DIRTT
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Seismic Structural Analysis of DIRTT Partition Wall Anchors DIRTT Interior Partition Walls

Project Location: TBD
DIRTT Project # 1505004 **5/19/2015**

General Notes:

The structural calculations contained within this report are not intended to be submitted as project specific structural calculations; however, the details shown in this report provide an acceptable engineered design for DIRTT partition wall anchors to resist the minimum 5 psf out-of-plane and "high" seismic lateral loads contained within the IBC 2006, 2009, and 2012 as well as CBC 2010 and 2013.

The "high" seismic lateral force defined by this report is shown in the Table 1 below.

Table 1- Max. Wall Height, H vs. Max. Earthquake Load, EL

Max. Wall Height, H (ft)	Max. Earthquake Load, EL (psf)
8	1.40
9	1.22
10	1.12
11	0.99
12	0.90

Linear interpolation is permissible

Table 1 reports the maximum Allowable Stress Design (ASD) horizontal earthquake load (EL) for a given maximum wall height. If site specific EL forces are less than those indicated in Table 1, then all details in this report will be code compliant. If site specific EL values are greater than what is mentioned in Table 1, then further structural analysis may be necessary and must be brought to DIRTT engineering's attention. For your reference, the simplified equation from ASCE 7 for the ASD horizontal earthquake load is $EL = (0.7)*F_p = 0.112*I_p*S_{DS}*W_p*(1+2*(z/h))$ were the minimum ratio of z/h to use is 0.43. The definition of the variables associated with calculating the ASD earthquake load, EL, are as follows:

(1) Seismic Importance Factor, I_p, based on Occupancy/Risk Category. The Seismic Importance Factor is either equal to 1.0 or 1.5. If the DIRTT partition walls will be installed in hospitals or fire departments where it is essential that the facility be operational after a major earthquake, then $I_p = 1.5$. If the building is non-essential such as offices, schools, water treatment plants, etc. then $I_p = 1.0$. If in doubt as to the value of the Seismic Importance Factor, I_p, consult DIRTT Engineering.

(2) Design Spectral Response Acceleration at Short Period, S_{DS}. This value is most commonly found on the first page, typically S1, on the structural drawings for any building. The magnitude of the S_{DS} value will indicate the severity of the ground acceleration during an earthquake expressed in g's. The value may be expressed as a percent or decimal such as 95% g or 0.95 g's. Use the decimal form of S_{DS} to calculate F_p. The value of S_{DS} may also be obtained from USGS website.

(3) Component operating weight, W_p, in terms of psf. This is also known as the wall dead load. If there are multiple wall module types with various wall dead load loads, then use the maximum wall dead load.

(4) the height above floor/ground level, z, the partition walls will be installed on. This could also simply be the floor level the partition walls will be installed on. For example, if the walls are installed on the 2nd floor of a building, use z = 2. Another example is if the walls are installed 30 ft up from the base building ground level, use z = 30 ft.

(5) the total height of the building above floor/ground level, h. For example, if there are 6 total stories to a building, use h = 6. Another example is if the total height of the building from ground floor to the roof is 100 ft, use h = 100 ft.

The calculations and details shown in this report are for the anchors of the partition wall. For calculations and details pertaining to the members of the partition wall (verticals, headers, sills, member splices, etc.) you will need to reference another appropriate DIRTT Engineering member calculation report.

If a given project consists of details not shown in this report or any other DIRTT engineering report, then further structural analysis is necessary and must be brought to DIRTT engineering's attention. Note that additional DIRTT components (doors, hanging loads, etc.) were not included as part of the seismic operating weight, W_p, of the partition wall systems contained within this report. If a given project will have such additional components, further structural analysis is necessary and must be brought to DIRTT engineering's attention.

Disclaimer:

This Certification is limited to the structural design of structural components of this Interior Partition Wall System. It does NOT include responsibility for:

- Structural design of gaskets and sealants
- The manufacture, assembly, or installation of the system.
- Quantities of materials or dimensional accuracy of drawings
- Separation of dissimilar materials

Engineers Design Approval Stamp: 5/19/2015

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Design Criteria:

1. Design loads per CBC 2010 and 2013, IBC 2006, 2009, and 2012, and ASCE 7-05 and 7-10. Minimum working load applied out-of-plane to walls = 5 psf. Maximum horizontal earthquake load applied in-plane and out-of-plane of walls = 1.4 psf.

2. Aluminum clips and members shall be alloy-temper 6063-T6 (F_y = 25 ksi) as specified in the drawings and calculations. Members designed per the Aluminum Association's 2010 Aluminum Design Manual.

3. Steel designed per Specification for structural steel, AISC 360-10.

4. Steel plates and parts shall be minimum F_y = 36 ksi yield and F_u = 58 ksi ultimate tensile strength as specified in the drawings and calculations.

5. Steel welds to be E70XX or better. Steel weld alloy to have a minimum ultimate tensile strength, F_u, of 70 ksi as specified in the drawings and calculations.

6. Steel studs shall be minimum yield strength F_y = 33 ksi, 20 gauge (0.0359" thick). Steel studs designed per the 2007 AISI North American Specification for the Design of Cold-Formed Steel Structural Members.

