NON – LOCK FRICTION TESTING

Fall 2015

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CURRENT METHOD
LOCKED WHEEL

- **ASTM - E-274 Skid Truck**
  - **Measure Drag Force during Sliding Friction**
  - **Primary Sensor – Tire (grooved/ribbed)**
  - **Collect Average force values over 59 ft.* (1 sec.)**
  - **Total Test Sequence ~ 225 ft.***
  - **Water consumed - ~ 2 gal.**

*** = at standard test speed (40 mph)**

EQUIPMENT

E – 274 ISSUES

- Long averaging distance – lost detail
- Large sample spacing (typically 1056 ft.):
  - CAUSES:
    - Water consumption per test
    - Total test sequence time
  - RESULTS:
    - Lost tests at intersections etc.
    - Sections shorter that ¼ mile very difficult to test
    - Miss key pavement sections of concern:
      - Ramps, Sharp curves, Traffic control areas
- Measuring “locked” sliding friction

PLAN

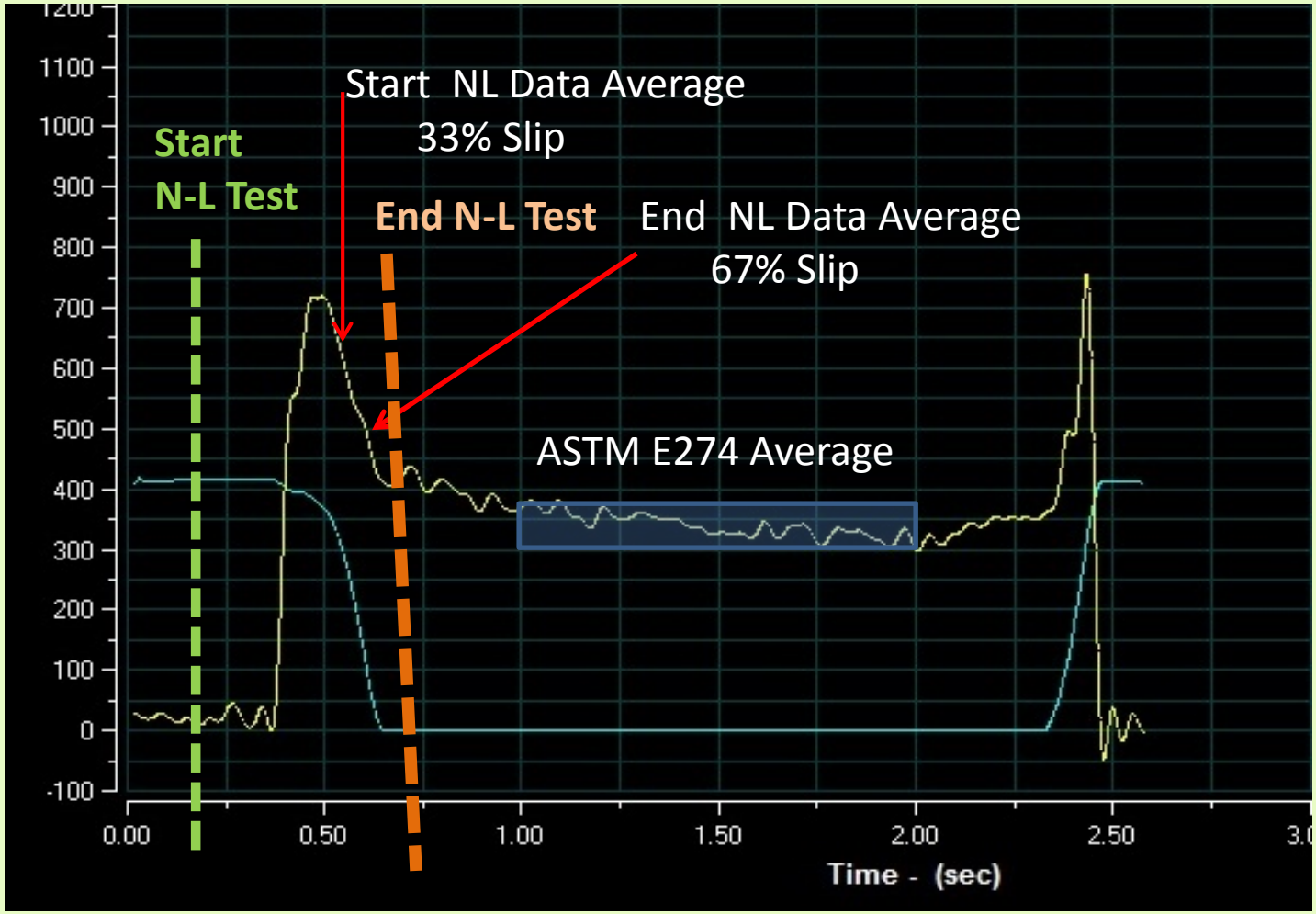
- **Apply the limited testing resources more effectively**
- **Collect a more representative sample**
- **Increase the size of the sample**
- **Functional test that more closely resembles the typical vehicle response (anti-lock brakes)**
- **Minimize the impact of tire structure properties**
- **Maintain focus on microtexture (ribbed tire)**

