



# Structural Seismic Retrofits For Hawaii Single Family Residences With Post and Pier Foundations

## Volume I

### Results of Study, Structural Analysis and Retrofit Strategies

Prepared for



FEMA

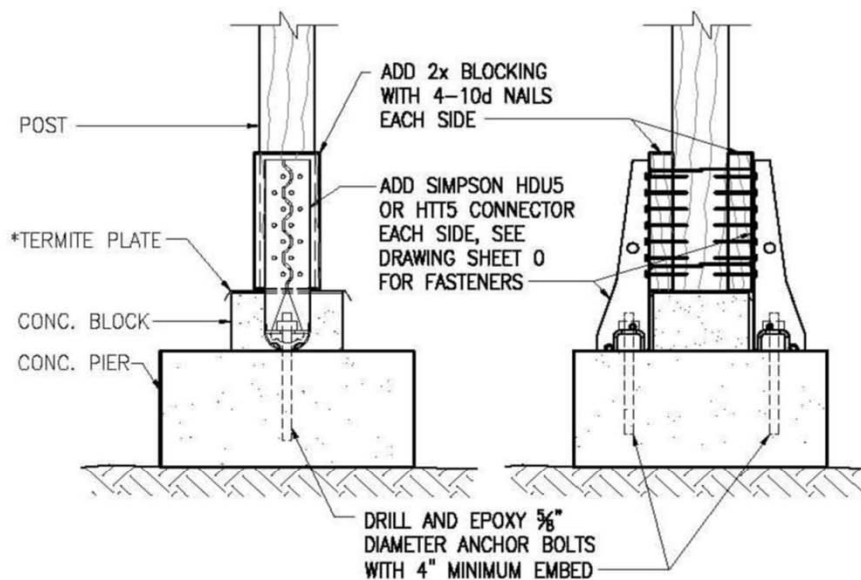
Hazard Mitigation Grant Program  
DR-1664-HI



Final Report  
May 15, 2009

Principal Investigators: Ian Robertson, Ph.D., P.E.  
Gary Chock, P.E.

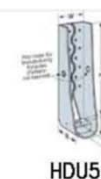
This demonstration is based off the 2009 report by structural engineers Dr. Ian Robertson and Gary Chock. You may be able to do the work yourself but first consult with a licensed structural engineer. The work can reduce earthquake and hurricane damage.



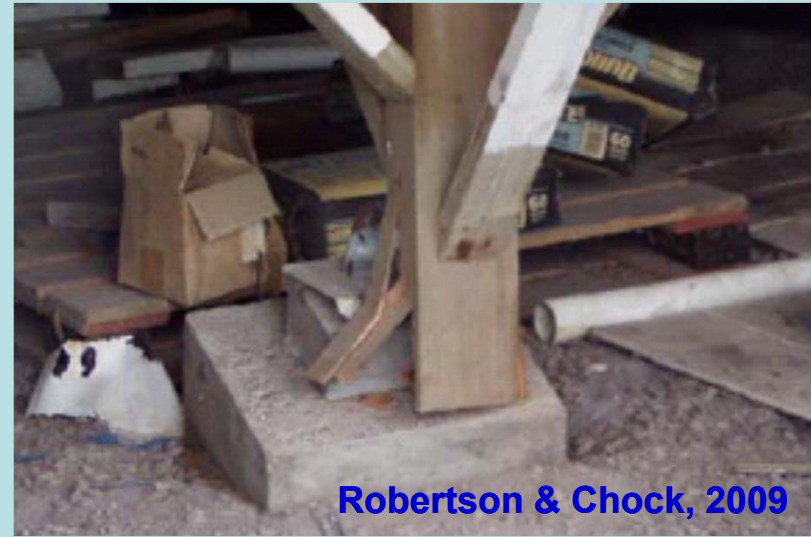
**FRONT VIEW**

**SIDE VIEW**

**\*NOTE:**  
TERMITE PLATE MAY BE REMOVED OR  
BENT AS NECESSARY FOR INSTALLATION  
OF NEW POSTS AND CONNECTORS



**Single-wall houses on post and pier foundations are easily damaged from earthquakes and hurricanes. The post sits on a termite pan, with no connections and are held by friction.**



