DESIGN CALCULATIONS – FOUNDATION WALL STRAPS

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Report Name: Attic Access Bulkhead Design Calculations

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REPORT DESCRIPTION

This report documents the structural design of the Attic Access Bulkhead (AAB). The AAB is designed to transfer the tension forces in the truss bottom cords or ceiling joists around the attic access opening. In addition to supporting the ceiling weight and attic storage loads, the bottom truss chords or ceiling joists are also in tension in order to resist the roof outward spreading forces. The AAB attaches to the sides of the truss bottom chords or ceiling joists and transfers the spreading forces to a steel beam on either side of the attic opening. The two steel beams are held together with a threaded rod at each end. The connection points to the truss are adjustable since they slide along the steel beam so that the attic access can be installed in the desired location.

This report calculates the roof spreading loads for varies roof spans, pitches and snow loads. The AAB can be used for any roof that is bound by this analysis.

USE LIMITATIONS

The use is limited to openings less than 50” in length and 24” in width. The use is also limited to roof spans, pitches and snow loads bounded by this analysis, see Table 2. Also, when modify the truss to install the AAB, only a section of the bottom chord may be removed, the webbing must remain. The AAB must be installed and fastened to the truss before cutting out the bottom chords or ceiling joists.

STEEL STRAP DESCRIPTION

The two steel beams on either side of the access opening are HSS2x4x3/16. They are made from carbon steel and have an allowable yield strength of 46,000 PSI. The two threaded rods are ¾” diameter A36 steel and have a yield strength of 36,000 PSI. The sliding saddles are made from HSS 2.5x5”x3/16 and have a yield strength of 46,000. The side plates which are attached to the sides of the truss bottom chords or ceiling joists and that are welded to the sliding saddles are made from 1/8” thick A36 carbon steel, 3” wide (weld length) and 18” long. The side plates have 10 ¼” diameter holes to accept 10 Simpson SDS25200 screws.

DESIGN ALLOWANCE

The Building Codes permits design of building elements as long as they are in accordance with accepted engineering practices:

As an alternative to the requirements in Section R301.1, the following standards are permitted subject to the limitations of this code and the limitations therein. Where engineered design is used in conjunction with these standards, the design shall comply with the *International Building Code*.

R301.1.3 Engineered design. Where a building of otherwise conventional construction contains structural elements exceeding the limits of Section R301 or otherwise not conforming to this code, these elements shall be designed in accordance with accepted engineering practice. The extent of such design need only demonstrate compliance of nonconventional elements with other applicable provisions and shall be compatible with the performance of the conventional framed system. Engineered design in accordance with the *International Building Code* is permitted for buildings and structures, and parts thereof, included in the scope of this code.

DESIGN METHODOLOGY

ASD- Allowable Stress Design

DESIGN CODE REFERENCES

American Institute of Steel Construction (AISC) – Thirteenth Edition, Part 14, page 14-4, reference (a)

2018 International Residential Code (IRC)

2018 International Existing Residential Code (IERC)

ASCE 7, Minimum Design Loads for Buildings and Other Structures

DESIGN ASSUMPTIONS

- The dead weight of the roof is 12 PSF. This is higher than a roof with 2x12s spaced at 12" on center, with ½" sheathing, #30 felt paper and two layers of asphalt shingles.

DESIGN PROCEDURE

The two steel HHS beams are 57" in length between the center of the two threaded rod connections. From the AISC steel manual Table 3-12, the allowed bending moment is 5.37 Kip-ft about the strong axis.

The most common size attic hatch with pull downstairs is 54" long. The AAB is designed with two connection points per beam and is design for trusses spaced at 24" on center. Depending on the exact location the AAB is placed in reference to the location of the trusses, the location of the point load can vary along the beam and in fact the attachments are made with a saddle that can slide along the beams to aid in the desired location of the attic hatch opening. Since the location of the point load on the beam can vary, the maximum moment in the beam is also dependent on where the truss point loads the beam along its length.

