessity as any inaccuracy will be the same percentage for the weight of the drag sled and the force (pounds of pull) required to move it over the test surface.

Pulling the drag sled along the surface being measured at a steady pace, note the pounds of pull required to keep the drag sled moving, as displayed on the scale. Be certain to keep the scale level in relation to the surface being measured. It is not necessary to adjust the drag factor for surface grade or super elevation when a drag sled is utilized upon the actual surface and in the direction the subject vehicle skidded.

Example:

Tire weight 47 pounds
Pull = 30 pounds
f = Force/Weight or f = 30/47
f = 0.63



The drag sled has now become the subject of criticism as it can not completely replicate the dynamics of a skidding vehicle. But, does this mean that the drag sled has reached extinction?

A Common Sense Approach

Over a three-year period, the authors conducted tests on different roadway surfaces at actual Palm Beach County collision sites to include damp, wet and dry surfaces. All participants in the study were instructed in pull and reading techniques of the drag sled and scale prior to testing as follows: The person pulling the sled was instructed to be outstretched at the beginning of the pull to ensure a fluid and steady pull. Reading or spotting (visually identifying the needled area of the scale) the static value was encouraged.

The following are results of two such tests utilizing the Vericom 2000, G-analyst and the drag sled. These examples and results are representative of the cumulative testing period:

On September 15, 2000, the authors conducted skid tests utilizing the Vericom 2000 against the drag sled. The test site was located at 1500 South Federal Highway. The first test conducted was with the Vericom 2000 on a damp asphalt surface at 11:00 p.m. with partly cloudy skies and light rain. The following are results from each test skid utilizing a 1996 Chevrolet Caprice, absent ABS braking which was disabled by the authors:

1. The first skid was conducted at 51 mph over a distance of 172 feet for a total time of 4.54 seconds. The peak was 0.59 and the average was 0.51.

2. The second skid was conducted at 48 mph over a distance of 154 feet for a total time of 4.25 seconds. The peak was 0.62 and the average was 0.52.

3. The third skid was conducted at 47 mph over a distance of 143 feet for a total time of 4.11 seconds. The peak was 0.57 and the average was 0.52.

4. The fourth skid was conducted at 48 mph over a distance of 145 feet for a total time of 4.08 seconds. The peak was 0.62 and the average was 0.53.

5. The fifth test was conducted at 46.9 mph over a distance of 134 feet for a total time of 4.00 seconds. The peak was 0.61 and the average was 0.53.

The second method was with the use of the drag sled. The drag sled was pulled across the same surface and in the same direction. The weight of the sled was verified by the authors to be 47 pounds. The first test results were: F1=30, F2=31, F3=31, F4=31, F5=32. The total pulls (F1 – F5) averaged an F of 31. Applied to f = F/W, f = 0.65.

To better understand what our test results mean we need to apply them to an example problem. This will allow us to see, in speed, the differences between the Vericom 2000 and the drag sled.

A vehicle skids a distance of 150 feet, absent ABS braking, utilizing the following averages from the data provided by the Vericom 2000:

1. 0.51 S = [square root of] 30 • 150 • 0.51 = 47.90 mph
2. 0.52 S = [square root of] 30 • 150 • 0.52 = 48.37 mph
3. 0.52 Same
4. 0.53 S = [square root of] 30 • 150 • 0.53 = 48.8 mph
5. 0.53 Same

Utilizing the same example problem above with the data from the drag sled:

S = [square root of] 30 • 150 • 0.65 = 54.08 mph

The difference between the drag sled and the Vericom 2000 is 8.8% or six to seven miles per hour.

On August 16, 2001 the authors conducted another test utilizing the G-Analyst against the drag sled. The test site was located on Forest Hill Boulevard at the intersection of Richards Lane. The first test conducted was with the use of the drag sled. Three individuals were utilized to render three sets of results. The weight of the sled was verified by the authors to be 47 pounds. The three individuals pulled the drag sled in the same direction and across the same surface. The test was conducted on a dry asphalt roadway on a clear and seasonable evening. The following are test results from the drag sled:

The first individual yielded the following results: F1=35, F2=36, F3=35, F4=36, F5=36. The total pulls (F1 – F5) averaged an F of 35.6. Applied to f = F/W, f = 0.75.

The second individual yielded the following results: F1=35, F2=35, F3=34, F4=35, F5=36. The total pulls (F1 – F5) averaged an F of 35. Applied to f = F/W, f = 0.74.

The third individual yielded the following results: F1=36, F2=37, F3=36, F4=36, F5=36. The total pulls (F1 – F5) averaged an F of 36.2. Applied to f = F/W, f = 0.77.

The next test was performed on the same date after the completion of the drag sled pulls. A 1996 Chevrolet Caprice was utilized absent ABS braking. The vehicle was equipped with a G-Analyst and was tested in the same direction as the drag sled. The test was conducted at 45 mph and yielded an f of 0.77 at the plateau.

Again, to better understand what our test results mean we need to apply them to an example problem.

A vehicle skids a distance of 200 feet, absent ABS braking, utilizing the following (f) values from the data provided by the drag sled:

1. f = 0.75 S= [square root of] 30 • 200 • 0.75 = 67.08 mph
2. f = 0.74 S= [square root of] 30 • 200 • 0.74 = 66.63 mph
3. f = 0.77 S= [square root of] 30 • 200 • 0.77 = 67.97 mph

Utilizing the same example problem above with the data from the G-Analyst:

S = [square root of] 30 • 200 • 0.75 = 67.08 mph

This particular test yielded a one percent difference or one mile per hour.

