RESEARCH REPORT

Feasibility Study: Developing a Guide for Engineered Wood I-Joist Floor Systems

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Feasibility Study: Developing a Guide for Engineered Wood I-Joist Floor Systems

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Executive Summary

There are currently over ninety (90) I-joist products available, produced by seventeen (17) North American manufacturers. Each manufacturer produces installation guides complete with span tables, details, and other information for their proprietary products. The number of different products available, each with their own proprietary details has led to some confusion in the building industry. As I-joist popularity continues to increase, there are concerns that this confusion could result in structural failures.

The Canadian Home Builders' Association approached Canada Mortgage and Housing Corporation (CMHC) with a request to consider the development of a generic guide for engineered wood I-joist floor systems for the residential construction industry. Buchan, Lawton, Parent Ltd was retained by CMHC to conduct a feasibility study on the development of such a guide.

The review of manufacturers' literature revealed that the breadth and types of information available varied widely from one product to the next.

Builders, manufacturers, manufacturers' associations, building officials and representatives of various organizations including the Canadian Home Builders' Association were contacted for feedback and input into the development of a generic guide. A short survey, in the form of a questionnaire, was given by phone, fax or electronic mail with specific questions for each group.

Overall, there was strong support from the various stakeholders for the development of a generic I-joist guide. A number of organizations also indicated that they would be willing to financially support the project and/or help with the development of the guide by providing generic details or by committing time to the production.

The strongest support of any group came from building officials across Canada. Building officials see the guide as something that could inform not only the framing crews but also the sub-trades who occasionally seriously misuse the products.

In general, the manufacturers supported the development of a guide. Some manufacturers, however, had reservations, stating that a generic document would drive the industry to the lowest common denominator. For this reason, all were in agreement that product performance aspects should not be incorporated into the guide.

Following a review of available information and feedback from the various stakeholder groups, we believe that a generic guide for I-joist installation in residential construction is a feasible project for CMHC to undertake.

Based on stakeholder input, the guide should cover:

- general I-joist information, such as; performance and environmental advantages over dimension lumber;
- special design and installation considerations when using engineered wood I-joists;
- generic details;
- proper use of framing hardware and blocking; and,
- storage and handling recommendations.

Résumé - Solives de bois en I

Il existe présentement plus de quatre-vingt-dix (90) sortes de solives de bois en I dans le commerce, produites par dix-sept (17) fabricants nord-américains. Chaque fabricant produit des guides complets accompagnés de tableaux des portées, détails d'exécution et autres renseignements touchant ses produits exclusifs. Le nombre de différents produits offerts, chacun étant assorti de détails d'exécution exclusifs, a semé de la confusion au sein de l'industrie de la construction. Comme la popularité des solives en I ne cesse de croître, on craint que cette confusion n'entraîne des défaillances structurales.

L'Association canadienne des constructeurs d'habitations a présenté à la Société canadienne d'hypothèques et de logement (SCHL) une demande l'invitant à envisager l'élaboration d'un guide générique portant sur les solives de plancher en bois préfabriquées en I destiné à l'industrie de la construction résidentielle. La SCHL a donc mandaté le cabinet Buchan, Lawton et Parent Ltd pour mener une étude de faisabilité concernant la création d'un tel guide.

Le dépouillement de la documentation des fabricants révèle que l'étendue et le type de renseignements offerts varie largement d'un produit à l'autre.

Les constructeurs, les fabricants, les associations de fabricants, les agents du bâtiment et les représentations de différents organismes, dont l'Association canadienne des constructeurs d'habitations, ont été rejoints et invités à faire connaître leurs réactions quant à la création d'un guide générique. Un court questionnaire d'enquête transmis par téléphone, par télécopieur et par courrier électronique, posait des questions précises à chacun des groupes.

Dans l'ensemble, les divers groupes cibles ont appuyé fortement la création d'un guide générique pour les solives en I. Certains organismes ont également indiqué qu'ils seraient disposés à soutenir financièrement le projet et / ou à contribuer à la création du guide en offrant des détails d'exécution génériques ou en consacrant du temps à la production du guide.

L'appui le plus fort est venu des agents du bâtiment de tout le Canada. En effet, les agents du bâtiment considèrent le guide comme un produit d'information destiné non seulement aux équipes s'occupant d'exécution de la charpente mais également aux sous-traitants qui à l'occasion font un usage contre-indiqué des produits.

En général, les fabricants appuient la création d'un guide. Certains expriment toutefois des réserves, déclarant qu'un document générique amènerait l'industrie au plus petit commun dénominateur. C'est pourquoi, tous conviennent d'affirmer que le guide ne doit pas traiter de la performance des produits.

Après avoir étudié les renseignements disponibles et les réactions des différents groupes cibles, nous estimons qu'un guide générique portant sur la mise en oeuvre des solives en I dans la construction résidentielle est un projet faisable pour la SCHL.

D'après l'apport des groupes cibles, le guide devra offrir :

- des renseignements généraux sur les solives en I, notamment sur les avantages en matière de performance et d'environnement par rapport aux bois de construction de dimensions courantes;
- des considérations spéciales de conception et de mise en oeuvre au moment de recourir à des solives préfabriquées en I;
- des détails d'exécution génériques;
- l'utilisation tout indiquée de la quincaillerie de charpente et des entretoises;
- des recommandations en matière d'entreposage et de manutention.

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INTRODUCTION

Engineered wood is making a significant contribution to improving the construction of Canadian homes and, at the same time, reducing our use of large dimension lumber. Engineered trusses, joists and composite wood products have made it possible to build a better house using nothing larger than 2 X 6 dimension lumber.

Wood floor joists are one building component where engineered wood provides tremendous advantages. Engineered wood I-joists are commonly used in new home construction today. Builders like them because they can span greater distances, produce strong, stiff, stable and level floor systems and are lighter and easier to work with. Society likes them because they often use wood fibres from under-utilized tree species thus reducing our use of old growth trees. Homeowners like them because they avoid squeaks and are less likely to warp.

The design of the wood I-joist is efficient at utilizing wood fibre in an optimum manner. The geometry of the "I" cross-section is created with a top and bottom flange connected by a web section. Flanges, made of dimension lumber or structural composite lumber, are designed to resist bending forces and provide stiffness to the product. The web section, typically made of plywood or oriented strand board (OSB), is designed to withstand shear forces in the joist.

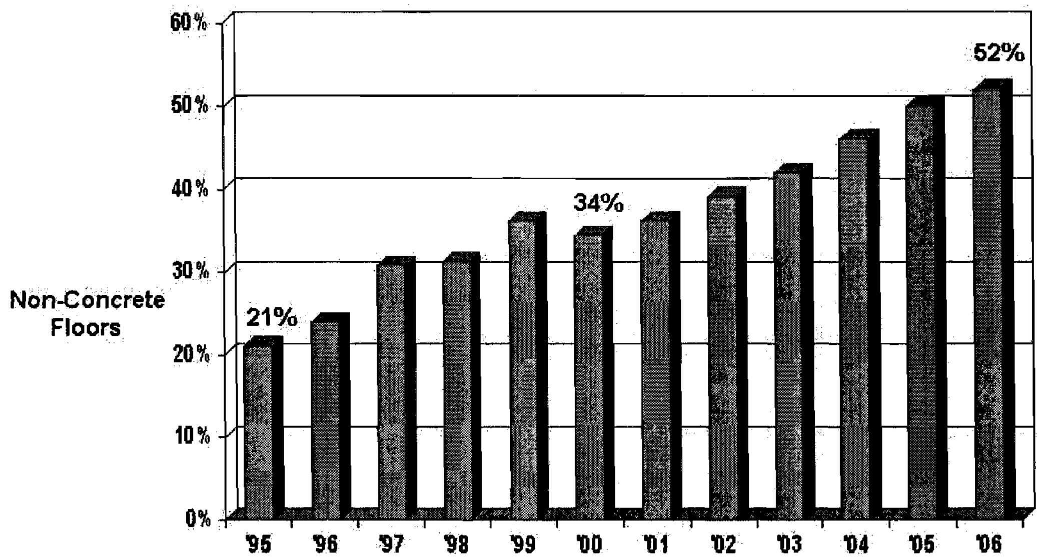
The efficiencies obtained through the use of an "I" cross-section require additional considerations beyond those of solid rectangular sections. Special attention must be taken with regard to end and interior reaction capacity, shear capacity, deflection, connector compatibility, vertical load transfer at points of bearing, web holes, flange notching and floor performance.

Prefabricated wood I-joists are specialized products, manufactured with specially designed equipment. Expertise in adhesives, wood products, manufacturing, and quality assurance are necessary ingredients for the production of high-quality prefabricated wood I-joists.

The unique manufacturing techniques, the variety of materials used as well as dimensional differences, result in design values that are proprietary to each manufacturer.

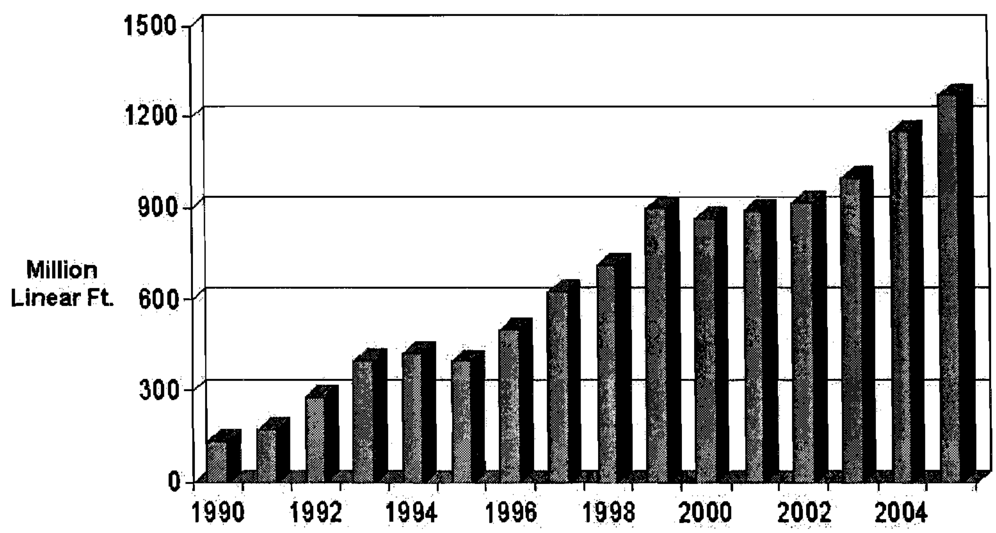
Currently, each engineered wood I-joist manufacturer has developed span tables, design properties, installation instructions and details for their own products. Although the products are similar, the level of detail in the manufacturer literature and the way in which it is presented varies widely from manufacturer to manufacturer. As I-joist popularity continues to rise (see Figures 1 and 2) and builders shift between the use of traditional joists and engineered wood I-joists manufactured by different manufacturers, there may be misunderstandings as to appropriate use and installation techniques for the various products.

Figure 1 - I-Joist Market Share - U.S. Single Family



APA-The Engineered Wood Association. January, 2001.

Figure 2 - North American I-Joist Production Trends



APA-The Engineered Wood Association. January, 2001

The Canadian Home Builders Association and Canada Mortgage and Housing Corporation have recognized this problem. The CHBA has suggested a generic guide be developed for engineered wood I-joist floor systems for the residential construction industry.

This report examines the feasibility of the development of such a generic wood I-joist guide.

EXISTING INFORMATION

Buchan, Lawton, Parent Ltd conducted a literature and internet search to identify any existing generic guides or best practice manuals for engineered wood I-joist floor systems.

This section summarizes the contents of two I-joist documents; The Engineered Wood Association's (APA) *Performance Rated I-Joists* and sections of the American Forest & Paper Association's (AF&PA) *Allowable Stress Design Manual for Engineered Wood Construction - Wood I-Joists.*

APA Performance Rated I-Joists

APA Performance Rated I-Joists (APA guide) is a design / construction guide published by the Engineered Wood Association, see Appendix A. The guide is intended for use with performance rated I-joists (PRIs), manufactured in conformance with APA's *Performance Standard for APA EWS I-Joists, PRI-400.*

The guide covers information on selecting, specifying and installing APA performance rated I-joists (PRIs). Information in the document includes:

- allowable spans;
- product substitution;
- ordering APA PRIs;
- typical floor framing and construction details;
- fire and acoustical design; and,
- other information including; storage and handling, web stiffeners, web hole specifications, etc.

Today, approximately 20% of the I-joist production in North America is done in conformance with the APA standard and, as such, falls under the scope of APA's design and construction guide. According to a March 2000 article in Fine Homebuilding, *The Argument for I-Joists*, this small number of participating member mills is mainly due to:

1. manufacturers' unwillingness to support a standard that they believe will drive products to the lowest common denominator;
2. concern that span listings stamped on the I-joist itself may lead to overlooking or ignoring special installation instructions, such as point loads, offset loads and fastening schedules; and,
3. concern that manufacturers will no longer be in a position to provide homeowners with warranties for their system since the guide promotes the benefit of being able to interchange I-joists from various members bearing the APA PRI standard.

The article, *The Argument for I-Joists,* is appended to this report in Appendix B.

AF&PA's *Allowable Stress Design Manual for Engineered Wood Construction - Wood I-Joists*

The American Forest & Paper Association's wood I-joist guideline to the *ASD Manual for Engineered Wood Construction*, see Appendix A, contains data and information on terms, design conditions, adjustment factors, reference design values and typical installation details for wood I-joists. The guideline outlines:

1. General product information;
2. Design values;
3. Design adjustment factors;
4. Design examples;
5. Supplemental design considerations; and,
6. Typical installation details.

Whereas AF&PA's manual has more technical information than APA's guide, the APA guide tends to better promote the use of I-joists (specifically APA PRIs) and facilitates specification of such products. Due to the fact that APA's guide is for use with products that have met a performance standard, it also includes design values, span tables and hole charts while AF&PA's refers the user to manufacturer literature.

EVALUATION OF MANUFACTURERS' INFORMATION

Currently, there are at least seventeen wood I-joist manufacturers in North America:

Boise Cascade Corporation
Cumberland Wood Industries Ltd.
DF Joists
Georgia Pacific Corporation
Jager Industries
Louisiana Pacific
Nascor Inc.
Norbord
Pacific Woodtech Corporation
Poutrelles Internationales
Roseburg Forest Products Company
Superior Wood Structures Ltd.
Superior Wood Systems Inc.
Standard Structures Inc., (SSI) *
Stark Truss Company Structures Inc.
Trus Joist, a Weyerhauser Business
Willamette Industries

*SSI is the only manufacturer in this listing that does not currently supply products to Canada

Collectively these manufacturers produce over ninety I-joist products available in various depths. Although many share basic characteristics, there are a number of material, dimensional and even orientational differences between the products offered. Manufacturing processes also differ between manufacturers.

Products

As part of this feasibility study, the manufacturers were contacted to obtain their proprietary information. The product/installation/specifier manuals (manuals) are usually developed in-house and reviewed by staff engineers. In some cases, these manuals may also be reviewed by outside consultants.

Buchan, Lawton, Parent Ltd compiled manufacturer product information from their manuals, websites and CCMC evaluations. A summary of product information is presented in Appendix C. The table lists manufacturers, products, web and flange properties and dimensions, as well as the web-flange joint depth. EI (a measure of stiffness) and allowable spans for various on centre spacing are also provided in the table for comparison purposes. The EI values and spans are given for an I-joist depth of 11-7/8-inch. Blanks in the table reflect that the data was either not applicable or the manuals were not provided to us.

Material changes have seen improvements in the strength and stiffness of I-joists. Although some manufacturers use dimension lumber flanges, the majority (representing approximately 80% of I-joists sold) use laminated veneer lumber (LVL) for the flanges. Laminated strand lumber (LSL) may also be used in some cases. Web materials are usually 3/8-inch oriented strand board (OSB), however some I-joists are constructed with plywood webs. Certain manufacturers produce their deeper joists with 7/16-inch OSB webs.

Dimensional differences are seen in the thickness and width of the flange and in the overall depth of the I-joist (deeper webs). Typically the flange thickness is 1-1/2-in., and flange widths are 1-1/2, 1-3/4, 2-5/16, 2-1/2, or 3-1/2-inches.

The four common I-joist net depths for residential floor systems are 9-1/2, 11-7/8, 14 and 16-inch. Depths are also available at 9-1/4, 11-1/4, 11-1/2, 12-1/2, 18, 20, 22, and 24-inches.

The flanges on most available products are oriented with the wider part perpendicular to the web. DF Joists and Nascor, however, produce I-joist products with the flange oriented on edge.

Other physical differences between wood I-joist products include: grades of dimension lumber or structural composite lumber, depth and type of web to flange joint, web joint types, flange joint types and adhesives used.

Manufacturer Literature

Typically, the information forming the manufacturers' literature includes:

1. Product information
2. Span tables
3. Floor load tables
4. Design properties
5. Typical framing details
6. Cantilever details
7. Filler and backer block tables
8. Web stiffener requirements
9. Framing connector charts and recommendations
10. Nailing requirements
11. Hole charts
12. Fire endurance assemblies
13. Safety recommendations
14. Care, storage and handling recommendations

Not all manufacturers cover all of the components listed above in the literature they provide. The table in Appendix D gives an overview of the information included in each of the manuals received. The table also allows for comparison between the various manufacturers' manuals, APA's guide and AF&PA's guide.

As can be seen from the table, there are many variations in the amount of information manufacturers include in their literature. The level of detail provided and the way in which the information is presented may also differ.

One company's literature may include 11 typical installation details while another may have 29 details. Some provide hole charts for rectangular and round holes while others only have charts for round holes. Hole charts may only be given for simple span joists or for both simple and multiple span joists.

Span tables can be based on a number of different configurations. The assumptions used when calculating the spans are generally listed below the tables. Typically, spans are given for the following conditions:

1. 40 psf live load, 10 psf dead load
2. L/360 deflection criteria
3. 5/8-inch subfloor glued and nailed to the top flange of the joist.

Manufacturers, however, may list spans based on a number of different load conditions, more stringent deflection criteria, nailed-only subfloor or any combination of these situations. In other words, when comparing span tables for different products, the assumptions or conditions under which the table was created must be taken into account in order to make meaningful comparisons.

To summarize, the type and breadth of information available in the different manufacturer manuals varies significantly from manufacturer to manufacturer.

KEY STAKEHOLDERS' SUPPORT

A range of stakeholders were contacted for the feasibility study. These included: builders, manufacturers, manufacturer associations, building officials, and other organizations including the Canadian Wood Council, the Engineered Wood Association (APA) and the Canadian Home Builders' Association. The survey took the form of a questionnaire. Building officials, manufacturers and the Wood I-Joist Manufacturer's Association were contacted by electronic mail with a follow-up telephone conversation whereas the majority of the other stakeholders were contacted by telephone.

Group	Responses *	Methodology
Builders from across Canada	9	Telephone/Fax Survey
Manufacturers from Canada & U.S.	8	Telephone/Email Survey
Building Officials from across Canada	11	Telephone/Email Survey
Canadian Wood Council (CWC)	1	Telephone Survey
Engineered Wood Association (APA)	1	Telephone Survey
Wood I-Joist Manufacturers' Association (WIJMA)	2	Telephone/Email Survey
Canadian Home Builders' Association (CHBA)	1	Telephone/Fax Survey

* Although many contacts were made, the number given in this column represents only the actual number of respondents.

Builders

Nine builders from across Canada were contacted for this feasibility study. Many of those initially contacted use the open web trusses. Of those using engineered wood I-joists (nine builders), most use only one product, thus eliminating the confusion of switching between manufactured products and literature. Although all the builders believed that the information provided by the manufacturer or the supplier was fairly clear, easy to use and adequate to properly install I-joists, almost 50% responded that they would like to see a best practice guide for installation.

According to the builders, the guide should contain as many details as possible. Builders explicitly mentioned including nailing patterns for doubling up the joists, rim joist details, stair openings, flue box details, and cantilevers. Tips on storage, handling and damp proofing were also mentioned. Most believed the format would be most useful as a written manual that could easily be brought on site. Access through the internet was also favoured by many. One builder mentioned that seminars would also be beneficial.

Manufacturers

Contact was established with a number of manufacturers by telephone or electronic mail with a follow-up telephone conversation. A summary of manufacturer responses follows.

Of the eight manufacturers who responded, four liked the idea of having a best practice installation guide for wood I-joist floor systems, two thought that an introductory guide without installation details would be suitable and two disliked the idea of a guide entirely.

Those that did not like the idea of a guide stated that there are already similar documents in existence and cited both AF&PA's National Design Specification (NDS) for Wood Construction (published in both LRFD and ASD formats) and APA's Performance Rated I-Joists. One manufacturer mentioned that they do not see any benefit in additional guides beyond these and the ones published by each manufacturer.

The two respondents that indicated that the guide would be suitable only without installation details stated that I-joists are proprietary and as such it is the responsibility of each manufacturer to establish installation details. They further stated that these details can give a manufacturer an edge over the competitor. As well, one respondent indicated that their I-joists are unique and do not necessarily fit in the mold of other joists. This is a selling feature and should not cause exclusion from the market. Including details in an I-joist guide could be very damaging to Canadian business.

