



Flood-Resistant Construction Guide



Installing Simpson Strong-Tie® Connectors in Flood-Prone Regions

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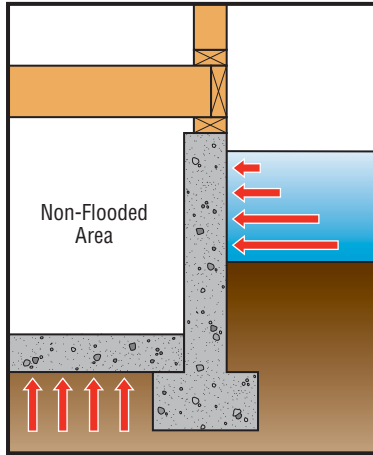
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MITIGATING FLOOD DAMAGE

Unlike earthquakes, tornadoes, and hurricanes, flooding is a natural disaster that commonly occurs throughout all regions of North America. While the causes tend to be different depending on the region, floods cause billions of dollars in damage annually to structures near the coast as well as inland.

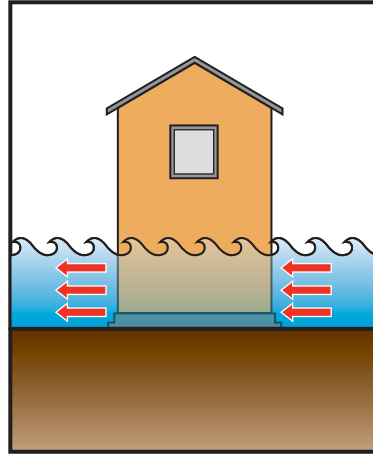
Flood Design

In flood-prone regions, it is important to design structures to resist the forces encountered during a flood. The movement of water and debris can also result in several design considerations unique to floods.



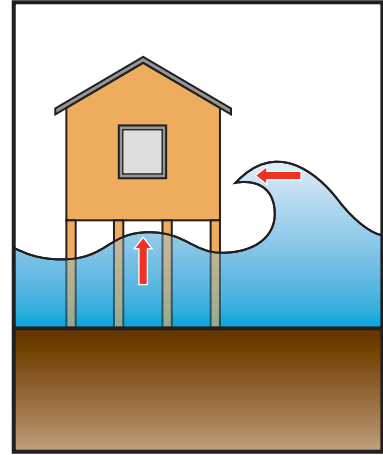
HYDROSTATIC FORCES

Lateral or vertical forces resulting from standing or slow-moving water in contact with a structure. Lateral loads can occur when a vertical wall has flood water on one side and is not flooded on the other side. Vertical (*buoyancy*) loads occur when elements of the structure displace flood waters.



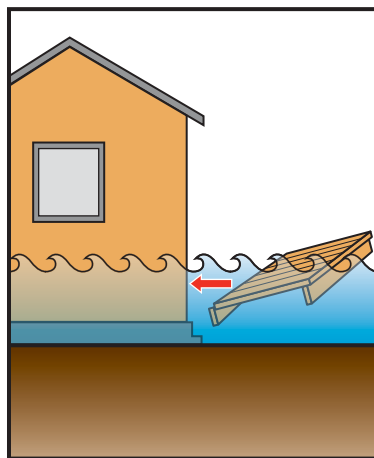
HYDRODYNAMIC FORCES

Lateral forces typically resulting from water moving at a moderate to high speed in contact with a structure. Lateral loads are created when the structure is impacted by the moving water and drag forces are created as the water moves around the structure.



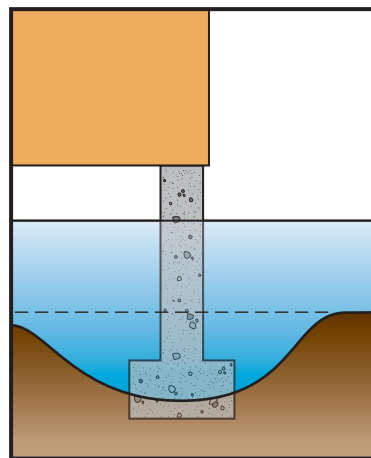
WAVE FORCES

Lateral or vertical forces resulting from breaking and non-breaking waves striking the structure. Vertical uplift loads occur when waves peak or run-up against a structure.



IMPACT FORCES

Lateral forces resulting from debris, ice and other objects carried by floodwaters impacting a structure.



SCOUR

The removal of soil, sand or fill material by moving water that can result in the loss of bearing capacity or anchoring capacity of the foundation.

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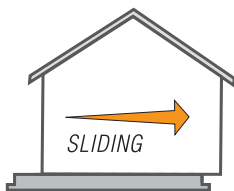
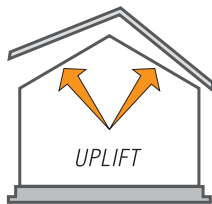
High Wind Design

Flooding is often caused by storms that can also bring damaging winds. High winds create uplift and lateral forces that can damage structures. Uplift forces can lift a structure, therefore they must be transferred down to the foundation to prevent damage. Several connections throughout the structure are required to create a continuous load path to resist uplift loads.

In addition to its uplift forces, high wind also imposes lateral forces that can make a structure rack, slide, or overturn. Additional steps must be taken to resist these loads and ensure that the structure will remain strong. This is done by adding bracing, shearwalls and connectors.

Large openings along wall lines, such as windows and doors, create structural challenges in resisting these lateral loads. This is especially true at garage fronts. Such openings often do not leave a large enough wall section to provide sufficient strength. These applications will require the use of prefabricated panels to meet the load requirements.

For more information on the effects of high wind, please refer to the Simpson Strong-Tie® *High Wind-Resistant Construction* catalog and the *Companion to the 2001 AF&PA Wood Frame Construction Manual for Wind Design*.



Resources and Links

Guidelines referred to here can be found in documents published by the Federal Emergency Management Administration (FEMA) and other organizations.