One of the investigators in the Palm Beach County Sheriff's Office Vehicle Homicide Unit makes a practice of rounding down an averaged f value generated from the sled. For example, five pulls averaging a 0.78 would be rounded down to the nearest tenth (in this case a 0.70) thus giving a potential defendant the benefit of the doubt. He convincingly reasons that mach speed is mach speed so what difference can a couple of miles per hour make?

Benefits of a Drag Sled

While opponents of the drag sled view its value limited to that of a marine anchor, the authors beg to differ. A number of benefits are as follows:

1) Portability - Those of us presently or formerly involved in the law enforcement application of accident reconstruction can relate all too well with the chaos of a preliminary investigation…just too many tasks to do at a scene. Photographs, evidence collection, witness statements, the media, and death notifications stretch our priorities. The last consideration on our plates is coordinating the skidding of a car through our pristine scene at four a.m. to obtain a road surface value! A drag sled carried in the trunk of a cruiser on the other hand, is an efficient and non-time consuming way to obtain such a value.

2) Special Conditions - While the authors would not argue the value of accelerometers, conditions may warrant a value obtained during the initial investigation. How many of us have experienced a roadway dew at a particular early morning crash site…conditions difficult to replicate or find on any other given day. The portability of the drag sled affords its user the practicality to obtain a then and there value. One of the authors recently investigated an angular, two-vehicle collision whereby the post collision legs involved multiple surfaces which included a graded sod embankment and a concrete private driveway. None of us should dispute the inability to obtain accelerometer values from such surfaces.

3) Economical - Huh? Law enforcement agencies are not financially challenged, are they? How many departments agree to pay for tires and the maintenance of skidding a car (let alone the manpower and inconvenience to shut down a roadway). After all we're not talking about a "real crime," just an accident (the authors apologize for the sarcasm but you know where we're coming from). The economical benefits of a drag sled as opposed to that of a test car is a no-brainer issue.

4) Safety - Another consideration is that of a safety issue involving the skidding of a test car. Efforts must be made to properly secure the test site with enough personnel to ensure the safety of both the general public and that of the investigator(s) and personnel involved in the testing.

Conclusion and Opinion

The conclusions proffered by the authors, following testing and training seminars, is an unremarkable revelation that the drag sled is an accident reconstruction tool…and we preface tool. Manmade instruments have their limitations. Computers such as accelerometers, for that matter, should not be blindly regarded as unequivocal producers of fact.

Accident reconstruction computer software programs are excellent tools for the experienced and yet dangerous to those users who choose not to validate results with traditional number crunching methodology. A total station's degree of pinpoint precision is only as good as its user's proficiency and competency in the use of the mapping instrument and interpretation of evidence. Have you ever called a financial institution and spoke with a live person regarding an account query? If so, you've probably heard a response to your inquiry of something like "But the computer says…"

The drag sled, unlike other accident reconstruction tools, is not a widely manufactured product (although a variety of publications exist for the building of a sled). As such, a particular sled may

or may not prove reliable. The authors suggest that a user of a drag sled conduct their own testing of an individual sled, validated by alternative testing similar to that of the authors. The duration of testing and a sled's application in a specific case should be scrutinized and determined by the reconstructionist before placing the sled into service.
Even so, once validated, the authors profess to a periodic comparison of sled results with an accelerometer. And speaking of validation, what is so terribly wrong with comparing a sled's results with that of empirical data? How many of us have faced the scoffing of a defense attorney or opposing counsel in a deposition or courtroom over the use of empirical data? After all, did not empirical data originate from a collection of actual testing?

Whether one pulls a sled or skids a car, the values generated should be compared with other means or sources. The experience and conscientiousness of the investigator will dictate whether he or she will accept the values obtained or seek further validation.

An annual calibration of a time-tested drag sled is a recommendation of Al Baxter and shared by the authors. Al noted during the recent training seminar that weights and measures units of local transportation departments could accomplish this task for both the sled and spring scale. Al pointed out the condition of curing cement as an ongoing loss of moisture whereby weight loss will inevitably occur which needs to be kept in check through independent calibration.

Likewise the condition of spring scales also need calibration to ensure proper readings. Further, the authors recommend the marking of the popular brass tubular scales to assist with pull readings. The painting of the engraved numbers, gradients and pointer of a scale with a contrasting color and/or marking the side of the scale with tape can take the guesswork out of "spotting" readings. The authors, to date, have not found a reliable digital scale for drag sled application due to erratic sampling readings.

In conclusion, the authors urge everyone in the accident reconstruction community to carefully consider the value of the drag sled. With proper testing prior to actual case use, and continued and periodic validation supported by a regular calibration program, the drag sled is an invaluable tool in the workshop of today's accident reconstructionist.

Footnote: Authors Kerry Fleming, Matthew King and David Rander are also partners in a private endeavor, Precision Mapping & Research, Inc., in West Palm Beach, Florida. As an accident reconstruction group, the foundation of our company is the documentation of trace evidence through forensic mapping and aerial photography.