Introduction

Where fall-arrest systems are connected to floor or roof systems constructed with engineered wood framing members, such as wood I-joists or structural composite lumber (SCL) products, the Wood I-Joist Manufacturers Association (WIJMA) recommends that a fall-protection system engineer be retained to design and detail the connection of the fall-arrest system to the framing in coordination with the design professional of record. The design of the connection must be in accordance with the National Design Specification (NDS) for Wood Construction or CSA O86 *Engineering Design in Wood*. In addition, all wood components must be protected from exposure to moisture.

The specific design and detailing of anchorage connections are typically not provided by the joist manufacturer or supplier. This document is intended to provide general guidance to the fall-protection system engineer and the design professional of record regarding recommended considerations for connecting to I-joists and SCL.

Worker safety codes throughout North America typically require a fall-protection system to be used where there is a roof or floor edge that presents a fall hazard. The applicable requirements may vary depending upon state, province, or local jurisdiction. However, most regulations require some form of fall protection when a worker is exposed to a potential fall distance on the order of 4 to 6 ft (1.2 to 1.8 m) or more. A variety of fall protection options may exist, depending upon the applicable code, including temporary guardrails, "fall-restraint" systems that prevent a worker from approaching an edge, defined edge marking systems, monitoring systems, etc. In situations where a worker may be exposed to a fall, personal "fall-arrest" systems are often used to stop a worker from falling an excessive distance or from contacting a lower level in the event of a fall.

A fall-arrest system and its anchorage may experience dynamic loads equivalent to several times the weight of the falling individual and gear (design loads for fall-arrest systems generally are on the order of several thousand pounds). Due to the significant loads involved and the importance of these systems for life safety, the design and detailing of anchorage points, including effects of the loads on framing members, should be performed by an engineer with expertise in designing fall-protection systems and should be carefully coordinated with the design professional of record.

Regulations

In the United States, the Occupational Safety and Health Administration (OSHA) has established requirements for fall-protection systems. Alternatively, individual states or local jurisdictions may have their own regulations regarding fall-protection systems that supersede the OSHA provisions. The American Society of Safety Professionals (ASSP) (formerly American Society of Safety Engineers (ASSE)) also provides guidance for fall-protection systems. Requirements for fall-protection systems used in Canada are found in Canada Occupational Health and Safety Regulations and CSA Z259 series standards.

Information on required loads for fall-arrest systems can be found in the following documents. Other regulations may also apply, depending on the jurisdiction.

ANSI/ASSP 359.1 *The Fall Protection Code*. American Society of Safety Professionals (formerly American Society of Safety Engineers).

ANSI/ASSP Z359.6 *Specifications and Design Requirements for Active Fall Protection Systems*. American Society of Safety Professionals (formerly American Society of Safety Engineers).

ASCE 7. *Minimum Design Loads and Associated Criteria for Buildings and Other Structures*. American Society of Civil Engineers.

CSA Z259.15 *Anchorage Connectors*. Canadian Standards Organization.

CSA Z259.16 *Design of Active Fall-Protection Systems*. Canadian Standards Organization.

CSA Z259.17 *Selection and Use of Active Fall-Protection Equipment and Systems*. Canadian Standards Organization.

International Building Code (IBC). International Code Council.

OSHA 1926 Subpart M, Standard 1926.502. *Fall Protection Systems Criteria and Practices*. Occupational Safety and Health Administration. https://www.osha.gov/laws-regs/regulations/standardnumber/1926/1926.502

Design and Detailing Guidelines

Due to the magnitude of the loads involved, connection of anchorage solely to sheathing should not be used – positive connection to framing or blocking must be provided. It is not recommended to resist anchorage uplift loads by nails in withdrawal. Threaded fasteners should be installed in accordance with fastener manufacturer's recommendations, including pre-drilling of holes as needed.

Prefabricated anchorage hardware commonly includes a lifeline attachment point that is elevated above its base. This configuration induces both a moment couple and a shear force into the floor or roof system for any load applied parallel to the plane of the floor or roof (Figure 1). For use with common member sizing software, the fall-protection system engineer or engineer of record must resolve the moment couple into equal and opposite loads applied perpendicular to the plane of the floor or roof. The shear force parallel to the plane of the floor or roof must be resolved back into the diaphragm, typically through attachment to the framing members and/or blocking.