Both agreed however that a general document which included only:

- General I-joist information (environmental advantages and performance advantages, etc.);
- Fire endurance assembly recommendations;
- Safety recommendations; and,
- Care, storage and handling recommendations

would better suit their needs.

The remaining four respondents liked the idea of having a best practice installation guide for wood I-joist floor systems that would include typical details. According to these manufacturers, however, performance items such as span and load tables should not be included. The manufacturer's literature should be referenced.

All agreed that safety, care, storage and handling recommendations should be included as well as general I-joist information that would highlight I-joist advantages. The majority (83%) thought that a web-accessed document and/or written manual would be appropriate formats for such a document.

Based on the manufacturers' input, the manual could include:
General I-joist information (environmental and performance advantages)

1. Typical framing details
2. Cantilever details
3. Filler and backer block tables
4. Web stiffener requirements
5. Framing connector recommendations
6. Fire endurance assembly recommendations
7. Safety recommendations
8. Care, storage and handling recommendations

The guide should refer to manufacturer literature for the following items:

1. Span tables
2. Floor load tables
3. Design properties
4. Hole charts

Trus Joist indicated a willingness to commit funds or time to the development of the guide. Jager Industries and Nascor indicated a willingness to commit time to such a project.

Building Officials

Eleven building officials from across Canada were contacted for input and feedback into the feasibility study. The survey was a short questionnaire, distributed by electronic mail with, in some cases, telephone call follow-ups.

Building officials were asked about the use of I-joists in their districts, common framing errors made, details that may be included, etc.

The market share for I-joists varies dramatically across the country and from city to city, likely mainly due to availability. Numbers for I-joist floor systems were estimated from as low as 5% of new construction to 95%.

The following summarizes the building officials' responses regarding common framing errors when using I-joists:

- Notching and drilling joist flange
- Missing or improper use of squash blocks
- Missing or improper use of filler and backer blocks
- Improper size, placement or number of web holes
- Improper use of hangers
- Inadequate/improper nailing of rim boards to plate
- Improper blocking for cantilever
- Inadequate spacing of joists
- Undersized joists
- Inadequate nail spacing

By far, the most common error noted by the building officials was notching and drilling of the I-joist flange. An interesting point was raised. It is not usually the framing crew that makes the error but more typically the plumbing, electrical and mechanical sub-trades who are unfamiliar with the product. Of course, drilling or notching the flange of an I-joist can result in serious structural failures.

All but one of the building officials listed at least two significant and common framing errors when using I-joists.

Nine of the eleven building officials think that a best practice installation guide would be a useful tool to both builders and building officials. Many felt that this would eliminate the confusion which sometimes occurs due to the differing details of the various manufacturers. They also pointed out that the manufacturer details rarely make it on-site and, as such, one guide with generic details would be useful. With regard to number of details to include, the general consensus among building officials was that more was better.

The reason given for not publishing a best practice guide was that specific details are required for each different floor system, generic details may not be able to accomplish this.

One building official in the Ottawa area indicated interest in participating in the preparation of the guide.

Wood I-Joist Manufacturer's Association (WIJMA)

Throughout the feasibility study, the Wood I-Joist Manufacturer's Association (WIJMA) has provided feedback on the development of an I-joist guide. Initial feedback indicated that WIJMA supported the idea of producing a generic best practice installation guide for wood I-joist floor systems.

WIJMA President Joe Kaiserlik tabled a discussion on the I-joist best practice guide at their meeting in April of this year. He believes that all eight of the WIJMA producer members and others in attendance at the meeting were enthusiastic about the idea of a set of generic installation details for I-joist products and incorporating them into a best practice guide.

A few years ago, WIJMA members began working on creating a set of generic details. The project did not advance, partly as a result of the scope of the project being too broad. WIJMA members now feel they should re-start the project and limit the scope to something less complicated than previously. They would be interested in continuing communication with CMHC and learning how their generic installation details would help to meet the needs of a possible CMHC best practice manual.

As was suspected, they would prefer the guide refer to manufacturer literature for allowable spans and design properties. WIJMA would like to see a section where general I-joist information would be presented in a fashion that highlights I-joist advantages (environmental, performance, etc.).

Based on WIJMA input, the manual should cover:

- Typical framing details (18-20 common details);
- Cantilever details;
- Web stiffener requirements;
- Fire endurance assembly recommendations;
- Safety recommendations; and,
- Care, storage and handling recommendations.

WIJMA responded that they would possibly be willing to commit funds or time to the development of the guide.

The Canadian Wood Council (CWC)

The Canadian Wood Council (CWC) was contacted for input into the feasibility study. From CWC's perspective, a best practice guide is required in the industry. Typical details should be incorporated into such a guide with focus on load transfer details, hanger details and squash block details. It should be written with both builders and building officials in mind as target audiences. A written manual accompanied with web site accessed documents would be the best format for the guide. The CWC currently has a similar project underway. It is our understanding that this is an on-going research project however they would be interested in committing time or producing a publication of this type in co-operation with CMHC.

The Engineered Wood Association (APA)

Initial conversations with APA revealed that the APA believes that a best practice manual would be a benefit from the I-joist industry perspective as well as the homebuilding industry and consumers. The APA also agrees that with I-joist popularity growing and new manufacturing plants opening (franchising), some sort of standard needs to be established with regard to performance and installation details. Although engineered wood I-joists are proprietary and manufacturers will claim that, as such, the installation details are proprietary, the APA estimates that over 95% of the details included in manufacturer literature are the same. It would be useful to give these common details in a best practice guide.

The APA also mentioned that they would be willing to work jointly with CMHC in the production of such a guide and provide CMHC with the electronic version of their guide *Performance Rated I-Joists* for use in the development.

The Canadian Home Builders' Association (CHBA)

A representative from the Canadian Home Builders' Association was contacted for input into this feasibility study. CHBA thinks that a best practice installation guide for engineered wood I-joists is quite necessary. According to CHBA, information such as framing details, framing connector use, filler and backer block tables, web stiffener requirements as well as safety, care, storage and handling recommendations would be useful for such a guide. Due to the fact that the manufacturer's information rarely makes it on-site and even when it does there is often inconsistency in number of details and information given, it would be better to include as many details as possible. The details can be grouped by commonality for quick reference.

CHBA suggests that such a document needs to be succinct. Builders will not want to read through a thick document to obtain specific information. Important information such as do's and don'ts should be easy to locate (i.e. appear beside relevant details).

CHBA does have concerns with CMHC spearheading such a publication. A document of this type may be seen as a promotion for using one type of joist product over another (i.e. I-joists over open web trusses or traditional lumber). Similar to that which has been done by the steel manufacturers, the wood I-joist industry itself should be publishing such a document, with CMHC perhaps contributing to the development.

CHBA indicated that they would be willing to review and provide comments to aid in the development of the guide.

Stakeholder Support Summary

In summary, most of the stakeholders contacted indicated that the idea of producing a generic best practice installation guide is a good one. The general consensus seemed to be that for performance items, the guide should refer the user directly to the manufacturer literature. The guide should also promote the use of I-joists by outlining the environmental benefits and performance advantages of using these products. There was general support for the guide to include: typical details (with special attention to web stiffeners, squash blocks, filler blocks, etc.), as well as safety, care, storage and handling recommendations. Specific details to include were flagged by the various contacts. Most respondents believed that the best media for the guide would be a written manual. Web site access would also prove to be beneficial.

With respect to financial or time commitments:

- One building official in the Ottawa area indicated interest in participating in the preparation of the guide.
- Trus Joist said that they would commit funds or time to the project. Jager Industries and Nascor would be willing to commit time to the project.
- WIJMA said that they would possibly commit funds or time to the project.
- CWC said that they would be willing to commit time to the project or produce a publication in co-operation with CMHC.
- APA offered to make the electronic format of their guide, *I-Joists for Residential Floors,* available for use in this project.
- CHBA would be willing to review and provide comments to aid in the development of the guide.

In view of the overall strong support from homebuilders, manufacturers, building officials and representatives from key associations, we believe that a generic wood I-joist guide is a feasible project for the Canada Mortgage and Housing Corporation to undertake.

INFORMATION TO INCLUDE IN A GENERIC GUIDE

In order to receive strong manufacturer support, the guide will need to be generic and refer the user to manufacturer literature for specific product performance related aspects. For this reason and due to the wide variety of products available, it is not feasible for the guide to contain span tables, floor load tables, and design properties. The guide, however, should not include contact information for the manufacturers as this industry is dynamic (mergers, franchises).

In order to satisfy the needs of the builder, the guide must be accurate, fairly comprehensive and simple to use. A number of media options exist for the guide. The guide can take the form of a published manual, an instructional video and/or may be accessible through the web. Because the guide should be a resource that is easy for a builder to take on-site, a written manual accompanied with a pocket guide would be appropriate formats.

We propose the generic guide include the following information:

1. Introduction
2. Product Information
3. Design and Installation Considerations
4. Generic Details
5. Filler Blocks, Backer Blocks, Squash Blocks and Web Stiffener
6. Nailing
7. Holes
8. Framing Connectors
9. Fire Endurance Assemblies
10. Safety, Care, Storage and Handling

The following subsections expand on the proposed contents.

Introduction

An introductory section can summarize the history and current use of I-joists in North America. This introduction could state product advantages from the perspective of resource utilization, ease of handling, strength and stiffness and other performance benefits.

Product Information

There are currently at least 17 manufacturers producing over 90 different I-joist products. As a result, only general product information could be included such as typical:

- flange and web materials;
- flange dimensions;
- web thickness; and,
- joist depth.

Design and Installation Considerations

To help builders use I-joist products as intended, a section outlining the key differences in design and installation of I-joists compared to dimensional joists would be a valuable addition. WIJMA's Technical Bulletin #1 covers such information and may be used as a resource. The CHBA has also produced a similar bulletin for their membership.

Generic Details

Following a review of the manufacturers' installation guides, typical details were compared and compiled. Aside from manufacturer suggested nail sizes, the proprietary details were very similar from manual to manual.

The following list was prepared based on the number of manuals that included the detail and the response of the stakeholders. The first seventeen listed are more common details and should be grouped in such a way that they are easy to locate. Feedback from WIJMA may determine the final list of generic details to include.

1. End Joist Blocking
2. Rim Board
3. Rim Joist
4. Squash Blocks at Rim
5. Squash Blocks at Interior Bearing
6. Post Loads
7. Joist End Nailing
8. Header detail (double I-joist, showing filler and backer blocks, hangers)
9. Stair Stringer
10. Hanger to Beam detail
11. Double I-Joist Nailing Schedule
12. Web Stiffener Attachment
13. Non-Load Bearing Cantilever Details (I-Joist outrigger)
14. Non-Load Bearing Cantilever Details (2X_ blocking outrigger)
15. Reinforced Load Bearing Cantilever (I-Joist outrigger)
16. Un-reinforced Load Bearing Cantilever (I-Joist outrigger)
17. Steel I-Beam connection (with hangers)
18. Bearing Plate
19. Various Hanger Details (to double I-joist)
20. Various Floor Opening Details
21. Intermediate Bearing (no load bearing wall above)
22. Non Stacking Walls
23. Exterior Deck Attachment
24. Bridging
25. Double Reinforced Load Bearing Cantilever
26. Brick Cantilever
27. Dropped Cantilever
28. Joist at Dropped Floor
29. Plumbing Details (to avoid floor penetrations)
30. Steel I-Beam Connections (without hangers, bottom flange bearing)
31. Ledger Support Connection

Filler Blocks, Backer Blocks, Squash Blocks and Web Stiffener

The guide should include background information on filler block, backer block, squash block and web stiffener use. It should clearly outline when each is needed and how to select appropriate sizes for different I-joist dimensions. In some cases, a generic "formula" may be created as a guideline for determining the required width and depth of each for different I-joist sizes, including tolerances.

Web stiffener requirements can be treated separately or as an installation detail (see Typical Framing and Cantilever Details). The guide may also give more in-depth information similar to that given for filler and backer blocks.

The APA has written a number of "Builder Tips" documents on each of the above. These documents:

- outline the purpose of each,
- give a physical description,
- give recommendation for the use of each, and
- include tables that recommend sizing for each for common flange widths and joist depths.

Refer to Appendix E for copies of the APA builder tips.

Nailing

General recommendations can be made with regard to closest allowable nail spacing and the selection of appropriate nail sizes and types. If care is not taken in selecting appropriate nails, the flange can split and weaken the I-joist.

Information on nail spacing and sizing recommendations can be given throughout the manual. It may be treated as a separate section, or included in the details. Suggested recommendations include nailing through the flange, backer blocks, filler blocks, squash blocks, web stiffeners and connectors. Highlighting any special considerations, such as nailing parallel to glue lines, could also be useful.

Framing Connectors

Some manufacturers include framing connector charts and/or recommendations in their proprietary manuals. The charts may list specific product model numbers from connector companies for each of the I-joist depths and for various connections (e.g. single or double joist connections, skewed connections). Many also include connector manufacturer product manuals to aid the user in the selection of hangers.

Information can be included regarding when to use connectors, what types of connectors to use (face or top mount hanger, uplift connectors), whether lateral restraint is needed with certain connectors as well as nailing recommendations.

Holes

All manufacturer literature reviewed included hole charts. There are basic rules to follow when cutting holes in the web. For instance, the flange should never be drilled, cut or notched. As well, when cutting rectangular holes, one should avoid over-cutting the corners as that can cause unnecessary stress concentrations. These and other common rules should be incorporated into the generic guide. For specific spacing and minimum distances between holes, the user should be referred to manufacturer literature. This section should also stress the importance of not cutting or drilling through the flange.

Fire Endurance Assemblies

The National Building Code of Canada specifies fire resistance rating for roof and or floor assemblies depending on the use and occupancy of the building. Accordingly, all I-joist manufacturers must have their products tested in various assemblies under an Underwriters' Laboratories of Canada standard. Because of this, the best practice guide will need to refer the user to manufacturer manuals for fire endurance assemblies.

It is our understanding that there is currently testing underway at the National Research Council with the intent of publishing generic fire rating and acoustic tables for I-joists. Consideration should be given to include such tables once they become available.

Safety, Care, Storage and Handling

The integrity and safe use of I-joists can be seriously impaired if they are damaged or used inappropriately. Proper safety, care, storage and handling procedures must be followed. All manufacturer manuals reviewed contained at least some recommendations on worker safety, I-joist storage and/or handling. Most manuals provided "Dos and Don'ts" warnings. Easy to read instructions or drawings illustrated permitted conditions.

Common safety, storage and handling recommendations to include in the best practice guide may include:

1. Providing bracing (nailing each I-joist after it is erected and temporary bracing with 1x's)
2. Avoiding stacking building materials on unsheathed joists
3. Storing, stacking and handling I-joists vertically and level only
4. Keeping I-joists dry
5. Avoiding cutting, drilling or notching flange
6. Avoiding bevel cuts beyond inside edge of bearing

The APA has a short illustrated document entitled *Storage, Handling, and Safety Recommendations for APA Performance Rated I-Joists*. This document may serve as a starting point and reference for the appropriate section in the best practice manual. See Appendix E for a copy of the document.

DEVELOPMENT COSTS

The development costs are estimated to be less than $30,000 Cdn. to develop a final draft best practice guide in English. These costs take into consideration that the APA will likely be able to provide any illustrated details in electronic format.

WIJMA has published a wealth of information in their technical bulletins on design and installation considerations that are unique to I-joists as well as many other topics. The APA has useful builder tips on backer blocks, squash blocks, web stiffeners etc. Cooperation from these organizations with respect to literature sharing could further reduce the estimated development costs. Based on the contacts made, we believe we have received this necessary support.

EXPORT POTENTIAL OF THE GUIDE TO THE USA

This industry is currently a North American industry. WIJMA and APA have manufacturer members from Canada and the U.S. With necessary attention to the each country's relevant building code requirements, the guide would have good export potential to the U.S as indicated by the surveys conducted for this feasibility study.

ISSUES/OBSTACLES TO PRODUCING A SUCCESSFUL GUIDE

We do not foresee many obstacles to producing a successful guide. When planning such a document, the target audience must be seriously considered. In this case, the needs of the builders must be addressed and met. We suggest having a process where not only the builders but also other stakeholders can give input at different stages in the development of the guide. One way to accomplish this would be to have an online survey at either the CMHC site or CHBA site or both. This process would ensure a quality document that satisfies the needs of all those involved. The downfall to this process lies with the additional cost of production. In the end, stakeholders with financial or time commitments should decide if this is the route to take.

The format of the guide is also a serious consideration. A large majority of those surveyed during this feasibility study indicated that a printed manual would be the ideal format. A smaller (and not so in-depth) pocket guide version of the document could be made available for on-site use by builders. Some builders indicated that how-to installation seminars might also be useful.

These seminars could be used as a way of promoting the guide, however considerable additional funding and planning would be required.

While having a complete and comprehensive document is something to strive for, it must remain easy-to-use for the homebuilder. During the review of the manufacturers' manuals, it was discovered that those manuals which provided a Table of Contents were much easier to use than those without. Locating a specific detail or group of details was quicker and easier. The best practice guide should contain a table of contents. The order in which the material is presented should make sense. Wherever possible, I-joist details should be grouped under common headings, for example; floor opening details, header band and rim band details, cantilever details, bearing on stud wall details, beam details, etc.

Distribution and cost are also important considerations. Builders will not likely want to pay more than $20 for such a guide. The cost of production and publication then will have to be borne by the various stakeholders. A web site accessed document that could be downloaded and printed by the builder would save some costs, however at the present time, CMHC's website order desk is not equipped to handle e-commerce purchases. The order desk page of the website presently allows users to view a catalogue of products and lists telephone and fax numbers and a mailing address to order the products. Hard copy documents could be made available through CHIC, CHBA and other home building association libraries across the country.

We do not foresee any problems with keeping the guide up-to-date. Over the years, I-joists have seen a number of design improvements. Many of today's I-joists are constructed with superior products and manufacturing techniques. It is unlikely that design improvements of the future will drastically change the way in which I-joists are installed. Updates should be considered on an as needed basis when new installation techniques do become available, for example, with the introduction of new connector hardware. A yearly or biyearly stakeholder review of the guide should be adequate to ensure that the content is current.

APPENDIX A

- **APA Performance Rated I-Joists**
- **AF&PA's ASD Manual for Engineered Wood Construction - Wood I-Joists**

APA Performance Rated I-Joists

ENGINEERED WOOD SYSTEMS
APA EWS

APA PERFORMANCE RATED™ I-JOISTS SAY WHAT THEY DO AND DO WHAT THEY SAY

APA – The Engineered Wood Association has made it easy to make the right choice for residential floor joist products.

APA Performance Rated™ I-Joists (PRI™) provide a high performance alternative to dimension lumber joists for residential floor applications. This guide will help you efficiently use APA PRIs by walking you through the simple steps of product selection, specification, and installation.

The APA trademark signifies that the I-joist manufacturer is committed to the strict quality standards of Engineered Wood Systems (EWS), a related corporation of APA, and that the PRIs are manufactured in conformance with PRI-400, *Performance Standard for APA EWS I-Joists.* APA's rigorous program of quality verification and testing is designed to assure predictable product performance.

PRI-400 brings product standardization while providing for a multitude of design and construction situations. The standard provides design information for numerous types and sizes of I-joists. Now specifiers and builders can select and use I-joists from various *APA EWS* member manufacturers, using just one set of design and installation criteria. Because PRIs can be selected based on their allowable span for glued uniformly loaded residential floors, it is easy to incorporate them into your design.

This guide emphasizes residential floor systems. However, much of the basic design information can be used for other construction applications. Review by a design professional is required for applications beyond the scope of this document. (See Table 5 for design properties.)

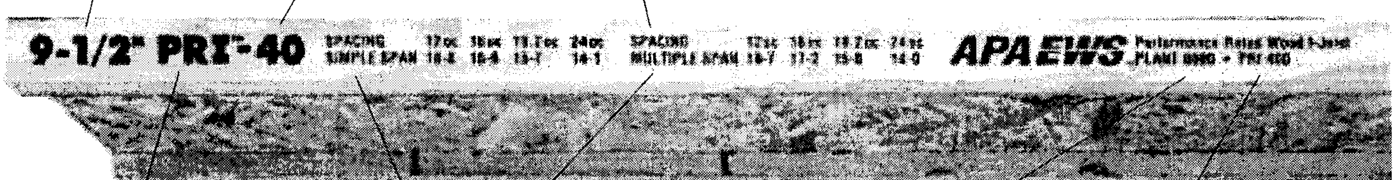
Simple to specify. Easy to install. Less confusion. APA Performance Rated I-Joists are the right choice for residential floor construction.

SAMPLE TRADEMARK – Position of trademark on I-joist may vary by manufacturer

The I-joist alternative to 2 x 10 lumber with a net depth of 9-1/2". Also available in depths of 11-7/8", 14", and 16".

Joist designation.