- ***Measure macro-texture separately (laser)***

RESULT – NL TEST

- Data averaging time of 0.1 to 0.2 sec (6-12ft.)
- Averaging between 33% and 67% “lock-up”
- Reduce total test time to under 1 sec
- Reduce water consumption to ~ 0.5 gal
- Routine sample spacing - 0.04 mi (211ft)
- Short routes - 0.02 mi. (106 ft)
- Projects ~ 0.01 mi. (53ft)

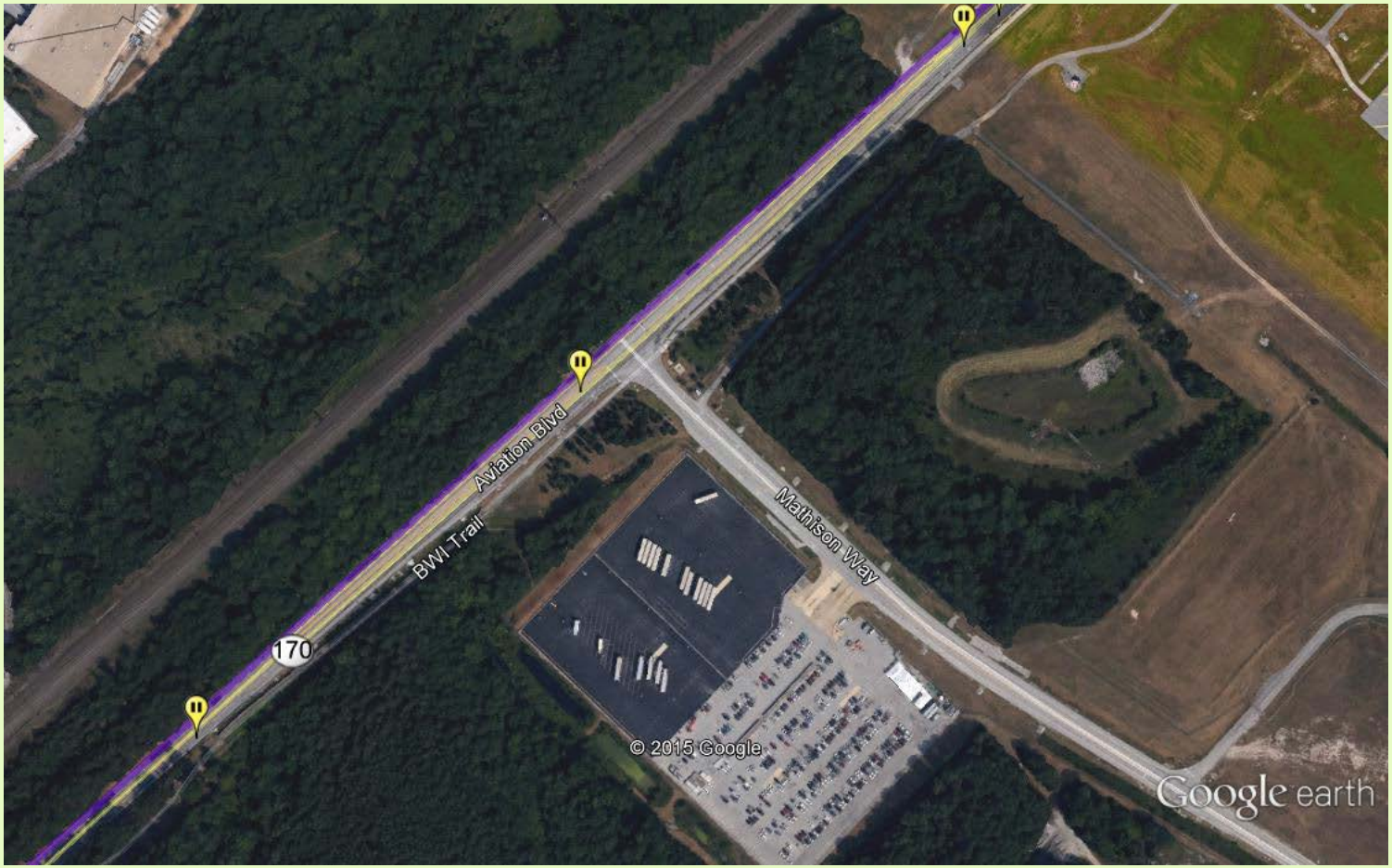
TEST SEQUENCE



ADVANTAGES

- More tests per mile (higher resolution data)
- Tests in critical areas (curves, intersections)
- Less water and tire wear per test
- Less impact from tire structure than other slip type tests
- Test is more representative of current vehicles with anti-lock brakes