DHS-FEMA

National Flood Insurance Program
www.floodsmart.gov

FEMA

www.fema.gov/library

- Home Builder's Guide to Coastal Construction (FEMA 499)
 - Fact Sheet No. 10: Load Paths
 - Fact Sheet No. 17: Use of Connectors
 - Fact Sheet No. 28: Decks, Pools, and Accessory Structures
 - Fact Sheet No. 30: Repairs, Remodeling, Additions, and Retrofitting
- Coastal Construction Manual (FEMA P-55)
- Local Officials Guide for Coastal Construction (FEMA P-762)
- Wind Retrofit Guide for Residential Buildings (FEMA P-804)
- Recommended Residential (foundation) Construction for Coastal Areas (FEMA P-550)

AMERICAN SOCIETY OF CIVIL ENGINEERS

www.asce.org

- Flood Resistant Design and Construction (ASCE 24)
- Minimum Design Loads for Buildings and Other Structures (ASCE 7)

INSTITUTE FOR BUSINESS AND HOME SAFETY

www.disastersafety.org

- *Fortified for Safer Living* guide

SIMPSON STRONG-TIE

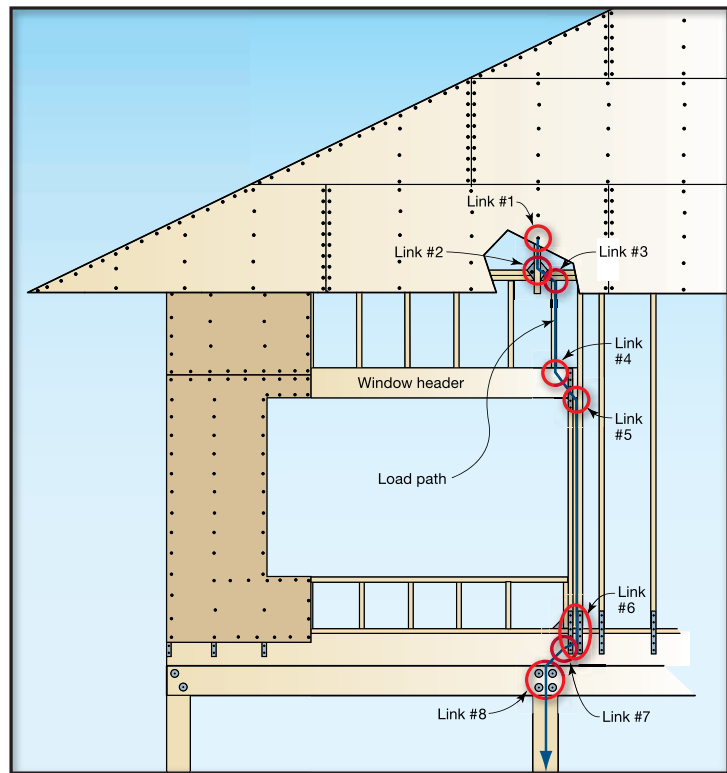
- *High Wind-Resistant Construction* catalog (C-HW)
- *Companion to the 2001 AF&PA Wood Frame Construction Manual for Wind Design* (T-01WFCM)
- *Anchoring Solutions for Simpson Strong-Tie® Connectors in Wind and Low-Seismic Regions* technical bulletin (T-ANCHORSPEC)

CONTINUOUS LOAD PATH: MAKING STRUCTURES SAFER IN FLOOD-PRONE AREAS

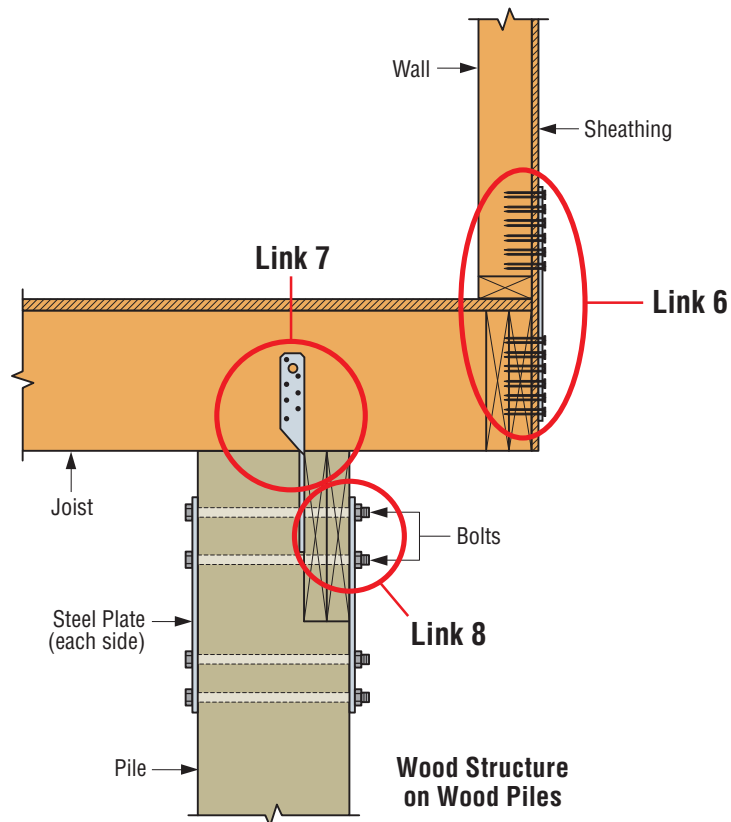
Following current building codes and installing structural connectors and fasteners used in a continuous-load-path system can effectively contribute to mitigating damage caused by coastal storm surge, flooding and wind.

When this system of connections is designed properly, loads are transferred throughout the structure and into the foundation. The accompanying graphic illustrates how the continuous load path extends from the roof sheathing/frame down to the foundation.

