PERFORMANCE STANDARD CONSIDERATIONS FOR I-JOISTS USED IN RESIDENTIAL FLOOR CONSTRUCTION

Borjen Yeh, Ph.D., P.E.
Thomas G. Williamson, P.E.
Michael R. O'Halloran, Ph.D.
APA - The Engineered Wood Association, U.S.A.

SUMMARY

Prefabricated wood I-joists have been used in North American residential construction for more than 25 years. The total production volume for I-joists in North America has grown approximately 500% from 1989 to 1998. With such growth, the need for a performance-based standard emerged since consumers are seeking a product that is easy to specify, purchase, install, and inspect.

The first standard that addresses I-joists in North America is the method of testing, ASTM D5055, which provides the basis for any further standardization efforts. For the development of a performance-based standard, it was important that considerations be given to the appropriate attributes of the standard, differences between manufacturing approaches, and product performance levels based on the current state of acceptance in North America. The effort led by *APA - The Engineered Wood Association* to provide standardization for I-joists is reviewed in this paper. A span-rating system similar to what has been successfully used in North America for structural-use panels has been introduced to simplify engineering specification, job site installation, and field inspection. This paper gives background information on the development of the span-rating system and applicable mechanical properties.

1. INTRODUCTION

Prefabricated wood I-joists have been used in North American residential construction for more than 25 years. The total production volume for I-joists grew from 39.6 million linear meters (130 million linear feet) in 1989 to 191.1 million linear meters (627 million linear feet) in 1997, as shown in Figure 1. The majority of these I-joists, approximately 80%, have been used in new residential floor construction, as shown in Figure 2. This figure represents a market share of approximately 27% of all new framed residential floors constructed in 1997 and is expected to grow to 40% in 1999 [1].

This phenomenal growth provides an impetus for standardization. Prior to 1997, all I-joists manufactured in North America were considered

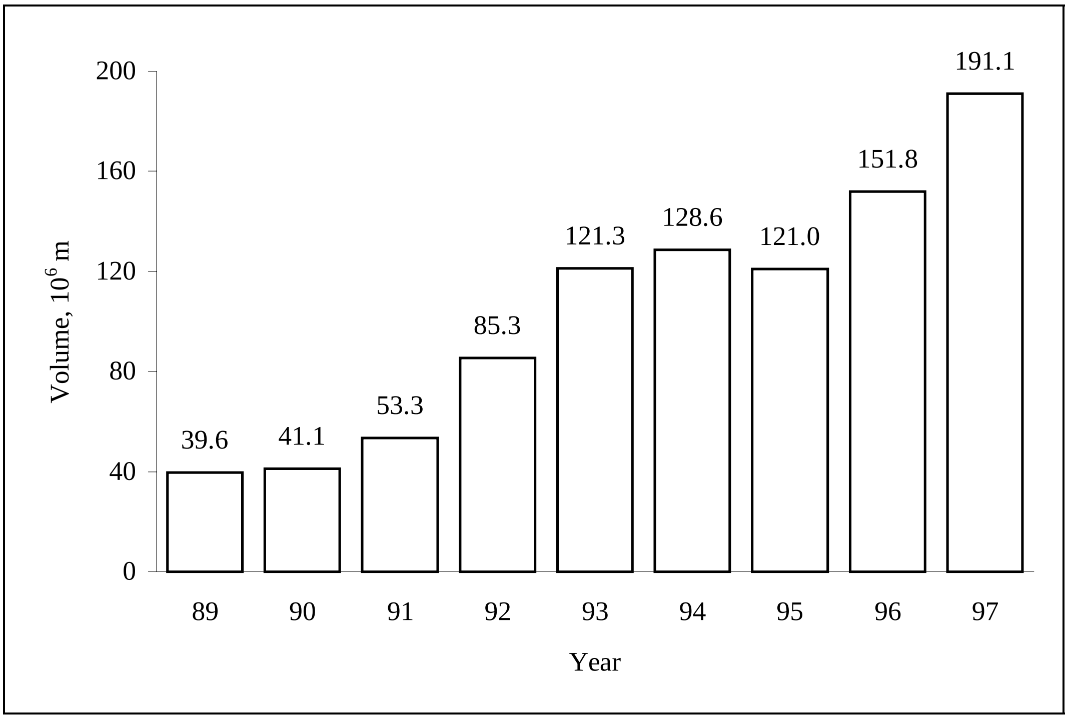

Figure 1. I-joist production volume in North America.

