Development of a Potable WIM System for Rural Roadways

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Weigh-In-Motion (WIM) System

- Measures static weights of moving vehicles
- Data consists of vehicle records composed of axle spacing, axle weights, and speed
- Provides most accurate classification among present technologies
- Primary MEPDG (Mechanical-Empirical Pavement Design Guide) input
- Primary input for freight estimation

Typical WIM system

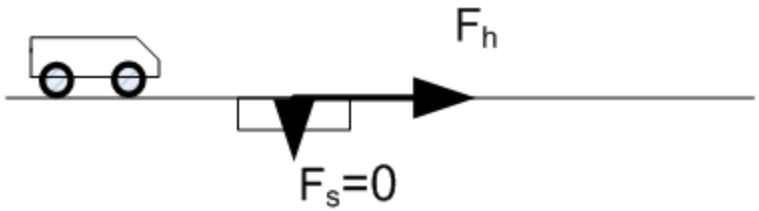
Need for Portable WIM

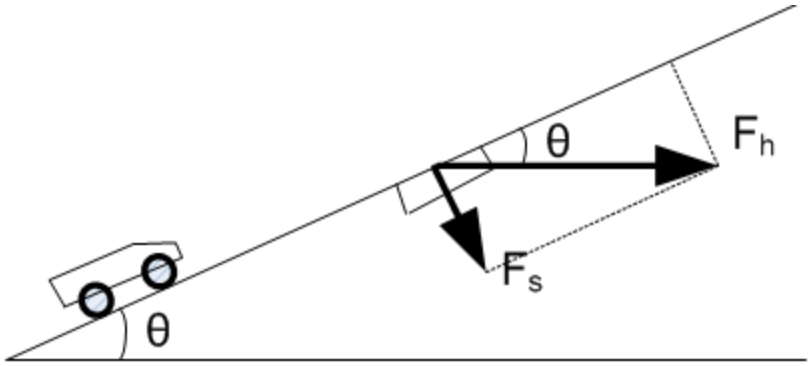
- Heavy truck volume on rural roads increased due to higher demands on agricultural commodities
- These rural roads need protection from overweight, i.e., needs weight monitoring
- Installing permanent WIM stations is expensive ($250K per site)
- Portable WIMs provide a low-cost solution of overweight monitoring for rural roads ($20K/unit)