The on-center spacing of the I-joists. (optional)



Identifies I-joists as being manufactured in conformance with APA Standard PRI-400, *Performance Standard for APA EWS I-Joists.*

The residential floor clear span that can be achieved for a glued-nailed floor system at the indicated spacing for a live load of 40 psf and a dead load of 10 psf. (optional)

Plant number

Conforms with APA Standard PRI-400, *Performance Standard for APA EWS I-Joists.*

To illustrate the selection of an APA PRI product, assume a design simple span of 16 ft-1 in. For architectural reasons limit the joist depth to 11-7/8 inches and joist spacing to 19.2 inches on center. From the 9-1/2 and 11-7/8 inch entries in Table 1, look down the 19" o.c. spacing column. For depths of 9-1/2 inch, select **9-1/2" PRI-60**, and from the 11-7/8 inch depths notice that **any** joist designation will work.

While any of the PRIs shown in Tables 1 and 2 may be available in a specific market area, availability of any PRI product should be verified prior to final product selection

The allowable spans in the tables in this design guide indicate the allowable clear span for various joist spacings under typical residential uniform floor loads (40 psf live load and 10 psf dead load) for glued-nailed systems.

The spans shown in Tables 1 and 2 are based on repetitive member usage which is typical for all wood products spaced 24" on center or less. In addition, floor sheathing must be field glued to the I-joist flanges to achieve the PRI allowable spans. Use of these span tables is limited to uniform load conditions and PRI floor spans shall not exceed these allowable spans. APA PRIs can be used for other applications such as roofs, to support line loads or concentrated loads, etc., when properly engineered using the appropriate design properties in Table 5.

TABLE 2

ALLOWABLE SPANS FOR *APA EWS* PERFORMANCE RATED I-JOISTS – Multiple Span Only

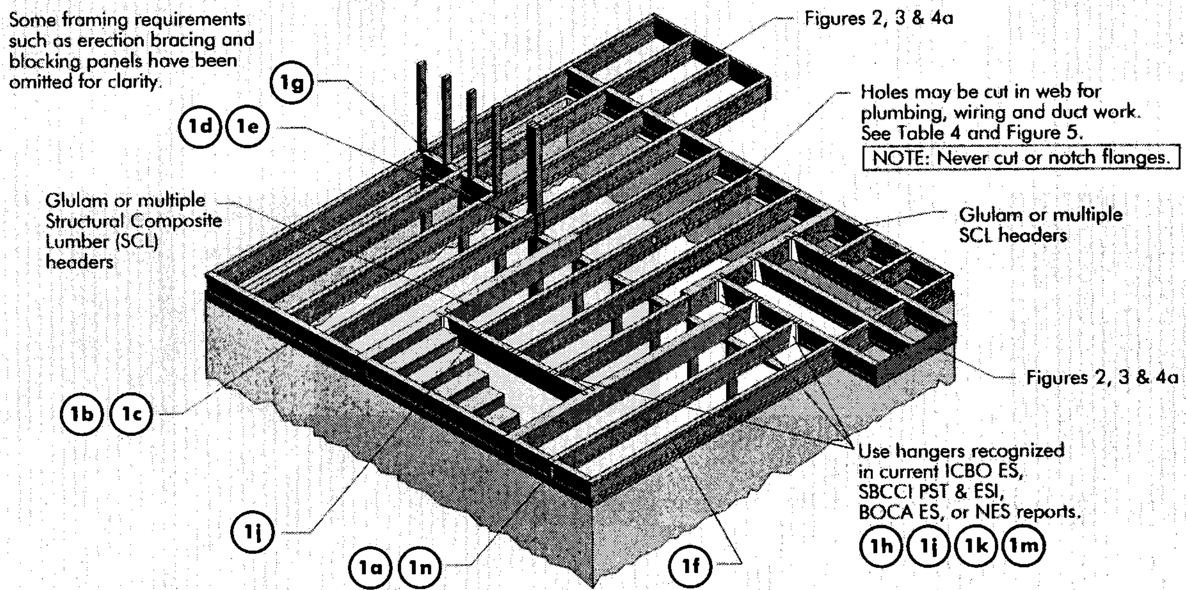
		Multiple Spans On Center Spacing			
Depth	**Joist Designation**	**12"**	**16"**	**19.2"**	**24"**
9-1/2"	PRI-20	18'-1"	16'-3"	14'-10"	13'-3"
	PRI-30	18'-8"	17'-1"	16'-1"	15'-0"
	PRI-40	19'-7"	17'-2"	15'-8"	14'-0"
	PRI-50	19'-5"	17'-9"	16'-9"	15'-8"
	PRI-60	20'-8"	18'-10"	17'-9"	16'-5"
11-7/8"	PRI-20	21'-8"	18'-10"	16'-9"	13'-5"
	PRI-30	22'-4"	20'-5"	18'-10"	15'-0"
	PRI-40	23'-0"	19'-11"	18'-2"	16'-2"
	PRI-50	23'-3"	21'-3"	20'-0"	16'-1"
	PRI-60	24'-8"	22'-6"	21'-2"	19'-1"
	PRI-70	25'-1"	22'-11"	21'-7"	18'-6"
	PRI-80	27'-1"	24'-8"	23'-3"	21'-8"
	PRI-90	27'-11"	25'-5"	23'-11"	22'-3"
14"	PRI-40	25'-6"	22'-1"	20'-1"	18'-0"
	PRI-50	26'-6"	24'-2"	20'-2"	16'-1"
	PRI-60	28'-1"	25'-7"	23'-8"	19'-9"
	PRI-70	28'-6"	25'-11"	23'-2"	18'-6"
	PRI-80	30'-10"	28'-0"	26'-5"	23'-11"
	PRI-90	31'-8"	28'-10"	27'-1"	25'-3"
16"	PRI-40	27'-8"	23'-11"	21'-10"	19'-6"
	PRI-50	29'-6"	24'-3"	20'-2"	16'-1"
	PRI-60	31'-2"	28'-1"	24'-9"	19'-9"
	PRI-70	31'-7"	27'-10"	23'-2"	18'-6"
	PRI-80	34'-2"	31'-1"	29'-3"	23'-11"
	PRI-90	35'-1"	31'-11"	30'-0"	26'-7"

Notes:

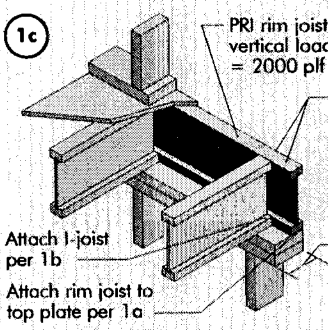
1. Allowable **clear** span applicable to multiple-span residential floor construction with a design dead load of 10 psf and live load of 40 psf. The live load deflection is limited to span/480.
2. Spans are based on a composite floor with glued-nailed sheathing meeting the requirements for APA Rated Sheathing or APA Rated STURD-I-FLOOR conforming to PRP-108, PS 1, or PS 2 with a minimum thickness of 19/32 inch (40/20 or 20 oc) for a joist spacing of 19.2 inches or less, or 23/32 inch (48/24 or 24 oc) for a joist spacing of 24 inches. Adhesive shall meet APA Specification AFG-01 or ASTM D3498. Spans shall be reduced 1 foot when the floor sheathing is nailed only.
3. Minimum bearing length shall be 1-3/4 inches for the end bearings, and 3-1/2 inches for the intermediate bearings.
4. Bearing stiffeners are **not** required when I-joists are used with the spans and spacings given in this table, except as required for hangers.
5. This span chart is based on uniform loads. For applications with other than uniformly distributed loads, an engineering analysis may be required based on the use of the design properties in Table 5.

FIGURE 1

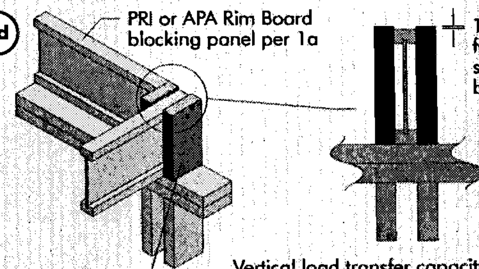
TYPICAL APA PERFORMANCE RATED I-JOIST FLOOR FRAMING AND CONSTRUCTION DETAILS



1c



1d



Provide lateral bracing per 1a, 1b, or 1c

Vertical load transfer capacity per pair of squash blocks as shown:

Pair of Squash Blocks	(lb)
2 x 4	4000
1-1/8" Rim Board	3000
1" Rim Board	2700

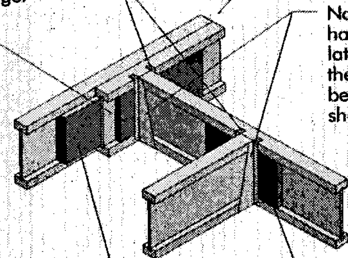
1h

Backer block (use if hanger load exceeds 250 lbs.) Before installing a backer block to a double I-joist, drive 3 additional 10d nails through the webs and filler block where the backer block will fit. Clinch. Install backer tight to top flange. Use twelve 10d nails, clinched when possible. Maximum capacity for hanger for this detail = 1280 lb.

BACKER BLOCKS (Blocks must be long enough to permit required nailing without splitting)

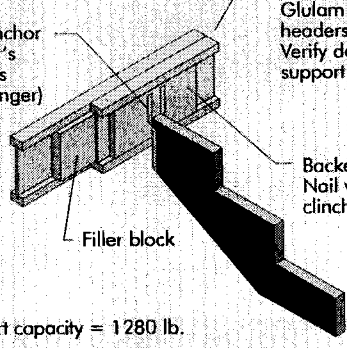
Flange Width	Material Thickness Required*	Minimum Depth**
1-1/2"	19/32"	5-1/2"
1-3/4"	23/32"	5-1/2"
2-5/16"	1"	7-1/4"
2-1/2"	1"	5-1/2"
3-1/2"	1-1/2"	7-1/4"

* Minimum grade for backer block material shall be Utility grade SPF (south) or better for solid sawn lumber and Rated Sheathing grade for wood structural panels.
** For face-mount hangers use net joist depth minus 3-1/4" for joists with 1-1/2" thick flanges. For 1-5/16" thick flanges use net depth minus 2-7/8".



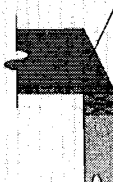
For hanger capacity see hanger manufacturer's recommendations. Verify double I-joist capacity to support concentrated loads.

1m



Maximum support capacity = 1280 lb.

1n



Note: Blocking required at bearing for lateral support, not shown for clarity.

Cantilever Details for Vertical Building Offset (Concentrated Wall Load)

I-joists may also be used in cantilever applications supporting a concentrated load applied to the end of the cantilever, such as with a vertical building offset.

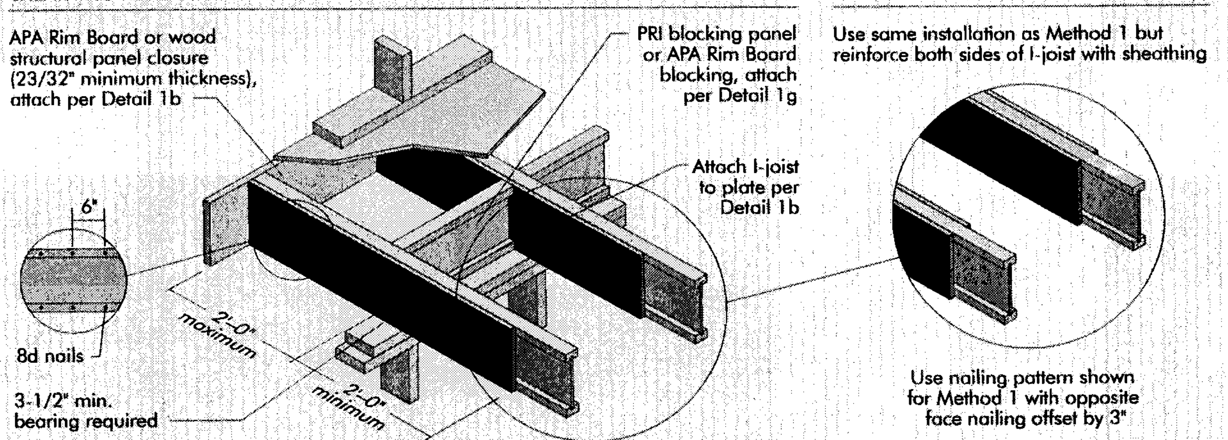
For cantilever-end concentrated load applications that require reinforcing based on Table 3, the cantilever is limited to 2 feet maximum. In addition, blocking is required along the cantilever support and for 4 feet on each side of the cantilever area. Subject to the roof loads and layout (see Table 4), three methods of reinforcing are allowed in load bearing cantilever applications: reinforcing sheathing applied to one side of the I-joist (Method 1), reinforcing sheathing applied to both sides of the joist or double I-joists (Method 2).

FIGURE 4a

CANTILEVER DETAIL FOR VERTICAL BUILDING OFFSET

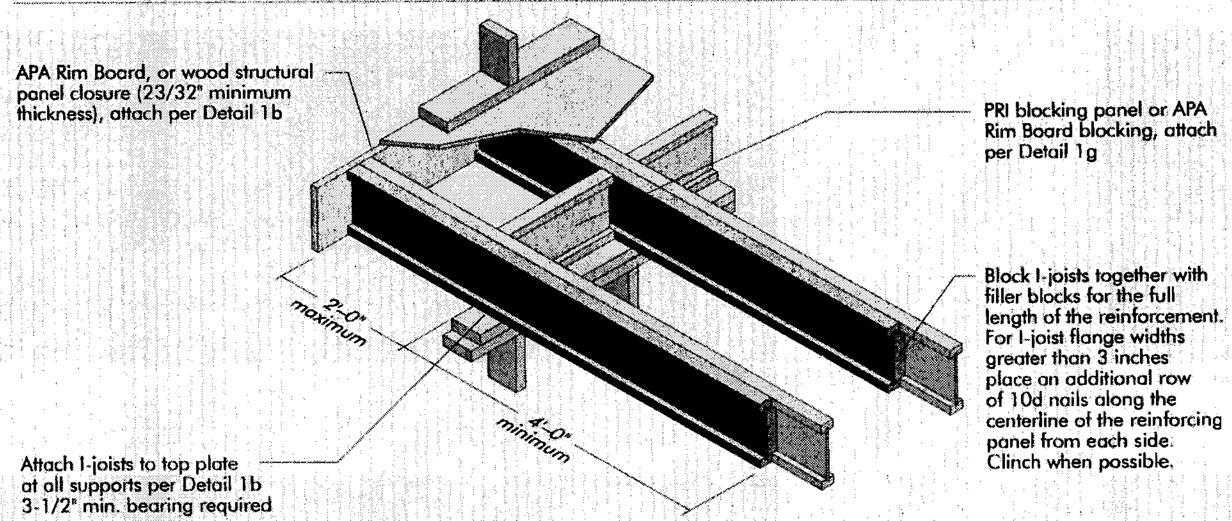
Method 1
SHEATHING REINFORCEMENT ONE SIDE

Method 2
SHEATHING REINFORCEMENT TWO SIDES



Note: APA RATED SHEATHING 48/24 (minimum thickness 23/32") required on sides of joist. Depth shall match the full height of the joist. Nail with 8d nails at 6" o.c., top and bottom flange. Install with face grain horizontal. Attach I-joist to plate at all supports per Detail 1b

Alternate Method 2
DOUBLE I-JOIST



Web Hole Specifications

One of the benefits of using I-joists in residential floor construction is that holes may be cut in the joist webs to accommodate electrical wiring, plumbing lines and other mechanical systems, therefore minimizing the depth of the floor system.

Rules for cutting holes in PRI Joists

1. The distance between the inside edge of the support and the centerline of any hole shall not be less than that shown in Table 4.

2. I-joist top and bottom flanges must NEVER be cut, notched, or otherwise modified.

3. Whenever possible field-cut holes should be centered on the middle of the web.

4. The maximum size hole that can be cut into an I-joist web shall equal the clear distance between the flanges of the I-joist minus 1/4 inch. A minimum of 1/8 inch should always be maintained between the top or bottom of the hole and the adjacent I-joist flange.

5. The sides of square holes or longest sides of rectangular holes should not exceed three fourths of the diameter of the maximum round hole permitted at that location.

6. Where more than one hole is necessary, the distance between adjacent hole edges shall exceed twice the diameter of the largest round hole or twice the size of the largest square hole *(or twice the length of the longest side of the longest rectangular hole)* and each hole must be sized and located in compliance with the requirements of Table 4.

7. A knockout is **not** considered a hole, may be utilized anywhere it occurs and may be ignored for purposes of calculating minimum distances between holes.

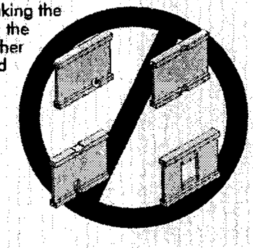
8. One and one-half inch holes shall be permitted anywhere in a cantilevered section of a PRI Joist. Holes of greater size may be permitted subject to verification.

9. A 1-1/2" hole can be placed anywhere in the web provided that it meets the requirements of 6 above.

Never drill, cut or notch the flange, or over-cut the web.

Holes in webs should be cut with a sharp saw.

For rectangular holes, avoid over cutting the corners, as this can cause unnecessary stress concentrations. Slightly rounding the corners is recommended. Starting the rectangular hole by drilling a 1" diameter hole in each of the 4 corners and then making the cuts between the holes is another good method to minimize damage to I-joist.



10. For joists with more than one span, use the longest span to determine hole location in either span.

11. All holes shall be cut in a workmanlike manner in accordance with the restrictions listed above and as illustrated in Figure 5.

12. Limit 3 maximum size holes per span.

13. A group of round holes at approximately the same location shall be permitted if they meet the requirements for a single round hole circumscribed around them.

FIGURE 5

APA PRI JOIST TYPICAL HOLES

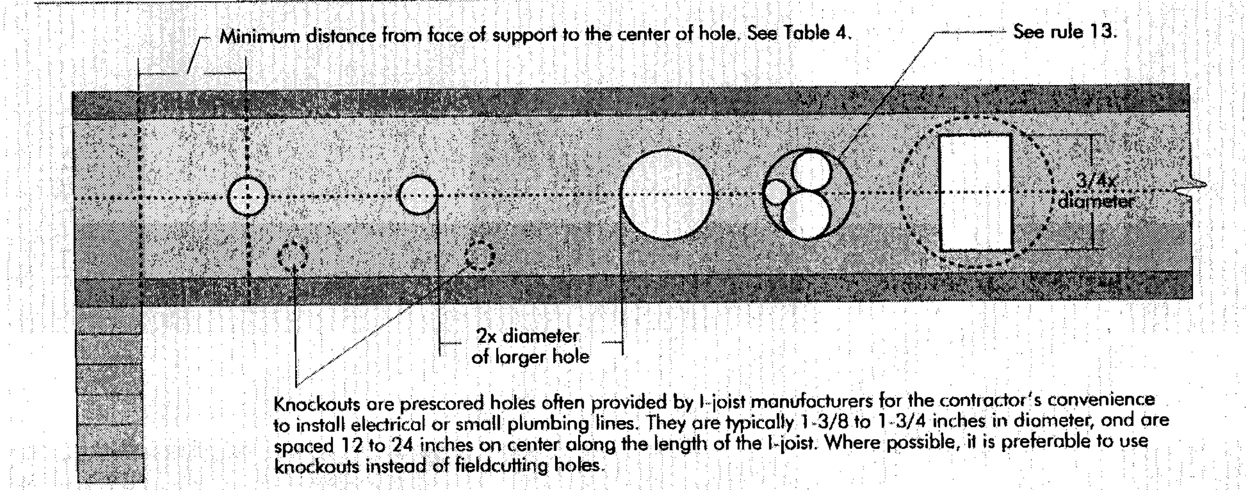


TABLE 5

DESIGN PROPERTIES FOR *APA EWS* PERFORMANCE RATED I-JOISTS[1]

Depth	Joist Designation	EI[2] 10^6 lbf-in.^{2}	M[3] Nonrepetitive lbf-ft	M[3] Repetitive lbf-ft	V[4] lbf	IR[5] lbf	ER[6] lbf	K[7] 10^6 lbf
9-1/2"	PRI-20	145	2,180	2,265	1,120	1,700	830	4.94
	PRI-30	161	2,800	2,910	1,120	1,905	945	4.94
	PRI-40	193	2,355	2,520	1,120	2,160	1,080	4.94
	PRI-50	186	3,290	3,420	1,120	2,040	1,015	4.94
	PRI-60	231	3,245	3,470	1,120	2,160	1,080	4.94
11-7/8"	PRI-20	253	2,910	3,025	1,420	1,700	830	6.18
	PRI-30	280	3,715	3,860	1,420	1,905	945	6.18
	PRI-40	330	3,145	3,365	1,420	2,500	1,200	6.18
	PRI-50	322	4,375	4,550	1,420	2,040	1,015	6.18
	PRI-60	396	4,335	4,635	1,420	2,500	1,200	6.18
	PRI-70	420	5,600	5,820	1,420	2,335	1,160	6.18
	PRI-80	547	6,130	6,555	1,420	2,760	1,280	6.18
	PRI-90	604	7,770	8,080	1,925	3,355	1,400	6.18
14"	PRI-40	482	3,860	4,130	1,710	2,500	1,200	7.28
	PRI-50	480	5,350	5,560	1,710	2,040	1,015	7.28
	PRI-60	584	5,320	5,690	1,710	2,500	1,200	7.28
	PRI-70	613	7,120	7,405	1,710	2,335	1,160	7.28
	PRI-80	802	7,525	8,050	1,710	3,020	1,280	7.28
	PRI-90	881	9,535	9,915	2,125	3,355	1,400	7.28
16"	PRI-40	657	4,535	4,850	1,970	2,500	1,200	8.32
	PRI-50	663	6,270	6,520	1,970	2,040	1,015	8.32
	PRI-60	799	6,250	6,685	1,970	2,500	1,200	8.32
	PRI-70	841	8,350	8,680	1,970	2,335	1,160	8.32
	PRI-80	1,092	8,845	9,460	1,970	3,020	1,280	8.32
	PRI-90	1,192	11,205	11,650	2,330	3,355	1,400	8.32

For SI: 1 lbf = 4.45kN, 1 lbf.ft. = 1.356 N.m, 1lbf.in.^{2} = 0.00287 N.m^2, 1 inch - 25.4 mm.

