Setting the Standard – Advancements in Wood Bridge Design in the Canadian Highway Bridge Design Code

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1 Abstract

The Canadian bridge design standard is being updated to account for the growing interest in mass timber construction and to allow for evolving and emerging wood bridge technologies. Governments and technical bodies are responding to this interest through the provision of funding and improvements to design standards. The Ontario Wood Bridge Reference Guide was recently published to promote the use of wood in bridges. The CAN/CSA-S6-19 Canadian Highway Bridge Design Code (CHBDC) governs the design of vehicular and pedestrian bridges in Canada. Section 9 of the CHBDC covers the design of wood bridges. The technical subcommittee for Section 9 is working to advance the code to reflect the state-of-the-art in wood bridge design. Initial advancements were made to the current 2019 edition of the CHBDC. The subcommittee is actively working on advancements for the forthcoming 2025 edition in the areas of shear design for glued-laminated timber beams, the load-sharing factor, glued-laminated timber deck panels, wood-concrete composites, camber requirements for glued-laminated timber beams, and pedestrian contact with preservative-treated wood. These advancements are expected to encourage further use of wood in bridges by providing guidance on evolving and emerging wood bridge technologies. This paper presents the on-going work of the subcommittee.

2 Introduction

After years of waning popularity, there is once again an interest in wood bridge construction in Canada, particularly where mass timber technologies are utilized. These technologies have seen markedly increased usage in construction applications in recent decades, including wood bridge construction, due to reasons of environmental sustainability and local economic development opportunities [1]. Canadian governments and technical bodies have helped perpetuate this increased usage through provision of project-specific funding and research funding, the creation of educational materials, and improvements to design standards.

Natural Resources Canada (NRCan), which is responsible for natural resources at the Canadian national level, has helped lead the way with respect to project funding. In 2017, they created the "Green Construction Through Wood" (GCWood) program to provide $39.8 million in industry funding to promote a "more wood-inclusive construction industry" [2]. Some of this funding was aimed at promoting wood bridge demonstration projects for spans over 20 m [3]. NRCan published their State of Mass Timber in Canada report in 2021 [4]. It included an online database to track planned, on-going, and completed mass timber bridge projects. Per the database, a total of 28 wood bridge projects had been undertaken, with almost all of them complete [5].

In 2017, Ontario Wood WORKS!, the Canadian Wood Council (CWC), and the Ontario Ministry of Natural Resources and Forestry collaborated to commission the Ontario Wood Bridge Reference Guide (OWBRG) [6]. The guide was co-authored by practicing consulting engineers with wood bridge expertise from both Moses Structural Engineers and Entuitive. It contains three sections concerning design best practices for wood bridges, current opportunities and limitations of wood bridges, and two fully worked wood bridge superstructure design examples. The purpose of the guide was to promote new wood bridge construction in Canada through design education, noting that Canadian engineering educational programs tend to be much stronger in teaching steel and concrete design than wood design. The guide was also seen as a modern augmentation of the Canadian Institute of Timber Construction's 1970 "Modern Timber Bridges" publication [7] and the CWC's 1992 "Wood Highway Bridges" publication [8]. These documents, while popular at one time, were no longer reflective of mass timber technologies and advancements in wood bridge design. Staff from the United States Forest Products Laboratory were particularly helpful in communicating advancements in timber bridge design when it came to authoring the design examples for the guide.

To compliment the OWBRG, NRCan and the CWC have commissioned Wood Research and Development (WRD), a wood engineering design and inspection firm, to author the Timber Bridge Maintenance and

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Restoration Detailing Guide. This forthcoming publication will provide guidance on the inspection, maintenance, and restoration of existing timber bridges. This guide, along with the OWBRG, are intended to provide the necessary engineering design knowledge for brownfield and greenfield wood bridge sites, respectively.