TESTING @ 0.2 Miles



TESTING @ 0.04 MILES

EQUIPMENT

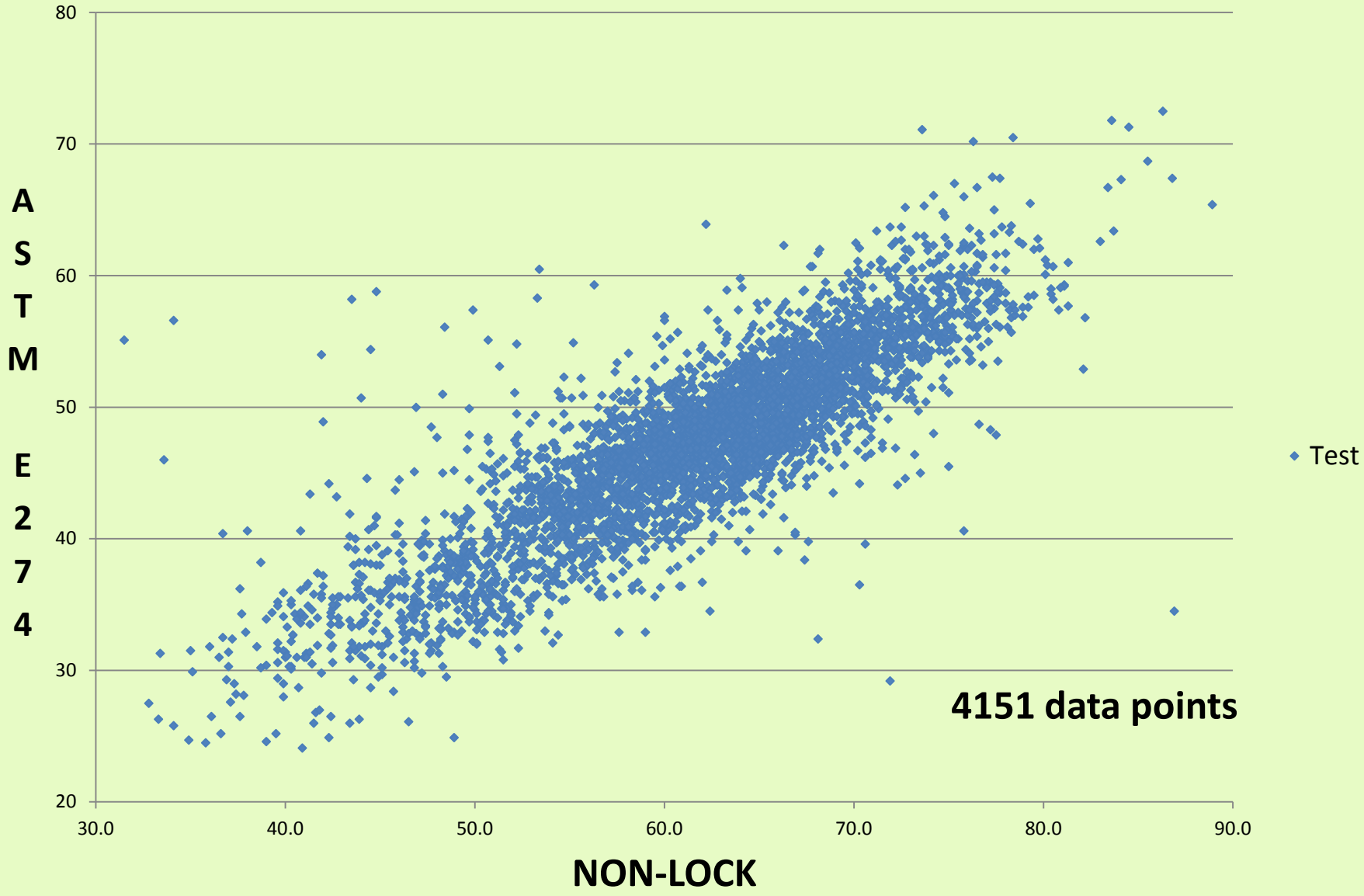
KEY IMPROVEMENTS

- Heavy duty brake calipers
- High output air compressor
- High output generator
- 1kHz data sampling rate
- Automatic load leveling
- Texture laser & GPS

SAMPLE DATA

- **Montgomery & Prince Georges Counties (widest range of friction values)**
- **Maryland state maintained roads**
- **Typical sample interval - 0.2 miles**