(1) The tabulated values are design values for normal duration of load. All values, except for EI and K, are permitted to be adjusted for other load durations as permitted by the code for solid sawn lumber.

(2) Bending stiffness (EI) of the I-joist.

(3) Moment capacity (M) of a single I-joist. When I-joists are in contact or spaced not more kthan 24 inches on center, are not less than 3 in number, and are joined by floor, roof, or other load distributing elements adequate to support the design load, repetitive moment shall be permitted for use in design.

(4) Shear capacity (V) of the I-joist.

(5) Intermediate reaction (IR) of the I-joist with a minimum bearing length of 3-1/2 inches without bearing stiffeners.

(6) End reaction (ER) of the I-joist with a minimum bearing length of 1-3/4 inches without web stiffeners. Higher end reactions are permitted. For a bearing length of 4 inches (5 inches for 14" and 16" PRI-50s), the end reaction may be set equal to the tabulated shear value. Interpolation of the end reaction between 1-3/4 and 4-inch (5-inch for 14" and 16" PRI-50s) bearing is permitted. For end reaction values over 1,550 lbf, web stiffeners are required.

(7) Coefficient of shear deflection (K). For calculating uniform load and center-point load deflections of the I-joist in a simple-span application, use Eqs. 1 and 2.

Uniform Load: $$\delta = \frac{5\omega\ell^4}{384EI} + \frac{\omega\ell^2}{K} \quad [1]$$

Center-Point Load: $$\delta = \frac{P\ell^3}{48EI} + \frac{2P\ell}{K} \quad [2]$$

Where: δ = calculated deflection (in.)
ω = uniform load (lbf/in.)
ℓ = design span (in.)
P = concentrated load (lbf)
EI = bending stiffness of the I-joist (lbf-in.^{2})
K = coefficient of shear deflection (lbf)

GUIDELINE
Wood I-Joists

ASD
ALLOWABLE STRESS DESIGN

MANUAL FOR ENGINEERED WOOD CONSTRUCTION

Table of Contents

2.1 Product Information

Wood I-joists are well accepted throughout the construction industry. I-joists are a high strength, cost efficient alternative to conventional framing. They are exceptionally stiff, lightweight and capable of long spans. Holes may be easily cut in the web according to manufacturer's recommendations, allowing ducts and utilities to be run through the joist. I-joists are dimensionally stable and uniform in size, with no crown. This keeps floors quieter, reduces field modifications, and eliminates rejects in the field. I-joists may be field cut to proper length using conventional methods and tools.

Manufacturing of I-joists utilizes the geometry of the cross-section and high strength components to maximize the strength and stiffness of the wood fiber. Flanges are manufactured from solid sawn lumber or structural composite lumber, while webs typically consist of plywood or oriented strand board. The efficient utilization of raw materials, along with high quality exterior adhesives and state of the art quality control procedures, result in an extremely consistent product that maximizes environmental benefits as well (see inside cover of this guideline).

Wood I-joists are produced as proprietary products which are covered by code acceptance reports by one or all of the model building codes. Acceptance reports and product literature should be consulted for current design information.

2.2 Common Uses

Prefabricated wood I-joists are used throughout the world. They are widely used as a framing material for housing in North America. I-joists are made in different grades and with various processes and can be utilized in various applications. Proper design is required to optimize performance and economics.

In addition to use in housing, I-joists find increasing use in commercial and industrial construction. The high strength, stiffness, wide availability and cost saving attributes make them a viable alternative in most low-rise construction projects.

Prefabricated wood I-joists are typically used as floor and roof joists in conventional construction. In addition, I-joists are used as studs where long lengths and high strengths are required.

2.3 Availability

I-joists are widely regarded as a premium construction material and are available throughout the US. To efficiently specify I-joists for individual construction projects, consideration should be given to the size and the required strength of the I-joist. Sizes vary with each individual product. The best source of this information is your local lumber supplier, distribution center or I-joist manufacturer. Proper design is facilitated through the use of manufacturer's literature and specification software available from I-joist manufacturers.

3.4 Moment Design

Published moment capacities of I-joists are determined from empirical testing of a completely assembled joist or by engineering analysis supplemented by tension testing the flange component. If the flange contains end jointed material, the allowable tension value is the lesser of the joint capacity or the material capacity.

Because flanges of a wood I-joist can be highly stressed, field notching of the flanges is not allowed. Similarly, excessive nailing or the use of improper nail sizes can cause flange splitting that will also reduce capacity. The producer should be contacted when evaluating a damaged flange.

$M' \geq$ Load conditions

where

M' = adjusted bending moment capacity value

3.5 Deflection Design

Wood I-joists, due to their optimized web materials, are susceptible to the effects of shear deflection. This component of deflection can account for as much as 15% to 30% of the total deflection. For this reason, both bending and shear deflection should be considered in the deflection design. A typical deflection calculation for simple span wood I-joists under uniform load is shown below.

Deflection = Bending Component + Shear Component

$$\Delta = \frac{5w\ell^4}{384EI} + \frac{w\ell^2}{k}$$

Individual producers provide equations in a similar format. Values for use in the preceding equations can be found in the individual producer's evaluation reports. For other load and span conditions, an approximate answer can be found by using conventional bending deflection equations adjusted as follows:

$$\text{Deflection} = \text{Bending Deflection}\left(1 + \frac{384\,EI}{5\ell^2 k}\right)$$

w = Uniform load in pounds per lineal inch

ℓ = Design span in inches

EI = Joist moment of inertia times flange modulus of elasticity

k = Shear deflection coefficient

Since wood I-Joists have the inherent capability to span farther than conventional lumber, the model building code maximum live load deflection criteria may not be appropriate for many floor applications. Many wood I-joist producers recommend using stiffer criteria, such as L/480 for residential floor construction and L/600 for public access commercial applications like office floors. The minimum code required criteria for storage floors and roof applications is normally adequate.

4.5 Bending (moment and shear)

The allowable bending and shear design values are computed by multiplying the reference design values by a series of adjustment factors. (Note that, while the following list of adjustment factors is somewhat intimidating, many of the factors equal unity for common applications.)

The reference values for M and V are discussed in Section 3 of this Guideline.

$$M' = M C_D C_M C_t C_L C_r$$

$$V' = V C_D C_M C_t$$

and

C_D per Section 2.3.2 of ANSI/AF&PA NDS-1997.

C_M is 1.0 up to 16% MC or as indicated in the manufacturer's literature and code acceptance report.

C_t is 1.0 for sustained temperatures up to 100 degrees and occasional temperatures up to 150 degrees F.

C_L is 1.0 for fully supported beams or as given in ANSI/AF&PA NDS-1997 Section 3.3.3 otherwise.

C_r is equal to values discussed in Section 4.4 for members used in a repetitive assembly as defined in ASTM D5055 or 1.00 otherwise.

4.6 Bearing (reactions)

The allowable bearing design value V_b' is computed by multiplying the tabulated design value by a series of adjustment factors.

$$V_b' = V_b C_D C_M C_t$$

and adjustments are as discussed in Section 4.5.

5.3 Deflection Design

In addition to strength calculations, deflection must be checked relative to code-prescribed limits. Additionally most manufacturers publish recommended deflection limits that are more stringent than code minimums. Assume code prescribed minimums of $\ell/240$ for total load and $\ell/360$ for live load. The manufacturer recommends $\ell/480$ for live load. By inspection live load deflections control.

Shear deformations must be taken into account when deflections are checked. The live load deflection for this joist is:

w = 53 plf = 4.42 lbs per inch

ℓ = 18.83' = 226 inches

$$\text{Deflection} = \frac{5w\ell^4}{384EI} + \frac{w\ell^2}{k}$$

$$= 0.429" + .037"$$

$$= 0.465" = \ell/485$$

The joist is acceptable on a deflection basis. A stiffer floor system could be provided by specifying glued/nailed floor sheathing.

5.4 Concentrated Load Example

Consider the example above with the additional provision of a lightly loaded bearing wall perpendicular to the joists located 10" from the end of the joist. Although this load is within "d" from the joist end, it must be considered. Assume an applied load of 400 pounds. The first consideration is to meet the manufacturer's requirements for reinforcing the joist under the concentrated load.

The critical shear (V) and reaction (V_b) are now approximately equal to 630 pounds (see above) plus the concentrated load of 400 pounds, or 1030 pounds. The shear and bearing design capacities are greater than the applied shear and bearing, but web stiffeners are now required to attain the required bearing resistance. Moment and deflection performance should also be verified.

5.5 Considerations for Web Holes

I-Joists provide great flexibility for locating holes in the web. Manufacturers provide product specific charts that address particular ***uniform*** load cases. Additional consideration is required for other than specified uniform loads and concentrated loads. The joist manufacturer should be contacted to determine the joist capacity with the requested hole. The partial span load case shown in Figure 2 of Section 6.3 should be considered. This load case is critical when evaluating full web height rectangular holes.

6.3 Load Cases

Most building codes require consideration of a critical distribution of loads. Due to the long length and continuous span capabilities of the wood I-joist, these code provisions have particular meaning. Considering a multiple span member, the following design load cases should be considered:

- All spans with total loads
- Alternate span loading
- Adjacent span loading
- Partial span loading (joists with holes)
- Concentrated load provisions (as occurs)

A basic description of each of these load cases follows:

Total loads on all spans - This load case involves placing all live and dead design loads on all spans simultaneously.

Alternate span loading - This load case places the L, L_R, S or R load portion of the design loads on every other span and can involve two loading patterns. The first pattern results in the removal of the live loads from all even numbered spans. The second pattern removes live loads from all odd numbered spans. For roof applications, some building codes require removal of only a portion of the live loads from odd or even numbered spans. The alternate span load case usually generates maximum end reactions, mid-span moments, and mid-span deflections. Illustrations of this type of loading are shown in Figure 2.

Adjacent span loading - This load case (see Figure 2) removes L, L_R, S or R loads from all but two adjoining spans. All other spans, if they exist, are loaded with dead loads only. Depending on the number of spans involved, this load case can lead to a number of load patterns. All combinations of adjacent spans become separate loadings. This load case is used to develop maximum shears and reactions at internal bearing locations.

Partial span loading - This load case involves applying L, L_R, S or R loads to less than the full length of a span (see Figure 2). For wood I-joists with web holes, this case is used to develop shear at hole locations. When this load case applies, uniform L, L_R, S, R load is applied only from an adjacent bearing to the opposite edge of a rectangular hole (centerline of a circular hole). For each hole within a given span, there are two corresponding load cases. Live loads other than the uniform application load, located within the span containing the hole, are also applied simultaneously. This includes all special loads such as point or tapered loads.

Concentrated load provisions - Most building codes have a concentrated load (live load) provision in addition to standard application design loads. This load case considers this concentrated load to act in combination with the system dead loads on an otherwise unloaded floor or roof. Usually, this provision applies to non-residential construction. An example is the "safe" load applied over a 2½ square foot area for office floors. This load case helps insure the product being evaluated has the required shear and moment capacity throughout it's entire length and should be considered when analyzing the effect of web holes.

A properly designed multiple span member requires numerous load case evaluations. Most wood I-joist producers have developed computer programs, load and span tables, or both that take these various load cases into account.

6.4 Floor Performance

Designing a floor system to meet the minimum requirements of a building code may not always provide acceptable performance to the end user. Although minimum criteria help assure a floor system can safely support the imposed loads, the system ultimately must perform to the satisfaction of the end user. Since expectancy levels may vary from one person to another, designing a floor system becomes a subjective issue requiring judgment as to the sensitivity of the intended occupant.

Joist deflection is often used as the primary means for designing in floor performance. Although deflection is a factor, there are other equally important variables that can influence the performance of a floor system. A glue-nailed floor system will generally have better deflection performance than a nailed only system. Selection of the decking material is also an important consideration. Deflection of the sheathing material between joists can be reduced by placing the joists at a closer on center spacing or increasing the sheathing thickness.

Proper installation and job site storage are important considerations. All building materials, including wood I-Joists, need to be kept dry and protected from exposure to the elements. Proper installation includes correct spacing of sheathing joints, care in fastening of the joists and sheathing, and providing adequate and level supports. All of these considerations are essential for proper system performance.

Vibration may be a design consideration for floor systems that are stiff and where very little dead load (i.e.: partition walls, ceilings, furniture, etc.) exists. Vibration can generally be damped with a ceiling system directly attached to the bottom flange of the wood I-joists. Effective bridging or continuous bottom flange nailers (i.e.: 2x4 nailed flat-wise and perpendicular to the joist and tied of to the end walls) can also help to minimize the potential for vibration in the absence of a direct applied ceiling. Limiting the span/depth ratio of the I-joist may also improve floor performance.

6.5 Joist Bearing

Bearing design for wood I-joists requires more than consideration of perpendicular to grain bearing values. Minimum required bearing lengths take into account a number of considerations. These include: cross grain bending and tensile forces in the flanges, web stiffener connection to the joist web, adhesive joint locations and strength, and perpendicular to grain bearing stresses. The model building code evaluation reports provide a source for bearing design information, usually in the form of minimum required bearing lengths.

Usually, published bearing lengths are based on the maximum allowable shear capacity of the particular product and depth or allowable reactions are related to specific bearing lengths. Bearing lengths for wood I-joists are most often based on empirical test results rather than a calculated approach. Each specific producer should be consulted for information where deviations from published criteria are desired.

To better understand the variables involved in a wood I-joist bearing, it's convenient to visualize the member as a composition of pieces, each serving a specific task. For a typical simple span joist, the top flange is a compression member, the bottom flange is a tension member, and the web resists the vertical shear forces. Using this concept, shear forces accumulate in the web member at the bearing locations and must be transferred through the flanges to the support structure. This transfer involves two critical interfaces: between the flange and support member and between the web and flange materials.

Starting with the support member, flange to support bearing involves perpendicular to grain stresses. The lowest design value for either the support member or flange material is usually used to develop the minimum required bearing area.

The second interface to be checked is between the lower joist flange and the bottom edge of the joist web, assuming a bottom flange bearing condition. This connection, usually a routed groove in the flange and a matching shaped profile on the web, is a glued joint secured with a waterproof structural adhesive. The contact surfaces include the sides and bottom of the routed flange.

In most cases, the adhesive line stresses at this joint control the bearing length design. The effective bearing length of the web into the flange is approximately the length of flange bearing onto the support plus an incremental length related to the thickness and stiffness of the flange material.

Since most wood I-joists have web shear capacity in excess of the flange to web joint strength, connection reinforcement is sometimes utilized. The most common method of reinforcement is the addition of web stiffeners (also commonly referred to as bearing blocks). Web stiff-

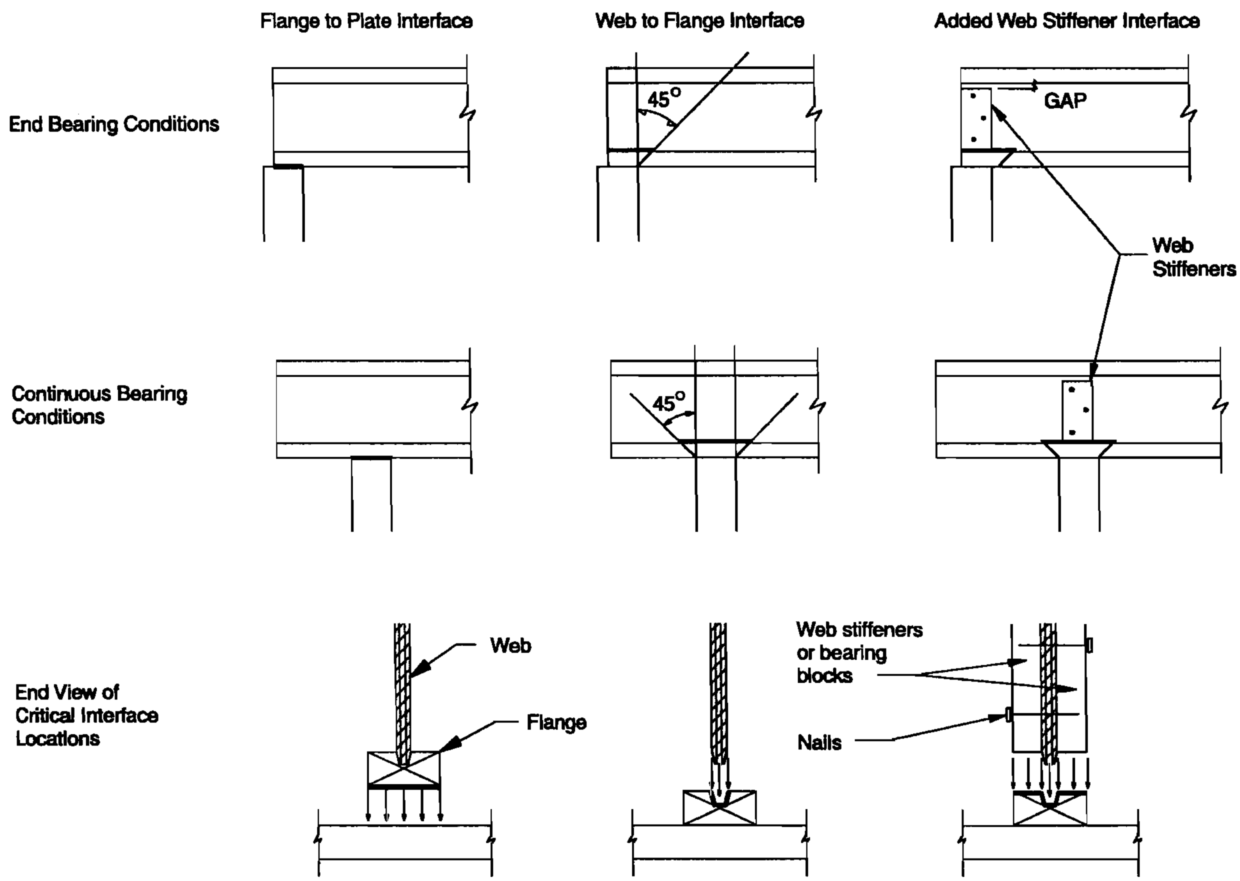


Figure 4 Web Stiffener Bearing Interface

6.7 Beveled End Cuts

Beveled end cuts, where the end of the joist is cut on an angle (top flange does not project over the bearing, much like a fire cut), also requires special design consideration. Again the severity of the angle, web material, location of web section joints, and web stiffener application criteria effect the performance of this type of bearing condition. The specific wood I-joist producers should be consulted for limits on this type of end cut.

It is generally accepted that if a wood I-joist has the minimum required bearing length, and the top flange of the joist is not cut beyond the face of bearing (measured from a line perpendicular to the joist's bottom flange), there is no reduction in shear or reaction capacity. This differs from the conventional lumber provision that suggests there is no decrease in shear strength for beveled cuts of up to an angle of 45°. The reason involves the composite nature of the wood I-joist and how the member fails in shear and or bearing. Figure 5 provides an illustration of the beveled end cut limitation.

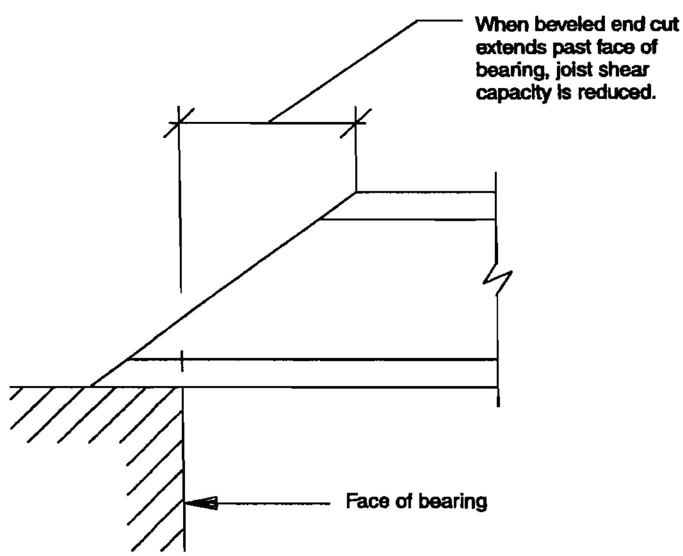


Figure 5 Beveled End Cut

For the high end support, bottom flange bearing in a suitable connector or on a beveled plate is recommended. When slopes exceed 30°, straps or gussets may be needed to resist the tangential component of the reaction.