A complete load path must be provided through the structure. Where loading creates net uplift on joists and blocking at a support, appropriate uplift restraint must be designed and detailed.

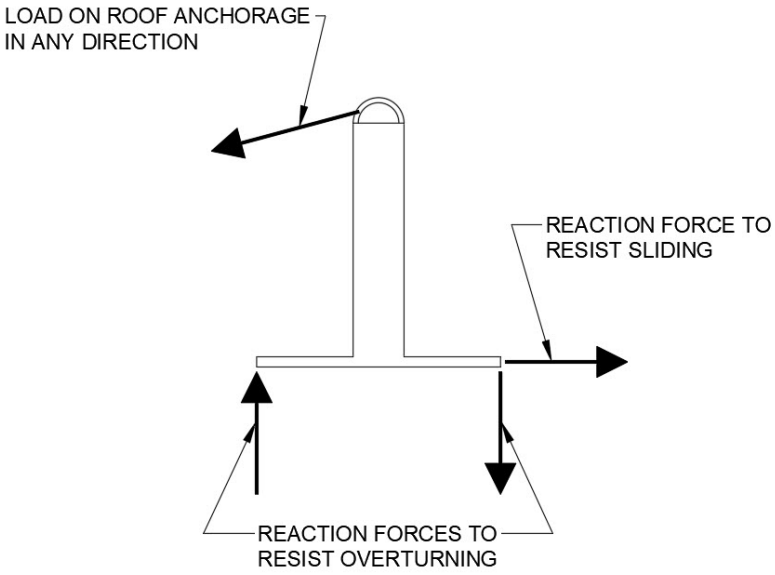

Figure 1. Conceptual reaction forces for anchorage. Magnitude and location of loads to be determined by fall-protection system engineer or designer of record.

Load Duration/Time Effect Factors

The design of wood members and connections requires consideration of the load duration or time effect. For structural design of the wood members and connections supporting fall-arrest anchorage, the load duration factor should not exceed 1.6 for allowable stress design (ASD). The time-effect factor for load and resistance factor design (LRFD) should not exceed 1.0. For Canadian limit states design (LSD) the load duration factor should not exceed 1.15.

Wood I-joist Systems

Attachment to wood I-joist systems requires special consideration to ensure adequate performance and to avoid damaging the joists. In general, positive connections should be made to either the I-joist webs through backer blocks or to blocking supported by metal connectors (Figure 2). Attachment to I-joists should be detailed to avoid drilling through or otherwise damaging the joist top flange (Figure 2). Direct attachment to the top flange of the joists should be avoided for this application to prevent flange pull-off from the prying action of the anchorage and to avoid flange splitting due to the number and concentration of fasteners that may be required. Backer blocks should fit between the I-joist flanges with a minimum 1/4” gap between the backer block and the I-joist top flange to avoid prying action against the flange from uplift loads (Figure 2). Careful attention should be given to designing the fasteners between the backer blocks and the I-joist web, because this connection may control the capacity of the overall connection based on the thickness of the web. When multi-ply joists, such as doubles, are required to support the loads, the connection between the joists must be detailed to ensure that adequate load sharing occurs.