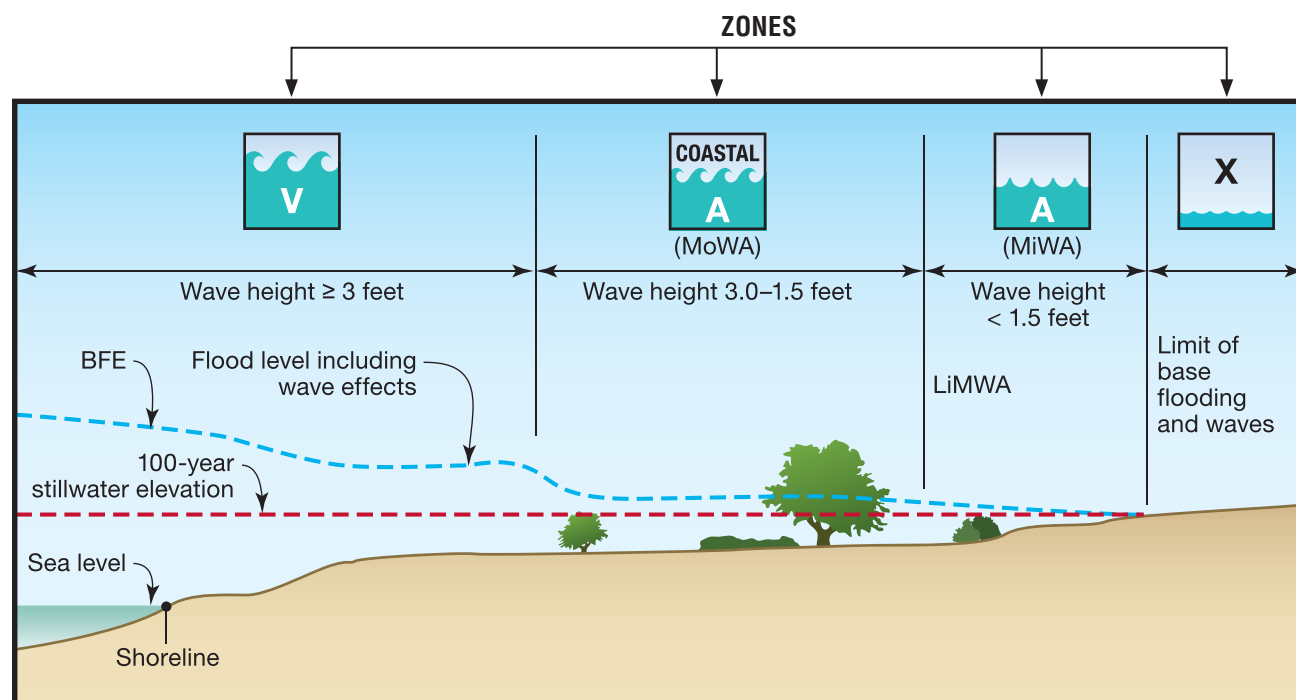
ASCE's *Flood Resistant Design and Construction* (ASCE 24) is referenced in the *International Building Code* (IBC) and states that "the structure, including anchorage and connections, shall be designed to resist effects of vertical loads, including uplift and lateral loads ...". This document will focus on the load path from the foundation up to and including the first-floor studs (links 6, 7 and 8 in the accompanying graphic). For links, 1-5, refer to the Simpson Strong-Tie® *High Wind-Resistant Construction* catalog (C-HW12) and the companion to the *2001 AF&PA Wood Frame Construction Manual for Wind Design* (T-01WFCM08).



Courtesy: FEMA



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Courtesy: FEMA

Appendix of Terms

Floodplain

Any land area susceptible to partial or complete inundation by water from any source.

Flood Hazard Area

Area subject to flooding.

Floodway

Channel and that portion of the floodplain reserved to hold the base flood without cumulatively increasing the water surface elevation more than a designated height.

Base Flood Elevation (BFE)

Elevation of flooding, including wave height, having a 1% chance of being equaled or exceeded in a given year (26% chance in 30 years). BFE is generally the elevation used by the National Flood Insurance Program to map Special Flood Hazard Areas.

Freeboard

An additional amount of height above the Base Flood Elevation (BFE) used as a factor of safety in determining the level at which a structure's lowest floor must be elevated or flood-proofed to be in accordance with state or community floodplain management regulations.

Design Flood Elevation (DFE)

Elevation of flooding, including wave height, used for design. Generally equal to the BFE plus freeboard as determined by the authority having jurisdiction and/or the property owner.

X Zone

Areas where the flood hazard is lower than that in the Special Flood Hazard Area. Flood insurance is not mandatory. However, 20% of all flood insurance claims occur in these zones.

Special Flood Hazard Area (SFHA)

Land in the floodplain subject to a 1% or greater chance of flooding in any given year. This is a FEMA-identified, high-risk flood area where flood insurance is mandatory for properties that have a mortgage or loan by a federally regulated financial institution.

A Zone

Special Flood Hazard Area that is subject to flooding from riverine or coastal sources where the waves are less than 3 feet high.

V Zone

Coastal Special Flood Hazard Area extending from offshore to an inland limit of a primary frontal dune along an open coast and any other area subject to high-velocity wave action where wave heights or wave runup depths are 3 feet or higher.

LiMWA

Limit of Moderate Wave Action

MoWA

Moderate Wave Action

MiWA

Minimal Wave Action

Corrosion Considerations

Metal corrosion is an important consideration when building structures in flood-prone areas. If an environment causes metal to corrode to a level where galvanized hardware will not retain its strength through the useful life of the structure, stainless-steel connectors are recommended. These environments would include areas where salt air or chlorides are present. Chlorides often result from de-icing salts, salts used to melt snow, coastal salt fog, mist or spray. The Simpson Strong-Tie minimum recommendation is type 316 stainless steel connectors and fasteners for use in ocean-salt air and other chloride environments.

While stainless steel provides the greatest resistance to corrosion, ASCE 24-05 sections 5.2.2.1 and 5.2.2.2 for corrosive and non-corrosive environments, respectively, address the use of other coatings as indicated:

5.2.1 Metal Connectors and Fasteners

Metal plates, connectors, screws, bolts, nails and other fasteners exposed to direct contact by flood water, precipitation or wind-driven water shall be stainless steel or hot-dip galvanized (HDG) in accordance with ASTM A123, ASTM A153, ASTM A653.

5.2.2.1 Corrosive Environments

... exposed to salt water, salt spray or other corrosive agents ... straps and anchoring devices shall be stainless steel or hot-dip galvanized after fabrication ...

