TIRE WIDTH-BASED SCREENING AT A WIM PRECLEARANCE SITE

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Abstract

The addition of a Tire Anomaly and Classification System (TACS) that utilizes VectorSense tire footprint sensors to a Weigh-In-Motion (WIM) prescreening site enabled the ability to detect wide front tires as part of the commercial vehicle screening criteria. Identification of wide tires allows for the correct application of the weight regulations. It creates a fair screening and bypass program for all participants, including carriers that have chosen wide steering tires to operate more efficiently. Front-axle classification is a new development added for the first time in the Canadian province of British Columbia at the Terrace Weigh2GoBC Virtual WIM site operated by the province's Commercial Vehicle Safety and Enforcement (CVSE) agency. Vehicles with wide tires on the steering axle may have their allowed weight limits increased by as much as 3100/kg for the steering axle. Data from this site indicates that 6% of all commercial vehicles screened had weights above the standard steer axle weight limit but under the wide tire limit. Making those vehicles eligible for bypass improves the efficiency of CVSE operations as they can more accurately target inspection activity.

Keywords: WIM Data, WIM Sensors, Stress-In-Motion, Heavy Vehicles, Enforcement, Compliance

1. Tire-Width Screening Augmented WIM Site

Traditional CVO Preclearance systems assess weight compliance with local laws on vehicles' nominal axle count, assuming typical tire type and configuration. This approach leads to operational challenges in areas with a high frequency of unique vehicle configurations, particularly where tire widths or types are attached to vehicle compliance. At these locations, a high number of vehicles are unable to be automatically assessed for compliance leading to the manual involvement of enforcement personnel. The addition of a Tire Anomaly and Classification System (TACS) that utilizes VectorSense tire footprint sensors adds the ability to detect wide base tires on steer axles at the Terrace, BC site. This allows for the correct application of the weight regulations and creates a fair screening and bypass program for all participants, including carriers that have chosen wide base tires for steer axles to be efficient in their operations.

1.1. Weigh2GoBC Project Background

The Weigh2GoBC program (Figure 1) in British Columbia, Canada, was developed to improve safety by ensuring vehicles are properly licensed and insured and that drivers comply with weight restrictions. The program also helps to reduce greenhouse gas emissions and congestion.

Figure 1 – Weigh2GoBC Inspection Station Locations (TranBC - CVSE)

1.2. Screening Efficiency

An objective of the Weigh2GoBC program is to conduct inspections as efficiently as possible. Stopping the same vehicles for inspection at multiple weigh stations across British Columbia's trade corridor is both inefficient and unnecessary. The Ministry of Transportation has calculated that each commercial vehicle that reports to a station takes an average of 10 minutes to be processed. With six stops along the main corridor, a vehicle would lose 60 minutes per trip. There is also an environmental cost to excess inspections, with increased fuel consumption averaging 0.5715 liters per inspection. (BC MoT, 2021)

To reduce the number of excess inspections, vehicles enrolled in the Weigh2GoBC program are equipped with an Automatic Vehicle Identification (AVI) ASTM v6 radio frequency transponder, which an AVI reader can read to uniquely identify vehicles. Using WIM and other sensor technology, commercial vehicle measurements are used to determine compliance, which may result in a warning or fine for a non-compliant vehicle but allows compliant vehicles to bypass subsequent inspections at other inspection station locations for a window of time.

1.3. Terrace B.C. Safety and Efficiency Considerations

The recently completed Weigh2GoBC site at Terrace, British Columbia, utilizes Weigh-In-Motion (WIM) technology to determine whether vehicles comply with the defined class/compliance scheme and vehicle dimension regulations. Vehicles are also checked for height, weight, and safety credentials at the Terrace Virtual Weigh Station site. Vehicles compliant with all regulations will be able to bypass inspection as they travel past other inspection stations for the next 24 hours.

