INVESTIGATION OF EXISTING BRIDGE FORMULAE AND BACKGROUND FOR THE DEVELOPMENT OF A EUROPEAN BRIDGE FORMULA

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ABSTRACT

Truck size and weight are regulated differently in every country with various levels of restrictiveness for the primary purpose of protecting highway infrastructure. There is now a trend to move towards performance based standards (PBS) where size and weights are regulated based on the vehicles performance requirement and interaction with the traffic and infrastructure rather than fixed values. A "bridge formula" is a variation of performance based standards, where it regulates parameters (axle spacing and number of axles) that are related to the performance of the vehicle in terms of the load effect imposed on bridges and pavements. Bridge formulae provide an efficient method to help with the regulation of truck weights while ensuring the sustainability of the infrastructure by allowing vehicle configurations that have an acceptable effect on structures. This paper presents the findings of a comprehensive literature review to identify and compare existing bridge formulae used around the world. From the knowledge gained from previous research and experience in the literature, issues with existing bridge formulae are identified and the opportunity to develop and implement a European bridge formula for the regulation of truck size and weights in Europe is considered.

1. INTRODUCTION

Truck size and weight are regulated differently in every country with various levels of restrictiveness for the primary purpose of protecting highway infrastructure. The Gross Vehicle Weight (GVW), axle loads, number of truck axles, and inter-axle spacing determine the level of impact of the live load induced on bridges and pavements. The regulations on these parameters determine truck characteristics which in turn impact truck productivity, transportation safety, efficiency, and the environment. An appropriate balance must be achieved between truck productivity and infrastructure design, operation, and maintenance to allow full utilization of the bridge capacities while preventing excessive infrastructure damage.

Typically truck size and weights are determined by prescriptive methods where gross vehicle and axle weight limits and vehicle dimensional limits are fixed, with little flexibility allowed in design. Currently, truck size and weight limits of European Union (EU) member states for international travel are regulated by prescriptive measures through the European Council Directive 96/53/EC [5]. However, higher weights may be permitted by individual countries for national travel.

There is now a trend to move towards performance based standards (PBS) where size and weights are regulated based on the vehicles performance requirement and interaction with the traffic and infrastructure rather than fixed values, specifically for promoting efficient freight transportation. Even for jurisdictions using this approach there are typically additional size and weight requirements that must be satisfied, however similar to jurisdictions using prescriptive rules, higher weights and dimensions may be permitted through special permits for oversize/overweight vehicles. A performance-based standard in its pure form regulates truck size and weight based only on performance measures, such as impact on safety and the environment, load effect imposed on infrastructure, traffic impacts, vehicle productivity, geometric effects, and amenity [1].

Canada developed a performance based method to assess the dynamic performance of vehicles against objective standards, and this method was used as the basis for defining size and weight limits for national configurations, agreed upon under the Memorandum of Understanding (M.o.U.) in 1988. The M.o.U. provided a complete specification for the vehicle, including internal dimensions critical to both infrastructure and vehicle dynamic performance. The approach has been used subsequently by provinces when considering new configurations that fall outside of the M.o.U. definitions, either for regulation or for special permits [12].

Australia is currently a leader in PBS regulations where they have implemented pure performance based standards for the design of their heavy vehicle configurations, currently focusing on vehicle safety performance and stability. However, additional size and weight limits must also be satisfied to take into account other factors such as infrastructure impacts.

A “bridge formula” is a variation of performance based standards, where it regulates parameters that are related to the performance of the vehicle in terms of the load effect imposed on bridges and pavements. These formulae are designed to protect bridges by determining the maximum weight allowed on any series of consecutive axles as a function of axle spacing and the number of axles. Bridge formulae provide an efficient method to help with the regulation of truck weights while ensuring the sustainability of the infrastructure by allowing vehicle configurations that have an acceptable effect on structures.

The level of restrictiveness of the truck size and weight limits set by each jurisdiction may vary significantly depending on the type of infrastructure, bridge design methods, design loads used, existing truck configurations based on type of commodities required to be transported, and politics of the jurisdiction. The restrictiveness may also be largely dependent on the level of enforcement and compliance by operators.

2. EXISTING BRIDGE FORMULAE

Several countries, including USA, Canada, Mexico, Australia, New Zealand, and South Africa have developed bridge formulae to limit the weights of heavy vehicles. The formulae are designed specific to each country’s transportation system and infrastructure characteristics and may vary significantly in terms of their general characteristics and level of restrictiveness.

2.1. General Characteristics

Bridge formulae are developed and applied differently by each country. The format, parameters, constraints (e.g. truck length, gross vehicle weight), and application method (e.g. route class specific, axle combinations) vary depending on the country’s truck fleet and infrastructure characteristics.