Weigh-Pad (WPad) Based Portable WIM

MnRoad Test Setup

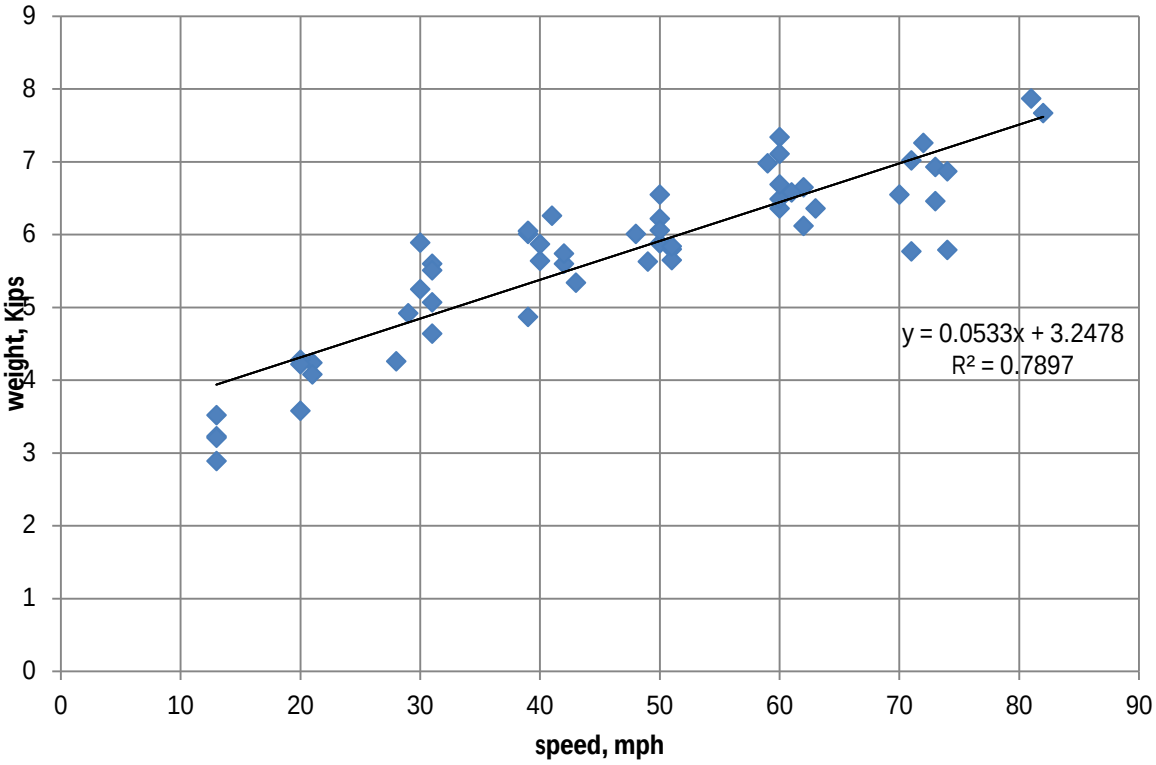
Speed Effect on Weight



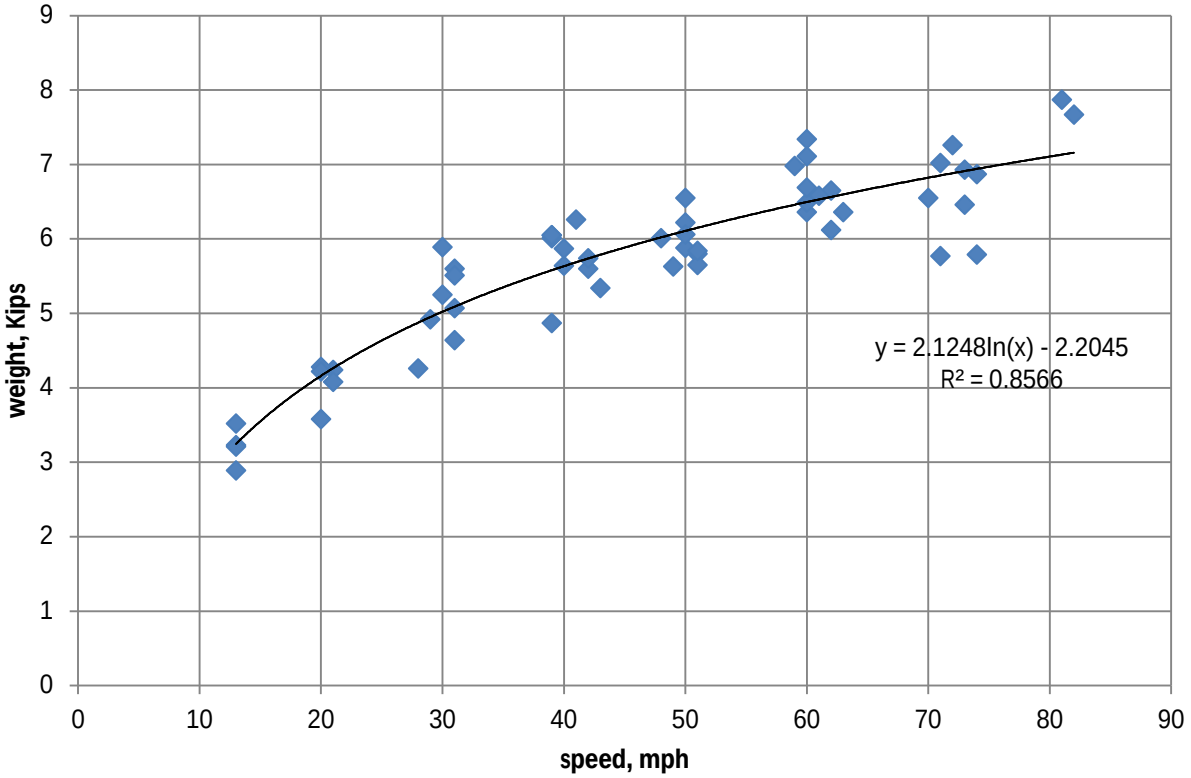


Speed Effect Test

Linear Regression



Log Regression