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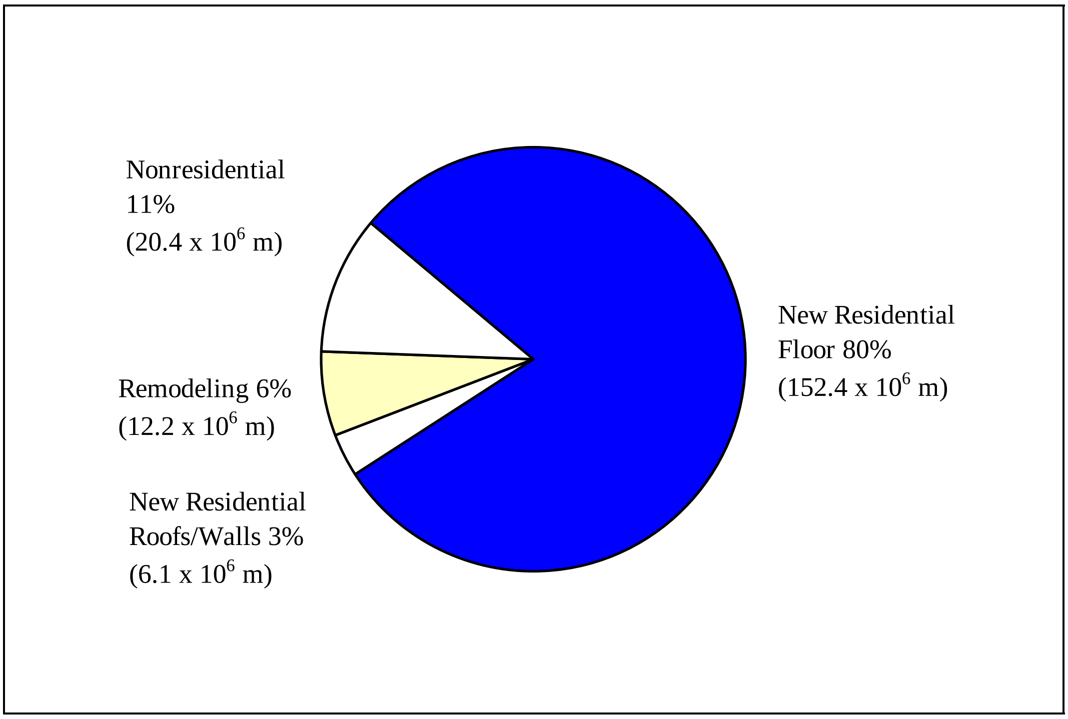

Figure 2. I-joist end uses in 1997.

proprietary, meaning that the I-joist design properties and permissible spans were dependent on the manufacturer who produced the products. As the design properties were proprietary, the installation details, permissible size and location of web holes, and cantilever extension details varied among different manufacturers. Moreover, it was not possible to substitute one product with another without an engineering verification.

However, a close comparison of similar I-joists produced by the top 10 manufacturers in North America reveals that the difference in the design properties is extremely finite. Nonetheless, due in part to this proprietary mentality, I-joists remain a product that is relatively difficult to specify, purchase, install, and inspect when compared to other generic engineered wood products, such as sawn lumber and structural glued laminated timber.

Surveys conducted by *APA - The Engineered Wood Association* showed that the vast majority of home builders and building officials supported the concept of I-joist standardization [2]. In July 1997, APA introduced a performance-based standard for residential floor I-joists, PRI-400 [3]. Since then, this standard has been reviewed and recognized by the evaluation service agencies of the major model building codes in the United States, including the Building Officials & Code Administrators International (BOCA), International Conference of Building Officials (ICBO), and Southern Building Code Congress International (SBCCI), and other local building code jurisdictions such as the New York City and the State of Wisconsin. This paper reviews the considerations that have been incorporated into the performance-based standard of PRI-400.