Support connections only to the web area of a wood I-joist, especially at the high end of a sloped application, are not generally recommended. Since a wood I-joist is made up of a number of pieces, joints between web sections occurring near the end of the member may reduce the joist's shear capacity when not supported from the bottom flange.

When a wood I-joist is supported from the web only, the closest web to web joint from the end may be stressed in tension. This could result in a joint failure with the web section pulling out of the bottom flange. Locating these internal joints away from the end of the member or applying joint reinforcements are potential remedies, but generally are not practical in the field.

The best bearing solution is to provide direct support to the joist's bottom flange to avoid reductions in capacity. Figure 7 shows typical high end bearing conditions.

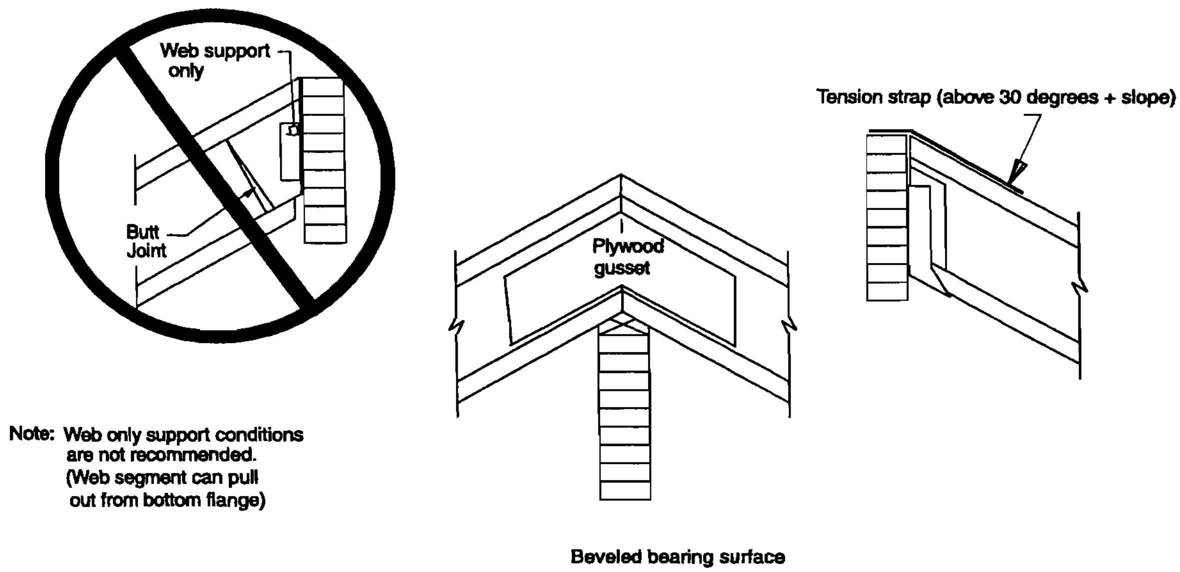


Figure 7 Sloped Bearing Conditions (High End)

6.9 Connector Design/Joist Hangers

Although there are numerous hangers and connectors available that are compatible with wood I-joists, many are not. Hangers developed for conventional lumber or glulam beams often use large nails and space them in a pattern that will split the joist flanges and web stiffeners. Hanger selection considerations for wood I-joists should include nail length and diameter, nail location, wood I-joist bearing capacity, composition of the supporting member, physical fit, and load capacity. For example, hangers appropriate for a wood I-joist to glulam beam support may not be compatible for an I-joist to I-joist connection.

In general, nails into the flanges should not exceed the diameter of a 10d common nail, with a recommended length no greater than 1½". Nails into web stiffeners should not exceed the diameter of a 16d common nail. Nails through the sides of the hanger, when used in combination with web stiffeners, can be used to reduce the joist's minimum required bearing length. Nails help transfer loads directly from the I-joist web into the hanger, reducing the load transferred through direct bearing in the bottom hanger seat.

Hangers should be capable of providing lateral support to the top flange of the joist. This is usually accomplished by a hanger flange that extends the full depth of the joist. As a minimum, hanger support should extend to at least mid-height of a joist used with web stiffeners. Some connector manufacturers have developed hangers specifically for use with wood I-joists that provide full lateral support without the use of web stiffeners. Figure 8 illustrates lateral joist support requirements for hangers.

For a double I-joist member loaded from one side only, the minimum connection between members should be capable of transferring at least 50% of the applied load. Likewise, for a triple member loaded from one side only, the minimum connection between members must be capable of transferring at least 2/3 of the applied load. The actual connection design should consider the potential slip and differential member stiffness. Many producers recommend limiting multiple members to 3 joists. Multiple I-joists with 3½" wide flanges may be further limited to two members.

The low torsional resistance of most wood I-joists is also a design consideration for joist to joist connections. Eccentrically applied side loads, such as a top flange hanger hung from the side of a double joist, create the potential for joist rotation. Bottom flange restraining straps, blocking, or directly applied ceiling systems may be needed on heavily loaded eccentric connections to resist rotation. Figure 10 shows additional I-joist connection considerations for use with face nail hangers.

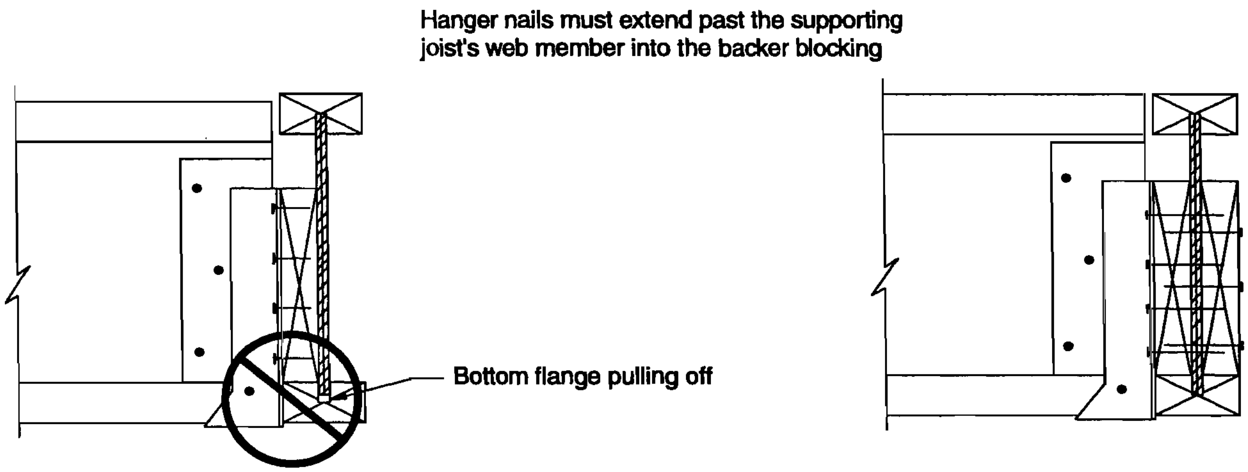


Figure 10 Connection Requirements for Face Nail Hangers

6.10 Vertical Load Transfer

Bearing loads originating above the joists at the bearing location require blocking to transfer these loads around the wood I-joist to the supporting wall or foundation. This is typically the case in a multi-story structure where bearing walls stack and platform framing is used. Usually, the available bearing capacity of the joist is needed to support its reaction, leaving little if any excess capacity to support additional bearing wall loads from above.

The most common type of blocking uses short pieces of wood I-joist, often referred to as blocking panels, positioned directly over the lower bearing and cut to fit in between the joists. These panels also provide lateral support for the joists and an easy means to transfer lateral diaphragm shears.

The ability to transfer lateral loads (due to wind, seismic, construction loads, etc.) to shear walls or foundations below is important to the integrity of the building design. Compared with dimension lumber blocking, which usually is toe-nailed to the bearing below, wood I-joist blocking can develop higher diaphragm transfer values because of a wider member width and better nail values.

Specialty products designed specifically for rim boards are pre-cut in strips equal to the joist depth, and provide support for the loads from above. This solution may also provide diaphragm boundary nailing for lateral loads.

6.12 Fire Assemblies

The Wood I-Joist Manufacturer's Association (WIJMA) has been active in support and development of the following projects to establish fire endurance performance of systems using I-Joist products:

- The Fire Resistance Design Manual, as published by the Gypsum Association, establishes a 1-hour system for I-Joist floor-ceiling assemblies using 2 layers of 5/8" type X gypsum wallboard (#FC 5406).
- Several ASTM E-119 fire tests have been conducted by wood I-Joist manufacturers to establish fire resistive properties of I-Joist systems. These systems are shown in each manufacturer's research report.
- National Fire Protection Research Foundation Report titled "National Engineered Lightweight Construction Fire Research Project." This report documents an extensive literature search of fire performance of engineered lightweight construction.
- A video has been produced by WIJMA: "I-JOISTS: FACTS ABOUT PROGRESS." This video describes some basic facts about changes taking place within the construction and fire service industries. Along with this video is a document that provides greater detail on fire performance issues for those that desire more in depth information.
- Industry research in fire endurance modeling for I-Joist systems.

Jobsite storage recommendations are similar to other dry engineered products. I-Joists should remain bundled and be stickered such that the joists are not in the mud or standing water. The joists should be protected from extended exposure to the elements. Additionally the I-Joists should be stored vertically to prevent ponding of water beteween the flanges. Specific recommendations for jobsite storage are available from each supplier and typical recommendations are shown in Figure 13.

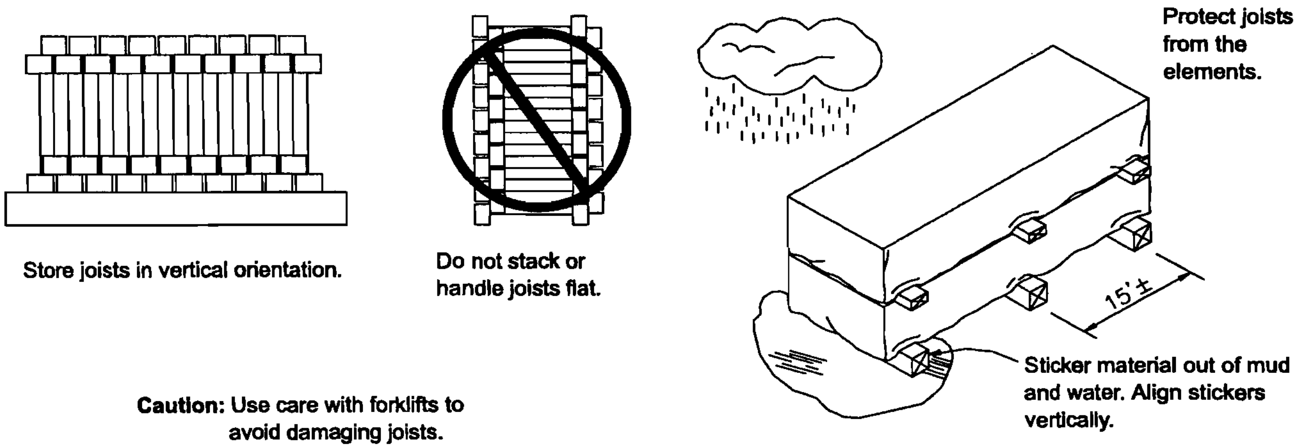
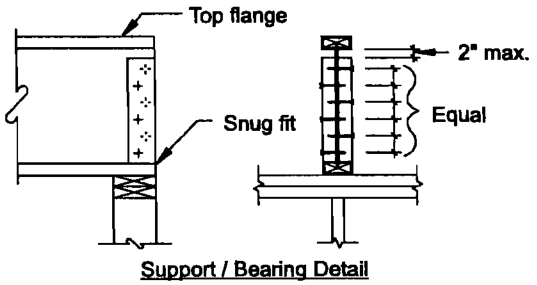


Figure 13 Jobsite Storage



1. Web stiffeners and nailing requirements vary by joist series and depth. Consult manufacturer's literature for proper installation.
2. Web stiffeners are required on joists with hangers that do not support the top flange laterally.
3. Web stiffeners may be required at concentrated loads within the joist span, such as bearing walls or posts above.

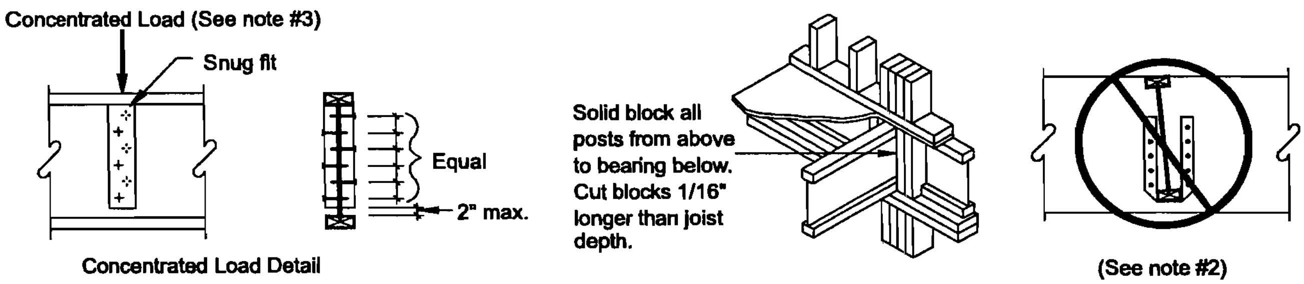
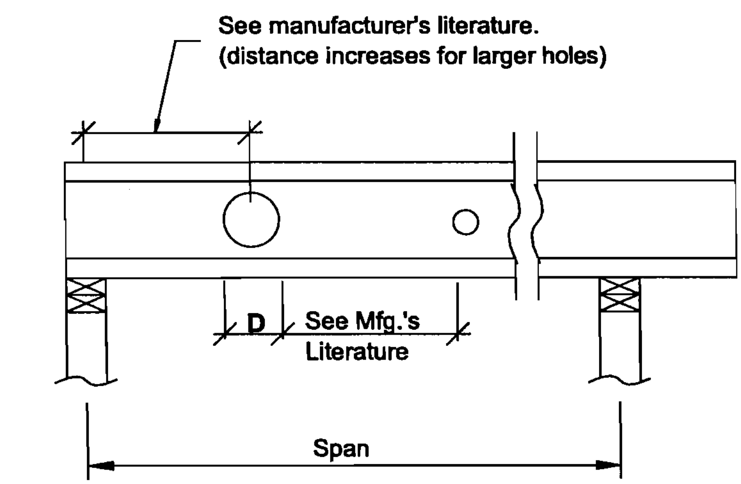


Figure 15 Web Stiffener Attachment

Each manufacturer publishes unique hole charts, and therefore hole charts cannot be used interchangeably between manufacturers. Key considerations are the size and shape of hole permitted, the location of the hole relative to the supports and the spacing between holes. Note hole charts are usually limited to expected span and load conditions. Figure 16 reflects information typically included by each manufacturer.



Rectangular and full height duct holes may also be possible. Refer to specific manufacturer's literature.

Important: Please read all instructions and notes before drilling holes and only cut in web area as specified.

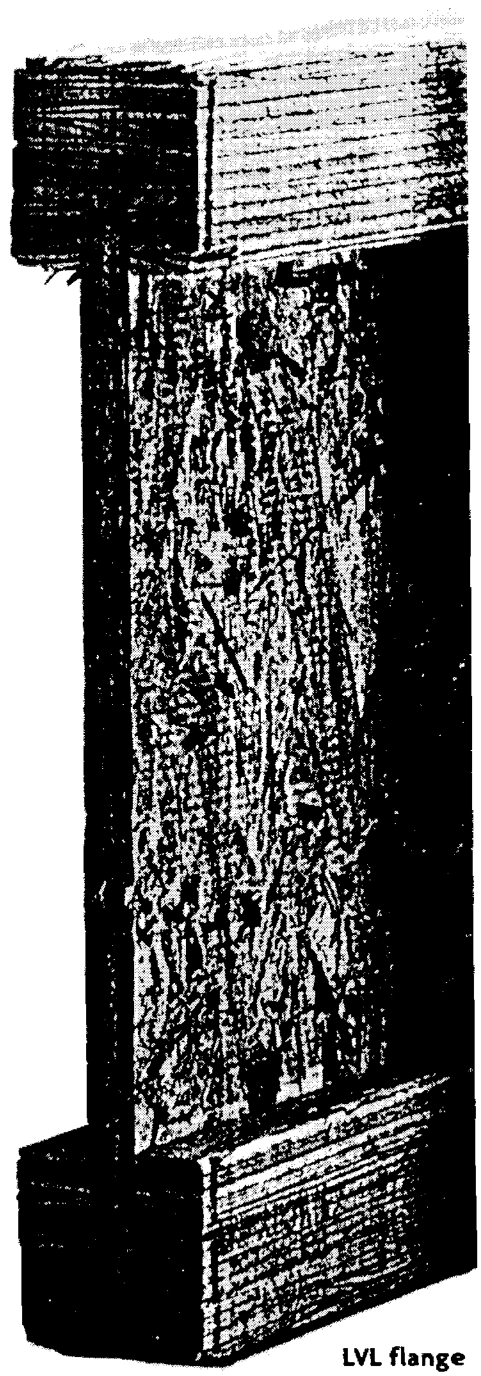
Figure 16 Hole Chart

APPENDIX B
The Argument for I-Joists
by Paul Fisette

The Argument for I-Joists

New products and increased competition make superior I-joist performance available at solid-lumber prices

BY PAUL FISETTE



Although Apollo 11 and Woodstock got all the attention, 1969 was also the year Trus Joist Corporation (now Trus Joist MacMillan) unveiled the first wood I-beam. The development of the I-joist was originally driven by performance, not price. High-end contemporary designs were inspired by homeowners who wanted open floor plans, which required long clear spans. I-joists, with their deep plywood webs edged by lumber flanges, were much stronger and stiffer than sawn joists, and they gave designers the free hand they needed to fashion less restrictive load-bearing strategies.

While I-joists offer many advantages over sawn lumber, unfamiliarity and high prices have kept most builders from trying them. But the truth is that I-joist installation is not that different from solid lumber (*FHB* #108, pp. 50-55). And the really good news is that the prices of I-joists are dropping. The timber crisis of the 1990s has made prices of engineered-wood products, such as I-joists, more stable than lumber. There is also a growing number of new, small companies that are fighting hard for market share; many of these companies have fine products at competitive prices.

I-joists don't waste fiber where it's not needed

To understand how an I-joist works, imagine what happens when weight is placed in the center of the floor (drawing left, facing page). As the joist deflects and bends—essentially forming an arc—the wood fibers along the top edge are compressed, while those along the bottom edge are stretched. Because the edges are moving in different directions, at some point the wood fibers in between are neither compressed nor pulled apart. I-joist designers take advantage of this fact by placing the strongest and stiffest fiber in the flanges where the stress is greatest. But they don't waste fiber in the center where it's not needed. This fact is why I-joists can get away with a web that's only 3/8 in. thick.