The most well-known bridge formula is the federal U.S. Bridge Formula B (BFB) that has been regulating truck size and weight on the Interstate highways in the U.S. since 1974 [8]. The formula determines the maximum allowable weight on any series of consecutive axles as a function of axle spacing and number of axles, and must be applied to every axle combination. In addition to the BFB, other weight regulations have been implemented that limit the gross vehicle weight to 80,000 lbs (37,088 kg) and axle weights to other limits depending on the axle configuration (i.e. single, tandem, tridem). The BFB was developed separately from the gross and axle weight limits, therefore the "capped BFB" refers to the BFB allowable weights limited at the 80,000 lbs (37,088 kg) gross vehicle weight limit. Due to criticisms of the current BFB on its inadequacy to fairly limit gross and axle weights of different truck configurations, alternative bridge formulae have been developed to overcome some of the limitations. However, none of the proposed bridge formulae have been implemented and the BFB still governs.

Table 1 - Characteristics of Existing Bridge Formulae

Bridge Formulae	Characteristics
U.S. Bridge Formula B	• Depends on axle spacing and number of axles • Applied to every axle combination • GVW limit of 37.088 tonnes
Mexico	• Similar format to U.S. BFB • Allowable weight varies depending on the route classification (Class A, B-primary, C-secondary, or D-feeder) • Applied only to the extreme outer axles to determine allowable gross vehicle weight
Canada	• Developed and used by Ontario • Depends on Equivalent Base Length (EBL) • Applied to all axle combinations • GVW limit of 63.5 tonnes
South Africa	Two different bridge formulae- applied to every axle combination • Legal loads (up to 56 tonnes and length limit of 22 meters): depends on axle spacing only • Abnormal loads: depends on axle spacing and Effective Width (EW) of the vehicle
Australia	Current: • Different formulae used by different states • Depends on axle spacing only • In most states applied to outer axles only to determine allowable gross vehicle weight Proposed • Depends on route and vehicle classification • Applied to all axle combinations • GVW limit of 42.5 tonnes for general access vehicles
New Zealand	• Bridge formula table • Limited to 44 tonnes

Identifying and comparing the characteristics of different bridge formulae helps identify common themes used in their development and important characteristics to consider in the development of new bridge formulae. Table 1 presents a comparison of the key characteristics of the different existing bridge formulae.

The U.S. and Mexico bridge formulae are similar in format and are the only formulae that use both the axle spacing and number of axles as a direct parameter to determine the allowable weights. The South Africa, Australia, and New Zealand bridge formulae depend on axle spacing only.

The Ontario Bridge Formula (OBF) varies from the other bridge formulae in that it introduced the Equivalent Based Length (EBL) concept, calculated from the number of axles and axle spacing of a vehicle. The EBL is an imaginary length on which the total concentrated load of any series of consecutive axles is uniformly distributed such that the moment envelope along the bridge would be similar to that caused by the concentrated loads [13].

The OBF was developed based on a survey (initially conducted in 1967 and updated with a survey conducted in 1971), where operating truck configurations and axle loads were identified and the EBLs were calculated and plotted. From this, the maximum observed loads (MOL) were determined. The OBF curve lies slightly below the upper bound of the survey data [13].

The Mexico and current Australia bridge formulae are applied only to the extreme outer axles in order to determine allowable gross vehicle weights. Additional axle weight limits are used to regulate the internal axle weights. Other countries (U.S., Canada, South Africa, and New Zealand) also have additional axle weight limits; however the bridge formulae must be satisfied for every axle combination.

South Africa and Mexico use different bridge formulae to allow different weights depending on the route and vehicle classification, respectively. South Africa developed separate bridge formulae for regulating legal vehicle loads up to 56 tonnes and 22 meters, and “abnormal loading” which are oversize/overweight vehicles requiring permits up to 125 tonnes and 28 meters. Mexico uses different coefficient values to increase the allowable weight with the improvement of the roadway class (Class A, Class B- primary, Class C- secondary, Class D- feeder).

Australia also proposes to follow this approach by creating a uniform set of bridge formulae to regulate heavy vehicle weights depending on both route and vehicle classification. (AUSTROADS, 1994) Three bridge formulae are developed for:

(1) general access vehicles (up to 42.5 tonnes) and Category 1 road trains (up to 132 tonnes)
(2) general access vehicles between 42.5 and 50 tonnes
(3) restricted access vehicles which include B-doubles and Category 2 road trains

Category 1 routes have a minimum required bridge design load with limited span lengths of 20 meters for simply supported and 10 meters for continuous span bridges. Category 2 routes require the same design load standard; however do not have span length limits. B-double routes require the strength capacity to allow operation of B-doubles at 62.5 tonnes.