In response to the renewed interest in timber bridges, the CAN/CSA-S6-19 Canadian Highway Bridge Design Code (CHBDC) [9] and its accompanying commentary [10] are being updated to reflect the state-of-the-art in wood bridge design. The CHBDC is the national design standard for new and existing bridges in Canada. It has been adopted by all Canada's provinces and territories, except for Manitoba, which instead uses the AASHTO LFRD Bridge Design Specifications [11]. The CHBDC is a limits states design code. It covers design loadings, load combinations, structural analysis, and detailed design criteria for bridge engineering materials and components. The current format of the code followed from the amalgamation of the CAN/CSA-S6-88 Design of Highway Bridges standard and the OHBDC-91-01 Ontario Highway Bridge Design Code in the year 2000. The current format has been published in 2000, 2006, 2014, and most recently in 2019. The next publication is intended for 2025.

Section 9 of the CHBDC is dedicated to wood structures. This section is maintained by a technical subcommittee comprised of subject matter experts ("the subcommittee"). Members include representatives from various levels of government, academia, consulting, and industry. The subcommittee membership has entirely turned over in the past decade, with no members remaining from the 2006 edition of the code and only three members remaining from the 2014 edition of the code. The previous membership had remained relatively stable for decades, with that membership ("the previous subcommittee") having contributed to the CHBDC the state-of-the-art in wood structures design from the 1970s through to the 1990s. The current membership is currently working to reflect modern advancements in wood design and mass timber technologies for the forthcoming 2025 edition of the code. Areas of primary focus include shear design for glued-laminated timber (glulam) beams, the load sharing factor, glulam deck panels, wood-concrete composites, camber requirements for glulam beams, and pedestrian contact with preservative-treated wood. The purpose of this paper is to communicate the technical content advancements that the subcommittee is pursuing in these topic areas for the 2025 edition of the code.

3 The 2019 Code Cycle

Before 2019, Section 9 of the CHBDC had remained relatively unchanged since the CHBDC was adopted in its current format in 2000. With the Section 9 subcommittee membership having turned over largely during the 2019 code cycle, there was opportunity for updating and introducing new content into Section 9. The following advancements were made during that code cycle:

- Specified material properties and resistance equations were revised to be consistent with CSA O86-19 Engineering Design in Wood standard [12] (CSA O86);
- New glulam material properties were introduced;
- Preservative treatment requirements were updated to reflect current industry standards;
- Structural composite lumber properties were deleted; and,
- Provisions were introduced for glulam deck panels.

Canadian structural engineers are typically taught wood design based on CSA O86, which is the wood design standard for buildings and associated structures. Very few engineers are taught wood design per the CHBDC. As such, the subcommittee sought to make the specified materials properties for sawn wood and glulam timber in the bridge code consistent with main wood design standard CSA O86. For unknown reasons, the previous subcommittee had long ago published specified material properties in the CHBDC that had implicitly been modified for service condition, a factor that accounts for strength and stiffness reduction as a function of wood moisture content. The resistance equations in CSA O86 account for service condition using an explicit factor that the designer can select. To avoid confusion between codes, the subcommittee decided to extract the implied service condition factor from the specified material properties published in the CHBDC so that the properties would be the same as published in CSA O86. In doing so, the service condition was introduced to several resistance equations in the CHBDC. Furthermore, some of the symbols and variables in the CHBDC resistance equations were modified to be consistent with CSA O86. The idea was to make the CHBDC a more comfortable code to use for wood designers who would be accustomed to CSA O86.

The 2019 CHBDC saw the introduction of material properties for glulam comprised of spruce, lodgepole pine, and jack pine. These species are common in the interior of Canada. Including material properties for

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their use in glulam members was intended to promote further use of glulam, and to provide new economic development opportunities for locales with an abundant supply of those species. The superstructure design example included in the 2017 OWBRG were based on these properties for the same reasons.

Minor changes were made to the preservative treatment requirements in the 2019 CHDBC. In particular, different types of alkaline copper quaternary (types A, C, and D) were permitted for use. The more important changes were in the CHBDC commentary, where a greater explanation was given regarding the function of preservatives, the relationship between wood moisture content and decay, environmental considerations when selecting a preservative treatment, and the impact of climate change on the rate of decay and likelihood of insect attack by termites.