2. STATUS OF ACCEPTANCE

The first standard that addresses I-joists in North America is the method of testing, ASTM D5055 [4]. This national consensus standard provides the basis for any further standardization efforts in North America.

ASTM D5055 gives detailed requirements for the qualification tests of I-joists for use in establishing design properties. By following the procedures given in ASTM D5055, an I-joist manufacturer can evaluate and establish design properties for their products. However, as the performance levels meeting a specific market need are not given in the standard, it does not serve the purpose of providing any degree of uniformity for product performance.

All major model building codes in the United States have adopted ASTM D5055 for years as the basis for product recognition. This proprietary product recognition is typically obtained through a code-compliance evaluation report issued by an evaluation service agency of the major model building codes. The evaluation report is proprietary and requires a lengthy review of test data and supporting documents, such as the in-plant manufacturing standard or quality assurance manual. To standardize the product acceptance process, the ICBO Evaluation Service publishes an acceptance criteria for I-joists [5].
A similar protocol for I-joist code acceptance is also implemented in Canada. In March 1998, the

Canadian Standards Associations (CSA) published a supplement to CSA O86.1, *Engineering Design in Wood (Limited States Design)* [6], which formally recognized I-joists for the first time in the Canadian design codes. The basis for the I-joist recognition in CSA O86.1 is ASTM D5055. The code-compliance evaluation report is issued in Canada by the Canadian Construction Materials Centre (CCMC), which uses a similar process adopted by the evaluation service agencies in the United States.

Once the evaluation report is issued, the I-joist manufacturer is entitled to supply its products for construction use if the product quality satisfies the requirements specified in the in-plant manufacturing standard or quality assurance manual on an on-going basis. Periodic in-plant quality audits by an independent qualified agency retained by the manufacturer is required by the code for quality assurance purpose. In addition, most manufacturers provide technical support to help end users properly specify and use their products.

This system appears to work well for most I-joist manufacturers in North America. However, while the I-joist design properties for each manufacturer are similar, they are proprietary and as such, it is difficult to interchange the products produced by various manufacturers. This complicates the specification and purchase of I-joists, thereby reducing their ready availability for home builders. From the building inspector's perspective, the multiplication of permissible spans and installation details for similar I-joists supplied by different manufacturers makes the job site inspection challenging. It is natural for the building inspectors to express their interest in a performance standard that gives one set of standard spans and rules for installation. In an effort to overcome some of these issues, APA initiated an I-joist standardization effort in 1993, which ultimately resulted in the publication of the *Performance Standard for APA EWS I-Joists*, PRI-400, in 1997 [3].

3. STRESS CLASSES

Prefabricated wood I-joists are relatively more complicated to design than prismatic members. In a floor joist that is subjected to uniform live and dead loads, the I-joist designer is required to check the structural adequacy of not only the moment capacity (M), shear capacity (V), and deflection, but the capacities at end (ER) and intermediate bearing (IR) locations. The I-joist deflection calculation must include both flexural and shear deflections.

The first challenge in establishing a performance-based standard is to specify a set of design properties using stress class systems. Ideally, the performance standard should only specify the performance levels without any prescriptive requirements on the raw materials. However, this goal is not easy to achieve when considering the variety of materials available for use as flanges and webs of I-joists. For example, the moment capacity and stiffness of an I-joist made with sawn lumber flanges are likely to be different from another I-joist of the same depth, but made with laminated veneer lumber (LVL) of similar size. Similarly, the shear capacity of an I-joist depends on the thickness and type of web materials, which can be made of plywood or oriented strand board (OSB). Therefore, as a starting point, it was determined that the stress class systems must at least encompass the predominant I-joists that had gained market place acceptance. In addition, the systems must be flexible so as to readily accommodate the product innovation that occurs in the I-joist industry on a routine basis.

The I-joist industry in North America has evolved, through the manufacturing, engineering, and marketing experience gained over the past 25 years, to such an extent that most design properties have been greatly optimized. In other words, for a given combination of flange and web materials, it is possible to estimate the attainable I-joist design properties. This simplifies the stress class systems to the selection of a series of flange and web types, grades, and sizes. This task was accomplished by consultation with existing APA I-joist producing members and information research on the predominant products available in the market place.