5.2.2.2 Noncorrosive Environments

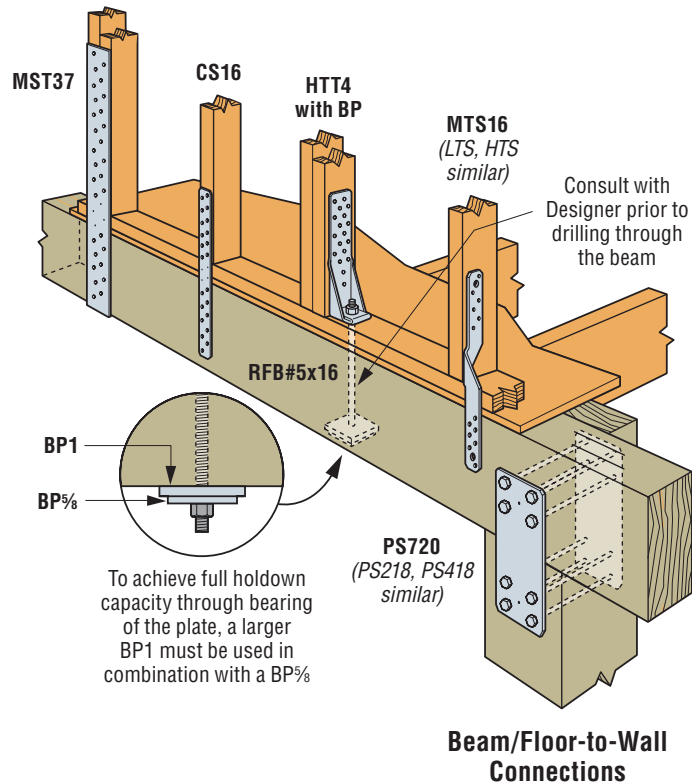
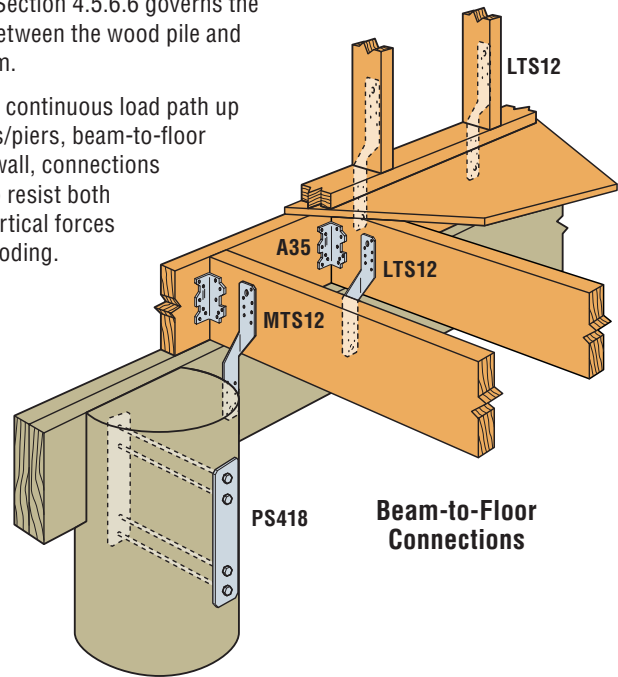
... exposed ... straps and anchoring devices shall be stainless steel or hot-dip galvanized after fabrication.

RAISED FOUNDATIONS

In V zones, structures are built on raised foundations to mitigate potential damage caused by hydrostatic and hydrodynamic loads as well as accompanying debris and scour. These structures are typically built with either wood piles or masonry/concrete piers that support floor beams. In each scenario, a continuous load path of connections throughout the structure is vital to resist flood loads.

ASCE 24-05 Section 4.5.6.6 governs the connection between the wood pile and the floor beam.

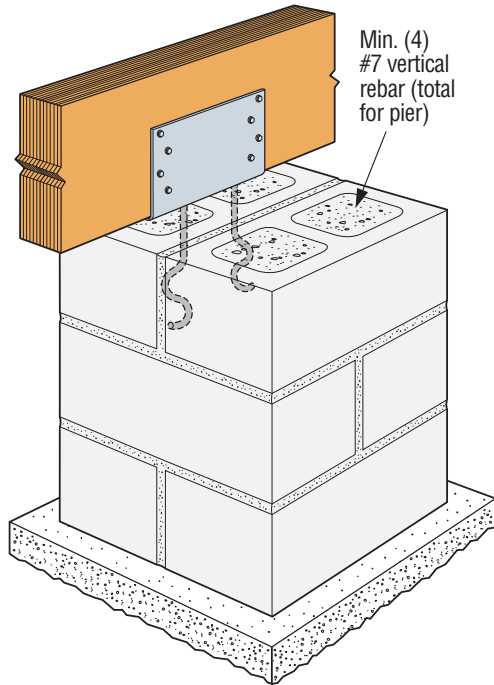
To maintain a continuous load path up from the piles/piers, beam-to-floor and floor-to-wall, connections are needed to resist both lateral and vertical forces caused by flooding.



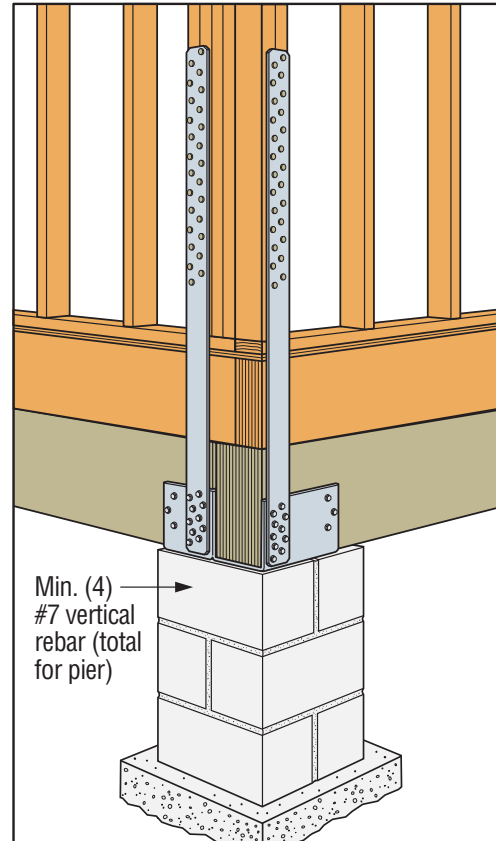
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RAISED FOUNDATIONS (cont.)