**Robertson & Chock, 2009**

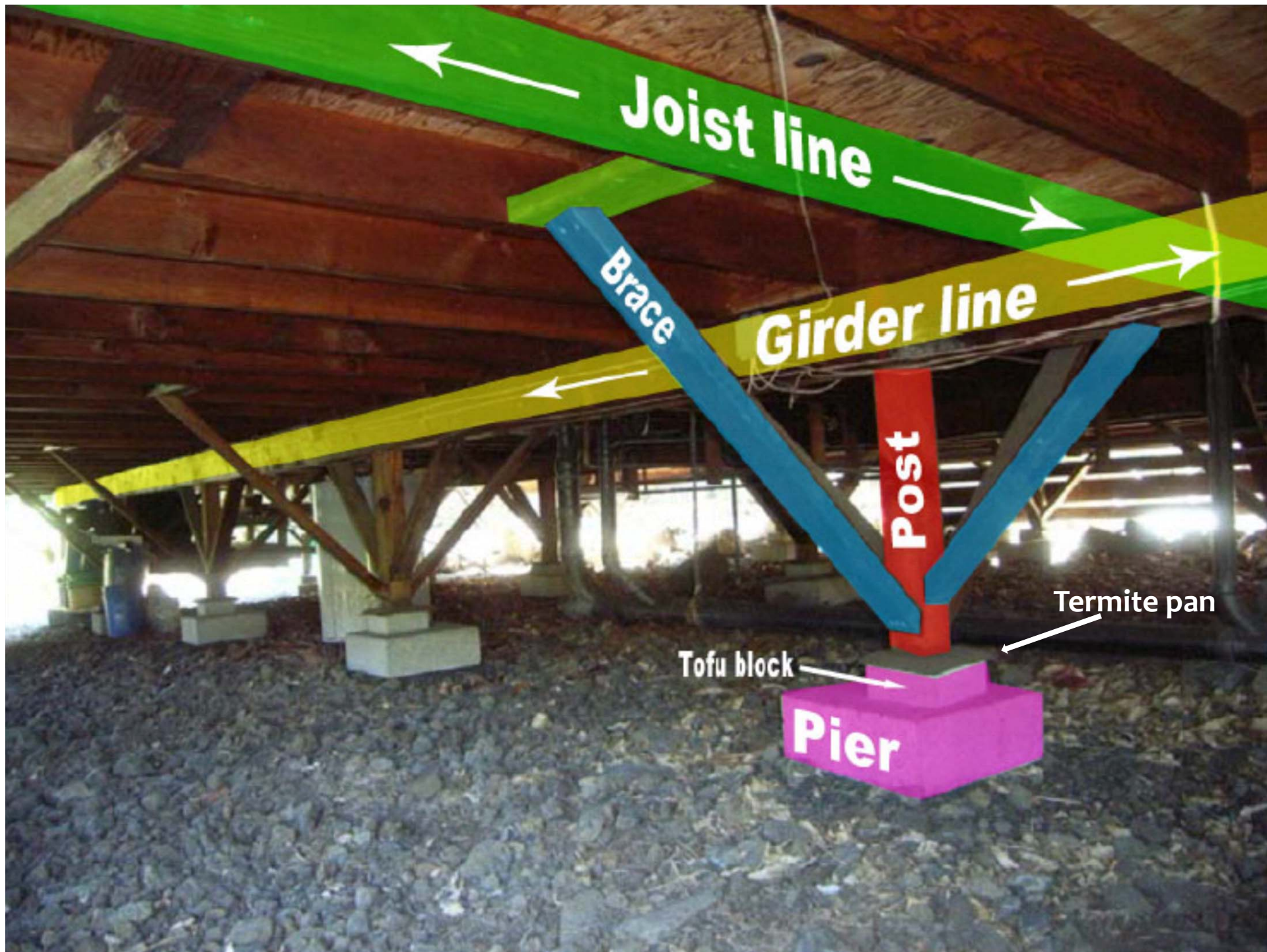




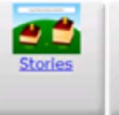



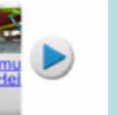
**Robertson & Chock, 2009**



**Robertson & Chock, 2009**

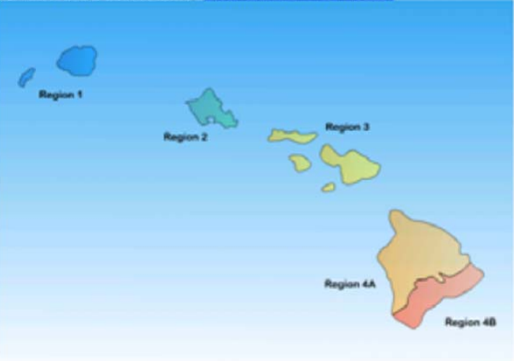














Which of these regions is the house located in ( homes with the following zip codes are located in 4B: 96718,96737,96749,96760,96771,96772,96777,96778)? [NEXT](#)

For increased accessibility [alternative HTML inputs](#).