Table 1 shows the characteristic values for the various mechanical properties of the 19 stress classes published in PRI-400 and the flange dimension for each stress class. The characteristic values represent the lower 5th percentile estimates with 75% confidence based on test data except that the flexural stiffness (EI) and shear deflection coefficient (K) represent the mean test values. For use in the allowable stress design in the United States, these characteristic values should be reduced by the factors given in the bottom row of Table 1. All flange thickness was assumed to be at least 38 mm (1-1/2 in.).

Note that although the flange dimensions for the PRI-150 and PRI-15 series, and PRI-30 and PRI-32 series are the same, the moment capacity and flexural stiffness for the same joist depth are different. This is a result of using different flange grades in developing these stress classes.

Joist designation (Series)	Joist net depth, mm	Flange width,[a] mm	EI,[b] 10^6 kN•mm^2	M,[c] kN•mm	V,[d] kN	IR,[e] kN	ER,[f] kN	K,[g] kN
I x 10 - C2 (PRI-150)	241	38	416	5716	11.8	19.8	8.5	21973
I x 10 - C4 (PRI-15)	241	38	462	7973	11.8	20.1	10.0	21973
I x 10 - C6 (PRI-25)	241	44	534	9370	11.8	21.5	10.7	21973
I x 12 - C8 (PRI-150)	302	38	726	7621	15.0	19.8	8.5	27489
I x 12 - C10 (PRI-15)	302	38	804	10584	15.0	20.1	10.0	27489
I x 12 - C12 (PRI-25)	302	44	924	12462	15.0	21.5	10.7	27489
I x 14 - C14 (PRI-25)	356	44	1378	15235	18.0	21.5	10.7	32381
I x 14 - C16 (PRI-35)	356	59	1759	20279	18.0	24.6	12.2	32381
I x 16 - C18 (PRI-25)	406	44	1903	17859	20.8	21.5	10.7	37007
I x 16 - C20 (PRI-35)	406	59	2414	23777	20.8	24.6	12.2	37007
I x 10 - S2 (PRI-30)	241	64	554	5980	11.4	22.8	11.4	21973
I x 10 - S4 (PRI-32)	241	64	663	9241	11.4	22.8	11.4	21973
I x 12 - S6 (PRI-30)	302	64	947	8007	14.6	26.4	12.7	27489
I x 12 - S8 (PRI-32)	302	64	1137	12346	14.6	26.4	12.7	27489
I x 12 - S10 (PRI-42)	302	89	1570	17459	14.6	29.1	13.5	27489
I x 14 - S12 (PRI-32)	356	64	1676	15153	18.0	26.4	12.7	32381
I x 14 - S14 (PRI-42)	356	89	2302	21432	18.0	31.8	13.5	32381
I x 16 - S16 (PRI-32)	406	64	2293	17798	20.8	26.4	12.7	37007
I x 16 - S18 (PRI-42)	406	89	3134	25188	20.8	31.8	13.5	37007
Reduction Factor for Allowable Stress Design			1.0	2.1	2.37	2.37	2.37	1.0

[a] Assumed flange width only for the purpose of developing the stress classes.
[b] Bending stiffness (EI) of the I-joist.
[c] Moment capacity (M) of a single I-joist.
[d] Shear capacity (V) of the I-joist with a bearing length of 102 mm (127 mm for C14 and C18). For shear values over 16.3 kN, web stiffeners are required.
[e] Intermediate reaction (IR) of the I-joist with a minimum bearing length of 89 mm without web stiffeners.
[f] End reaction (ER) of the I-joist with a minimum bearing length of 44 mm without web stiffeners.
[g] Shear deflection coefficient (K).
Conversion factors: 1 in. = 25.4 mm; 1 lbf = 4.448 N; 1 lbf-ft = 1.3558 kN•mm; 1 lbf-in.^{2} = 2.8697 kN•mm^2

Table 1. Characteristic values for performance-rated I-joists.

Figure 3 shows the relationship between the I-joist shear capacity and joist depth. As expected, the I-joist shear capacity increases with increased joist depth in a linear manner. The slightly lower shear capacities for the PRI-30, 32, and 42 series I-joists in the joist depths of 241 and 302 mm (9-1/2 and 11-7/8 in.) reflect the grade limitation accepted by some APA I-joist producing members using sawn lumber flanges. These low values are expected to be brought up in line with the other series of I-joists in the next revision of PRI-400. The other properties were developed based on similar considerations using different relationship models (e.g., moment capacity increases linearly with increased joist depth squared in the same joist series).