The online beam stress analysis program Forte by Weyerhaeuser was utilized to determine what loading location produced the largest moment and shear in the beam. Since the closest the first truss can be to the end of the beam is 6", the truss connection loads were incremented from 6" (and 30" for the adjacent truss) along the beam in one-inch increments. It was determined that the largest moment was produced in the beam when the first truss was located 14" from the threaded rod connection and the next truss was located 38" from the threaded rod location. It was also determined that the maximum shear stress was produced when the first truss connection was 9" from the threaded rod location and the next truss was 33" from the threaded rod location. Of course, since the AAB is symmetric the results would be the same if loaded from the opposite end.

Therefore, the analysis used to determine the moment stress in the side beams uses the 14" and 38" location of the point loads. Using the Forte program, it was determined that two-point loads of 3350# (from the two trusses) could be applied to the side of the beam in order to reach the maximum allowable bending moment of 5.37-kip ft.

SNOW LOADING

The ground snow loads are adjusted using the ASCE 7 code for a typical, non-slippery roof. This result is the ground snow load being multiplied by 0.77. If typical (e.g., slippery, sheltered roofs, etc.) roofs are not present, contact an Engineer.

WIND LOADING

The wind loads are a function of the roof pitch. The wind loads for the different roof pitches were determined using ASCE 7 in the 115 MPH zones for a mean roof height of 40ft. If greater mean roof heights or different wind zones are present, contact an Engineer.

ROOF LIVE LOAD

The code required 20 PSF roof live load was used.

DEAD LOAD

A 12 PSF dead load was used and the increase in dead load as a function of the roof pitch was taken into account.

ROOF EAVES

The roof eaves were ignored in the calculation. This is conservative as the roof eaves actually create an opposite moment in the roof and would lessen the spreading forces on the roof being restrained by the Attic Access Bulkhead.

FASTENERS TO SIDE OF TRUSS OR RAFTER

The fasteners which secure the steel plates to the side of the truss bottom chord or ceiling joists are Simpson SDS14200, which are ¼" in diameter and 2" in length. Each plate has 10 fasteners. Per Table 2 below, with the thickness of the side plate, each screw is acceptable for 290#, see Table 1. Per the load combination of snow, this can be increased to 15% to 333.5# per screw. For a total of 10 screws, this is an allowable of 3,335#.

THREADED RODS

The threaded rods are ¾" in diameter which results in a cross-section area of 0.44 in^2. The maximum spreading force would be 3335# since there are two threaded rods at each end of the frame. This results in a tension stress in the threaded rods of 3335#/0.44in2 = 7,580 psi which is less than the material allowable of 36,000 x 0.60 psi = 21,600 psi.

Table 1 – Simpson Screw Design Shear Loads

Strong-Drive®
SDS **HEAVY-DUTY CONNECTOR** Screw

Heavy-Duty Simpson Strong-Tie® Connectors

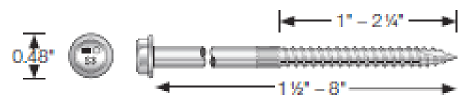
The Simpson Strong-Tie® Strong-Drive® SDS screw is a ¼" diameter high-strength structural wood screw ideal for various connector installations as well as wood-to-wood and EWP fastening applications.

Install Tips: A low-speed ½" drill with a ⅜" hex driver (BITHEXR38-134) is the recommended tool for installation.