2.2. Comparison of Bridge Formulae

The level of restrictiveness of the truck size and weight limits set by each jurisdiction vary significantly depending on the type of infrastructure, bridge design methods, bridge design loads, existing truck configurations, commodity type demand, and politics of the jurisdiction. In principle, higher capacity bridges should be permitted to support higher operating loads.

The majority of the U.S. Interstate bridges have been designed to an HS20 live load model, a tractor semitrailer truck at 72,000 lbs (33,379 kg). To account for heavier loads, some states use HS25 loads, 25 percent larger than HS20 loads. In Canada, bridges are designed to the Ontario Highway Bridge Design (OHBD) live load (5-axle truck at 77,143 kg) within Ontario and the CL-625 live load model (5-axle truck at 65,115 kg) in the other provinces.

All three load models are applied differently in terms of superimposing lane loads, dynamic load allowances, and load factors used in the Load Factor Design (LFD). In the end, the two Canadian bridge design loads result in similar bending moments on simple span bridges. Canadian bridges, based on both design models, are designed for significantly higher loads than the U.S. bridges, with the exception of short span bridges up to 15 meters. The factored design moments of OHBD and CL-625 loads are up to double that for HS20 loads for 45 metre simple span bridges [12].

The difference in bridge design methods and loads are evident amongst countries. The level of restrictiveness of the bridge formulae can be compared in terms of allowable weights and load effect on bridges, while keeping in mind the differences in infrastructure capacity and truck fleet characteristics.

Applying a bridge formula to the outer axles of the vehicle, i.e. between the first and last axles, determines the allowable gross weight of the vehicle. Figure 1 presents the gross weights determined by different bridge formulae on a series of seventeen work horse and higher capacity truck configurations commonly used in the United States, Canada, and Europe. The truck configurations are identified in the study conducted by the Joint Transport Research Centre on Heavy Vehicles [14].

The level of restrictiveness of the different bridge formulae can be noticed in Figure 1. The Australia bridge formula used for limiting weight on general access vehicles and road trains on category 1 routes is the most permissive, followed by the South Africa bridge formula. For the analysed truck configurations, the BFB and Mexico bridge formula allow the lowest gross vehicle weights up to the truck configuration with 18.2 meter wheelbase, where the New Zealand bridge formula table then becomes the most restrictive due to the 44 tonne limit in the table.

The bridge formulae used in the U.S., Canada, South Africa, and New Zealand and the proposed Australian bridge formula must also be applied to all internal axle combinations. For some truck configurations, in order to satisfy the allowable weights for internal axle combinations the GVW determined by the outer axles is not able to be reached. Figure 2 shows the actual allowable gross weights that the vehicles can operate if the bridge formulae are applied to all axle combinations. The allowable weights are reduced in most cases relative to applying the bridge formulae only to external axles. This shows that allowing the gross vehicle weights determined by applying the bridge formulae only to the external axles may result in axle loads that exceed the overstress criteria used in the development of the bridge formulae.