It should be noted that the stress classes established in Table 1 are performance-based. In other words, any I-joists that meet or exceed all of the tabulated values for a given stress class can be qualified for that specific stress class regardless of the actual type, grade, and size of the web and flange materials used, provided the materials meet the durability requirements specified in PRI-400.

4. SPAN-RATING SYSTEM

A significant benefit of a performance-based standard, such as PRI-400, is that one set of permissible spans can be established for I-joists produced by different manufacturers. This approach is helpful to designers and specifiers who can easily select the appropriate joists once the building geometry is set with the understanding that a number of different manufacturers will be able to supply the I-joists specified. It is also helpful to building officials as the permissible spans can be included in the trademark and building inspectors can quickly verify the proper application of the I-joists at the job site.

This so-called span-rating system has been successfully used in North America for structural-use panels for years. Table 2 shows the permissible spans for I-joists used in residential floor construction in the United States based on the design properties of PRI-400 I-joists, and a design dead load of 0.48 kPa (10 psf) and live load of 1.92 kPa (40 psf), as typically used in this type of

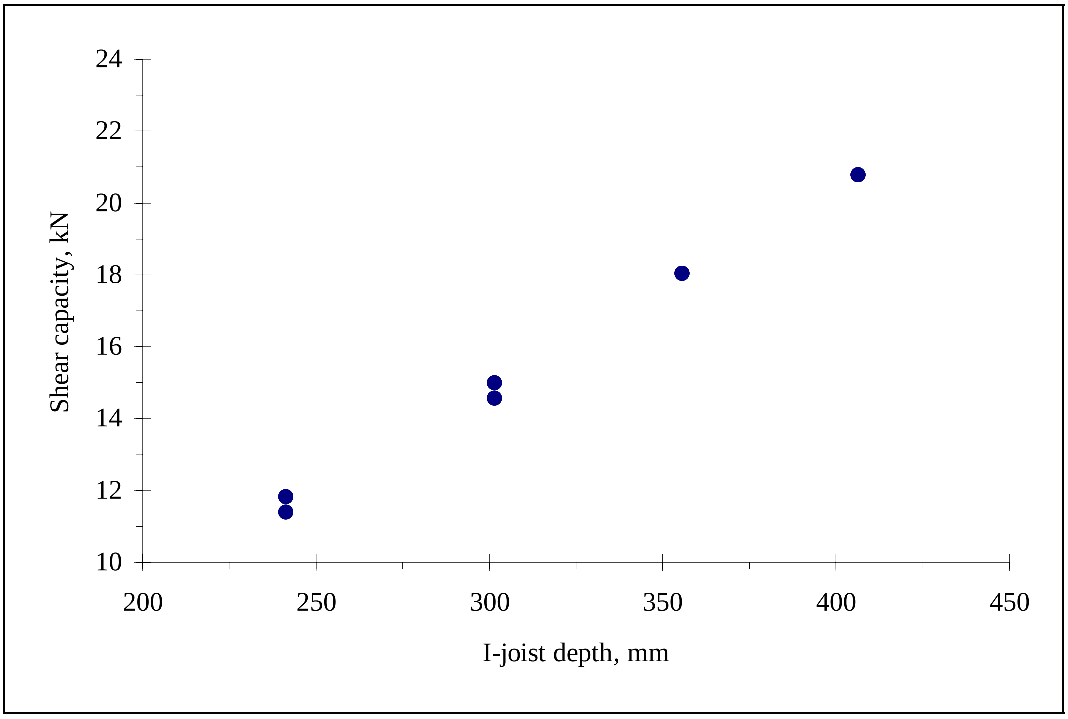

Figure 3. I-joist shear capacity vs. joist depth.

construction. It is to be noted that the span ratings given in Table 2 were developed using a live load deflection criterion of span/480, which is more restrictive than the normally acceptable criterion of span/360 and is expected to improve the floor performance.