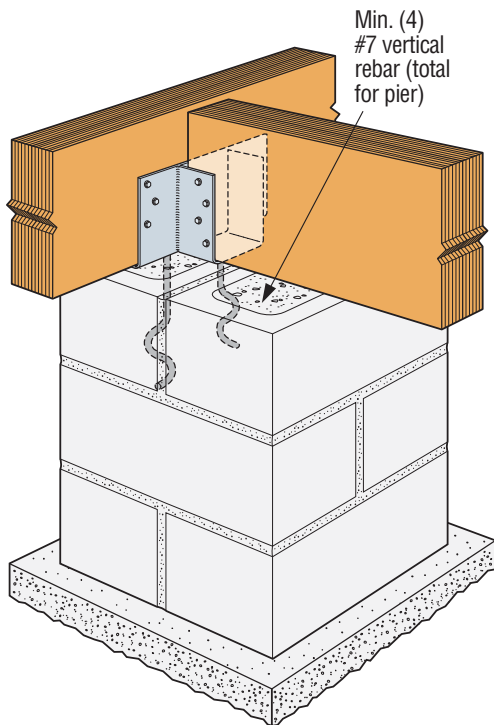
To maintain a continuous load path between concrete/masonry piers and floor systems, beam seats or column caps provide the required resistance to flood forces.



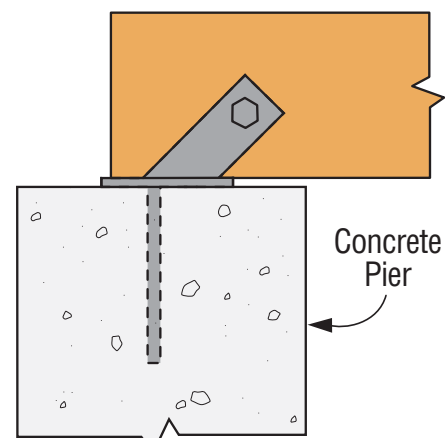
Typical CCQM Installation



Typical ECCLQM Installation



Typical CCTQM Installation



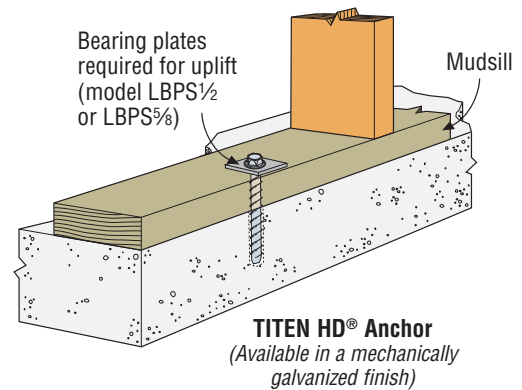
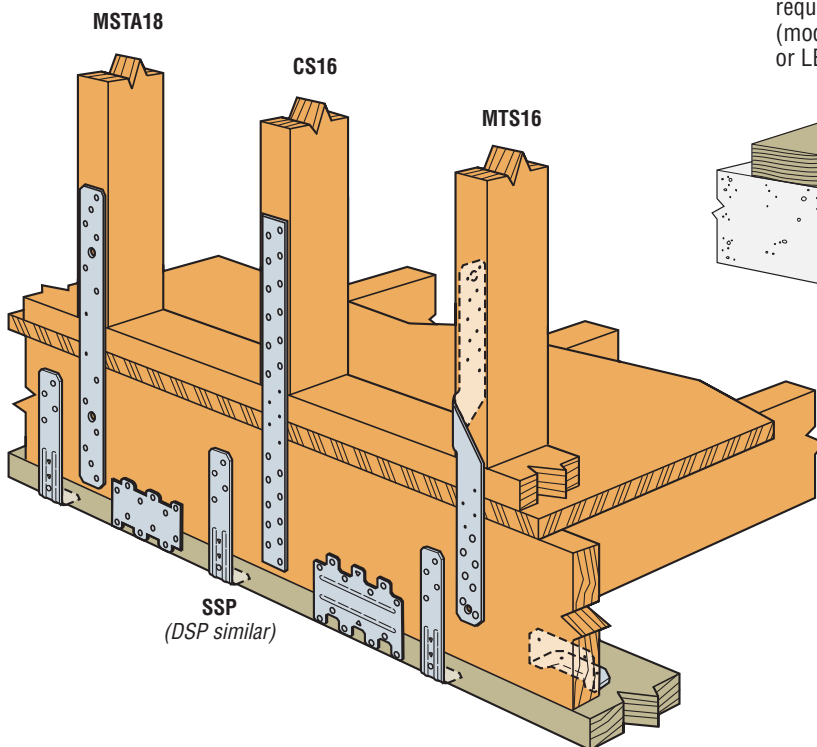
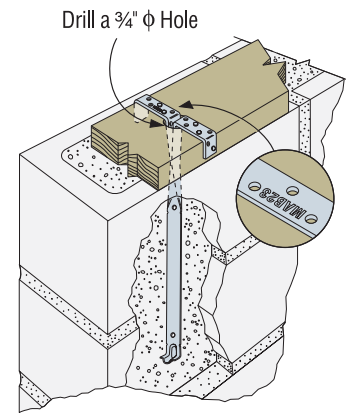
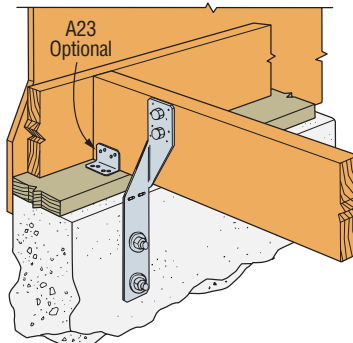
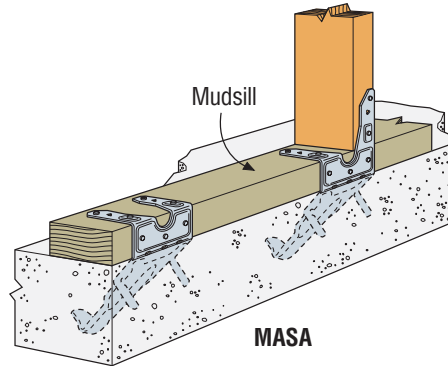
Typical GLB Installation

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SOLID FOUNDATIONS

Solid foundations can be used for structures located outside of a V Zone. Structures located away from the coastline are subject to lesser hydrodynamic loads, impact forces (*debris*) or scour than shoreline buildings.