Until 2014, the Section 9 of the CHBDC had included material properties for structural composite lumber (SCL). After review of this technology, the subcommittee decided to delete the SCL material properties from the code because SCL is often proprietary and material properties tend to vary between manufacturers. Going forward, a designer will have to select an SCL product upon which to base their design. Doing so will ensure that correct material properties are used.

Glulam deck panels were introduced into the CHBDC in 2019. These decks were invented in the 1970's at the United States Forest Product Laboratory in Madison, WI [13] [14]. Despite their popularity in American wood bridge applications, their use had been rare in Canada until the past decade. In the 1970's and 1980's, Canadian wood bridge research efforts had been focussed on the invention and development of stress-laminated wood decks [15] [16] [17] [18] [19]. At present, increased glulam production and ease of installation relative to nail-laminated and stress-laminated wood decks have made glulam deck panels an attractive decking solution. To reflect this shift in popularity, the subcommittee introduced provisions to assist designers with glulam deck panel design. The changes were not completed in time for the 2019 code cycle. Consequently, further provisions are expected for the 2025 code, as explained below in section 4.3.

4 Forthcoming Advancements to the CHBDC

This section of the paper explains in detail the technical topics that the subcommittee is investigating for inclusion in the 2025 edition of the CHBDC. References are made to other national-level wood design standards including CSA O86, the AASHTO LFRD Bridge Design Specifications [11] (AASHTO), the American Wood Council's National Design Standard for Wood Construction [21] (NDS), the Eurocode 5: Design of Timber Structures standard [22] (Eurocode 5), the Australian AS 5100.9:2017 Bridge Design Part 9:Timber standard [23] (AS 5100.9:2017), and the American Railway Engineering and Maintenance-of-Way Association's Manual for Railway Engineering [24] (AREMA).

4.1 Shear Design of Glulam Beams

At the conclusion of the 2019 code cycle, the subcommittee identified the shear design of glulam beams as a topic to be improved upon for the 2025 code. Issues with respect to the specified shear stress for Douglas-fir, the volume shear effect, and the size effect factor applied for in-situ evaluation of glulam beams were identified as particular topics for improvement. The following sections explain the forthcoming improvements.

4.1.1 Specified Shear Strength

As aforementioned, before the 2019 CHBDC, the specified material properties for glulam beams included an implied service condition factor. The previous subcommittee had embedded this factor into the material properties to account for strength and stiffness reductions due to wet service conditions. The limits states editions of CSA O86 historically featured this factor as well, but it had always been an explicit factor that was part of all resistance calculations. For unknown reasons, the previous CHBDC Section 9 subcommittee decided in 2000 to present specified material properties that were already modified for service condition. For glulam beams, the service condition factors had been applied for "semi-wet" service, an intermediate condition between wet and dry services that was unique to the CHBDC. The semi-wet service condition factor was the average of the wet and dry service condition factors defined in CSA O86. No definition of semi-wet service had been given. The current subcommittee's understanding is that the previous subcommittee believed that the relatively large volume of a glulam beam prevented the beam's moisture content from becoming increasingly high enough to the point of wet service, implicitly supposing that a designer had suitably detailed the bridge to protect the girders from repeated exposure to direct moisture.

During the 2019 code cycle, the subcommittee elected to adjust all the specified material properties and member resistance equations, symbols, and variables to reflect those in CSA O86. In doing so, the implied service condition factor was removed, thus reverting the specified material properties back to the values presented in CSA O86. However, in removing the implied semi-wet service condition factor for Douglas-fir glulam beams, it was observed that the specified shear strength remained less than what is reported in CSA O86. In CSA O86, that specified shear strength was 2.0 MPa. After removing the implied semi-wet service condition factor of 0.94, the specified shear strength in the CHBDC increased from 1.4 MPa to 1.5 MPa. This difference puzzled the subcommittee during the 2019 code cycle. It was of great interest because the resulting specified shear strength was 75% of the CSA O86 shear strength, a problem that was even more problematic given that the sizing of glulam beams in bridges is often governed by their shear capacity. A sufficient explanation of this difference was not available when the 2019 code was finalized, so the committee decided to keep the 1.5 MPa value on an interim basis until a full review could be conducted and a rational explanation identified.