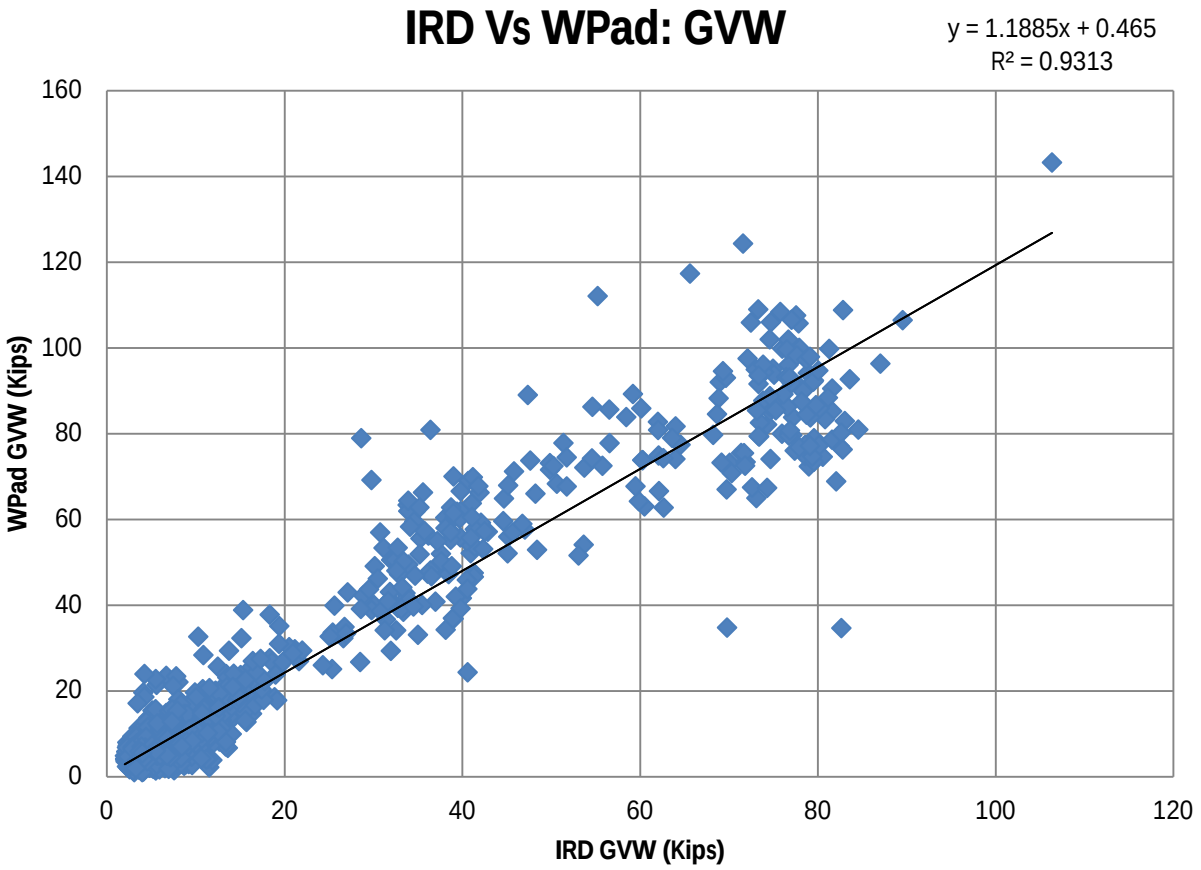
Cotton Test Setup

Setup: 15 min per lane

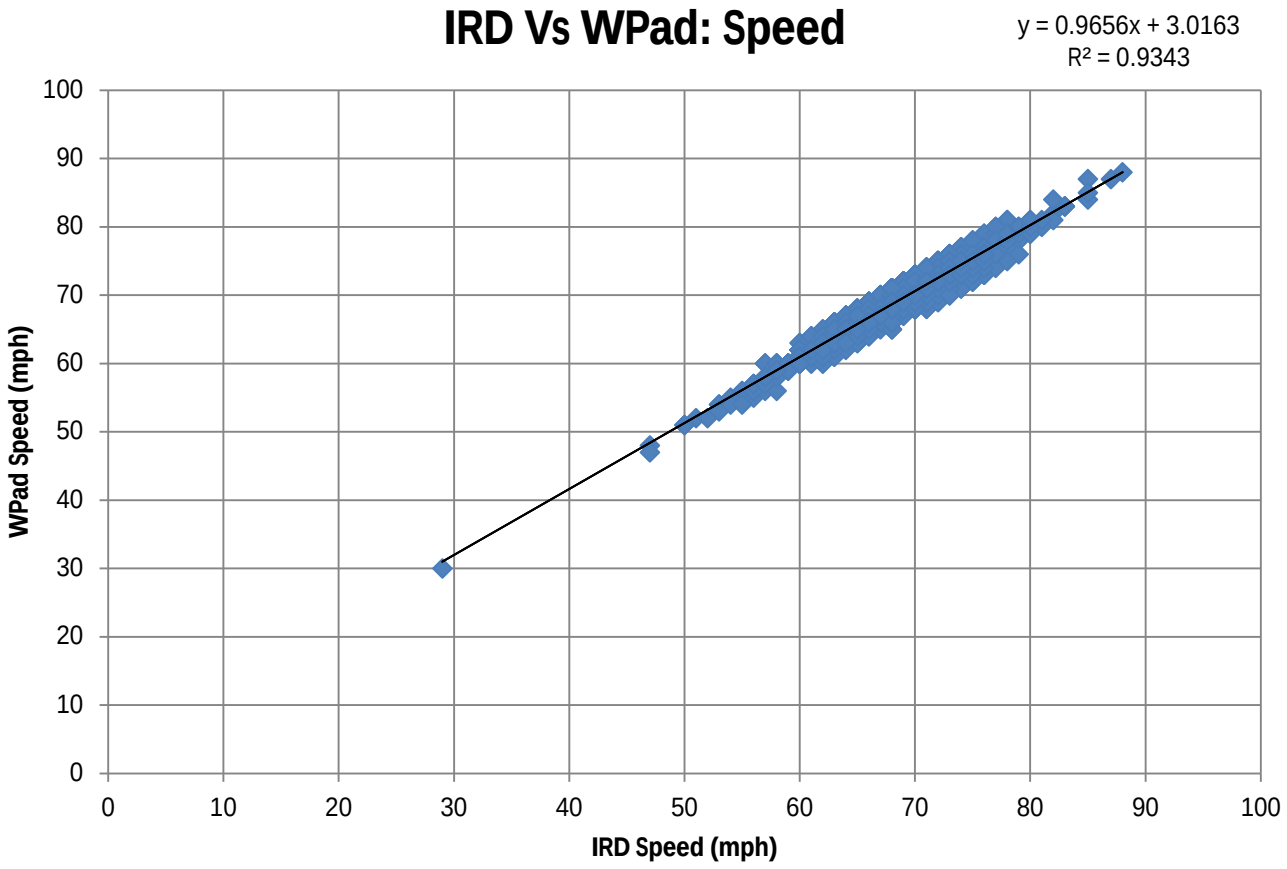
Removal: 7min per lane

After WPad Installation

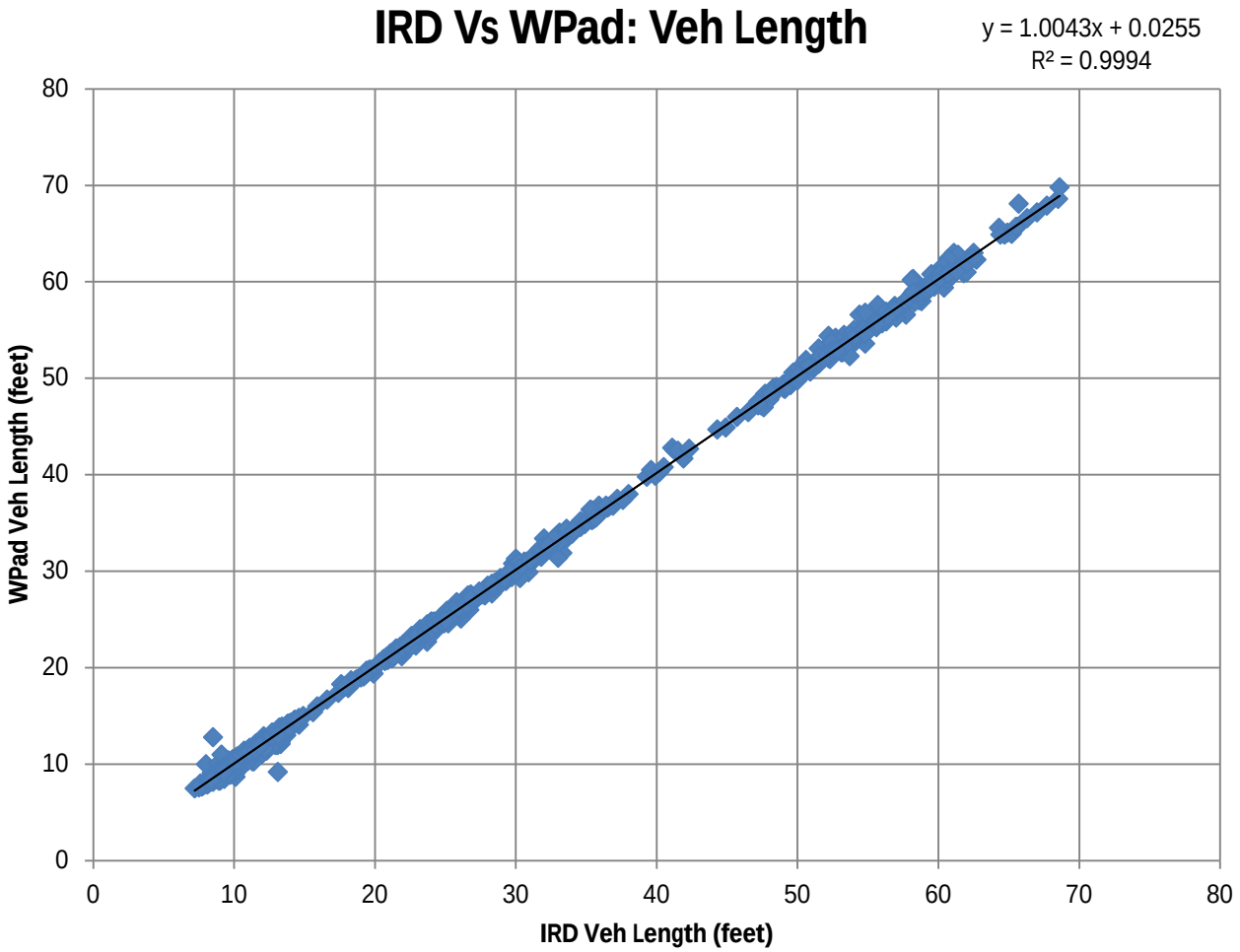