In addition to the requirements mentioned above, the span ratings are established based on the premise that the floor system meets the following conditions:

- The floor panels should meet the requirements for APA Rated Sheathing or APA Rated STURD-I-FLOOR conforming to PRP-108 [7], PS 1 [8], or PS 2 [9] with a minimum thickness of 15 mm (19/32 inch) (40/20 or 20 oc) for a joist spacing of 488 mm (19.2 inches) or less, or 18 mm (23/32 inch) (48/24 or 24 oc) for a joist spacing of 610 mm (24 inches). Adhesive should meet the requirements given in ASTM D3498 [10].
- Mechanical properties of the floor I-joists should meet the requirements for the performance-rated I-joists, as given in Table 1.
- The floor panels should be glued and nailed to the I-joists based on the nailing schedule required by the governing building code.
- The floor system should contain no less than 3 I-joists.

As a result, the parameters given below were used to develop the permissible spans given in Table 2:

- Design values (EI and EA) for floor panels were in accordance with APA Technical Note N375B [11], and the lower value obtained from APA Rated Sheathing and APA Rated STURD-I-FLOOR was used.
- The shear deflection coefficient , K, was set equal to 91.1 kN/mm (0.52 x 10^6 lbf/in.) times the net I-joist depth. The development of this value is given in the following section.
- The glued floor construction factor was set equal to 0.45 for calculating the composite floor EI [12].

If the floor system does not conform to the requirements given above, the permissible span may be calculated using the capacities given in Table 1 and the parameters identified above.

In accordance with the span-rating system and the capacity values given in Table 1, the I-joists produced by various manufacturers qualified under the performance standard become interchangeable for a given joist designation. This can significantly increase the availability of I-joists, which in turn could further increase the market share of I-joists in North America.

5. SHEAR DEFLECTION COEFFICIENT

The total deflection of an I-joist can be calculated using Equation 1.

$$\delta_t = \delta_b + \delta_s \qquad \text{[Eq. 1]}$$

where:

Joist Designation (Series)	Clear Span (mm) with Simple- or Multiple-Span Floor I-Joist Spacing of (o.c.)			
	305 mm	406 mm	488 mm	610 mm
I x 10 - C2 (PRI-150)	4928	4496	4242	3835
I x 10 - C4 (PRI-15)	5182	4724	4470	4140
I x 10 - C6 (PRI-25)	5410	4928	4648	4318
I x 12 - C8 (PRI-150)	5867	5359	4953	4445
I x 12 - C10 (PRI-15)	6172	5613	5309	4572
I x 12 - C12 (PRI-25)	6426	5867	5537	4902
I x 14 - C14 (PRI-25)	7315	6655	6147	4902
I x 14 - C16 (PRI-35)	7899	7188	6756	5613
I x 16 - C18 (PRI-25)	8103	7391	6147	4902
I x 16 - C20 (PRI-35)	8738	7950	7036	5613
I x 10 - S2 (PRI-30)	5486	4928	4496	4013
I x 10 - S4 (PRI-32)	5791	5283	4978	4674
I x 12 - S6 (PRI-30)	6553	5715	5207	4648
I x 12 - S8 (PRI-32)	6909	6299	5944	5563
I x 12 - S10 (PRI-42)	7595	6909	6502	6071
I x 14 - S12 (PRI-32)	7849	7163	6756	6020
I x 14 - S14 (PRI-42)	8611	7849	7391	6909
I x 16 - S16 (PRI-32)	8712	7950	7493	6020
I x 16 - S18 (PRI-42)	9550	8687	8204	7290

(a) Clear span applicable to simple- or multiple-span residential floor construction with a design dead load of 0.48 kPa (10 psf) and live load of 1.92 kPa (40 psf). For multiple-span applications, the end spans shall be 40% or more of the adjacent span. The live load deflection is limited to span/480.

(b) Spans are based on a composite floor with glued-nailed sheathing meeting the requirements for APA Rated Sheathing or APA Rated STURD-I-FLOOR conforming to PRP-108 [7], PS 1 [8], or PS 2 [9] with a minimum thickness of 15 mm (40/20 or 20 oc) for a joist spacing of 488 mm or less, or 18 mm (48/24 or 24 oc) for a joist spacing of 610 mm. Adhesive shall meet the requirements given in ASTM D3498 [10].