Significant effort was put into addressing this issue during the 2025 code cycle. A careful review of all previous versions of the CHBDC, CSA O86, and their commentary documents was undertaken. It was ultimately concluded that the lower specified shear strength value used in the 2000, 2006, 2014, and 2019 editions of the CHBDC was the result of this shear stress value not being kept in calibration with advancement made to the shear stress values in CSA O86. It is believed that a 0.75 shear reduction factor may have still been incorporated from the time of working stress design codes, which was before 1984 for CSA O86 and before 1979 for the OHBDC that preceded the CHBDC. It is believed that this shear reduction factor was an outdated empirical factor used to account for reductions in shear strength that were at the time believed to be caused by the presence of knots along the critical shear plane [25]. As demonstrated by Gupta et al. [26], the shear strength of Douglas-fir members is in fact not statistically significantly affected by the presence of knots, therefore rendering the empirical 0.75 times shear reduction factor redundant. Accordingly, the specified shear strength for Douglas-fir glulam beams is intended be increased from 1.5 MPa to 2.0 MPa in the 2025 CHBDC. The subcommittee assessed the impact of this change by comparing the demand-to-capacity ratios for several beams loaded with concentrated loads, with ratios calculated per the CHBDC, CSA O86, AASHTO, AREMA, and NDS. The results using the CHBDC shear resistance equation for a specified shear strength of 2.0 MPa were considered acceptable [25].

The correction of the specified shear strength is of great significance because glulam beams are the most popular mass timber technology used in Canadian wood bridge engineering, and the design of these beams is often governed by their shear capacity. By increasing the specified shear to its proper value, significant economy will be afforded to future designs, allowing them to better compete with steel and concrete alternatives. While the subcommittee is proposing this change, this item has yet to be balloted for approval in the 2025 code.

4.1.2 Shear Resistance

The calculation of glulam shear resistance in CSA O86 is based on the influence of beam volume and loading pattern, as was identified by Foschi and Barrett in the 1970's for Douglas-fir glulam beams [27] [28]. Their research was distilled into a practical design approach in CSA O86 in the form of the "total factored shear resistance" , W_r, which is unique for glulam beams. This resistance accounts for shear stresses along the critical horizontal plane over the entire length of the beam using a variable called the shear-load coefficient, C_v. It is compared to the summation of all vertical loads acting on the member to determine a safe design. This approach is unlike traditional beam design, wherein the maximum factored shear force determined by traditional structural analysis is compared to a shear resistance calculated using elementary beam theory.

When the CHBDC was created in 2000, the previous subcommittee took a different approach of addressing the influence of beam volume and loading pattern on the shear resistance of a glulam beam. Instead of accounting for this influence in the resistance equation like CSA O86, the previous subcommittee instead accounted for it in the demand using a concept referred to as the "shear load". The shear load, V_f, involved integrating the shear force diagram over the entire length of the beam, L, per equation (1),

$$V_f = 0.82\left[\frac{1}{L}\int_0^L |v(x)|^5 dx\right]^{0.2} \qquad (1)$$

where $|v(x)|$ is the absolute value of the factored shear force at a section at distance x along the beam. Physically, the shear load is the total horizontal shear force over the entire length of the beam resulting from the applied vertical loading. By using the shear load, the previous subcommittee enabled the glulam shear resistance to be calculated the same as for a sawn wood beam. In essence, by introducing the shear load to the CHBDC, the previous subcommittee reduced the difficulty of the shear resistance calculation relative to CSA O86 but increased the difficulty of the shear demand calculation.