GVW Comparison



Speed Comparison



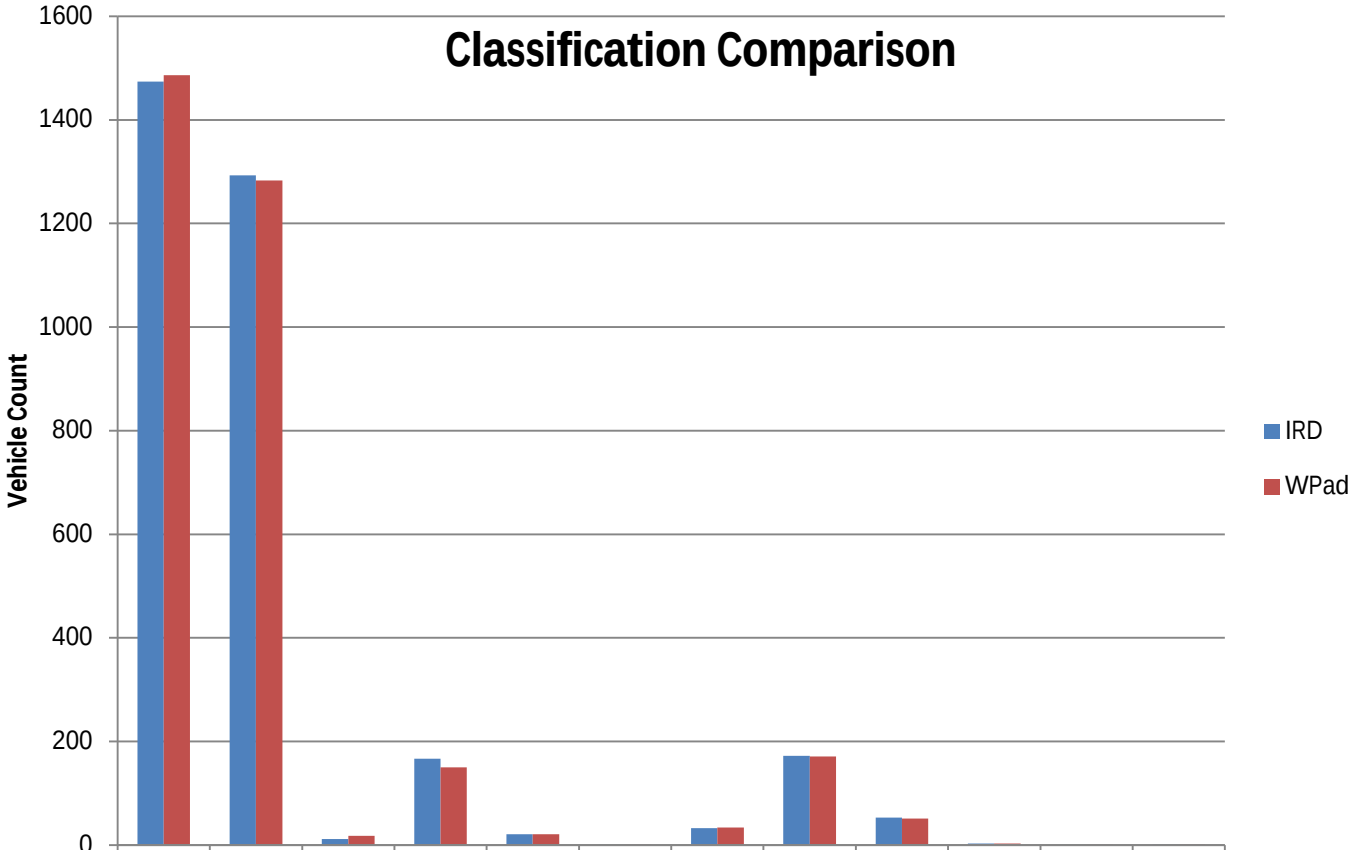
Vehicle Length Comparison



GVW Ratios

	GVW Range in Kips									
speed	0->10	10->20	20->30	30->40	40->50	50->60	60->70	70->80	80->90	90->
0->20 mph	0	0	0	0	0	0	0	0	0	0
20->30 mph	1.16x1	0	0	0	0	0	0	0	0	0
30->40 mph	0	0	0	0	0	0	0	0	0	0
40->50 mph	1.61x1	2.14x1	0	0	0	0	0	0	0	0
50->60 mph	1.34x71	1.4x12	1.3x1	1.57x2	1.62x1	1.33x2	1.13x2	1.1x2	0	0
60->70 mph	1.36x1506	1.23x139	1.45x19	1.43x66	1.37x29	1.4x15	1.18x20	1.16x61	1.04x16	1.35x1
80->90 mph	1.19x1138	1.09x70	1.31x2	1.34x9	1.26x5	1.01x1	1.53x2	1.18x16	0.93x5	0
90-> mph	0.95x18	0.37x1	0	0	0	0	0	0	0	0