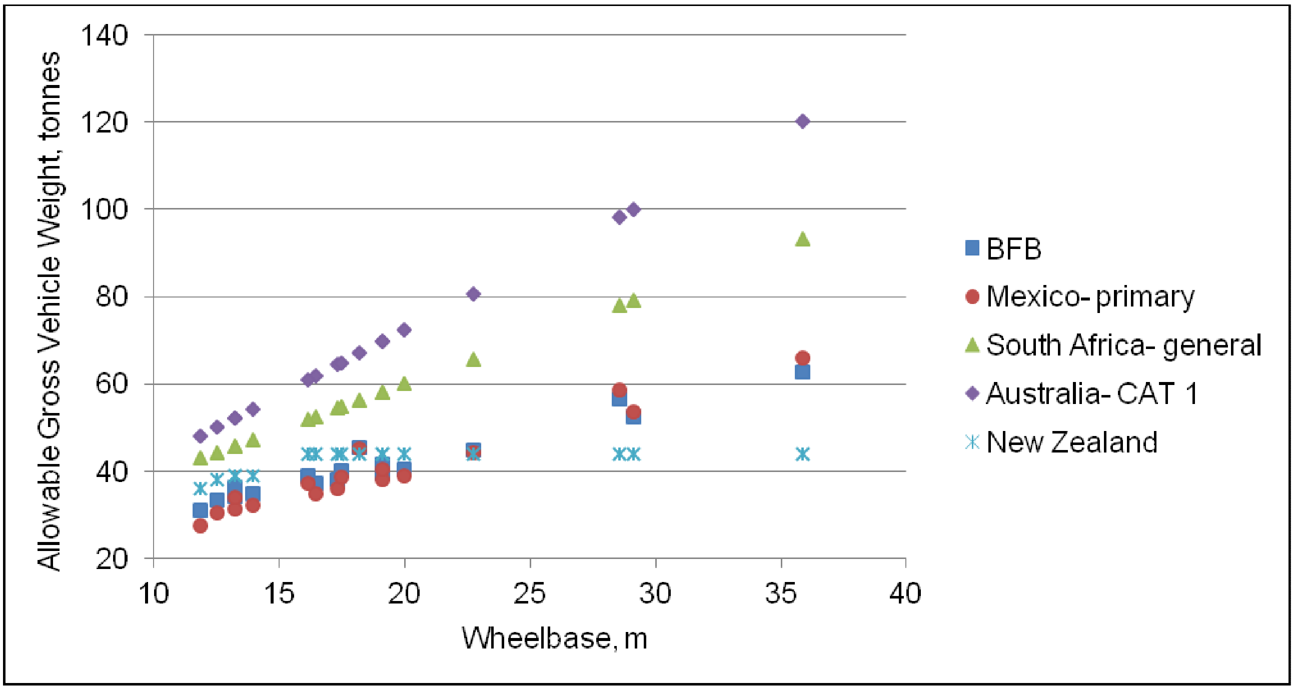

Figure 1 - Allowable gross vehicle weights by different bridge formulae applied to outer axles only for a series of European and North American truck configurations

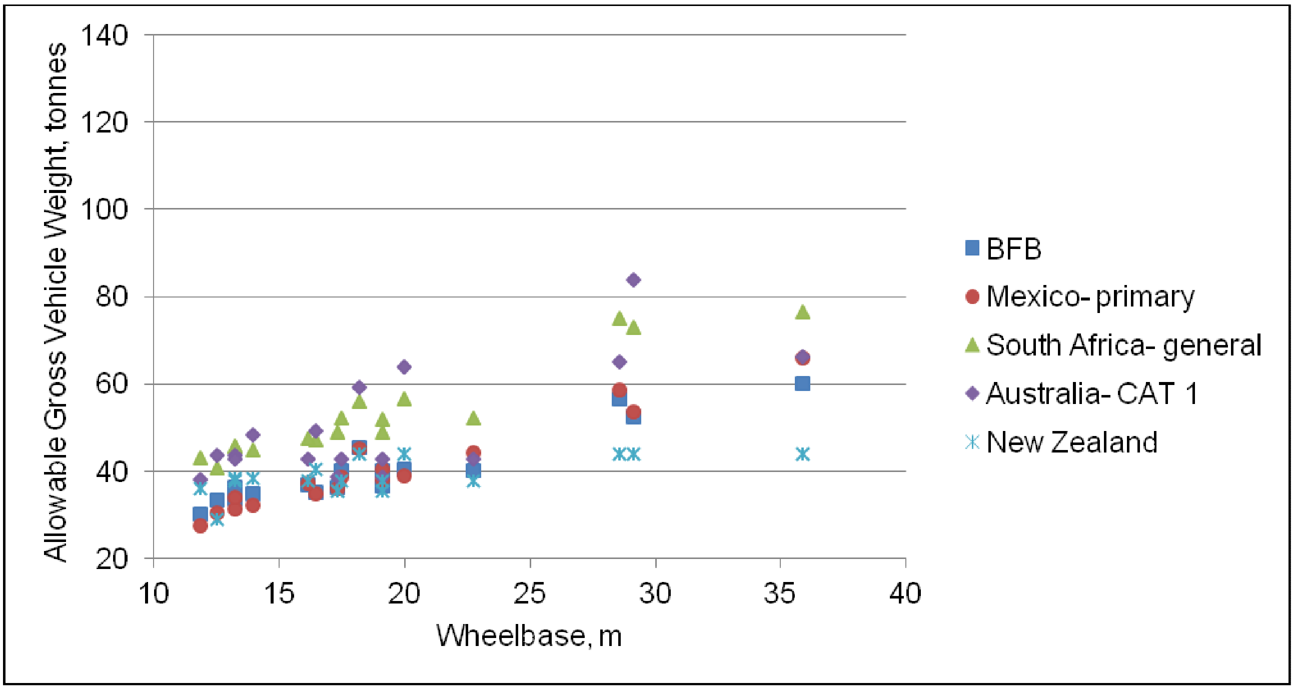

Figure 2 - Allowable gross vehicle weights by different bridge formulae applied to all axle combinations for a series of European and North American truck configurations

The load effects of the series of trucks with all axle combinations complying with the bridge formulae are determined to compare the aggressiveness of the different bridge formulae. Figure 3 presents the bending moment at mid-span of a 50 meter span simply supported bridge. The bending moments range between 5400 to 13200 t.m. The aggressiveness of the bridge formulae in terms of load effects is similar to the level of restrictiveness of the bridge formulae in terms of the allowable loads presented in Figure 2. The bridge formulae imposed the highest bending moments where the highest gross vehicle weights were permitted. The Australia and South Africa bridge formula impose the highest load effects.