The nature of the traffic at this site presented some problems with the use of weigh-in-motion alone to identify overweight vehicles for inspection. Logging trucks and other commercial vehicles from the mining and construction industries use the road and have different characteristics from typical Canadian heavy goods vehicles used for long-haul transport. They consistently carry heavy weights for their class and use wide-base tires on their steering axles (Figure 2).

Figure 2 – Typical Commercial Vehicle with Wide-Base Tires on the Steer Axle

If screened by the Weigh2GoBC system using the same criteria as typical vehicles, the vehicles equipped with wide-base tires on their steering axles would be directed to report based on their weights. However, the ministry determined that identifying their tire type and allowing those vehicles that use wide-base tires a higher weight tolerance would improve the bypass rate without resulting in increased road damage.

Research on the effects of wide-base tires on flexible pavements has indicated that the tires can carry the higher weight/tire without having an overall negative impact. The tires' load distributions are comparable to dual tires and tests on flexible pavement with a range of loads and temperatures showed that using wide-based tires on towed, driven and steering axles would

provide an overall efficiency benefit and cost savings even when factoring in greater damage compared with those axles equipped with dual tire assemblies. (Al-Qadi & Elseifi, 2007)

2. Tire Footprint Sensing and Weigh-In-Motion System

Typically, North American regulations set maximum available loads based on force (N)/width (mm) of the vehicle tires, but agencies do not normally measure actual tire widths in their pre-clearance or e-screening systems. Integrating high-speed strain-motion sensors with the WIM system allows BCWeigh2Go to adjust maximum weights based on the tire width.

TACS provides tire anomaly detection and advanced vehicle classification with tire width. Steer axle classification is a new development added for the first time at the Terrace Weigh2GoBC site. The new functionality is made possible by the in-road VectorSense tire footprint sensor technology that can detect tire width with a high degree of accuracy. When a tire rolls over a VectorSense sensor, thin slices of the tire contact are measured thousands of times per second. These measurements allow for the construction of contact pressure profile with the tire width and location for each tire on a vehicle. Vehicles with detected wide base tires on the steer axle will be given a higher weight allowance on that axle. Although Vectorsense is capable of WIM, in this case, the tire information is combined with weight detection by Single Load Cell (SLC) WIM scales that meet the ASTM E1318-09 Type III specification (Figure 3). Vehicles that would previously be flagged on the weight of the steer axle alone may, in fact, be compliant with regulations. This will enable more efficient screening at this site and benefit bypass decision accuracy in the province.

Figure 3 – SLC WIM Scales and VectorSense Sensors at Terrace, BC Virtual Weigh Station

2.1. Vehicle Screening

Custom operator software was developed for BCWeigh2Go, which displays vehicle weights and any violations such as exceeding Gross Vehicle Weight (GVW) or axle group weights (Figure 4). Weight limits for the steer axle are automatically adjusted if the tire width measured by the VectorSense sensors indicates that the weight limit should be increased.