The response to the shear load from the engineering community was generally one of confusion. In our experience, few engineers understood the physical meaning of the shear load and were deterred from undertaking its cumbersome calculation.

To eliminate any confusion surrounding the shear load, the current subcommittee is intending to eliminate the shear load and to implement the shear design approach used by CSA O86 for glulam beams. CSA O86 includes tables of precalculated values of the shear-load coefficient to reduce the difficulty of glulam shear resistance calculations. Table 7.12 of CSA O86, which is for this purpose, specifically includes a series of concentrated loads intended to represent a moving truck load. Unfortunately, the magnitude and relative position of the concentrated loads are different than the design truck loading mandated by the CHBDC. The S9 subcommittee is considering publishing a similar table in the commentary of the 2025 CHBDC to assist designers with the discrete point loads of the CL-625 and CL-625-ONT design trucks that form the basis of live load design in the CHBDC.

4.1.3 Size Effect Factor for Shear

Section 14 of the CHBDC concerns the evaluation of existing bridges. This section contains clauses concerning the resistance of wood members in existing structures. The Section 9 subcommittee was asked by the Section 14 subcommittee to review all Section 14 clauses pertaining to wood. Clause 14.14.1.7.2 concerns the size-effect factor for shear resistance calculations. The factor, k_{sv}, is defined in equation (2),

$$k_{sv} = \frac{75}{\sqrt{d}}\frac{1}{(1+2a/d)} \leq 2.5 \qquad (2)$$

where d is the member depth and a is the distance measured from the centreline of the support to the end of a split, if any split were to be present. The intent of this formula was to provide a means of assessing the effect of end splits observed in an existing wood member during a tactile inspection of the structure. The formula was carried over the OHBDC [10] and was first introduced in 1979 [25]. The formula was intended for sawn wood members. It was introduced at a time when glulam usage was rare in Canadian bridges. Sawn wood members are typically installed with high moisture contents. It is understood that they tend to develop end splits and checks as their moisture content reduces through in-situ seasoning. By using the formula, a designer that has physically inspected a sawn wood member can more accurately assess the shear resistance in the presence of any end splits.

The problem with the size effect factor in clause 14.14.1.7.2 is that it is only valid for beam and stringer grade and post and timber grade sawn wood members of Select Structural or No. 1 grade quality. No formula is provided for glulam members. This had led to some confusion amongst engineers. The Province of British Columbia published a supplement to the CHBDC in 2016 [29]. This supplement is intended to augment or override the CHBDC. This supplement overrides clause 14.14.1.7.2, indicating that the size-effect factor is also applicable to glulam members, which the subcommittee has observed to be problematic. The upper limit of 2.5, while appropriate for sawn wood members, produces excessively large shear resistances for glulam members. Accordingly, the Section 9 subcommittee is thinking of providing a size effect formula in clause 14.14.1.7.2 for glulam members, but with a lower upper limit. After review of the formula and comparison with a similar clause in AREMA, the subcommittee found an upper limit of 1.3 to be appropriate for glulam members. This proposed change is being considered by the subcommittee and has yet to be balloted for approval in the 2025 code.

4.2 Load-Sharing Factor

The member resistance equations in the CHBDC feature a variable called the "load-sharing factor", K_m. This factor is an augmented version of the "system factor", K_H in CSA O86. The system factor affords an increase in resistance for member arrangements in which it is unlikely that multiple members have a strength-reducing defect in the same cross-sectional plane. The load-sharing factor in the CHBDC also includes the beneficial effect of a member within a multiple member system to shed load to adjacent members when the individual member is nearing its ultimate failure. This benefit is based on the work of Sexsmith et al. [30] conducted at Forintek in 1979. For that research, laminated beams consisting of multiple 2x10 rough sawn dimension lumber laminations were transversely prestressed using prestressing bars and were tested to failure in four-point bending. The main finding was that the modulus of rupture for the laminated beams was greater than that observed for individual laminations tested to failure, implying non-linear material behaviour. This finding was used by Bakht and Jaeger [31] to develop an analytical procedure that became the calculation of the load-sharing factor in the CHBDC [10].