Flood water buildup on the exterior of a foundation wall applies inward pressure on the wall. As a result, section 2.6 of ASCE 24-05 states that "foundation walls that enclose an area below the DFE ... shall contain openings to allow for automatic entry and exit of floodwaters during design flood conditions." These flood openings will allow the water to flow through the openings into a non-living area to equalize the pressure. In addition, to ensure that the structure remains securely fastened to the foundation, it must be designed with foundation-to-sill plate and sill plate-to-rim joist connections. These Simpson Strong-Tie® connectors provide resistance to vertical loads per section 1.5.5 of ASCE 24-05.



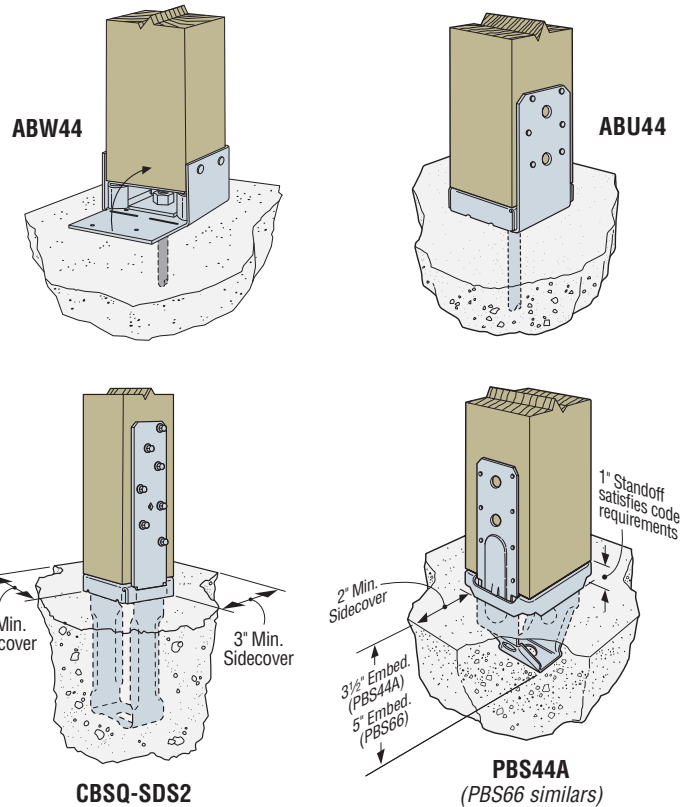
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DECKS

Decks require strong connections to columns/piles and footings as well as to the adjacent structure in order to resist the various loads caused by a flood. Without proper connections, a deck can tear away and become a hazard to downstream people and structures as it is swept along by flood waters. In sections 9.1 and 9.2 of the ASCE 24-05, several guidelines that address deck connections to the house are provided based on the coastal flood zone in which the structure is located. If a deck is not attached to the structure, it should be designed in accordance with section 4.8.

Several Simpson Strong-Tie® posts and column bases are specifically designed to resist lateral loads between the post and concrete foundation. Depending on loads, these connectors can provide the required lateral resistance. The particular flood zone can also affect how to best connect decks to structures or the foundation. For example, in V Zones, decks are required to be attached to piles and the deck is mandated to be elevated above the required flood elevation. Section 4.5.7 of ASCE 24-05 states "... where founded on erodible soils, supports shall extend to at least 10 ft. below mean water level or shall be ... anchored by a pile, spread footing ... meeting the requirements of Section 4.5.1" In other coastal flood areas, concrete footings are acceptable but should be deep enough to resist erosion and scour from flood waters.

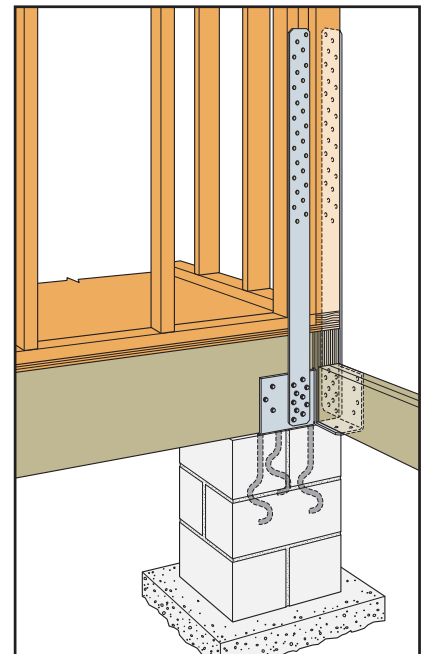
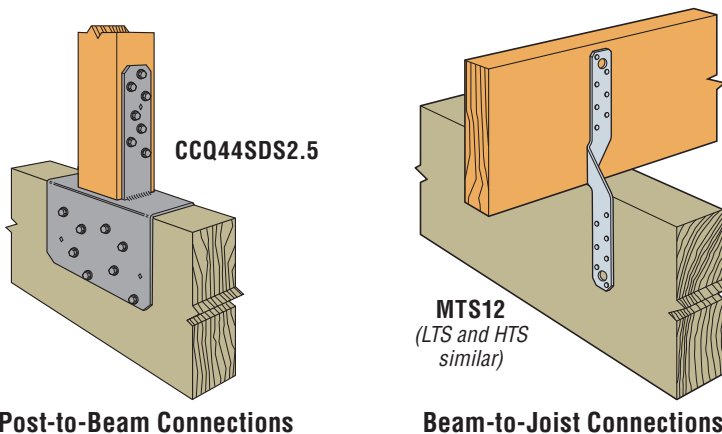
For additional deck-specific construction information, visit www.strongtie.com and download a .pdf copy of our *Deck Framing Connection Guide* (F-DECKCODE).