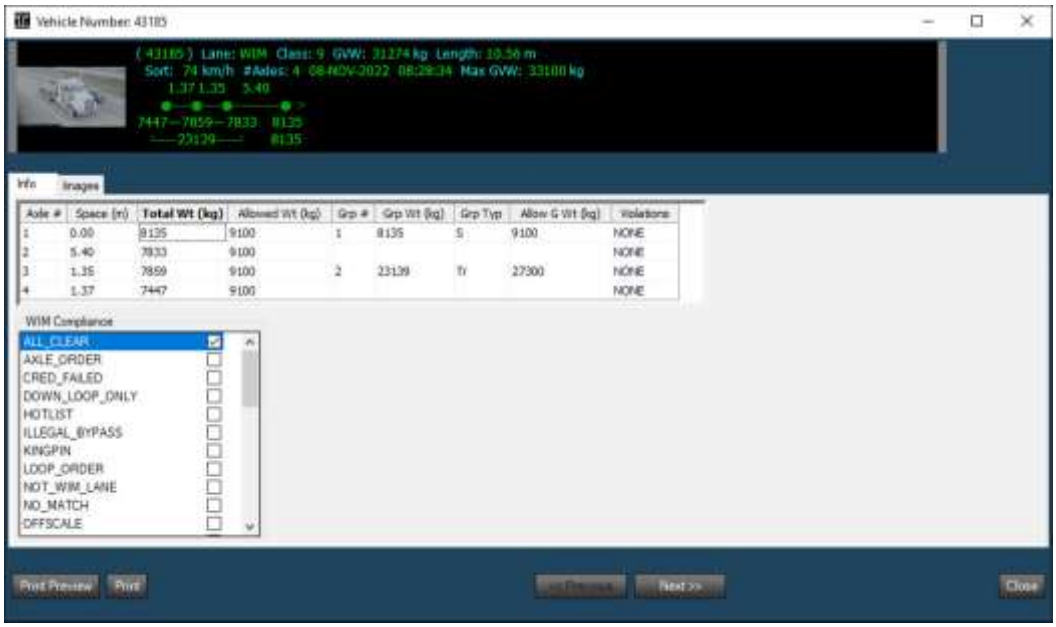

Figure 4 – Vehicle Record Displaying Weights and Screening Information

2.2. Tire Anomaly Detection

At Terrace, TACS performs a valuable role, making the roads safer in this mountain region for the driver, carrier, and the traveling public. TACS screens commercial vehicles to identify those vehicles which are unsafe due to missing or under-inflated tires. TACS supports the real-time screening of commercial vehicles at highway speeds of up to 160 km/h. Using the contact pressure profile of each tire on an axle and comparing to other tires on the same axle, TACS identifies flat, missing, and underinflated tires as well as mismatched diameter tires on dual tire sets — all potentially significant safety problems. TACS flags underinflated tires that could become safety issues in the near future and that are already less efficient.

2.3. Sensor Data and Weight Limit Adjustments

Data from the sensors is collected continually, and reporting includes counts for bypass eligibility based on the site criteria. Depending on the vehicle classification, the steer axle weight limits are increased by as much as 3100 kgs/axle for wide base tires, which have a tire width greater than the normal tire width of 275 mm. In the 3 months of operation, the system detected 27,323 commercial vehicles. TACS, using the Vectorsense sensors, has identified 3,544 commercial vehicles that had wide base tires on the steer axle. The weight limits were increased on 1699 vehicles with steer axle weights exceeding normal steering axle weight limits but not over the adjusted wide tire weight limit for steering axles. Percentages of vehicles meeting each screening criteria are shown in Table 1. These vehicles would have been flagged with an overweight violation based on the steer axle weight for normal tires, and this flag was removed, allowing them to pass this weight check.

Table 1: Site Statistics (July 31 to November 8, 2022)

Vehicle Screening Characteristic	Percentage
Commercial Vehicles with wide-base tires on steer axles	13%
Trucks with wide-based tires on steer axles that have a weight above the weight limit for normal-width steer axle weight limit but under the wide tire limit.	6%
Commercial Vehicles with identified Tire Anomalies	0.8%

3. Conclusion

The ability to screen based on a combination of tire types and weights further improves safety, improves the efficiency of operations, and reduces congestion by more accurately screening for vehicles meeting overweight criteria. This system achieved better screening on 13% of the traffic by checking the width of the tires on the steering axles. This helps British Columbia's Commercial Vehicle Safety and Enforcement (CVSE) agency meet the Weigh2GoBC preclearance program objectives of accelerating the flow of goods through the Pacific trade corridor, saving carriers time, fuel, and money while reducing greenhouse gas emissions.

This type of tire width screening can be adapted to the requirements of other jurisdictions where tire widths are factored into weight limits. Tire-type screening can enable the correct classification of vehicles based on tire footprint measurements to ensure accurate weight compliance checking.

4. References

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