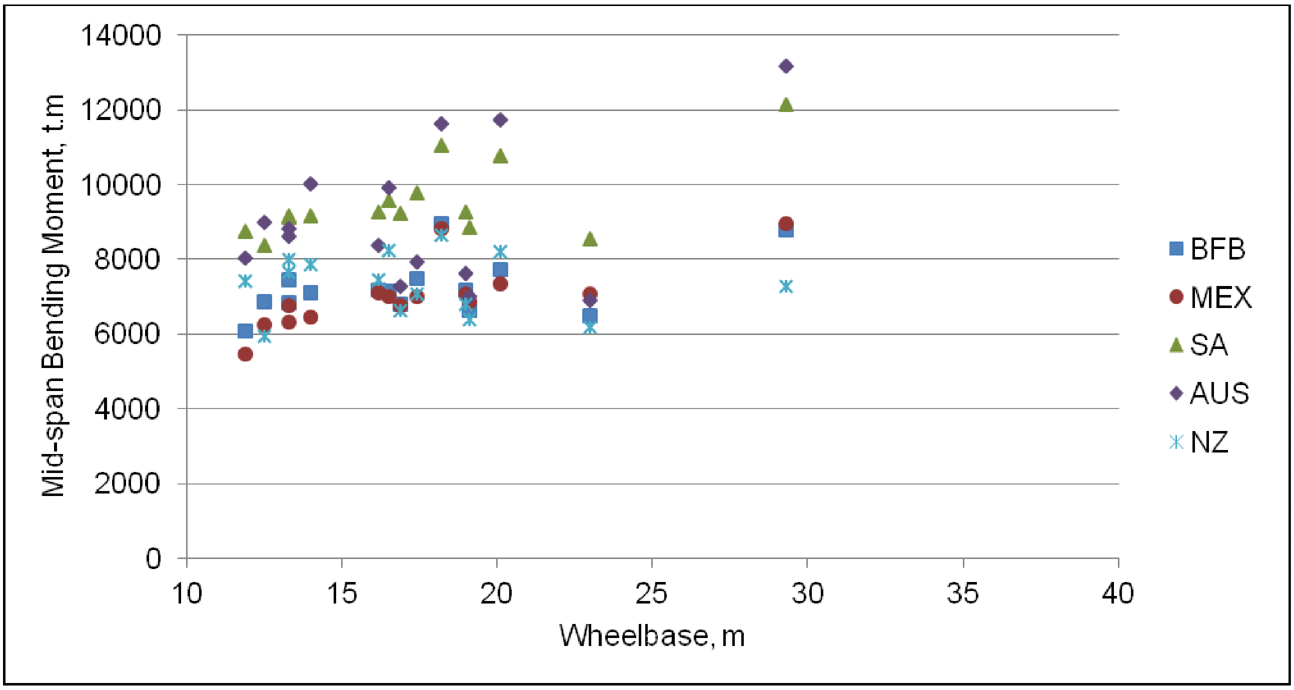

Figure 3 – Bending moment of different bridge formulae at mid-span on a 50 meter single span bridge

The significant variation in the level of allowable loads and load effects may be due to the variations in the bridge design methods and design loads. Higher design loads and safety margins may permit higher loads and load effects on bridges. Analysis of other load effects including bending moment on piers of continuously supported bridges and shear effects should also be conducted for further comparison of aggressiveness of the bridge formulae.

3. POTENTIAL ISSUES WITH BRIDGE FORMULAE

Bridge formulae are an efficient method of regulating truck size and weight while ensuring the protection of infrastructure. The level of efficiency varies depending on the design criteria used in the development of the formula, and the method of implementation as part of the legislation and by operators in the trucking industry. Issues associated with the effects of the bridge formulae are evident through the experience of jurisdictions using bridge formulae as a method of truck size and weight regulation.

3.1. Issues with the Bridge Formula B

The U.S. Bridge Formula B has received the most critiques since its implementation in the Federal-Aid Highway Legislation in 1974. It was designed based on the truck configurations and truck weights operating at the time of development.

Bridges in the U.S. have typically been designed to H15 (single unit truck at 30,000 lbs or 13,908 kg) and HS20, (tractor-semitrailer truck at 72,000 lbs or 33,379 kg) live load models. The majority of Interstate bridges have been designed to HS20 loads. To account for heavier loads, some states use HS25 loads, 25 percent larger than HS20 loads. The bridge formula was developed such that the design allowable stresses on HS20 bridges are not exceeded by 5 percent and H15 bridges by 30 percent. The 5 percent overstress criterion on HS20 bridges was based on the fact that the majority of heavy vehicles would travel on the Interstate and primary highways. Setting a more restrictive overstress criterion would reduce the fatigue damage on the bridges that occur due to repetitive loading [16].