- **> 4000 test locations**
- **Vast majority asphalt pavement**

LOCK vs NON-LOCK



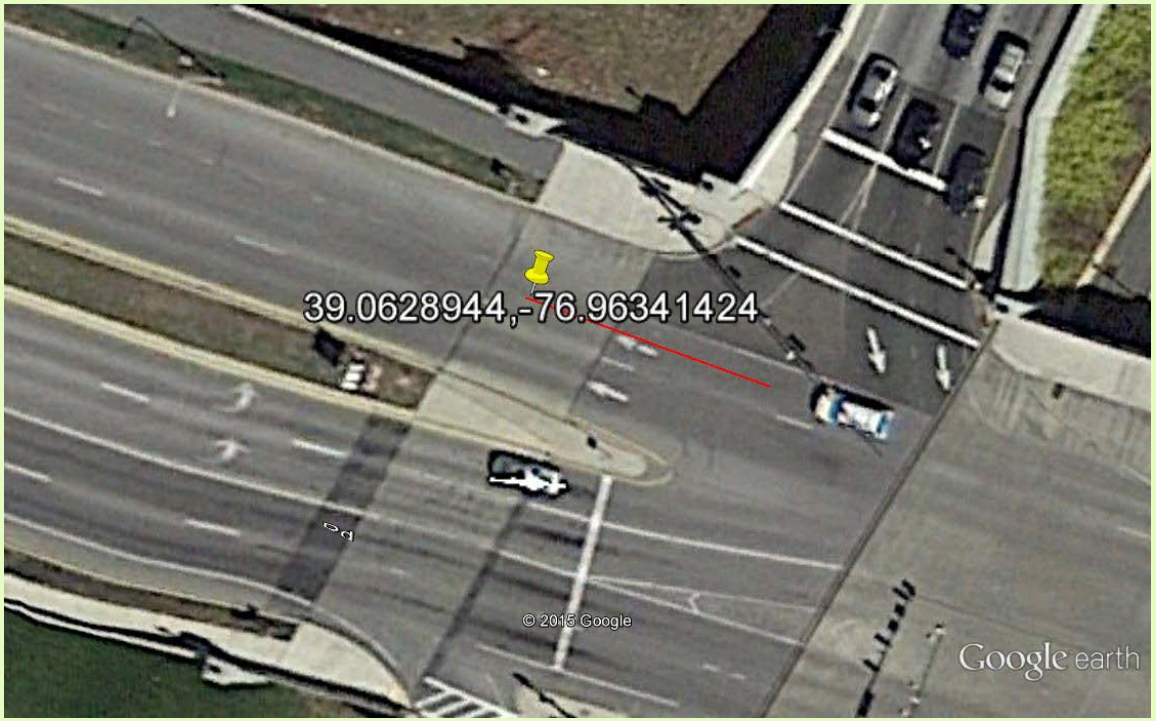
DATA FILTERING

- **Removed first:**
  - **Speed less than 20 mph**
  - **Water (gal/min) less than 60% speed (mph)**

- **Removed outliers: (highway discontinuities)**
  - **Expansion joints**
  - **Pavement markings**
  - **Railroad tracks**
  - **Patches**
  - **Bridges**