(c) Minimum bearing length shall be 44 mm for the end bearings, and 89 mm for the intermediate bearings.

(d) Web stiffeners are not required when I-joists are used with the spans and spacings given in this table, except as required by hanger manufacturers and over supports at load-bearing cantilever locations.

Conversion factor: 1 in. = 25.4 mm

Table 2. Span ratings for performance-rated I-joists for use in the United States.[a,b,c,d]

δ_t = total deflection (mm),
δ_b = flexural deflection (mm), and
δ_s = shear deflection (mm).

The shear deflection of an I-joist is significant when compared to a prismatic structural member of the same dimension, and therefore should not be ignored when calculating the total deflection under service loads. The shear deflection of an I-joist is customarily calculated based on Equation 2.

$$\delta_s = \frac{8\ M}{K} \qquad \text{[Eq. 2]}$$

where:
M = maximum moment (kN•mm) and
K = shear deflection coefficient (kN).

For I-joists using the same web materials, the shear deflection coefficient, K, can be considered linearly correlated to the I-joist depth (d), regardless of the flange grades and sizes used in residential floor construction. Based on the methodology given in the *Plywood Design Specification Supplement 2: Design and Fabrication of Glued Plywood-Lumber Beams* [13], Table 3 provides a list of theoretical K/d ratios for different flange widths and grades with a 9.5-mm (3/8-inch) thick web made of APA Rated OSB (either Structural I or non-Structural I) or Structural I plywood. Note that the lower the K/d ratio, the more significant the effect of shear deflection will be on the calculated total floor deflection (see Eqs. 1 and 2).

As shown in Table 3, the lowest theoretical K/d ratio when using an OSB web is 101.6 kN/mm (0.58 x 10^6 lbf/in.). A judgment was made to tabulate the K/d ratio at 90% of this lowest theoretical value or 91.1 kN/mm (0.52 x 10^6 lbf/in.) in PRI-400. For simplicity, this value applies to I-joists using either plywood or OSB webs. Therefore, the published K value is, respectively, 21973 kN (4.94 x 10^6 lbf), 27489 kN (6.18 x 10^6 lbf), 32381 kN (7.28 x 10^6 lbf), and 37007 kN (8.32 x 10^6 lbf) for the I-joist depths of 241 mm (9-1/2 in.), 302 mm (11-7/8 in.), 356 mm (14 in.), and 406 mm (16 in.).

Joist net depth (mm)	K/d ratio (kN/mm) with a flange[a] width of				
	38 mm	44 mm	59 mm	64 mm	89 mm
OSB[b] Web					
241	103.3	103.3-105.1	106.8	106.8-108.6	108.6-110.3
302	101.6-103.3	103.3	105.1	105.1-106.8	106.8-108.6
356	101.6	103.3	105.1	105.1	106.8
406	101.6	101.6-103.3	103.3-105.1	105.1	106.8
Structural I Plywood[c] Web					
241	43.8-45.5	45.5	45.5	45.5	47.3
302	43.8	43.8	45.5	45.5	45.5
356	43.8	43.8	43.8	43.8	45.5
406	43.8	43.8	43.8	43.8	45.5

[a] Assumed 38-mm thick flanges with an MOE ranging from 11.7 - 15.2 GPa (1.7 to 2.2 x 10^6 psi).
[b] Assumed a 9.5-mm thick APA Rated OSB (either Structural I or non-Structural I) web with a shear-rigidity-through-thickness (G_vt_v) of 13.6 kN/mm (77,500 lbf/in.).
[c] Assumed a 9.5-mm thick APA Rated Structural I plywood web with a shear-rigidity-through-thickness (G_vt_v) of 5.7 kN/mm (32,500 lbf/in.).
Conversion factors: 1 in. = 25.4 mm; 1 lbf/in. = 1.751 x 10^{-4} kN/mm

Table 3. Theoretical K/d ratios.