The current U.S. BFB has been criticized for being overly permissive for longer trucks (short six axle trucks and all trucks with seven or more axles) if the maximum 80,000 lbs (37,088 kg) Gross Vehicle Weight (GVW) limit is not in place. Without the GVW limit, a long nine axle combination truck could overstress HS20 bridges by as much as 12 percent under the BFB allowable weights, depending on the bridge span length [3]. The permitted percentage of overstress on bridges varies amongst states; therefore some bridges may not require posting.

On the other hand, the 80,000 lbs (37,088 kg) GVW cap was selected arbitrarily and is deemed too restrictive on longer combination vehicles. Bridges on the Interstate highway can carry more weight than those allowed by the capped BFB without overstressing HS20 bridges beyond the permissible limit of 5 percent [4]. However, many bridges on non-Interstate highways would be deficient if the max GVW was increased. This limitation indicates the inadequacy of the arbitrarily selected GVW cap. [6] determined more rational overstress criteria using a structural reliability theory approach which relates the statistics of static and dynamic bridge load effects to the resistance of bridges. This takes into account the possibility of overloads and simultaneous truck presence

The BFB has also been criticized for applying overly conservative weight limits on shorter trucks. The bridge formula may result in lower axle weight limits than the permissible 20,000 lbs (9,272 kg) on single and 34,000 lbs (15,762 kg) on tandem axles as well as lower GVW limit than the permissible 80,000 lbs (37,088 kg). Only a small percentage of bridges on the Interstate highway (about 2 percent) are designed for H15 loads or less, therefore removing the 30 percent overstress criterion for H15 bridges would allow much higher weights on trucks with shorter wheelbases [16].

Specialized Hauling Vehicles (SHVs) are a prime example of vehicles at a disadvantage with the BFB. SHVs are short wheel based trucks carrying heavy loads, such as dump trucks and ready-mix concrete trucks. Due to manoeuvrability and safety issues within urban areas, the wheelbase of SHVs cannot be lengthened to take advantage of the higher GVW limits permitted by the BFB. A more liberal bridge formula or a special permit program would be required to allow the operation of these vehicles with higher weights [16].

The House Document 354 [17], which is a report provided to the Congress by the U.S. Department of Commerce that formally recommended the implementation of the Bridge Formula B, includes a footnote prohibiting certain vehicles that would otherwise be allowed by the BFB, to operate on H15 bridges due to causing overstress greater than 30 percent on H15 bridges. The specified prohibited vehicles are 3S2 (5 axle tractor-semitrailer) with wheelbase less than 38 ft (11.582 m), 2-S1-2 (5 axle tractor- semitrailer-trailer) with wheelbase less than 45 ft (13.716 m), 3-3 (6 axle tractor-semitrailer) with wheelbase less than 45 ft (13.716 m), and 7, 8, and 9 axle vehicles regardless of wheelbase. This prohibition is incorporated in the law however it is often not adopted or enforced by States.

The BFB and Mexico bridge formulae include the number of axles as a parameter for determining axle weights. However, “the relation between the allowable weight and number of axles is sometimes contrary to the dependence of stresses on the number of axles” [4]. Increasing the number of axles in an axle group without increasing the length of the vehicle has very little effect on bridge stresses and may actually result in the increase of imposed stress due to the concentration of loads; however the higher number of axles is substantially beneficial to pavements [3].

The bridge formula may result in unsuspected new truck configurations to take advantage of the allowable weights and to increase payloads. In the case of the BFB, in order to carry higher gross weights, the length of the vehicle and/or the number of axles must increase. This has resulted in vehicles with long draw bars, to allow higher payloads by increasing the length of the vehicle while maintaining the same cubic capacity to not increase the tare weight [11].

In addition, specialized hauling vehicles (SHVs) have difficulty complying with the BFB weight limits due to their short wheelbases. Therefore, SHVs and short combination vehicles increase the number of axles to allow the transportation of higher weights. The high number of axles creates challenges with manoeuvrability of the vehicles, specifically on horizontal curves. This has resulted in four axle tractors with lift axles [11].

Split tandem axles were also introduced and are now a common feature of five axle tractor semitrailers carrying heavy commodities. A split tandem axle is a widely spaced tandem axle group, up to 10 ft, allowing higher weights up to 6000 lbs (2,782 kg) relative to a standard 4 ft (1.22 m) tandem axle [11].

