



INTERNATIONAL ROAD DYNAMICS INC.  
INTELLIGENT TRANSPORTATION SYSTEMS

## THE WEIGH FORWARD METHODS FOR DEALING WITH HEAVY TRUCKS ON TOLL ROADS

Author: Rish Malhotra, International Business Specialist  
Co-Author: Terry Bergan, President & CEO

Presented by: Terry Bergan, President & CEO  
ITS World Congress, Stockholm, Sweden  
TS086 – HGV Charging  
Tuesday, September 24

**In various applications – particularly within the tolling area – WIM has long proved itself to be a valuable option for roads managers. Today, sophisticated systems are on offer that will evolve to form the WIM technology of the future.**

The wear and tear on pavements, bridge structures, and other components of the transportation infrastructure caused by an individual vehicle is directly proportional to the weight of that vehicle or axle. In fact, as gross vehicle weights and axle weights increase, the damage to the highway and bridge infrastructure increases exponentially, as was concluded by the American Association of State Highway Officials (AASHTO) Highway Study. Where WIM is applied, both axle and GVW weights are monitored. A truck may be GVW compliant and still have individual overweight axles causing significant and costly damage to infrastructure.

Traditional methods of recouping the costs, in the form of either fuel taxes or tolls based on vehicle type can only factor in weight on a cost averaged basis, spreading the charge across all vehicles in a class. This process thus overcharges under-loaded vehicles and undercharges over-loaded vehicles, relative to the actual cost of their consumption of the transportation infrastructure. This in turn promotes overloading, as the cost per mile decreases with each extra pound carried. There is also an additional cost of biasing the system to encourage overloading from the increased accident rate; overloaded vehicles have a greater stopping distance, reduced maneuverability, increased risk of rollover, and an increased rate of mechanical failure.

### APPLYING WEIGH-IN-MOTION

WIM has a long history of application in data collection for use in planning transportation infrastructure. This has expanded to use in enforcement in sorting compliant from violating vehicles to increase throughput and ease congestion at inspection stations. The incorporation of RFID for AVI and various video imaging technologies has increased the scope of WIM into one of the main elements of what is now known as ITS. Most recently, in the ongoing search for ever more efficient methods of funding the building and maintenance of roadways and bridge structures, both public and private sector leaders are turning to the concept of tolls based on vehicle weight.

### WEIGHING STRATEGIES

In order to change to a toll strategy that charges by weight and penalizes overloading, it is necessary to weigh and classify vehicles. There are three main options for doing this. The first is to have static weigh stations on the toll way. While being the most accurate, this method has a number of drawbacks. Vehicle throughput is very slow compared to other options, resulting in delays and congestion. It requires an additional large infrastructure investment and staff to build and man the weigh station. The departure from the weigh station and merging of heavy vehicles with the main traffic stream poses a safety hazard. Thus,



the GVW accuracy of the static weigh stations though being the best comes at a high initial investment and equipment cost to the buyer. The added cost to the user also includes the delay and slow down caused by the time taken by the traditional scales to calculate the GVW.

A second option is to have high-speed WIM lanes on the toll way. This method is the least intrusive as it involves no impediment to traffic flow. The challenge is that it requires a way of identifying all heavy vehicles at highway speeds. There are currently three methods in common use for automatically identifying vehicles in the traffic stream: LPR systems, optical OCR systems, and RFID tag systems. While many vehicles can be identified by using one or all of these methods, there are still a number of vehicles which require identification by alternate means or further verification. By utilizing low-speed WIM, operators can verify the identification of heavy vehicles which are missed or unidentified by these other methods.

The third option is to have low-speed WIM lanes at toll plazas. This method integrates the weighing operation into the normal toll collection process at the plaza. The WIM operation requires little additional delay. When combined with ETC, this system can process the majority of vehicles without stopping, while still allowing manual collection from vehicles that have not subscribed to the ETC program (the efficiency is significantly increased by having some WIM toll lanes reserved for ETC vehicles only). IRD has implemented low speed WIM in toll lanes in both, China and India. In China, IRD has installed its low-speed WIM solution using Bending Plates at several toll plazas. Two bending plates are installed in a staggered format on each lane of the toll plaza. Test results conducted on the bending plates in China has proved that it is possible to achieve accuracies of at least  $\pm 4\%$  at 90% confidence levels. In India, IRD has installed its Slow Speed WIM (SSWIM) scale solution on the two exterior extra wide lanes in toll plazas. On average, installing IRD's bending plate solution or the slow speed WIM scales for slow speed operations costs anywhere between US\$25,000 to US\$35,000 per lane including the electronics. Introducing low-speed WIM lanes at toll plazas assists the overall weighing operation by offering a significant reduction in delay in comparison to using static weigh stations on the toll ways which is why this method is now gaining popularity. While legislation in China allows for the issuance of citations for overweight vehicles, India is currently testing this concept with the eventual aim of issuing fines for overweight vehicles. Legislation in most countries varies with certain limitations on the use of this technology for enforcement.

### **TODAY'S BEST METHOD**

For these reasons, it appears that at the present time and wherever applicable, WIM at the toll plaza is the most easily implemented and efficient method of collecting tolls based on weight. International Road Dynamics (IRD) has installed a number of WIM@Toll plaza systems in India, China and Korea, and has systems at the planning stages in Africa, the Middle East and North America.

IRD has been instrumental in all stages of development of modern computer-based WIM systems. Some of the pioneering theoretical concepts for WIM systems were proposed by the founders of IRD in the mid 1970s. Research projects in the late 1970s were used to develop the hardware and software components required to bring WIM systems from theory into practical application. In the 1980s, the systems went into commercial production and IRD became a corporate entity to produce and deliver WIM systems to customers worldwide. As it has developed, the company has expanded the technologies that it can integrate into an ITS system. IRD now installs and maintains all major types of WIM technology: single load cell, bending plate, Lineas Quartz and piezoelectric in its systems. A range of video imaging technologies, including color, low light and infrared imaging, LPR, OCR, and RFID are used to assist in vehicle identification. Almost every system produced includes various vehicle dimensioning sensors such as height sensors, light curtains, tire width sensors and axle sensors. Toll and Commercial Vehicle Operations or Truck Weigh Station systems now frequently employ some form of DSRC for AVI/ETC.

Large scale systems require computer networking for communications between system components, data collection, database operations, user access, and web-based operations. IRD has implemented and operates large scale systems that incorporate both private network and internet-based networking solutions.



Traditionally, data collection, weight and dimension enforcement, truck weigh stations and toll collection have been separate operations in the management of the transportation infrastructure. Integration of these fields into one system equates to efficiency.

The concept of tolling based on weight as a fair and equitable way to recoup the cost of consumption of transportation infrastructure by a commercial carrier is an idea whose time has come. Today, the most expeditious way to implement toll by weight is through WIM at a toll plaza; the structures, equipment and expertise are already being put to use in IRD's WIM@Toll systems. Concessionaires and other commercial vehicle operators are widely in support of this concept as charging toll to overloaded vehicles is beneficial in recovering the infrastructure development and maintenance costs in the long run.

Future trends toward universal RFID of commercial vehicles indicate further integration of transportation management functions, and this will in all probability include toll using high-speed WIM.



**WIM@Toll Plaza**



**Truck driving through WIM station**



**Weighing scales**



**Costly and inconvenient pavement damage caused by illegally overloaded trucks**