AN OUTLIER LOCATION

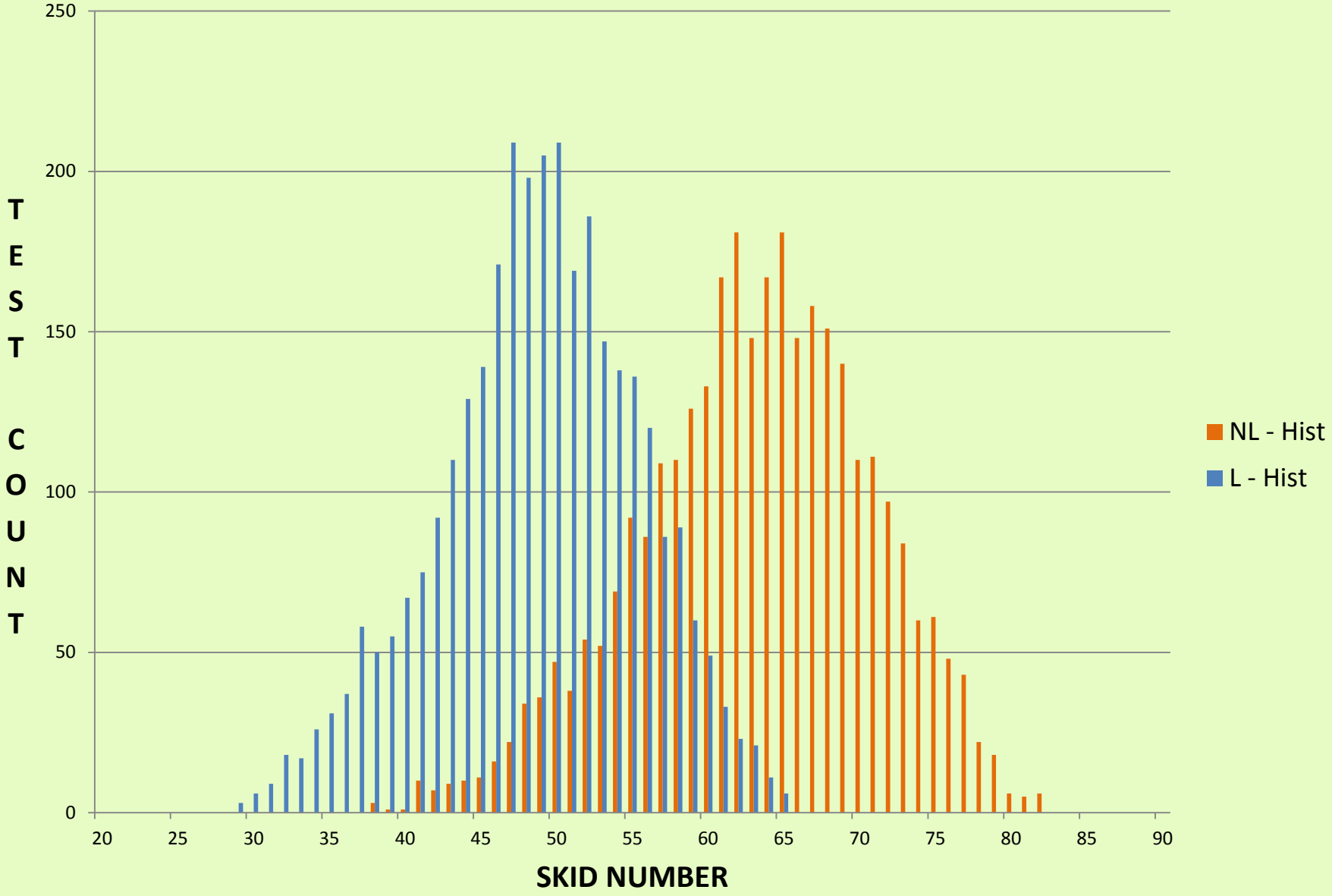
- **PAVEMENT DISCONTINUITY**



DATA FILTERING SUMMARY

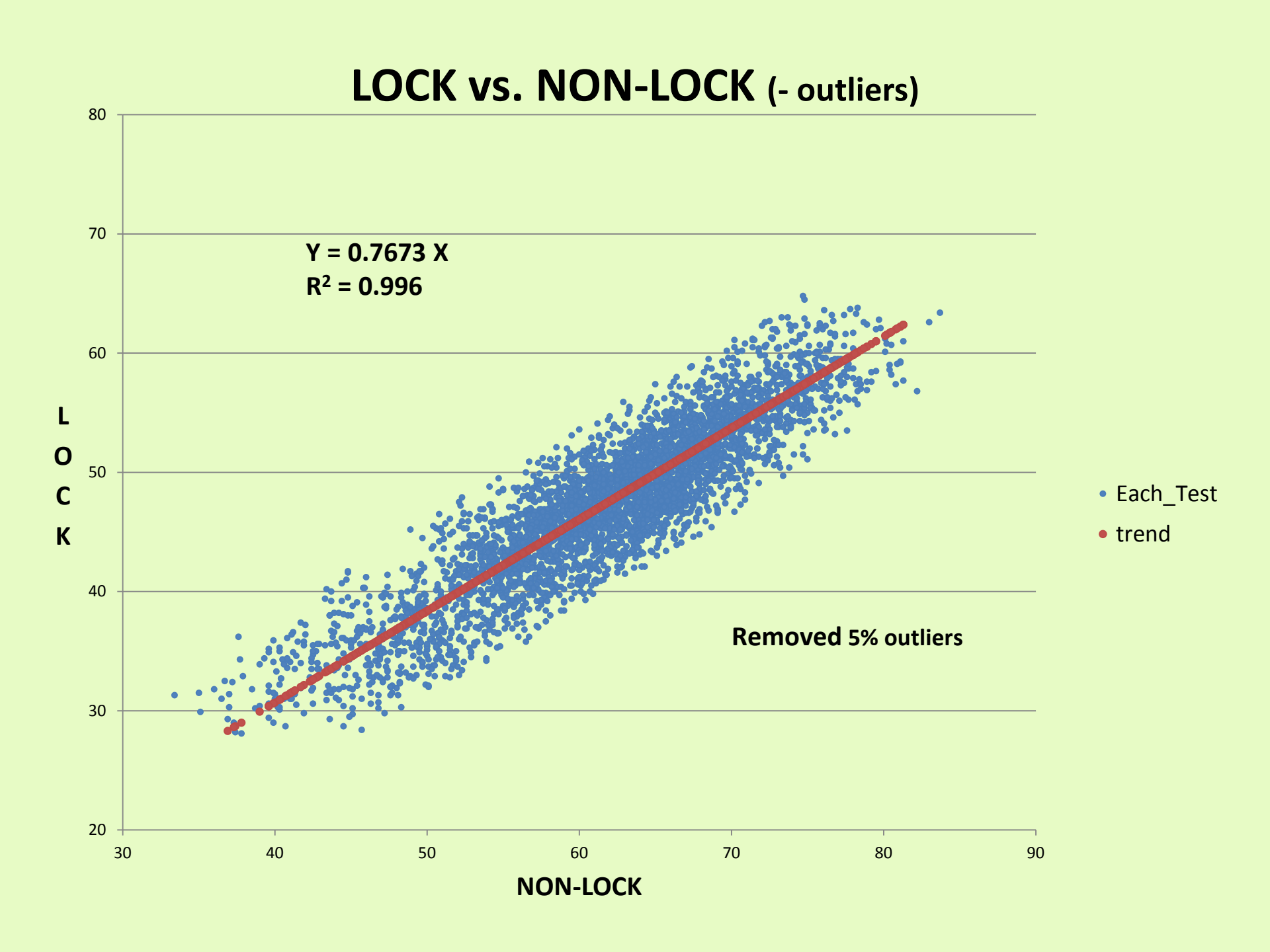
- **Total tests – 4563**
- **Bad tests – (s,w) 412**
- **Acceptable tests - 4151**
- **Deemed outliers - 191**
- **Remaining tests - 3960**

DATA DISTRIBUTION



DATA DISTRIBUTION

	N - L	Lock
Mean	62.24435	47.74793
Standard Error	0.135867	0.117658
Median	62.7	48
Mode	64.5	48.7
Standard Deviation	7.671346	6.643228
Sample Variance	58.84955	44.13247
Kurtosis	-0.0997	-0.15843
Skewness	-0.30811	-0.25061
Range	44.4	36.4
Minimum	36.9	28.1
Maximum	81.3	64.5


LOCK vs. NON-LOCK (- outliers)
Y = 0.7673 X
R2 = 0.996
Removed 5% outliers
LOCK
NON-LOCK
80
70
60
50
40
30
20
30
40
50
60
70
80
90
Each_Test
trend

NEXT STEPS

- **INTEGRATION OF TEXTURE DATA**
  - **More complete traction picture**
  - **May get appropriate factor for speed compensation**

- **INTEGRATION OF SPEED DATA**
  - **Data collection at 25-55 mph is a goal**

QUESTIONS?