Table 9.5 of the CHBDC provides intermediate variables that allow for the calculation of the load-sharing factor for various wood systems, including nail-laminated decks, stress-laminated decks, wood-concrete composite decks, and sawn wood stringers. Of note, it does not provide guidance for glulam deck panels nor glulam beams. At present, it is known that some designers are calculating the load-sharing for glulam beams using the approach for sawn wood stringers. This practice is believed to be unconservative because the lesser variability in material properties for glulam relative to sawn wood is likely to limit any strength benefits arising from the presence of defects.

The subcommittee is currently working to develop the load-sharing factor for glulam deck panels and glulam beams. A large testing program is being undertaken by WRD to assist this process. The program is being co-funded by WRD and NRCan. The program will consist of testing 58 glulam beams to failure in four-point bending. Twenty-eight of the beams will be tested as individual beams to establish the 5th percentile lower exclusion limit. The remaining 30 beams will be used to construct five full-scale wood bridges. Each bridge will be comprised of five glulam beams spanning 40 ft (12.192 m) and spaced at 1200mm centres. The bridges will feature 130 mm thick transverse glulam deck panels and blocking. These bridges will all be tested to failure. The intent of the tests is to establish the load-sharing factor for glulam beams. Testing is anticipated to be undertaken in the spring of 2022, with the results published by the end of 2022. This testing program is believed to be the first of its kind internationally.

4.3 Glulam Deck Panels

The subcommittee is working to develop additional clauses to aid in the design of glulam deck panels. The intent is to provide at least a similar level of guidance to that provided in AASHTO.

At present, CSA O122 [32], the Canadian national standard for the manufacture of structural glulam members, prescribes glulam layups to achieve reliable material properties for glulam beams only. It does not address glulam deck panels. The experience of our subcommittee is that Canadian designers are sourcing deck panels from the United States and using the reference design material properties provided by the NDS. This practice presents a concern with respect to the NDS material properties and the calibration of the CHBDC. The subcommittee is intending to work with Canadian glulam manufacturers to obviate this concern by developing Canadian material properties for glulam deck panels for use with the CHBDC and CSA O86.

The subcommittee is also looking to advance clauses regarding live load distribution in glulam deck panels under discrete wheel loads. Bakht [33] developed design curves for this purpose in 1988. These curves were found to be applicable to stress-laminated decks as well. They were developed based on the work of McCutcheon and Tuomi [13] [14]. The curves were developed into closed-form equations in clause 5.7.3.2 in Section 5 of the CHBDC. Section 5 covers structural analysis. Unfortunately, clause 5.7.3.2 only speaks to stress-laminated decks and does not mention glulam decks. The Section 9 subcommittee is working with the Section 5 subcommittee to correct this issue. Furthermore, these subcommittees are working together to investigate the possibility of new equations that would reflect improved live load distribution. During the development of the OWBRG, it was observed that the live load distribution equations in AASHTO yielded much better distribution than the equations in clause 5.7.3.2 of the CHBDC. This effort is not expected to be completed quickly and may require an additional code cycle to complete.

The braking load calculation in the CHBDC provides the braking force for an entire bridge as a function of the total bridge length. This approach is sufficient for bridges with concrete decks, wherein the deck acts as a large diaphragm to distribute the load amongst the primary load carrying members. No guidance is provided, however, for discrete deck elements such as glulam deck panels. The Section 9 subcommittee has reached out to the Section 3 (loads) subcommittee for assistance on this matter, so that appropriate provision can be made for designing glulam deck panels for the in-plane shear forces and bending moments arising from braking loads. The OWBDG provides an interim design approach for calculating the braking load applied to a single deck panel.