Post-to-Concrete Deck/Porch Connections

PORCHES

Similar to decks, porches require a solid connection between the supporting columns/posts and the substructure to avoid collapse. In flood-prone areas, most of these connections will be cast-in-place solutions, similar to those for decks. Installing these types of connectors will help avoid many of the common reasons for porch collapses, such as posts washing away from hydrodynamic loads or scour.

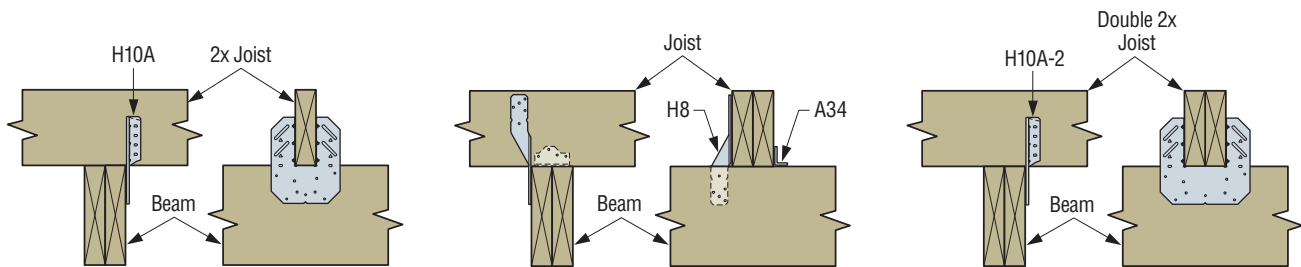


ECCLRQMD-KT
Ideal for applications where a member is needed off the corner of the structure, such as a deck beam.

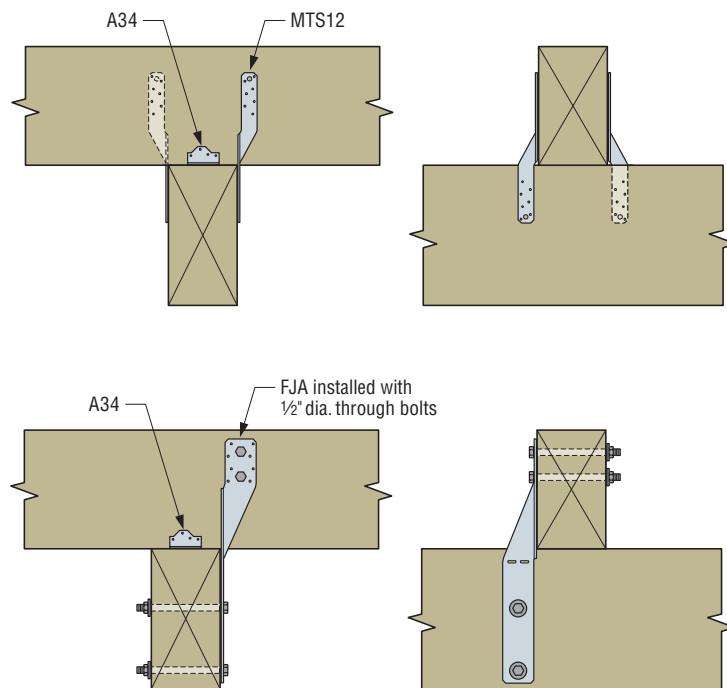
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BOARDWALKS

Boardwalks must be designed to resist the design loads described in ASCE 7 as well as the requirements of ASCE 24. The following details provide several connectors between beams and their supports to resist the design loads. When designing in flood zones, smaller hurricane ties may be inadequate for joist-to-beam or beam-to-support connections. To resist the loads imposed by flood waters, straps and connectors that engage most of the height of the wood members can greatly reduce the potential for wood failure from cross-grain tension.

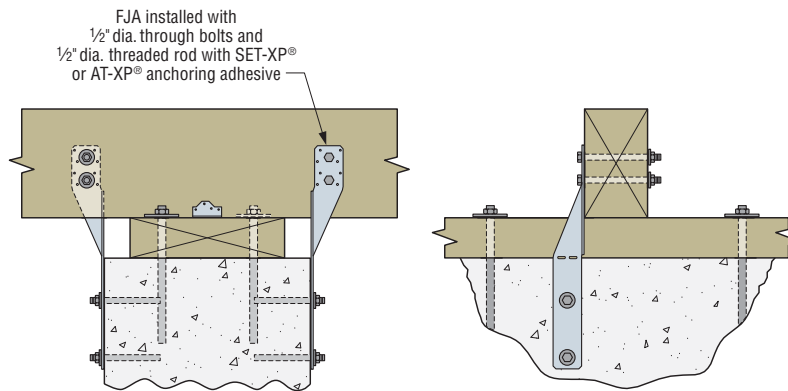
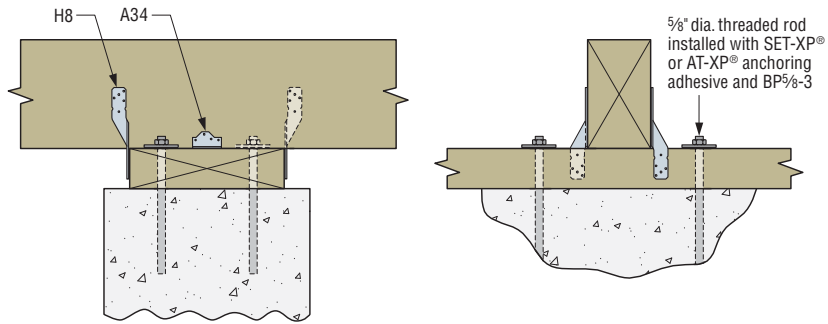