Codes/Standards: ICC-ES ESR-2236; City of L.A. RR25711, State of Florida FL9589

U.S. Patents 5,897,280; 7,101,133

For More Product Information, see p. 75



SDS – Allowable Shear Loads-Steel Side-Plate Applications

Size (in.)	Thread Length (in.)	Coating/ Material	Model No.	DF/SP Allowable Shear Loads (lb.) Steel Side Plate Thickness, mil (ga.) 54 (16)	DF/SP 68 and 97 (14 and 12)	DF/SP 123 (10) or greater	SPF/HF Allowable Loads (lb.) Steel Side Plate Shear, mil (ga.) 54 (16)	SPF/HF 68 and 97 (14 and 12)	SPF/HF 123 (10) or greater
¼ x 1½	1	Double-barrier coating	SDS25112	250	250	250	180	180	180
¼ x 2	1¼		SDS25200	250	290	290	180	210	210
¼ x 2½	1½		SDS25212	250	390	420	180	280	300
¼ x 3	2		SDS25300	250	420	420	180	300	300
¼ x 3½	2¼		SDS25312	250	420	420	180	300	300
¼ x 4½	2¾		SDS25412	250	420	420	180	300	300
¼ x 5	2¾		SDS25500	250	420	420	180	300	300
¼ x 6	3¼		SDS25600	250	420	420	180	300	300
¼ x 8	3¼		SDS25800	250	420	420	180	300	300
¼ x 1½	1	Type 316 stainless steel	SDS25112SS	250	250	250	180	180	180
¼ x 2½	1½		SDS25212SS	250	390	420	180	280	300
¼ x 3	2		SDS25300SS	250	420	420	180	300	300
¼ x 3½	2¼		SDS25312SS	250	420	420	180	300	300

1. Screws may be provided with the 4CUT™ or Type-17 point.
2. Allowable loads are shown at the wood load duration factor of C_D = 1.00. Loads may be increased for load duration up to a C_D = 1.60.
3. Allowable withdrawal load for DF/SP/SCL is 172 lb./in. and for SPF/HF withdrawal is 121 lb./in. Total withdrawal load is based on actual thread penetration into the main member.
4. LSL wood-to-wood applications that require 4½", 5", 6" and 8" SDS screws are limited to interior-dry use only.
5. Minimum spacing requirements are listed in ICC-ES ESR-2236.

ROOF SPREAD FORCE

The tension force in the bottom truss chord or ceiling joists required to resist the outward spreading force on a roof is a function of the roof loading, roof pitch and roof span. The formula is as follows:

$$T = \frac{12\ x\ S\ x\ Q}{P}$$

Where, T, is the tension chord in the bottom roof chord (lbf), S is the total span of the roof (ft), Q is the roof loading (PSF) and P is the pitch of the roof (x on 12). The load must also be adjusted for the rafter spacing (increased by two for a 2 foot on center spacing for example).

A Microsoft Excel Spreadsheet was used to solve the above equation to determine the roof span, S. The tension, T was set to 3,335# (limited by the fasteners), and the roof pitch and loads varied. The results are provided in Table 1 below.

Table 2 – Maximum Allowable Total Roof Span per Ground Snow and Roof Pitch

Ground Snow (PSF)	Maximum Allowable Total Roof Span in feet from Bearing Point to Bearing Point at Pitch X on 12										
	2	3	4	5	6	7	8	9	10	11	12
10	17.4	25.9	34.2	41.9	48.8	55.6	62	67.9	74.2	80.2	85.9
20	17.4	25.9	34.2	41.9	48.8	55.6	62	67.9	74.2	80.2	85.9
30	15.8	23.6	31.2	38.7	45.7	52.1	58.2	63.9	69.9	75.6	81.1
40	13	19.4	25.7	31.9	37.9	43.7	49.4	54.9	60.1	65.2	70.1
50	11	16.4	21.8	27.1	32.2	37.2	42.2	46.9	51.6	56	60.4
60	9.6	14.3	19	23.6	28.1	32.5	36.8	41.1	45.2	49.1	53
70	8.5	12.6	16.8	20.9	24.9	28.8	32.7	36.5	40.2	43.8	47.3
80	7.6	11.3	15	18.7	22.2	25.9	29.4	32.8	36.2	39.4	42.6
90	6.9	10.3	13.6	17	20.2	23.5	26.7	29.8	32.9	35.9	38.8
100	6.3	9.4	12.5	15.5	18.5	21.5	24.4	27.3	30.1	32.9	35.6