Option	Choice
<a href="#">Region</a>	
<a href="#">Inland/Shoreline</a>	
<a href="#">Stories</a>	
<a href="#">Floor Area / Shape</a>	
<a href="#">Maximum Post Spacing</a>	
<a href="#">Max Post Height</a>	
<a href="#">Minimum Post Height</a>	
<a href="#">Damaged Braces</a>	
<a href="#">Interior Posts</a>	
<a href="#">Exterior Posts</a>	
<a href="#">Thin Posts</a>	
<a href="#">Detached Braces</a>	
<a href="#">Number of joist bays</a>	
<a href="#">Number of girder bays</a>	

The retrofit design depends on what seismic zone the house is in. Even for the most active area, the south part of Hawai'i, the retrofits can provide earthquake and hurricane protection. For these areas shear walls may be needed also.

Proximity to the coastline is also a factor.







Maximum Post Height:  feet and  inches  
For increased accessibility [alternative HTML inputs.](#)

**Other factors to consider besides the seismic zone are number of stories, post spacing, post height, and the ratio of the tallest post with the shortest. Refer to the 2009 Report and 2018 Assessment for proper spacing to retrofit the post.**



# New Simpson Products Make for Easier Installation



Titen Heavy Duty Concrete Anchor Screw



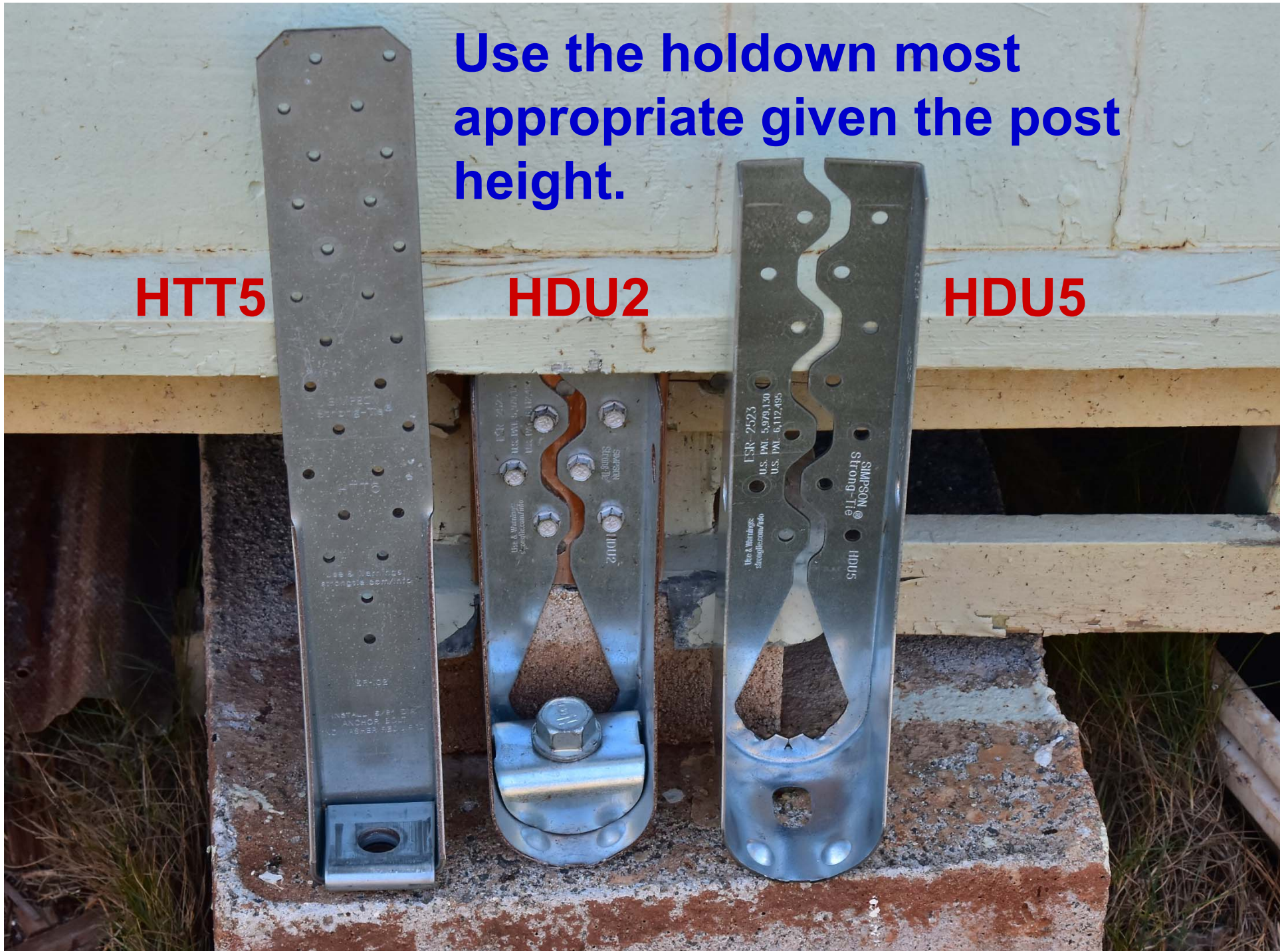


Use the holdown most appropriate given the post height.