4.4 Wood-Concrete Composites

Wood-concrete composites (WCCs) offer great potential to increase the span ranges of wood bridges. They have been the subject of significant research over the past decade. The CHBDC has historically included language on WCCs, but for a very specific pair of systems. Both systems consist of a longitudinal nail-laminated deck with a cast-in-place concrete topping. The difference lies in the wood-concrete interface. The first system features a series of grooves and daps fabricated in the tops of the wood laminations. The second system features a series of transverse grooves in the tops of the wood laminations with battered common spikes driven into the grooves. These systems were developed in the 1950's [34] and late 1970's [35] [36], respectively. They were rarely used in Canada, and few remaining examples exist in practice. The problem with these systems is that they rely on following a very narrow, prescriptive set of parameters, resulting in both systems having maximum span capabilities of about 6 m. This limitation has left them with little opportunity for use, other than for very short bridges, or as floor systems in truss bridges. The subcommittee is currently interested in retiring these designs to the code commentary and introducing new, flexible clauses for WCCs that is in line with modern research and design codes.

The subcommittees for CSA O86 have developed draft clauses for WCCs. These clauses reflect the state-of-the-art in WCC design. They are primarily based the approach provided in Annex B of Eurocode 5 for mechanically jointed beams and are intended for indoor structures. The Section 9 subcommittee is currently awaiting approval of these clauses by CSA O86. It is anticipated that they will be eventually adopted by the CHBDC, with modifications and additions as necessary to account for the additional challenges presented for outdoor structures such as large changes in temperature and moisture content.

4.5 Camber Requirements for Glulam Beams

The CHBDC currently requires glulam beams to be cambered for twice their unfactored dead load plus an additional one six-hundredth of the span length. The first component of the camber requirement implies a creep coefficient of 1.0. The second part of the camber requirement was added to provide additional protection against unsightliness resulting from excessive deflections [10]. Essentially, the one six-hundredth term was a conservative factor applied to correct for any design errors. Leading up to this current code cycle, requests were made to eliminate this one six-hundredth term because it further complicates the fit-up of connections caused by camber. The subcommittee is investigating this possibility, acknowledging that other codes, such as AASHTO, Eurocode 5, and AS 5100.9:2017 do not have such a requirement. In addition, the subcommittee is considering updating the 2025 CHBDC commentary clause for glulam camber to remind designers and fabricators of the need to adjust cambers to reflect other sources of deflection including connection stiffness, connection slip, changes in moisture content, and concrete creep and shrinkage for the case of WCCs.

4.6 Pedestrian Contact Preservative-Treated Wood

The CHBDC mandates the use of wood preservatives for all wood bridges. The code prescribes a list of permitted preservatives. It limits that list to a select of waterborne preservatives when the treated wood component is expected to receive "pedestrian contact". The definition of pedestrian contact has been a historically confusing term in the CHBDC, having never been defined in the code due to the difficulty in doing so. The subcommittee is currently working to define pedestrian contact so that the implications of its definition are in line with similar codes, particularly the AASHTO code. Of interest, glulam members are rarely treated with waterborne preservatives because of the resulting high moisture content and dimensional changes that typically ensue. Instead, they are usually treated using oil-borne preservatives. At present, a glulam member, such as a deck panel or a girder rising above the deck to also act as a barrier would effectively not be permitted for use in pedestrian bridges because of the possibility of direct pedestrian contact, unless the glulam member was made of an untreated naturally durable species. By defining pedestrian contact, there exists the possibility that glulam members could see increased usage in pedestrian bridges without having to be made of an untreated naturally durable species.

5 Conclusions

The Section 9 subcommittee of the CHBDC is working to update the code to reflect state-of-the-art advancements in wood bridge design. Advancements are being made with respect to the shear design of glulam beams, the load-sharing factor, glulam deck panels, wood-concrete composites, camber requirements for glulam beams, and pedestrian contact with preservative-treated wood. While the subcommittee has yet to affirm these advancements, many of them are anticipated to be balloted for approval for inclusion in the forthcoming 2025 edition of the CHBDC.

6 Acknowledgement

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