3.2. Issues to Consider with the Development and Implementation of Bridge Formulae

Based on the critiques of the BFB, experience from other countries implementing bridge formulae, and the characteristics of existing bridge formulae, some issues to consider in the development and implementation of new bridge formulae include the following:

- Arbitrary axle and gross weight limit caps may not be suitable for the truck fleet configurations. The overstress criteria used in the development of the BFB have been selected arbitrarily and have failed to consider impacts of fatigue damage or the possibility of overloads and simultaneous truck presence. Ghosn [6] determined more rational overstress criteria using a structural reliability theory approach which relates the statistics of static and dynamic bridge load effects to the resistance of bridges

- Due to the large range of U.S. truck configurations, it is difficult to develop one bridge formula suitable to adequately regulate weights on all truck configurations. This is evident in the inadequacy of the BFB to fairly limit weights on Specialized Hauling Vehicles and Long Combination Vehicles. South Africa has developed two bridge formulae to separately regulate legal loads for the standard general access vehicles and oversize/overweight vehicles. The alternative U.S. bridge formulae that have been developed and proposed over the years, including Ghosn [6] and James [9], comprise a set of bridge formulae that regulate heavy vehicle weights for ranges of truck lengths.

- In addition to the wide range of truck configurations, the strength capacity of bridges varies significantly. In the case of the BFB, considering both H15 and HS20 bridges in a bridge formula was deemed too restrictive for HS20 bridges [9]. The proposed U.S. TTI HS20 [4, 9] bridge formulae removed the overstress criteria of H15 bridges, and only considered bridges designed to HS20 design loads in the development of the formula. This allows acceptable higher weights on HS20 bridges, however may result in unacceptable overstressing of H15 bridges. The Mexico and proposed Australia bridge formulae follow the same approach where different weights are allowed for different route classifications with suitable strength capacities.

- Applying a bridge formula to only the outer axles may allow axle loads on bridges that exceed the overstress criteria that were used in the development of the bridge formula. Currently the majority of the Australian bridge formulae are applied to the outer axles only. The proposed Australian bridge formulae are to resolve this problem by being applied to all axle combinations.

- Bridge formulae should be applied consistently among States or provinces. Most States allow higher operating truck weights on their State highways, which encourages truckers to use State highways relative to the Interstate highway network. State highways may have bridges with lower strength capacities, higher congestion, and may not be geometrically suitable for large articulated vehicles.

- The bridge formula may result in unintended new truck configurations in order to take advantage of the allowable weights to increase payloads which may not have acceptable infrastructure impacts or dynamic performance. With the implementation of any size and weight regulation there is a need to monitor the fleet as it evolves to ensure undesirable vehicles and effects are prevented. The BFB resulted in the introduction of vehicles with long draw bars, lift axles, and split tandems [11]. The OBF resulted in growth in use of widely spaced liftable axles which had poor dynamic performance and produced excessive loads on bridges and roads when raised and were highly damaging to infrastructure [12].

- Bridge formulae should be implemented such that they are complying with the design criteria. In the case of the BFB, the exemptions of specified truck configurations from compliance to the bridge formula are not adopted by some states.

- Bridge formulae should be easily understood and applied by carriers and truck enforcement staff to regulate truck weights at truck inspection stations. The OBF was deemed difficult, time consuming, and too complex to be applied, therefore tables were provided with gross weights for ranges of axle spacing of the most common configurations [12].

With the continuously changing infrastructure and truck transportation characteristics, bridge formulae must be re-evaluated and updated to ensure the adequacy to limit weights. Appropriately analysing the impact of bridge formula truck configurations and the strength capacity of bridges allows creating a balance between impact on infrastructure and truck productivity. Weigh-in-Motion data may be used for analysing the truck fleet characteristics for the calibration of existing bridge formulae or the development of a new bridge formula, as used for the development of a proposed Hong Kong bridge formula [10].

4. NEED FOR A EUROPEAN BRIDGE FORMULA

Currently the commercial motor vehicle size and weight of EU (European Union) member states are regulated by the European Council Directive 96/53/EC developed in 1996 [5]. The directive defines the maximum permitted gross vehicle and axle weights and dimensions for various vehicle types and configurations travelling internationally between member states. Although commercial vehicle size and weight limits are harmonized between EU countries for cross-border travel, each country may set separate higher weight limits, and in some cases larger dimension limits, for national (intrastate) travel. The European truck size and weight limits are currently fixed prescriptive values regardless of the vehicle performance.

European Modular System vehicles have also been introduced in Europe and implemented as pilot studies in Finland, Sweden, and some routes in the Netherlands. EMS are higher productivity vehicles at 60 tonnes and 25.25 metres. The difference in national weight limits across EU countries and the increasing demand for larger and heavier vehicles brings the need to ensure the structural integrity and service life of bridges [15].