Note that although the use of the K/d ratio of 91.1 kN/mm (0.52 x 10^6 lbf/in.) may appear to be non-conservative for I-joists made of plywood webs, this matter is actually resolved at the time of I-joist qualification. According to ASTM D5055, the calculated I-joist total deflection, including both flexural and shear deflections, must be substantiated by full-scale flexure tests. In reality, the I-joists made of plywood web need to have a flexural EI value that is slightly higher than the EI tabulated in Table 1 in order to compensate for the higher shear deflection and to satisfy the qualification requirements for the specific stress class. This process can be readily handled by the qualification procedures and remains transparent to the designer who does not have to be concerned about this detail.

6. QUALITY ASSURANCE

To implement PRI-400 in a consistent manner for all APA I-joist producing members, a companion document that addresses the very critical quality assurance aspect of the standardization effort, the *Quality Assurance Policy for APA EWS Performance-Rated I-Joists*, has also been published [14]. In this QA Policy, requirements for sampling, testing, data analysis, and acceptance criteria for each type of I-joist qualification test, flange qualification, web characterization, supplier change qualification, and on-going QA are clearly identified. As a supplement to the QA Policy, the *Test Setup for I-joist Qualification* [15] has also been published to provide detailed information for each type of I-joist qualification test required by ASTM D5055 and PRI-400. These publications have been reviewed and accepted by all of the evaluation service agencies of the major model building codes in the United States.

7. OTHER CONSIDERATIONS

Other efforts that have been or are being considered in conjunction with the PRI-400 standardization effort include, but are not limited to, the following:

- Floor vibration -- Even though PRI-400 does not directly address floor vibration issues, it adopts a relatively restrictive live load deflection criterion of span/480, as mentioned earlier in Section 4. Given that this enhanced deflection criterion alone will not solve all serviceability problems that are related to floor vibration, APA is considering adopting one or more recommendations proposed by various research institutions for minimizing floor vibrations as possible improvements to the existing standard. In the meantime, APA is developing a version of PRI-400 for use in Canada based on limit states design, in which the vibration criteria adopted by CCMC of Canada will be included.
- Installation details -- Installation of an I-joist requires more attention than a conventional sawn lumber joist. For examples, the location and size of a web hole that allows the passage of utility pipes through the I-joist web, and the requirements for I-joist reinforcement under concentrated loads or cantilevered conditions are customarily required to be pre-engineered. As all I-joists qualified under PRI-400 have the same design properties for each stress class, one set of installation details, as provided in the APA *Design and Construction Guide: I-Joists for Residential Floors* [16], can be applied to all I-joists produced by various manufacturers, thereby simplifying the interchange of I-joists. As the designers and home builders gain familiarity with these details, the possibility of product mis-application and the need for technical support can be greatly reduced.

- Fire and noise rating -- Fire and noise-rated floor assemblies are usually required for multi-family dwellings in the United States and Canada. There are several design options that are currently available for fire and noise-rated floor assemblies that combine PRI-400 I-joists and wood structural-use panels [16]. In working with the fire and acoustics testing laboratories in North America, APA is currently seeking other alternative designs that could provide more efficient use of I-joists in floor assemblies.

8. FINAL REMARKS

The phenomenal growth of prefabricated wood I-joists in North America during the last decade and the demand for simplifying the specification, purchasing, installation, and field inspection of these products provide an impetus for product standardization. The PRI-400 performance-rated standard introduced by APA in 1997 uses the stress-class and span-rating systems to meet these needs. The obvious benefits for such a standard are the ease of specifying and purchasing I-joists that are interchangeable among manufacturers qualified under the performance standard. This should increase product availability and lead designers to specify more I-joist framing systems, and thereby enhancing the competitiveness of I-joists with other building materials. In addition, one set of installation rules could reduce the potential of product mis-application and minimize the need for technical support. Moreover, the span-rating system included in the trademark could be very helpful for the inspection of buildings constructed with I-joists.

This standard has just been introduced to the I-joist industry in North America during the past 2 years and several areas of improvement to the standard are being considered. Nonetheless, the demand for the standard has been strong, as demonstrated by the fact that the number of manufacturers adopting the standard has increased from 4 plants in 1997 to 11 plants in 1998. Among them, several are brand new facilities with automated high speed production capabilities. It can be anticipated that more manufacturers will come to adopt this standard in the next few years, especially when the specifiers and designers begin to realize the advantages of using this performance standard.

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