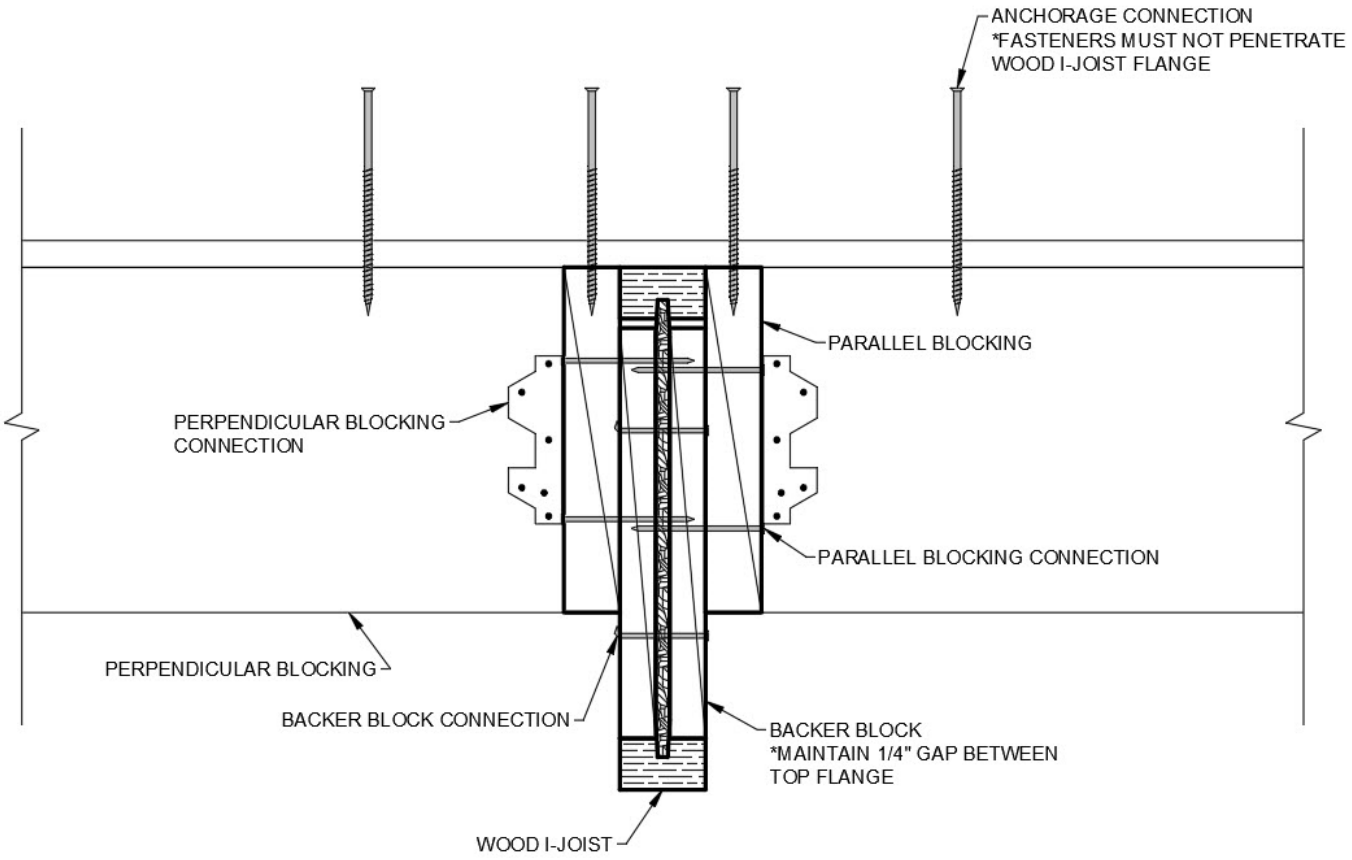

Figure 2. Conceptual detail for connecting anchorage to I-joist. Specific connection design and detailing to be provided by fall-protection system engineer or designer of record.

Structural Composite Lumber (SCL) Joist Systems

Direct attachment to SCL members is permissible. Refer to the SCL manufacturer's recommendations regarding fastener spacing in the wide and narrow faces of the SCL member. The effect of fasteners on the net section of the SCL members must be considered.

SCL Attachment Plate

Some anchorage attachment systems use an SCL attachment (spreader) plate between the prefabricated anchor and the floor or roof decking. The anchor is typically attached to the SCL plate, and the SCL plate is attached to the floor or roof system. Where this system is used, the same considerations previously discussed apply for attachment of the spreader plate to the joists. In addition, the SCL plate must be designed for the effects of any applied loads, including bending, shear, fastener shear, fastener withdrawal, fastener head pull-through, and cross-grain bending/tension. Since these attachment plates are commonly installed on top of a roof deck, it is critical that adequate moisture protection is properly detailed and installed.

Anchorage Proof Loading

Proof loading is sometimes used as part of an anchorage certification program. When proof loading is used, it should be conducted in conjunction with careful inspection, engineering analysis, and engineering judgment to ensure that the load is high enough to be meaningful, but low enough to avoid damaging the anchorage, members, and connections that are intended to remain in service.

Damage/Reinspection of Joists

In the event of a fall, all components of the personal fall-arrest system subjected to impact loading, including the anchorage, must be immediately removed from service until they are inspected and determined to be undamaged by a qualified engineer. The supporting joists, blocking, and connections must also be inspected for damage and repaired or replaced, as appropriate. Damage to the joists may compromise not only the safety of the fall-arrest system but also the load-carrying capacity of the floor or roof structural system.