A bridge formula is a simple solution where it would allow the consistent limitation and efficient enforcement of truck weights under performance-based standards among countries with truck traffic exchange, while ensuring the structural capacity of bridges by limiting the imposed stresses on bridges.

A EU bridge formula (or set of EU bridge formulae) should take into account issues identified from the experience of other jurisdictions using bridge formulae, outlined in this paper. The bridge formula should have a simple form in order to be readily understandable and easy to apply.

For an initial step, a preliminary EU bridge formula may be developed by assessing and comparing the extreme load effects of different truck configurations on a variety of selected bridges. All load effects (including bending moment, shear forces, torsion, and pier reactions) should be analysed for a variety of bridge types (single and continuous) and bridge span lengths (5 to 200 meters). The bridge formula must conform to current European trucks, including those specified in Directive 96/53/CE, and the EMS vehicles allowed in northern Europe. Figure 4 presents the bending moment at mid-span of a 50 metre span bridge for all existing European Directive truck configurations. From the axle spacing ranges specified by the European Directive, minimum, maximum, and mid axle spacing values are analysed to account for the worst cases. The bending moments range from 3700 to 8900 t.m.

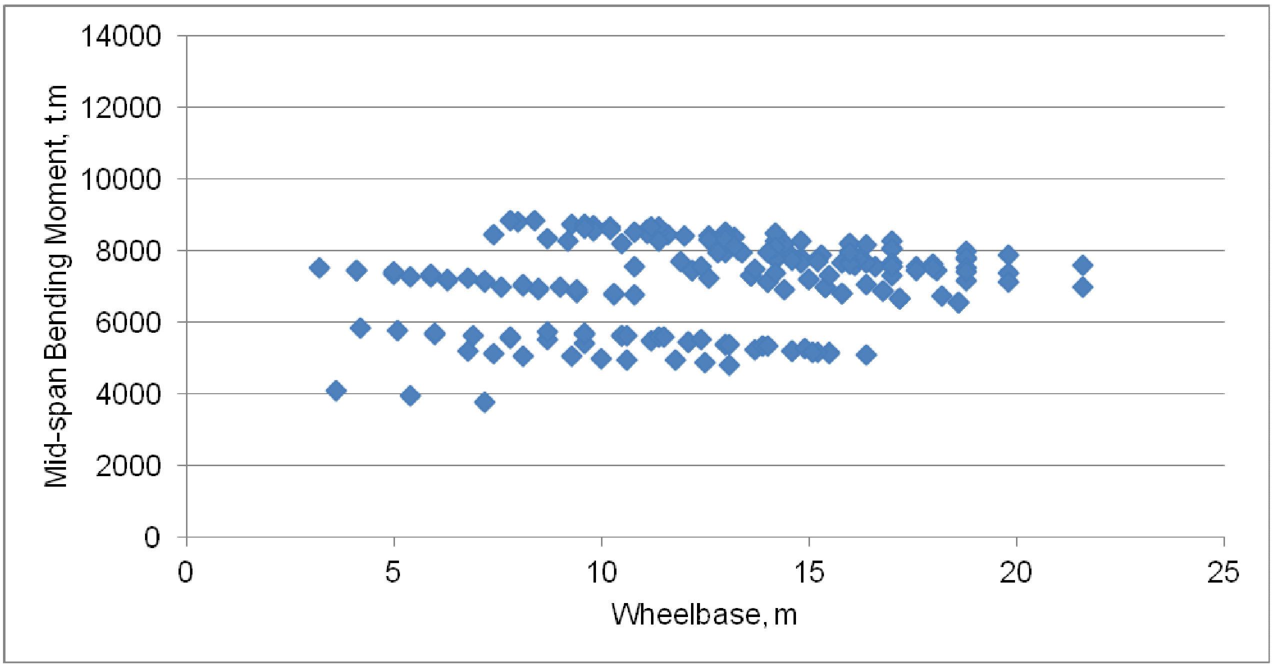

Figure 4 – Bending moment at mid-span of a 50 metre single span bridge for a series of European truck configurations

5. CONCLUDING REMARKS

Bridge formulae are an efficient method of regulating truck size and weight while ensuring the protection of infrastructure. The level of efficiency varies depending on the design criteria used in the development of the formula, and the method of implementation as part of the legislation and by operators in the trucking industry. Many issues may arise from the implementation of an unsuitable bridge formula to the infrastructure and transportation characteristics of a jurisdiction. Some of the issues associated with current bridge formula are outlined in this paper. The results of this analysis will help guide decision-making regarding the preservation of bridge infrastructure in Europe and developing countries, and will contribute new knowledge for countries which currently apply a bridge formula to regulate truck weights.

Morevover, the bridge formula is a performance based approach, which allows for future weight and size truck evolutions over a long-term period, but preserve the existing stock of bridges, designed with past and current loading codes.

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