HTT5

HDU2

HDU5





## Long Holdown & Epoxy Anchor Bolt



## Short Holdown & Epoxy Anchor Bolt



## Short Holdown & Titen Concrete Anchor Screw





# Procedures



**Remove decorative fencing with multi-tool using flat wood blade, hammer and small nail-trim remover.**







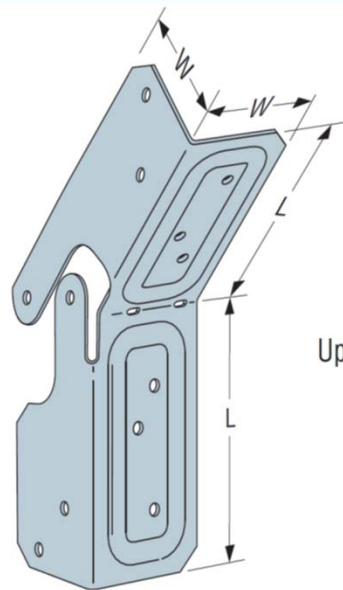
**Install Simpson Strong Tie AC4 connector to inside post and beam. The AC4 is for 4" x 4" post. AC6 is for larger posts.**

**Use 3.5 inch 16d nails and a palm nailer. A hammer can be used but it is tiring and time consuming.**



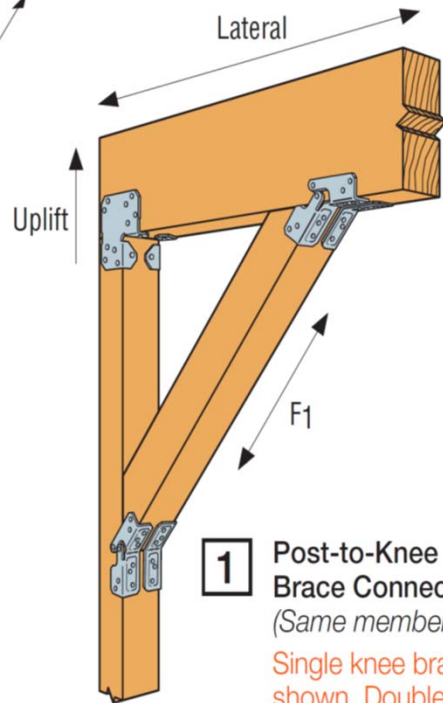


# Knee brace stabilizer (Simpson KBS1Z) installed for all knee braces.



KBS1Z

U.S. Patent 9,045,895



**1** Post-to-Knee  
Brace Connection  
(Same member width)

Single knee brace  
shown. Double knee  
brace installation  
similar.







**Trace outline of  
holdown on termite  
pan.**

**Cut termite pan  
with snips.**



**Fold down or hammer  
down termite pan  
against tofu block.  
Do for inside and  
outside.**





**Attach 2" x 4" between post and edge of tofu block.**



**Attach Simpson HDU2 holdown to 2" x 4" and concrete foundation.**





**Repeat process for outside of post with 2" x 4"**



**Attach HTT5 holdown to 2" x 4" and concrete foundation.**



**Drill hole with rotary hammer, clean hole of dust with air spray and brush. Then fill with epoxy. If epoxy used – drill hole is 1/8" larger than anchor bolt. Set anchor bolt and holdown.**





The Titen concrete anchor screw eliminates the need to epoxy. Drill hole with **rotary hammer** - same size as anchor screw (e.g., 5/8" hole for 5/8" anchor). Drill anchor screw with **impact driver**. Treat for corrosion with zinc rich galvanizing spray, primer for galvanized metal and enamel paint.





**For short posts, complete for all exterior posts and double the corners. Refer to the 2009 report and 2018 assessment for post retrofit spacing.**







## Single-Wall House with Load Path!!

**HPT hurricane clip on  
each rafter. See Part  
4.1.1 of the  
Homeowner's  
Handbook on  
procedures.**

**Each exterior  
post retrofitted.  
See Part 4.1.2 of  
the  
Homeowner's  
Handbook on  
procedures.**







**This single wall house on O'ahu now has a continuous load path.**

Depending on the carrier, there are potential discounts on hurricane insurance for the different retrofits based on the stronger house and the reduced risk of property damage. This will vary with each company.

**Hurricane Clips – 10%**

**Foundation Upgrades – 10-12%**

Upgrades are cumulative, so total discount for this house is up to 22%.

One quote for this house went from \$1,184 to \$932 per year for hurricane insurance.