Joist-to-Beam Connections

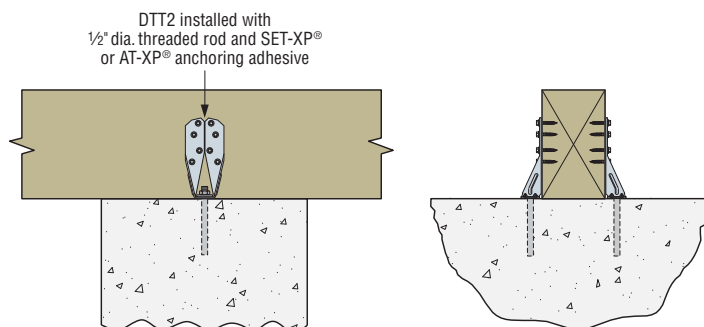
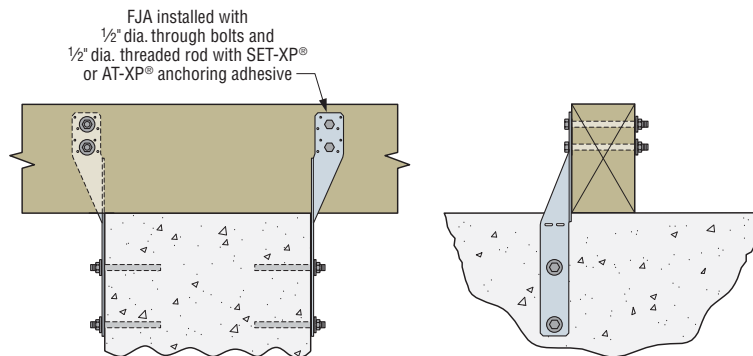


Beam-to-Beam Connections

BOARDWALKS (cont.)



Beam-to-Concrete Nailer Connections



Beam-to-Concrete Pile Cap Connections

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FASTENERS

Type 316 Stainless-Steel Annular Ring-Shank Nails

Industry studies have shown smooth-shank stainless-steel nails have lower withdrawal capacity compared to smooth-shank carbon-steel nails. When using stainless-steel connectors, the annular-ring-shank nails in the tables below may be used in place of the specified smooth-shank stainless-steel nails. See engineering letter L-F-SSNAILS at www.strongtie.com for nail replacement chart and other related information.

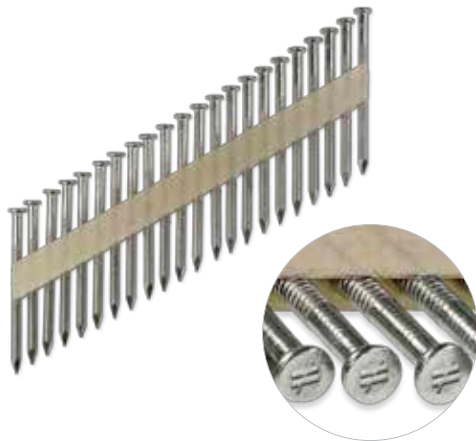


Hand-Drive Common, Annular Ring Shank Nails

Nail Size	Model Prefix	Shank Dia. (in.)	Head Dia. (in.)	Approx. Count per lb.	1 lb. Model No.	5 lb. Model No.	25 lb. Bucket Model No.
8dx1½"	SSNA8	0.134	⅝	147	SSNA8D	SSNA8D5	SSNA8DB
8dx2½"	SSA8D	0.134	⅝	94	SSA8DD	SSA8D5	SSA8DB
10dx1½"	SSNA10	0.147	⅝	126	SSNA10D	SSNA10D5	SSNA10DB
10dx3"	SSA10D	0.147	⅝	66	SSA10DD	SSA10D5	SSA10DB
16dx3½"	SSA16D	0.161	1⅛	44	SSA16DD	SSA16D5	SSA16DB

33° Paper Tape, Full Round Head, Ring Shank Structural-Connector Nails

Nail Size	Model No.	Diameter (in.)		Carton Quantity
		Shank	Head	
10dx1½"	T9A150MCN	0.148	0.281	1500
10dx2½"	T9A250MCN	0.148	0.281	1000



CONNECTORS

Available Finishes/Materials

ZMAX®	HDG	Type 316 Stainless Steel
ANGLES		
A34Z	—	A34SS
A35Z	—	A35SS
POST BASES		
ABU##Z ²	—	ABU##SS ²
ABW##Z ²	—	—
—	CBSQ##-SDS2HDG ²	CBSQ##SS ²
PBS44AZ	PBS44AHDG	—
—	PBS66HDG	—
COLUMN CAPS		
—	CCQ##-SDS2.5HDG ²	CCQ##SS-SDS2.5 ²
—	ECCQ##-SDS2.5HDG ²	ECCQ##SS-SDS2.5 ²
—	CCQM##-SDSHDG ²	—
—	CCTQM##-SDSG ²	—
—	ECCLQM##G-KT ²	—
—	ECCLQMD##GX-KT ²	—
BEARING PLATES		
LBP##Z ²	—	—
LBPS##Z ²	—	—
—	BP ##HDG ²	—
—	BP ##-3HDG ²	—
STRAPS		
MSTA##Z ²	—	MSTA##SS ²
—	MST##HDG ²	—
CS16Z	—	CS16SS
—	PS## ²	—
TIES		
—	FJAHDG	—
H8Z	—	H8SS
H10AZ	—	H10ASS
H10A-2Z	—	—
—	—	LTS12SS
—	—	LTS18SS
MTS12Z	—	MTS12SS
MTS16Z	—	—
MTS20Z	—	MTS20SS
HTS20Z	—	—
—	SSPZ	—
—	DSPZ	—
MUDSILL ANCHORS		
MAB23Z	—	—
MASAZ	—	—
TENSION TIES		
DTT2Z	—	DTT2SS
—	HTT4HDG	—
THREADED ROD		
—	RFB ##HDG ²	—

1. A full list of corrosion resistant products is available at www.strongtie.com/corrosion.
2. Products noted are available in multiple sizes. Replace "##" in the model number with sizes from our current Wood Construction Connectors catalog.

This flier is effective until December 31, 2015, and reflects information available as of July 1, 2013. This information is updated periodically and should not be relied upon after December 31, 2015; contact Simpson Strong-Tie for current information and limited warranty or see www.strongtie.com.