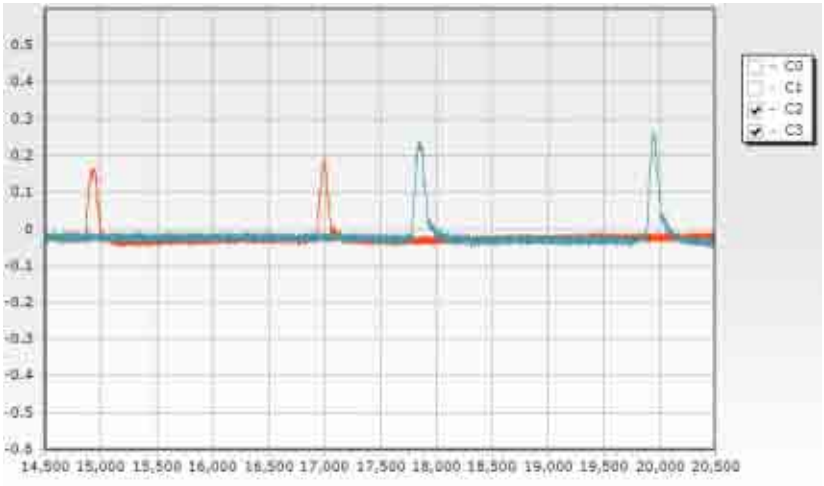
Classification Comparison

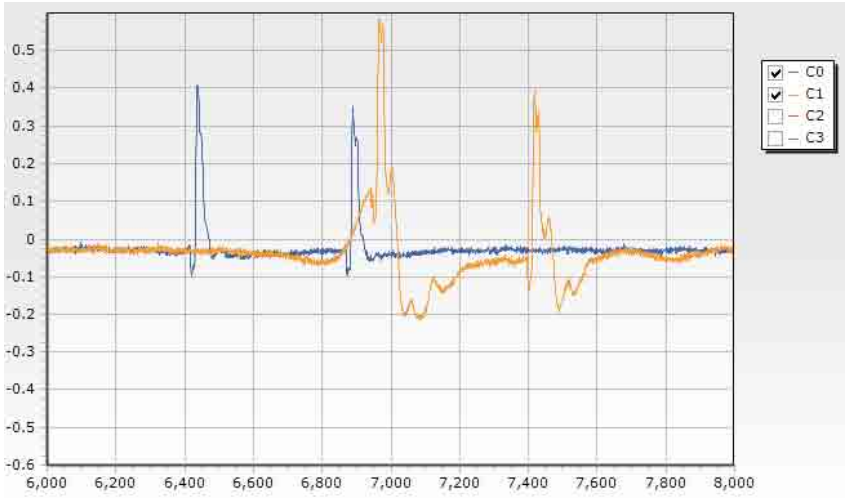


	c2	c3	c4	c5	c6	c7	c8	c9	c10	c11	c12	c13
IRD	1474	1293	12	167	21	1	33	172	53	3	1	2
WPad	1486	1283	18	150	21	1	34	171	51	3	1	2

Installation Problems

Sensor Vibration Effect





Observations

- Among speed, axle spacing, and weight, weight had most differences.
- Inconsistency in weight seems due to a wave effect of loads caused by vehicle suspension systems.
- Vibrations caused superfluous signals, causing computational error.
- Installation to minimize vibration is critical for the success of WPad.

Conclusion

- With a proper installation, WPad can provide a low cost solution for overweight violation of rural roads.
- The consistency was not as good as permanent stations but not as bad.
- Classification difference was less than 1%.
- Different types of the pad material could improve the consistency by reducing vibration.