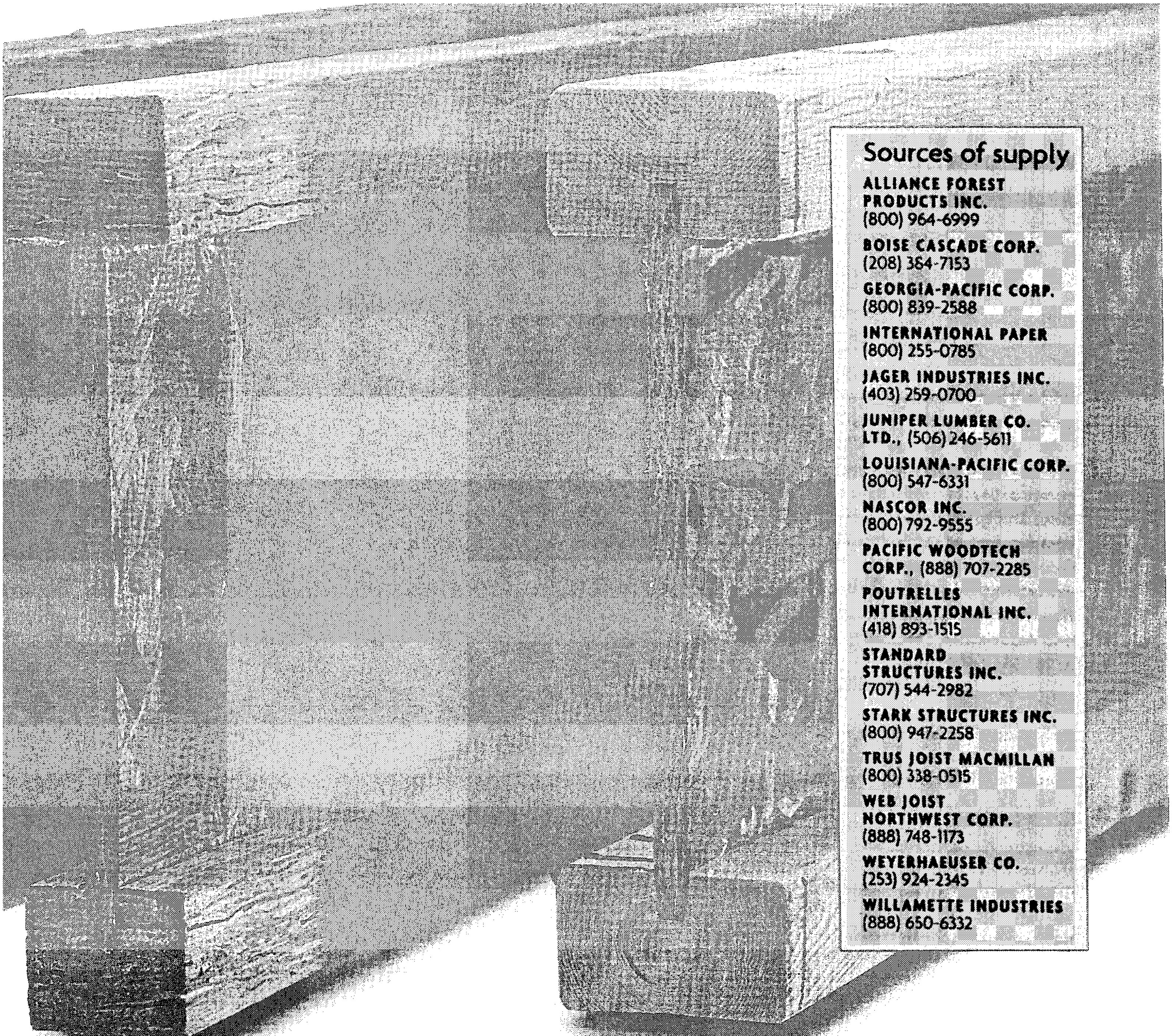
To understand further why I-joists are so efficient, it's important to understand the properties of solid lumber. Double the thickness of a joist, and it will carry twice the load; double the depth of a joist, and it will carry four times the load. Likewise with stiffness: Double the thickness of a joist, and the deflection is cut in half; double the depth of a joist, and the deflection is reduced to one-eighth. Adding depth to a joist increases strength, stiffness and potential clear span. With an I-joist, a minimal amount of wood fiber is all it takes to increase the depth.

One I-joist can do the work of two or more solid joists

Solid-lumber joists are typically available in maximum lengths of 16 ft., and they're usually laid out 16 in. o. c. To span the average house, separate joists are installed across the front and the back, and lapped over a girder beam at midspan.

Because I-joists are available in lengths up to 60 ft., spanning the house is not a problem, so the number of joists is instantly cut in half. In most cases, I-joists can be laid out on 19½-in. or 24-in. centers (chart p. 73). Besides material savings, fewer joists mea less handling and less nailing.

Art Pakatar, construction coordinator fc Belmonte Builders in Albany, New York, ex presses the views of many builders when h says, "We changed to I-joists a few yea back and will never use lumber joists agai We save money, improve performance an feel like we're helping the environment Like Pakatar, many builders appreciate th consistency that I-joists provide. I-joists a straight, so floors and ceilings lie flat. I-jois are stable because their moisture content



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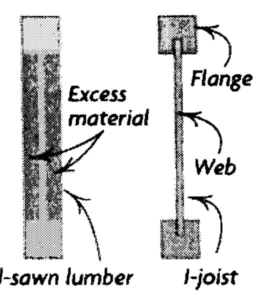
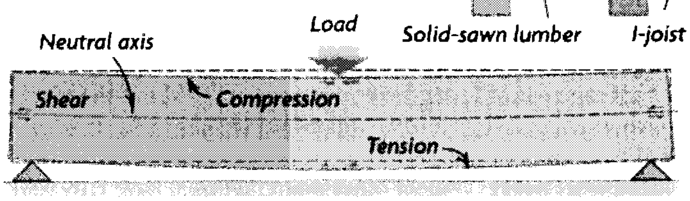
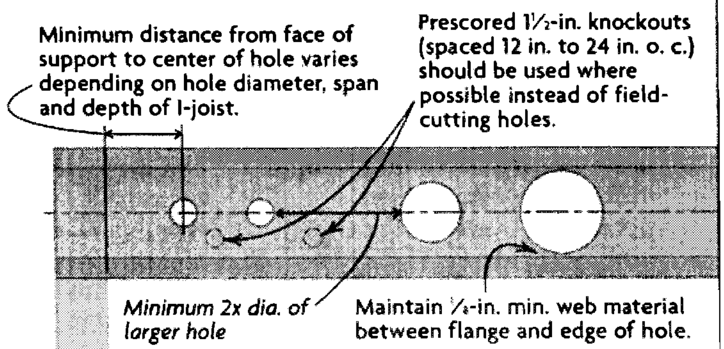
TimberStrand flange **Solid-sawn flange**

How an I-joist works. The deflection that results from a bending load puts great strain on the top and bottom edges of a beam but has little effect on the wood in between. The flanges of an I-joist are built of strong lumber to resist these forces, while the web of an I-joist basically functions to tie the flanges together.



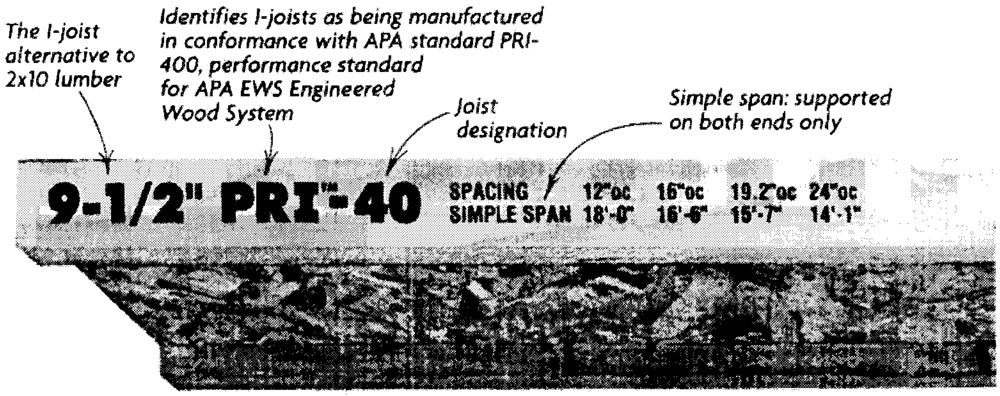


Drilling holes in I-joists. The flanges must never be cut or notched, but fairly large holes can be cut through the webs (the largest holes are permitted at midspan). Manufacturers' span tables must be consulted to determine maximum diameters for holes near supports.



Drawings: Dan Thornton

I-joist standardization: Wave of the future or passing fad?



Unlike plywood, oriented strand board and other panel products, I-joists have no universal standard. Every manufacturer issues its own specifications and span recommendations. Each time a builder buys a new product, there is a new set of rules to follow. APA (The Engineered Wood Association, Tacoma, WA; 253-565-6600; www.apawood.org) would like to change all that. Before he became APA's technical director, Tom Williamson was a Trus Joist MacMillan distributor for 15 years. He recognizes that a significant level of confusion is caused by having too many proprietary product specifications. Williamson says, "It became obvious to us that we had to standardize to make it easier for specifiers to specify, suppliers to inventory and builders to buy."

The APA performance-rated I-joist (PRI) standard was brought into the marketplace in 1997 and is recognized by all of the model building codes. The APA's standard basically creates a family of I-joist products that have similar design properties. It then develops span tables based on performance levels. The APA technical guide provides construction details for blocking, fasteners, rim joists, cantilevers and web-hole placement.

Manufacturers who like the idea can buy into the plan and adopt the PRI standard. But few of them have: So far, only 20% of the I-joists sold follow the PRI standard.

closely controlled. Shrinkage, nail pops and floor squeaks are a thing of the past.

Promotional literature does make some exaggerated claims, however. Manufacturers promise big savings when installing plumbing, electrical and mechanical systems. Thin webs are easier to drill through, and larger holes are permitted, especially in midspan (drawing right, p. 71). But the word from the field is that few subcontractors see enough difference to offer discounts for I-joist jobs.

Builders don't always save as much on labor as they're led to believe, either. Flush-mounting I-joists against the face of a beam is particularly tedious and requires the use of expensive metal hangers. Some of the more complicated framing schemes may even require crews to receive additional training. When working with I-joists, it's always good practice to provide detail sheets to the job foreman and to mark the locations for special fastening details right on the blueprints.

Ironically, the design that makes I-joists such an efficient use of lumber makes them a concern for firefighters. Because it's less beefy than a solid joist, a burning I-joist collapses faster than a solid joist does.

Solid-sawn flanges offer I-joist quality at lower costs

The evolution of I-joists has been a combination of high and low technology. The first I-joists were made with plywood webs and solid-lumber flanges. In 1977, most manufacturers followed Trus Joist's lead and began making flange stock out of laminated veneer lumber (LVL), stronger and more stable than solid lumber. Since 1990, virtually every manufacturer has abandoned plywood in favor of oriented strand board (OSB) web material. OSB is less expensive, more widely available and—because all the strands interlock—stronger than plywood in shear.

Recent I-joist technology has taken a step backward, sort of: Between 15% and 20% of I-joists are now being built with solid-lumber flanges. These days, solid-lumber flanges are made from 2x3s or 2x4s that have been specially selected and finger-jointed for high strength and stiffness. The solid flanges do not have the strength of LVL, but they make up the difference with larger cross sections. Well-made solid-flange I-joists can span distances equal to the best LVL versions. And the kicker is that they typically cost 20% less than their LVL cousins. Builder Pakatar reports that switching to ALLJoist, a solid-flange product manufactured by Alliance Forest Products (sources of supply, p. 71) "saved $1,400 off the cost of building a 3,200-sq. ft. model home."

Along with seeing material cost savings, many framers find that I-joists with wider solid-lumber flanges are easier to install: They don't wiggle like spaghetti while they're carried and laid up, and they don't easily tip over the way their thin-flanged LVL cousins do. Solid flanges make the joists run more true across the span, so they don't have to be straightened as much when decking is applied. Wider flanges provide more room for nailing and a larger surface area for gluing; they also slightly reduce the space between joists, making the subfloor a bit stiffer.

Choosing the right brand

I-joists are essentially nothing more than three pieces of wood glued together. The most efficient cross-sectional geometry and assembly methods have been mastered by engineers for years. If you look at the technical specifications of all major brands, you will find virtually no difference in sizes or span ratings. Price and service are where the differences lie.

Solid-flange I-joists, which are made by a number of different companies (sources of supply, p. 71), are the obvious price winners, but service is another story. For service and technical support, the clear leader is Trus Joist MacMillan (TJM). With a 55% share of the I-joist market, TJM has the most extensive distribution network. It also has more than 170 field representatives, while most other manufacturers have only four or five. Additionally, with the most comple

Manufacturers who make the ther 80% of I-joists, including ıdustry leader Trus Joist IacMillan, do not support ıPA's plan for standardization. ome argue that setting a tandard will drive products o the lowest common denom- nator, removing the incentive or innovation and the devel- ıpment of new products. Oth- ırs are concerned that builders may see the span listings stamped on the side of the I-joists and install them based on that recommendation alone without considering any other special requirements, including point loads, offset loads and fastening schedules.

Standardization in the world of I-joists clearly does not eliminate the need for technical support and design services. But Thomas Denig, president and chief executive officer of TJM, points out, "With price as the primary differentiator, manufacturers will most likely seek to reduce costs by reducing or eliminating sales and technical-design assistance, software, dealer and contractor training, and job-site support." Denig also warns that the proposed ability to mix I-joist brands in a floor system is a bad idea. He says, "Manufacturers will no longer be in a position to provide homeowners with warranties for the system." APA's Williamson admits that these concerns are legitimate but thinks the problems are solvable. Stay tuned.

—*P. F.*

ine of structural products—Microllam LVL), TimberStrand (LSL), Parallam PSL) and TJIs (I-joists)—available to engi- ıeer virtually any floor system, TJM also of- ers the convenience of one-stop shopping. 3ut you pay for this service. Even TJM field epresentatives admit that their product line s 10% more expensive than that of their ıearest competitor.

This is not to say that you can't get adequate service from another company, but you need to ask your supplier some specific questions, such as:

- Who provides the engineering service: dealer, distributor or manufacturer?
- How long will it take to size the joists in a set of plans?
- How long will it take for delivery?
- What technical information do they provide: joist layout? hanger locations? performance specs?
- What happens if my customer changes a stair layout? Who engineers the change? How long will it take to make the changes?
- What is the policy if I receive what I think is defective material on site?
- Who is the person that I will be working directly with? □

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Comparing costs: I-joists vs. solid lumber

The chart below compares costs for two types of I-joist (an LVL-flange model from Louisiana-Pacific and a solid-flange model from Alliance Forest Products) to a standard 2x10 floor frame for a modest (44 ft. by 28 ft.) ranch. At 16 in. o. c., the cost of solid-flange I-joists is comparable to that of 2x10s. At 24 in. o. c., not even 2x12s would be strong enough, but both I-joists easily exceed load and deflection limits. Also, the wider spacing saves enough on material to make the LVL-flange product less expensive than 16-in. o. c. 2x10s. Note: Prices were quoted last summer by suppliers in western Massachusetts.

16-in. layout	Kiln-dried #2 SPF 2x10			LPI LVL-flange I-joist			AJS10 solid-flange I-joist		
	Qty.	Unit cost	Total cost	Qty.	Unit cost	Total cost	Qty.	Unit cost	Total cost
Field joists	68 @ 14 ft.	1.22/LF	1161.44	34 @ 28 ft.	1.45/LF	1380.40	34 @ 28 ft.	1.12/LF	1066.24
Blocking+misc.	56 LF	1.22/LF	68.32	120 LF	1.45/LF	174	120 LF	1.12/LF	134.40
Rim boards	96 LF	1.22/LF	117.12	96 LF	1.65/LF	158.40	96 LF	1.65/LF	158.40
Total cost			1346.88			1712.80			1359.04

24-in. layout	Kiln-dried #2 SPF 2x10	LPI LVL-flange I-joist			AJS10 solid-flange I-joist		
	Won't work: maximum allowable span at 24 in. o. c. is 11 ft. 1 in.*	Qty.	Unit cost	Total cost	Qty.	Unit cost	Total cost
Field joists		24 @ 28 ft.	1.45/LF	974.40	24 @ 28 ft.	1.12/LF	752.64
Blocking+misc.		102 LF	1.45/LF	147.90	102 LF	1.12/LF	114.24
Rim boards		96 LF	1.65/LF	158.40	96 LF	1.65/LF	158.40
Total cost				1280.70			1025.28

*Design parameters: 40 psf live load, 15 psf dead load, L/360 maximum deflection.

APPENDIX C
I-Joist Product Information

Manufacturer	Product	Web Type Web to Web Joint Web Lengths	Flange Type & Width Lengths Orientation	Available Depths (in.)	Web flange joint depth (in.)	EI X 10^6 in^2-lbs.	Span (see notes) 1st row L/360, 2nd row L/480			
							12 oc	16 oc	19.2 oc	24 oc
Boise Cascade Corporation	BCI/40	3/8" Douglas fir plywood — 4' lengths	1-1/2" LVL Continuous Flatwise	9-1/2, 11-7/8, 14	—	268	— —	— —	— —	— —
Boise Cascade Corporation	BCI/45	3/8" Douglas fir plywood — 4' lengths	1-3/4" LVL Continuous Flatwise	9-1/2, 11-7/8, 14, 16	2/5	309	22'11" 16'2"	20'11" 14'8"	19'9" 13'10"	18'4" 12'10"
Boise Cascade Corporation	BCI/60	3/8" Douglas fir plywood — 4' lengths	2-5/16" LVL Continuous Flatwise	11-7/8, 14, 16, 18, 20	2/5	401	24'9" 17'6"	22'7" 15'10"	21'3" 14'10"	19'7" 13'10"
Boise Cascade Corporation	AJS 10	3/8" OSB Vee 4' lengths	2-1/2" Black Spruce Finger joined Flatwise	9-1/2, 11-7/8, 14, 16	—	373	24'1" 22'3"	20'10" 20'3"	19'0" 19'0"	17'0" 17'0"
Boise Cascade Corporation	AJS 15	3/8" OSB Vee 4' lengths	3-1/2" Black Spruce Finger joined Flatwise	9-1/2, 11-7/8, 14, 16	—	519	— —	— —	— —	— —
Boise Cascade Corporation	AJS 20	3/8" OSB Vee 4' lengths	2-1/2" MSR Finger joined Flatwise	9-1/2, 11-7/8, 14, 16	—	373	— —	— —	— —	— —
Boise Cascade Corporation	AJS 25	3/8" OSB Vee 4' lengths	3-1/2" MSR Finger joined Flatwise	9-1/2, 11-7/8, 14, 16	—	519	27'1" 24'6"	24'9" 22'4"	23'4" 21'1"	21'7" 19'11"
Cumberland Wood Industries Ltd.	CWI 15	3/8" OSB T&G —	1-5/8" Douglas Fir Finger joined Flatwise	9-1/2, 11-7/8	—	263	— —	— —	— —	— —
Cumberland Wood Industries Ltd.	CWI 25	3/8" OSB T&G —	2-1/2" Douglas Fir Finger joined Flatwise	9-1/2, 11-7/8	—	422	— —	— —	— —	— —
DF Joists	—	— — —	— At least one product is oriented on end	—	—	—	— —	— —	— —	— —
Georgia Pacific Corporation	GPI 15SP	3/8" OSB T&G 4' or 8' lengths	1-1/2" LVL — Flatwise	9-1/2, 11-7/8	1/2	304	— —	— —	— —	— —
Georgia Pacific Corporation	GPI 25SP	3/8" OSB T&G 4' or 8' lengths	1-3/4" LVL — Flatwise	9-1/4, 9-1/2, 11-1/4, 11-7/8, 14, 16	1/2	350	— —	— —	— —	— —

Manufacturer	Product	Web Type Web to Web Joint Web Lengths	Flange Type & Width Lengths Orientation	Available Depths (in.)	Web flange joint depth (in.)	EI X 10^6 in^2-lbs.	Span (see notes) 1st row L/360, 2nd row L/480			
							12 oc	16 oc	19.2 oc	24 oc
Georgia Pacific Corporation	GPI 35SP	3/8" OSB T&G 4' or 8' lengths	2-5/16" LVL — Flatwise	11-7/8, 14, 16	1/2	452	—	—	—	—
							—	—	—	—
Georgia Pacific Corporation	GPI 55SP	7/16" OSB T&G 4' or 8' lengths	3-1/2" LVL — Flatwise	11-7/8, 14, 16	1/2	640	—	—	—	—
							—	—	—	—
Georgia Pacific Corporation	GPI 15YP	3/8" OSB T&G 4' or 8' lengths	1-1/2" LVL — Flatwise	9-1/2, 11-7/8	1/2	253	—	—	—	—
							—	—	—	—
Georgia Pacific Corporation	GPI 25YP	3/8" OSB T&G 4' or 8' lengths	1-3/4" LVL — Flatwise	9-1/2, 11-7/8	1/2	315	—	—	—	—
							—	—	—	—
Georgia Pacific Corporation	GPI 35YP	3/8" OSB T&G 4' or 8' lengths	2-5/16" LVL — Flatwise	9-1/4, 9-1/2, 11-1/4, 11-7/8, 14, 16	1/2	375	—	—	—	—
							—	—	—	—
Georgia Pacific Corporation	GPI 40YP	3/8" OSB T&G 4' or 8' lengths	2-1/2" LVL — Flatwise	11-7/8, 14, 16	1/2	415	—	—	—	—
							—	—	—	—
Georgia Pacific Corporation	GPI 25ES	3/8" OSB T&G 4' or 8' lengths	1-3/4" LVL — Flatwise	9-1/2, 11-7/8	1/2	315	—	—	—	—
							—	—	—	—
Georgia Pacific Corporation	WI40	OSB — —	2-1/2" Solid Sawn — Flatwise	9-1/2, 11-7/8, 14	—	330				
							21'6"	19'7"	18'2"	16'3"
Georgia Pacific Corporation	WI60	OSB — —	2-1/2" Solid Sawn — Flatwise	9-1/2, 11-7/8, 14, 16	—	396				
							22'8"	20'8"	19'6"	18'3"
Georgia Pacific Corporation	WI80	OSB — —	3-1/2" Solid Sawn — Flatwise	11-7/8, 14, 16	—	547				
							24'11"	22'8"	21'4"	19'11"
Jager Industries	JSI 20	3/8" OSB — —	2-1/2" #2 grade SPF Continuous or finger joined Flatwise	9-1/4, 9-1/2, 11-1/4, 11-1/2, 11-7/8, 12-1/2,14, 16	—	308	17'7	16'7"	16'0"	—
Jager Industries	JSI 30	3/8" OSB T&G —	2-1/2" MSR SPF Finger joined Flatwise	9-1/4, 9-1/2, 11-1/4, 11-1/2, 11-7/8, 12-1/2, 14, 16, 18, 20	—	370	18'2"	17'1"	16'6"	—

Manufacturer	Product	Web Type Web to Web Joint Web Lengths	Flange Type & Width Lengths Orientation	Available Depths (in.)	Web flange joint depth (in.)	EI X 10^6 in^2-lbs.	Span (see notes) 1st row L/360, 2nd row L/480			
							12 oc	16 oc	19.2 oc	24 oc
Jager Industries	JSI 42	1/2" OSB T&G —	3-1/2" MSR SPF Finger joined Flatwise	22, 24	—	NA	NA NA	NA NA	NA NA	NA NA
Jager Industries	JSI 44	3/8" OSB T&G —	3-1/2" MSR SPF Finger joined Flatwise	9-1/4, 9-1/2, 11-1/4, 11-1/2, 11-7/8, 12-1/2, 14, 16, 18, 20	—	571	— —	— —	— —	— —
Jager Industries	SI 25	3/8" OSB T&G —	2-1/2" MSR spruce Finger joined Flatwise	9-1/4, 9-1/2, 11-1/4, 11-1/2, 11-7/8, 12-1/2, 14, 16, 18, 20	—	341	— —	— —	— —	— —
Louisiana Pacific	LPI 20	3/8" OSB T&G or vee 4' and 8' lengths	2-1/2" SPF # 2 or MSR Finger joined Flatwise	9-1/2, 11-7/8, 14	5/8	300	22'9" 20'7"	20'8" 18'9"	18'10" 17'11"	16'10" 16'9"
Louisiana Pacific	LPI 32	3/8" OSB T&G or vee 4' and 8' lengths	2-1/2" SPF Finger joined Flatwise	9-1/2, 11-7/8, 14, 16	5/8	406	24'11" 22'6"	22'8" 20'6"	21'2" 19'5"	18'6" 18'2"
Louisiana Pacific	LPI 26	3/8" OSB T&G or vee 4' lengths	1-1/2" LVL Continuous Flatwise	9-1/4, 9-1/2, 11-1/4, 11-7/8	5/8	256	— —	— —	— —	— —
Louisiana Pacific	LPI 26A	3/8" OSB T&G or vee 4' lengths	1-1/2" LVL Continuous Flatwise	9-1/4, 9-1/2, 11-7/8	5/8	286	22'5" 20'3"	20'6" 18'6"	19'7" 17'8"	17'3" 16'6"
Louisiana Pacific	LPI 30	3/8" OSB T&G or vee 4' lengths	1-3/4" LVL Continuous Flatwise	9-1/2,11-7/8,14, 16	5/8	298	— —	— —	— —	— —
Louisiana Pacific	LPI 30A	3/8" OSB T&G or vee 4' lengths	1-3/4" LVL Continuous Flatwise	9-1/2,11-7/8,14, 16	5/8	334	23'6" 21'3"	21'5" 19'4"	20'5" 18'5"	17'3" 17'3"
Louisiana Pacific	LPI 36	3/8" OSB T&G or vee 4' lengths	2-1/4" LVL Continuous Flatwise	11-7/8, 14, 16	5/8	384	— —	— —	— —	— —
Louisiana Pacific	LPI 36 A	7/16" OSB T&G or vee 4' lengths	2-1/4" LVL Continuous Flatwise	11-7/8, 14, 16	5/8	429	25'4" 22'11"	23'1" 20'10"	22'0" 19'10"	20'7" 18'6"
Louisiana Pacific	LPI 56 A	7/16" OSB T&G or vee 4' lengths	3-1/2" LVL Continuous Flatwise	11-7/8, 14, 16	5/8	668	29'0" 26'3"	26'5" 23'10"	25'1" 22'7"	23'5" 21'1"

Manufacturer	Product	Web Type Web to Web Joint Web Lengths	Flange Type & Width Lengths Orientation	Available Depths (in.)	Web flange joint depth (in.)	EI X 10^6 in^2-lbs.	Span (see notes) 1st row L/360, 2nd row L/480			
							12 oc	16 oc	19.2 oc	24 oc
Louisiana Pacific	TLI 25	3/8" OSB — —	1-3/4" LVL Continuous Flatwise	9-1/2, 11-7/8, 14	1/2	351	— —	— —	— —	— —
Louisiana Pacific	TLI 35	3/8" OSB — —	2-5/16" LVL Continuous Flatwise	11-7/8, 14, 16	1/2	455	— —	— —	— —	— —
Louisiana Pacific	CTR 100	3/8" OSB — —	1-1/2" LVL Continuous Flatwise	9-1/2, 11-7/8	5/8	216	— —	— —	— —	— —
Louisiana Pacific	CTR 125	3/8" OSB — —	1-1/2" LVL Continuous Flatwise	9-1/2, 11-7/8	5/8	248	— —	— —	— —	— —
Louisiana Pacific	CTR 150	3/8" OSB — —	1-1/2" LVL Continuous Flatwise	9-1/2, 11-7/8	5/8	287	22'4" 20'5"	20'5" 18'7"	18'8" 17'9"	14'10" 14'10"
Louisiana Pacific	CTR 200	3/8" OSB — —	1-3/4" LVL Continuous Flatwise	9-1/2, 11-7/8, 14, 16	5/8	248	— —	— —	— —	— —
Louisiana Pacific	CTR 225	3/8" OSB — —	1-3/4" LVL Continuous Flatwise	9-1/2, 11-7/8, 14, 16	5/8	287	— —	— —	— —	— —
Louisiana Pacific	CTR 250	3/8" OSB — —	1-3/4" LVL Continuous Flatwise	9-1/2, 11-7/8, 14, 16	5/8	328	23'3" 21'2"	21'3" 19'4"	20'2" 18'5"	18'8" 17'3"
Louisiana Pacific	CTR 300	3/8" OSB — —	2-5/16" LVL Continuous Flatwise	9-1/2, 11-7/8, 14, 16	5/8	318	— —	— —	— —	— —
Louisiana Pacific	CTR 325	3/8" OSB — —	2-5/16" LVL Continuous Flatwise	9-1/2, 11-7/8, 14, 16	5/8	370	— —	— —	— —	— —
Louisiana Pacific	CTR 350	3/8" OSB — —	2-5/16" LVL Continuous Flatwise	11-7/8, 14, 16	5/8	417	25'0" 22'10"	22'9" 20'9"	21'8" 19'9"	20'3" 18'6"
Louisiana Pacific	CTR 550	7/16" OSB — —	3-1/2" LVL Continuous Flatwise	11-7/8, 14, 16	5/8	610	28'1" 25'6"	25'6" 23'2"	24'3" 22'0"	22'8" 20'6"

Manufacturer	Product	Web Type Web to Web Joint Web Lengths	Flange Type & Width Lengths Orientation	Available Depths (in.)	Web flange joint depth (in.)	EI X 10^6 in^2-lbs.	Span (see notes) 1st row L/360, 2nd row L/480			
							12 oc	16 oc	19.2 oc	24 oc
Nascor Inc.	NJU	3/8" OSB — 4' lengths	SPF MSR — Flatwise	9-1/2, 11-7/8, 14, 16	1/2	495	 19'2"	 17'10"	 17'3"	 —
Nascor Inc.	NJ Series	3/8" OSB — 4' lengths	2-1/2" SPF #2 or better Finger joined or continuous On edge	9-1/4, 9-1/2, 11-7/8	3/4	250	17'3" 17'3"	16'4" 16'4"	15'10" 15'10"	— —
Nascor Inc.	NJH Series	3/8" OSB — 4' lengths	2-1/2" SPF #2 or better — Flatwise	9-1/2, 11-7/8, 14, 16	1/2	325	18'0" 18'0"	17'0" 17'0"	16'5" 16'5"	— —
Norbord	PRI-40	3/8" OSB — —	2-1/2" Solid Sawn Finger joined Flatwise	9-1/2, 11-7/8, 14	—	330	— 21'6"	— 19'7"	— 18'2"	— 16'3"
Pacific Woodtech Corp.	PWI-150L	3/8" — —	1-1/2" LVL — Flatwise	9-1/2, 11-7/8	—	280	— 20'6"	— 18'9"	— 17'9"	— 16'7"
Pacific Woodtech Corp.	PWI-175L	3/8" — —	1-3/4" LVL — Flatwise	9-1/2, 11-7/8, 14, 16	—	322	— 21'4"	— 19'6"	— 18'5"	— 17'3"
Pacific Woodtech Corp.	PWI-231L	3/8" — —	2-5/16" LVL — Flatwise	11-7/8, 14, 16	—	420	— 23'4"	— 21'4"	— 20'1"	— 18'9"
Pacific Woodtech Corp.	PWI-250S	3/8" — —	2-1/2" Solid Sawn — Flatwise	9-1/2, 11-7/8, 14, 16	—	330	— 21'6"	— 19'7"	— 18'2"	— 16'3"
Pacific Woodtech Corp.	PWI-250S+	3/8" — —	2-1/2" Solid Sawn — Flatwise	9-1/2, 11-7/8, 14, 16	—	396	— 22'8"	— 20'8"	— 19'6"	— 18'3"
Pacific Woodtech Corp.	PWI-350S	3/8" — —	3-1/2" Solid Sawn — Flatwise	11-7/8, 14, 16	—	547	— 24'11"	— 22'8"	— 21'4"	— 19'11"
Poutrelles Internationales	PII-24S	3/8" OSB Vee 4' lengths	2-1/2" SPF # 2 Finger joined Flatwise	9-1/4, 9-1/2, 11-1/4, 11-7/8, 14, 16	—	331	— —	— —	— —	— —
Poutrelles Internationales	PII-24S	3/8" OSB Vee 4' lengths	3-1/2" SPF # 2 Finger joined Flatwise	9-1/4, 9-1/2, 11-1/4, 11-7/8, 14, 16	—	463	— —	— —	— —	— —

Manufacturer	Product	Web Type Web to Web Joint Web Lengths	Flange Type & Width Lengths Orientation	Available Depths (in.)	Web flange joint depth (in.)	EI X 10^6 in^2-lbs.	Span (see notes) 1st row L/360, 2nd row L/480			
							12 oc	16 oc	19.2 oc	24 oc
Poutrelles Internationales	PII-24M	3/8" OSB Vee 4' lengths	3-1/2" MSR Finger joined Flatwise	9-1/4, 9-1/2, 11-1/4, 11-7/8, 14, 16	—	505	— —	— —	— —	— —
Roseburg Forest Products Company	—	— — —	— — —	— — —	—	—	— —	— —	— —	— —
Superior Wood Structures Ltd.	SIB 30	3/8" OSB Vee 4' lengths	2-1/2" SPF #2 or better Finger joined Flatwise	9-1/2, 11-1/2, 12-1/2, 14, 16	5/8	*276	*17'7" —	*16'7" —	*16'0" —	*16'1" —
Superior Wood Structures Ltd.	SIB 31	3/8" OSB Vee 4' lengths	2-1/2" MSR Finger joined Flatwise	9-1/2, 11-1/2, 12-1/2, 14, 16	5/8	*340	*18'3" —	*17'2" —	*16'7" —	*16'8" —
Superior Wood Structures Ltd.	SIB 41	3/8" OSB Vee 4' lengths	3-1/2" MSR Finger joined Flatwise	9-1/2, 11-1/2, 12-1/2, 14, 16	5/8	*475	*19'7" —	*18'2: —	*17'6" —	*17'7" —
Superior Wood Systems Inc.	SWI 24	3/8" OSB — —	1-5/8" MSR — Flatwise	9-1/2, 11-1/4, 11-7/8, 14	—	238	20'6" 18'6"	18'6" 16'8"	16'10" 15'8"	15'0" 14'5"
Superior Wood Systems Inc.	SWI 34	3/8" OSB — —	2-5/8" MSR — Flatwise	9-1/2, 11-1/4, 11-7/8, 14, 16	—	385	23'9" 21'6"	21'6" 19'5"	20'2" 18'2"	18'7" 16'9"
Superior Wood Systems Inc.	SWI 44	3/8" OSB — —	3-1/2" MSR — Flatwise	14, 16	—	NA	NA NA	NA NA	NA NA	NA NA
Standard Structures Inc.	—	OSB — —	LVL and solid sawn Depth 1-1/2" to 3" Width 2-1/2" to 3"	Range 9-1/2 to 30	—	—	— —	— —	— —	— —
Stark Truss Company Structures Inc.	—	— — —	— — —	— — —	—	—	— —	— —	— —	— —
Trus Joist	TJI 321	3/8" OSB Serrated 4' lengths	2-2/3" MSR Finger joined Flatwise	9-1/2, 11-7/8, 14, 16, 18, 20	5/8	407	— —	— —	— —	— —
Trus Joist	TJI 100TS	3/8" OSB Serrated 4' lengths	1-3/4" LSL — Flatwise	9-1/2, 11-7/8, 14, 16	5/8	239	— —	— —	— —	— —

Manufacturer	Product	Web Type Web to Web Joint Web Lengths	Flange Type & Width Lengths Orientation	Available Depths (in.)	Web flange joint depth (in.)	EI X 10^6 in^2-lbs.	Span (see notes) 1st row L/360, 2nd row L/480			
							12 oc	16 oc	19.2 oc	24 oc
Trus Joist	TJI 120TS	3/8" OSB Serrated 4' lengths	1-3/4" LSL — Flatwise	9-1/2, 11-7/8, 14	1/2 or 5/8	246	—	—	—	—
							—	—	—	—
Trus Joist	TJI 150TS	3/8" OSB Serrated 4' lengths	2" LSL — Flatwise	9-1/2, 11-7/8	1/2	276	—	—	—	—
							—	—	—	—
Trus Joist	TJI 150	3/8" OSB Serrated 4' lengths	1-1/2" LVL — Flatwise	9-1/2, 11-7/8	5/8	276	17'4"	16'3"	15'3"	—
							—	—	—	—
Trus Joist	TJI 250	3/8" OSB Serrated 4' lengths	1-3/4" LVL — Flatwise	9-1/2, 11-7/8, 14, 16	5/8	319	17'11"	16'10"	15'10"	—
							—	—	—	—
Trus Joist	TJI 350	3/8" OSB Serrated 4' lengths	2-5/16" LVL — Flatwise	9-1/2, 11-7/8, 14, 16	5/8	395	18'11"	17'9"	16'8"	—
							—	—	—	—
Trus Joist	TJI 550	7/16" OSB Serrated 4' lengths	3-1/2" LVL — Flatwise	11-7/8, 14, 16	5/8	593	20'10"	19'9"	18'7"	—
							—	—	—	—
Willamette Industries	SJ-32	3/8" OSB Vee 4' lengths	MSR or LVL Finger joined or continuous Flatwise	9-1/2, 11-7/8, 14, 16	1/2	366	—	—	—	—
							—	—	—	—
Willamette Industries	SJ-42	3/8" OSB Vee 4' lengths	MSR or LVL Finger joined or continuous Flatwise	9-1/2, 11-7/8, 14, 16, 18, 20	1/2	605	—	—	—	—
							—	—	—	—
Willamette Industries	SJ-15	3/8" OSB Vee 4' lengths	LVL Continuous Flatwise	9-1/2, 11-7/8	1/2	304	—	—	—	—
							—	—	—	—
Willamette Industries	SJ-25	3/8" OSB Vee 4' lengths	LVL Continuous Flatwise	9-1/2, 11-7/8, 14, 16	1/2	350	—	—	—	—
							—	—	—	—
Willamette Industries	SJ-35	3/8" OSB Vee 4' lengths	LVL Continuous Flatwise	9-1/2, 11-7/8, 14, 16	1/2	452	—	—	—	—
							—	—	—	—
Willamette Industries	SJ-55	3/8" OSB Vee 4' lengths	LVL Continuous Flatwise	11-7/8, 14, 16	1/2	673	—	—	—	—
							—	—	—	—

Manufacturer	Product	Web Type Web to Web Joint Web Lengths	Flange Type & Width Lengths Orientation	Available Depths (in.)	Web flange joint depth (in.)	EI X 10^6 in^2-lbs.	Span (see notes) 1st row L/360, 2nd row L/480			
							12 oc	16 oc	19.2 oc	24 oc
Willamette Industries	SJ-15G	3/8" OSB Vee 4' lengths	LVL Continuous Flatwise	9-1/2, 11-7/8	1/2	253	— —	— —	— —	— —
Willamette Industries	SJ-25G	3/8" OSB Vee 4' lengths	LVL Continuous Flatwise	9-1/2, 11-7/8	1/2	291	— —	— —	— —	— —
Willamette Industries	SJ-35G	3/8" OSB Vee 4' lengths	LVL Continuous Flatwise	11-7/8, 14, 16	1/2	376	— —	— —	— —	— —
Willamette Industries	SJ-150	3/8" OSB Vee 4' lengths	1-1/2" LVL Continuous Flatwise	9-1/2, 11-7/8	1/2	283	— 20'6"	— 18'9"	— 17'9"	— 16'7"
Willamette Industries	SJ-250	3/8" OSB Vee 4' lengths	1-3/4" LVL Continuous Flatwise	9-1/2, 11-7/8, 14, 16	1/2	326	— 21'4"	— 19'6"	— 18'5"	— 17'3"
Willamette Industries	SJ-350	3/8" OSB Vee 4' lengths	2-5/16" LVL Continuous Flatwise	9-1/2, 11-7/8, 14, 16	1/2	407	— 23'1"	— 21'1"	— 19'11"	— 18'7"
Willamette Industries	SJ-550	7/16" OSB Vee 4' lengths	3-1/2" LVL Continuous Flatwise	11-7/8, 14, 16	1/2	606	— 25'7"	— 23'4"	— 22'0"	— 20'6"

Notes: Spans are based on L/360 & L/480 deflection criteria. Spans are given for the following on centre spacing, separated by backslashes: 12", 16", 19.2", 24".
Spans are for 40 psf live load and 10 psf live load except for Superior Wood Structure spans given for 40 psf live and 15 psf dead load.
Spans are based on a 5/8" subfloor, nailed and glued.

APPENDIX D
I-Joist Manufacturer Literature Summary

Manufacturer/Association	1	2	3	4	5	6	7	8	9	10	11	12	13	14
APA's PRI	✓	✓	O	✓	12	4	✓	✓	O	✓	✓	1	✓	✓
AF&PA's manual	NA	NA	O	NA	5	0	O	✓	O	O	O	O	O	✓
Boise Cascade Corp. AJS products only	✓	O	O	✓	27	5	✓	✓	O	✓	✓	✓	✓	✓
Boise Cascade Corp. BCI products only	✓	✓	✓	✓	11	3	✓	✓	O	✓	✓	✓	✓	O
Georgia Pacific Corporation	✓	✓	✓	✓	22	5	✓	✓	✓	✓	✓	✓	✓	✓
Jager Industries	✓	✓	✓	✓	20	3	✓	✓	✓	✓	✓	✓	✓	✓
Louisiana Pacific	✓	✓	✓	✓	16	4	✓	✓	✓	✓	✓	✓	✓	✓
Nascor Inc.	✓	✓	O	✓	19	4	✓	✓	✓	O	✓	✓	✓	✓
Pacific Woodtech Corp.	✓	✓	✓	✓	12	4	✓	✓	✓	✓	✓	✓	O	✓
Poutrelles Internationales	O	O	O	O	29	2	✓	✓	✓	O	✓	O	O	✓
Superior Wood Structures	✓	✓	O	O	12	1	O	O	O	O	✓	O	✓	✓
Superior Wood Systems Inc.	✓	✓	O	✓	12	5	✓	✓	✓	✓	✓	O	O	O
Trus Joist	✓	✓	O	✓	11	7	✓	✓	✓	✓	✓	O	✓	O
Willamette Industries	✓	✓	O	✓	13	4	✓	✓	✓	O	✓	O	✓	✓

✓ - Included in manufacturer literature
O - Not included in manufacturer literature

1. Product information
2. Span tables
3. Floor load tables
4. Design properties
5. Typical framing details (no. of details)
6. Cantilever details (no. of details)
7. Filler and backer block tables
8. Web stiffener requirements
9. Framing connectors charts or recommendations
10. Nailing requirements
11. Hole charts
12. Fire endurance assemblies
13. Safety recommendations
14. Care, storage and handling recommendations

APPENDIX E
APA Builder Tips

I-Joist Squash Blocks

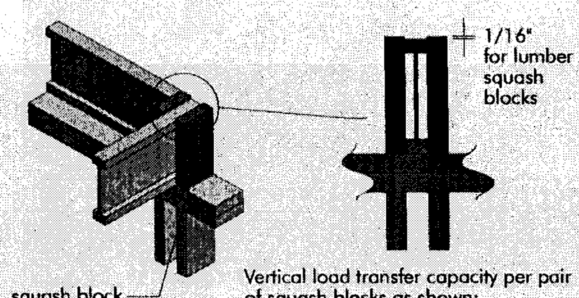
A squash block is a block of wood or APA Rated Rim Board that is installed adjacent to an I-joist to carry a point load that would otherwise be transmitted to the I-joist.

Squash blocks are required in conventional platform construction where loads from above are transferred down through the floor into the wall or foundation below. This occurs where load-bearing walls fall on floors or posts supporting headers are located within the walls. Beneath these wall and point loads, the I-joists usually do not have enough interior reaction or exterior reaction capacity remaining to safely transfer these loads without risking a web-bearing failure. The solution is to place extra load-carrying members in line with these loads and insure that these squash blocks carry the load and the I-joists do not. Blocking members are normally used for line loads like load-bearing walls, however, in the case of point loads, squash blocks are more often specified.

Squash block materials: A lumber squash block is a 2 x 4 or 2 x 6 lumber block that is oriented with the grain of the wood running parallel to the vertical axis of the web of the joist. The squash block is cut just slightly longer than the I-joist is deep, usually 1/16 inch longer. This is done to insure that the block will pick up the vertical load and not the I-joist. The grain is oriented parallel to the vertical axis to minimize the impact of shrinkage by the lumber block.

FIGURE 1

SQUASH BLOCK INSTALLATION AND CAPACITIES



Vertical load transfer capacity per pair of squash blocks as shown:

Pair of Squash Blocks	(lb)
2 x 4	4000
1-1/8" Rim Board	3000
1" Rim Board	2700

The minimum grade for lumber squash blocks is Utility grade SPF (south).

APA Performance Rated Rim Board may also be used for the fabrication of squash blocks. As rim board is an engineered wood product and not subject to shrinkage like lumber, cutting the engineered wood squash block 1/16 inch longer is NOT necessary. Select a rim board of I-joist-compatible depth, cut to width, and install as shown in Figure 1.

Recommendations for I-joists designed in accordance with APA Standard PRI-400:

1. Fully supported squash block capacities can be found in Figure 1. As squash blocks are usually placed in pairs – to minimize load eccentricity – the values given in Figure 1 are for pairs of squash blocks. Often times, the builder will simply match the width of the squash blocks with the width of posts used from above.

For example: Assume a squash block is required to carry the load of a post above that is made up of (3) 2 x 4s. The total width of the post is 4-1/2 inches (3 x 1.5 inches = 4-1/2 inches). If the squash block is to be made up of 1-1/8 inch rim board, four squash blocks would be required (4 x 1-1/8 inches = 4-1/2 inches). If the squash block is to be made up of 1 inch Rim Board, five squash blocks would be required (5 x 1 inch = 5 inches).

ENGINEERED WOOD SYSTEMS
APA EWS

I-Joist Filler Blocks

Filler blocks are used to fill the rectangular space between a pair or more of I-joists acting as a single bending member The purpose of the blocks is to transfer load from one bending member to the next – load sharing. This is accomplished by forcing each of the joists to deflect the same amount under the applied load Filler blocks must be placed the full length of the double I-joists. Filler blocks, however, do not have to be continuous – they can be made up of shorter lengths of lumber and/or wood structural panel.

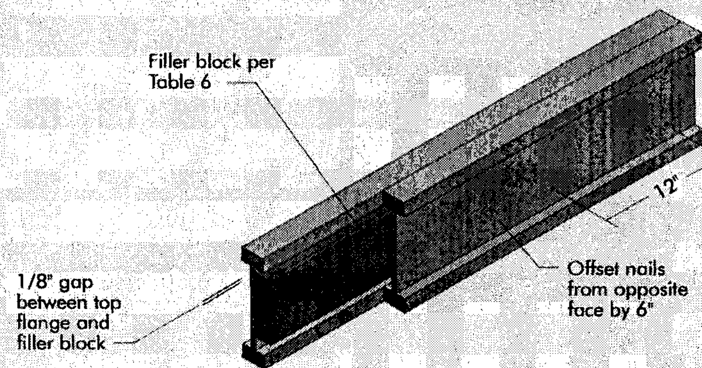
Filler block material: Filler blocks are composed of lumber, rim board, and wood structural panel materials on hand – whatever it takes to meet the filler block size requirements of Table 1. The minimum grade of wood structural panels is Rated Sheathing; minimum lumber grade is Utility grade SPF (south) or better. Any rim board product would also work satisfactorily.

The depth of the filler block should equal the distance between the flanges of the I-joist minus 1/8 inch. This gap is placed between the filler block and the top flange. The reason for the gap is to prevent the inadvertent use of a slightly oversized block. Forcing such a block to fit between the flanges of an I-joist could damage the joist to the point where it may not function as designed.

In a similar manner, the thickness of the filler block is also important. Too thick is better than too thin. If the filler block is too thick, the result is a small gap between the flanges, which will not cause a problem. Too thin can cause problems when the nailing schedule shown in Figure 1 is attempted. Notice that the nails are placed near the top and bottom of the filler block. This puts them very close to the flanges of the joist. If there is a gap between the web of the joist and filler block, the mechanics of driving a nail will attempt to close up that gap. This can damage the web or the web-to-flange glue bond. It can also cause the flange of the I-joist to rotate, making for an uneven surface and/or reducing the capacity of the I-joist, due to the induced eccentric loading.

FIGURE 1

FILLER BLOCKING INSTALLATION DETAILS



Notes:
1. Support back of I-joist web during nailing to prevent damage to web/flange connection.
2. Leave a 1/8-inch gap between top of filler block and bottom of top I-joist flange.
3. Filler block is required between joists for full length of span.
4. Nail joists together with two rows of 10d nails at 12 inches o.c. (clinched when possible) on each side of the double I-joist. Total of 4 nails per foot required. If nails can be clinched, only 2 nails per foot are required.

ENGINEERED WOOD SYSTEMS
APA EWS

I-Joist Backer Blocks

Backer blocks are used to fill the rectangular space between the outside edge of the I-joist flange and the web of the I-joist. In this respect, a backer block is quite similar to a filler block; however, it is only half as thick. Unlike a filler block, the backer block does not run the full length of the I-joist. It is only as long as it needs to be. The purpose of the backer blocks is to provide a flat, flush surface by which surface- or top-mounted hangers or other structural elements can be attached to I-joists.

With **top-mounted hangers**, the backer block prevents rotation on the lower portion of the hanger by filling the void between the hanger and the web. If the top-mounted hanger does not rely on any attachment into the side of the I-joist supporting it, as with face-mounted hangers, the backer block is really only providing bearing for the bottom of the hanger and an additional backer block on the other side of the I-joist web is not required.

With **face-mounted hangers**, the backer block provides anchorage for the hanger nails. It also provides an avenue for the transferral of the hanger load to the web of the I-joist. For such applications, backer blocks on both sides of the web are almost always required.

Physical description: Backer blocks are made up of lumber, rim board, or wood structural panel materials on hand – whatever it takes to fill the space between the outside edge of the flange and the web. The minimum grade of wood structural panels is Rated Sheathing; minimum lumber grade is Utility grade SPF (south) or better. Any rim board product also works satisfactorily.

The depth of the backer block should equal the distance between the flanges of the joist minus approximately 1/8 inch. The location of this gap is always between the bottom of the block and the bottom flange. Ideally, the carpenter should cut the blocks so they fit perfectly between the flanges. However, rather than risk too tight of a fit, and damage to one or both of the flange-to-web joints, the industry recommends the slightly loose fit.

The thickness of the backer block can be critical. If the backer block extends out beyond the edge of the flange when a

FIGURE 1

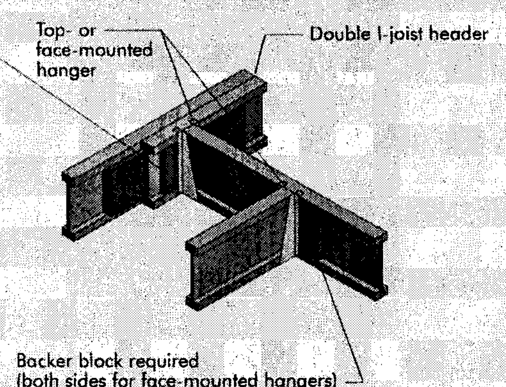
BACKER BLOCK INSTALLATION DETAILS

Backer block (use if hanger load exceeds 250 lbs.) Before installing a backer block to a double I-joist, drive 3 additional 10d nails through the webs and filler block where the backer block will fit. Clinch. Install backer tight to top flange. Use twelve 10d nails, clinched when possible. Maximum capacity for hanger for this detail = 1280 lb.

BACKER BLOCKS (Blocks must be long enough to permit required nailing without splitting)

Flange Width	Material Thickness Required*	Minimum Depth**
1-1/2"	19/32"	5-1/2"
1-3/4"	23/32"	5-1/2"
2-5/16"	1"	7-1/4"
2-1/2"	1"	5-1/2"
3-1/2"	1-1/2"	7-1/4"

* Minimum grade for backer block material shall be Utility grade SPF (south) or better for solid sawn lumber and Rated Sheathing grade for wood structural panels.
** For face-mount hangers use net joist depth minus 3-1/4" for joists with 1-1/2" thick flanges. For 1-5/16" thick flanges use net depth minus 2-7/8".



I-Joist Web Stiffeners

A web stiffener is a wood block that is used to reinforce the web of an I-joist at locations where:

- The webs of the I-joist are in jeopardy of buckling out of plane. This usually occurs in deeper I-joists.
- The webs of the I-joist are in jeopardy of "knifing" through the I-joist flanges. This can occur at any I-joist depth when the design reaction loads exceed a specific level.
- The I-joist is supported in a hanger and the sides of the hanger do not extend up to the top flange. With the top flange unsupported by the hanger sides, the joist may deflect laterally, putting a twist in the flange of the joist The web stiffener supports the I-joist along a vertical axis as designed. (In this application, the web stiffener acts very much like a backer block.)

There are two kinds of web stiffeners: ***bearing stiffeners*** and ***load stiffeners.*** They are differentiated by the applied load and the location of the gap between the slightly undersized stiffener and the top or bottom flange.

Bearing stiffeners are located at the reactions, both interior and exterior, when required. I-joists ***do not*** need bearing stiffeners at any support when subjected to the normal residential uniform loads and installed in accordance with the allowable spans printed on the I-joist or in *APA Design/Construction Guide – I-Joists For Residential Floors,* Form No. X710.

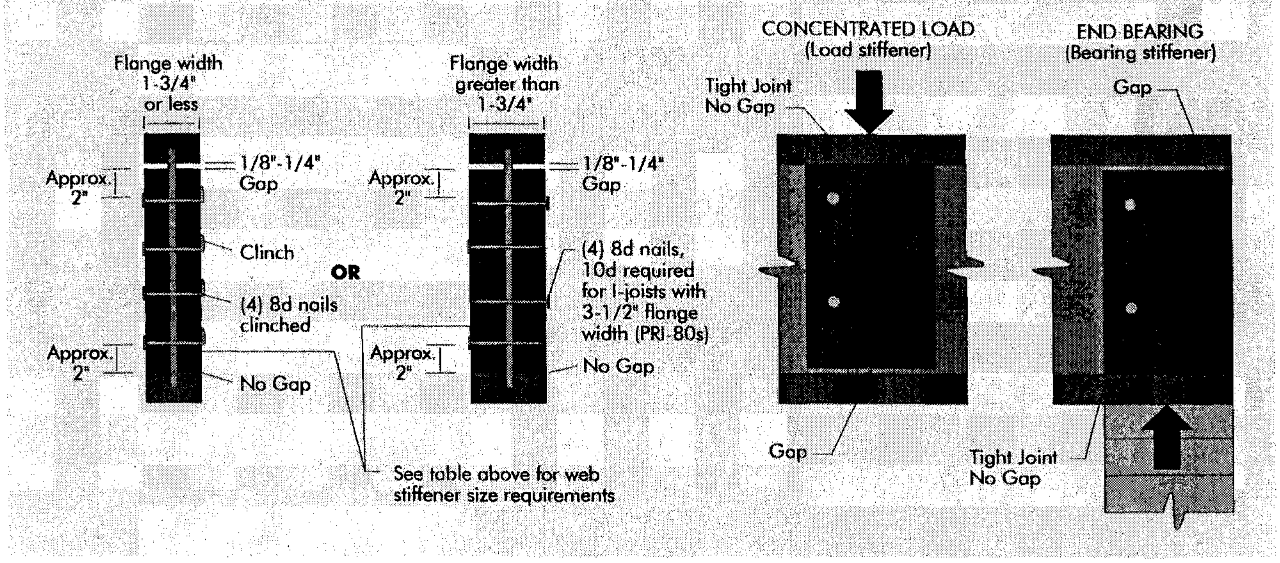
Load stiffeners are located between supports where significant point loads are applied to the top flange of an I-joist.

Physical description:

Web stiffener blocks may be comprised of lumber, rim board, or wood structural panels. The minimum grade of wood structural panels is Rated Sheathing; minimum lumber grade is Utility grade

FIGURE 1

WEB STIFFENER INSTALLATION DETAILS



ENGINEERED WOOD SYSTEMS
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I-Joist Blocking

I-joists are often installed with blocking, a rectangular piece of engineered wood or a section of I-joist that is placed between adjacent joists at various locations. For these applications blocking has three major functions:

1. To provide lateral support to the floor joists – to prevent them from physically "rolling over" due to lateral loads. This is accomplished by the shape and stiffness of the blocking panel.

2. To provide a means of transferring shear loads from the walls above to the floor/foundation below. This is accomplished by nailing into the top and bottom flanges.

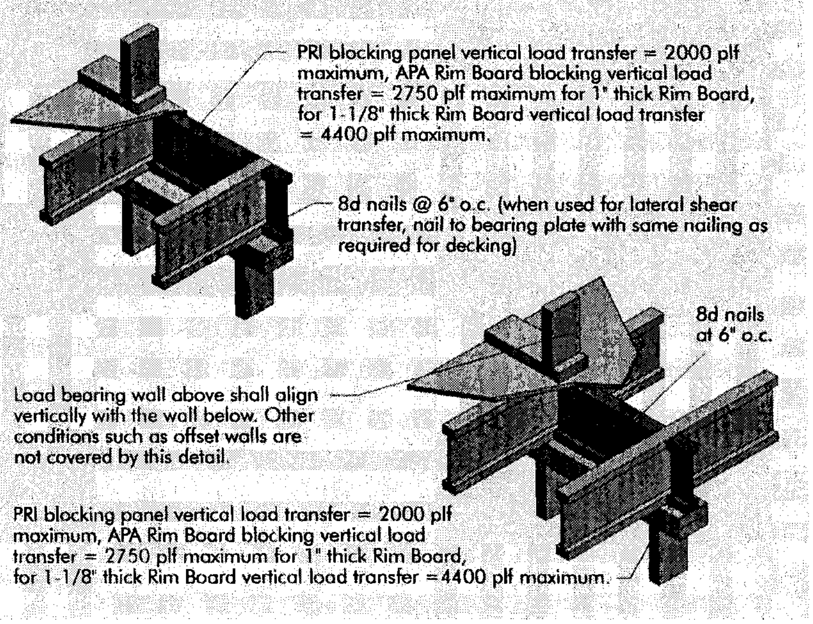
3. To provide a means of transferring vertical loads from the wall above to the foundation/floor below. The blocking is used in bearing to accomplish this.

Blocking materials: Blocking panels are normally site-fabricated out of engineered wood materials on hand. Sections of APA Rated I-joist, APA Rated Rim Board or I-joist-compatible LVL may be used for blocking. It is essential that engineered wood materials be used because the shrinkage anticipated with the use of sawn lumber would make the blocking unable to perform the vertical load-transfer function and could seriously impede its ability to transfer shear loads.

Fabricate the blocking panels from engineered wood products of I-joist-compatible sizes and cut to fit tightly between the floor joists.

FIGURE 1

BLOCKING PANEL INSTALLATION DETAILS



Recommendations for I-joists designed in accordance with APA Standard PRI-400:

1. Blocking panels are required at each end of floor joists not otherwise restrained from overturning by a band joist or rim board.

2 Blocking panels are required between floor joists supporting load-bearing walls running perpendicular to the joists.

3. Blocking panels are required between floor joists at the interior support adjacent to a nonload-bearing cantilever in the floor system.

4. For a load-bearing cantilever, blocking panels are required between floor joists at the exterior support adjacent to the cantilever, as well as for 4 feet along the exterior support on either side of the cantilevered joists.

5. Install blocking panels in accordance with Figure 1.

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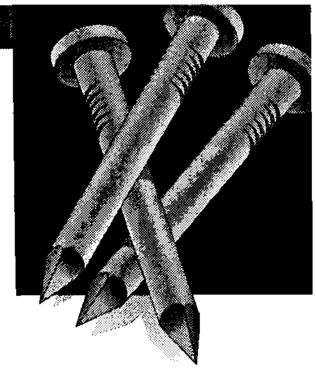
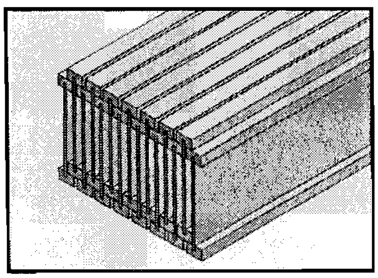


Storage, Handling, and Safety Recommendations for APA Performance Rated I-Joists

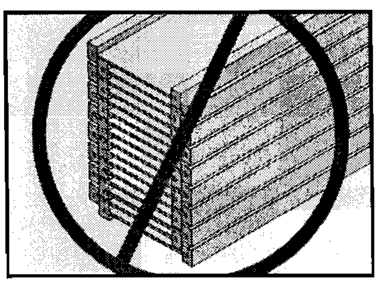
To assure optimum performance and safe handling, APA trademarked I-joists must be stored and applied properly. The following guidelines will help protect joists from damage in storage, during shipment, and on the construction site, and protect the installer from jobsite injury.

Storage and Handling

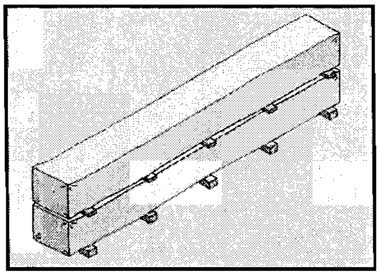
1. Store, stack and handle I-joists vertically and level only.



2. Do not store I-joists in direct contact with the ground and/or flatwise.



3. Protect I-joists from weather, and use stickers to separate bundles.



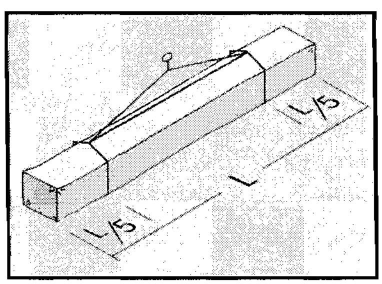
4. To further protect I-joists from dirt and weather, do not open bundles until time of installation.

5. Take care not to damage I-joists with forklifts or cranes.

6. Do not twist or apply loads to the I-joist when horizontal.

7. Never use or try to repair a damaged I-joist.

8. When handling I-joists with a crane on the job site ("picking"), take a few simple precautions to prevent damage to the I-joists and injury to your work crew.

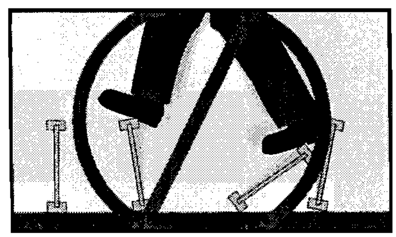


- Pick I-joists in bundles as shipped by the supplier.
- Orient the bundles so that the webs of the I-joists are vertical.
- Pick the bundles at the 5th points, using a spreader bar if necessary.

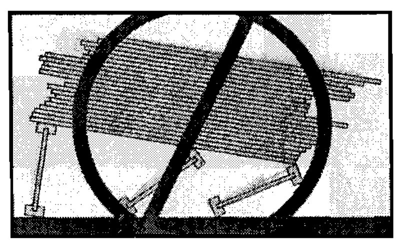
Safety Tips

I-joists are not stable until completely installed, and will not carry any load until fully braced and sheathed.

Do not allow workers to walk on I-joists until joists are fully installed and braced, or serious injuries can result.



Never stack building materials over unsheathed I-joists. Stack only over beams or walls.



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Avoid accidents by following these important guidelines:

1. Brace and nail each I-joist as it is installed, using hangers, blocking panels, rim board, and/or cross-bridging at joist ends. When I-joists are applied continuous over interior supports and a load-bearing wall is planned at that location, blocking will be required at the interior support.

2. When the building is completed, the floor sheathing will provide lateral support for the top flanges of the I-joists. Until this sheathing is applied, temporary bracing, often called struts, or temporary sheathing must be applied to prevent I-joist rollover or buckling.

- Temporary bracing or struts must be 1x4 inch minimum, at least 8 feet long and spaced no more than 8 feet on center, and must be secured with a minimum of two 8d nails fastened to the top surface of each I-joist. Nail bracing to a lateral restraint at the end of each bay. Lap ends of adjoining bracing over at least two I-joists.
- Or, sheathing (temporary or permanent) can be nailed to the top flange of the first 4 feet of I-joists at the end of the bay.

3. For cantilevered I-joists, brace top and bottom flanges, and brace ends with closure panels, rim board, or cross-bridging.

4. Install and nail permanent sheathing to each I-joist before placing loads on the floor system. Then, stack building materials over beams or walls only.

5. Never install a damaged I-joist.

Failure to follow applicable building codes and span ratings, failure to use allowable hole sizes and locations, or failure to use web stiffeners when required can result in serious accidents. Follow these installation guidelines carefully.

We have field representatives in most major U.S. cities and in Canada who can help answer questions involving APA trademarked products. For additional assistance in specifying APA engineered wood products, get in touch with your nearest APA regional office. Call or write:

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