7. Steel wire to be galvanized, soft-annealed mild carbon steel manufactured in accordance with ASTM A641 with minimum F_y = 48 ksi yield and F_u = 63 ksi ultimate tensile strength.

8. Sheet metal screws used in the field to install and anchor DIRTT partition walls shall have a minimum yield strength of F_y = 65 ksi and ultimate tensile strength F_u = 110 ksi.

9. Wood stud bulkhead assumed to be have minimum specific gravity (SG) = 0.42. Steel stud bulkhead assumed to be minimum 20 gauge (0.0359" thick) with minimum yield strength F_y = 33 ksi. Bulkheads designed and supplied by others.

10. Wood screws shall have minimum yield strengths of F_y = 80 ksi, 80 ksi, and 70 ksi for #10, #12, and #14 wood screws, respectively, and be used as shown in the drawings and calculations. Wood assumed to have minimum specific gravity (SG) = 0.42 for wood screw design.

11. Powers Power-Stud+ SD1, Hilti Kwik Bolt TZ (KB-TZ), and/or Hilti Kwik HUS-EZ (KH-EZ) concrete anchors with specified diameters, embedment depths, minimum concrete slab thicknesses, minimum edge distances, and minimum and maximum spacing's shall be used as specified in the drawings and calculations. Anchors to be installed per manufacturers' specifications. Other anchors may be approved by the authority having jurisdiction prior to installation.

12. Concrete assumed to be minimum f'_c = 3000 psi, lightweight, cracked, and no supplementary reinforcement present (Condition B) for anchor design. If installing concrete anchors into concrete filled steel deck, then see the deck profile and anchor spacing requirements given in anchors associated ICC report.

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Design Criteria:

13. The design and supply of supplementary members and their attachments that DIRTT partition walls are attached to (i.e. concrete floor and/or deck, metal decks, wood decks, ceiling grids, steel and/or wood frame studs/bulkheads, drywall, carpet, etc.) are not supplied or designed by DIRTT Environmental Solutions.

14. DIRTT Environmental Solutions is not responsible for project details not contained within this report.

Responsibilities of the Structural Engineer of Record:

15. Design any supplementary members and their attachments which the partition walls are anchored to. Verify the adequacy of any existing members and their attachments which the partition walls are anchored to for the forces exerted on them by the partition walls in addition to all other loads and forces. Verify building vertical differential floor movement is within tolerances that keep partition walls fully engaged at the ceiling track, when utilized, and verify that building vertical differential floor movement will not cause DIRTT partitions to become load bearing.

16. Verify that the installation is in conformance with the current building codes and with the details shown in the drawings and calculations. Verify that the partition wall anchor locations, anchor details, and the material/gauge of the substrate where attachments are made agree with the information shown in the drawings and calculations.

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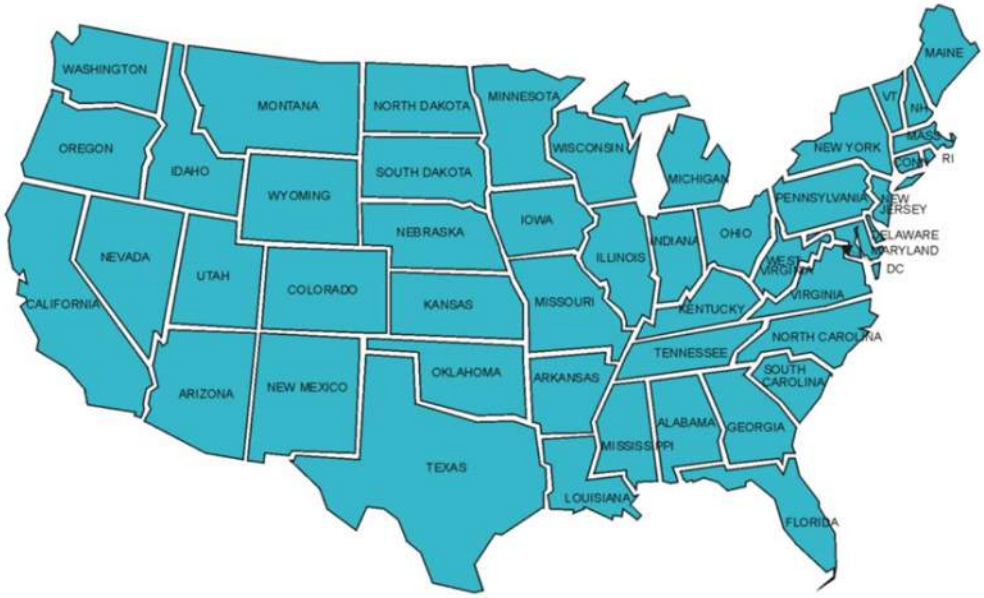


Design Parameters

Item #

1. Seismic design parameters and forces per Chapter 13 ASCE where Soil Site Class = D, a_P = 1.0, R_P = 2.5. Maximum horizontal seismic design force(s) noted on cover sheet.
2. Maximum out-of-plane and in-plane lateral load at head and sill members of partition walls is 2.50 pli and 0.70 pli, respectively.
3. 6mm (1/4"), 10mm (3/8"), and 12mm (1/2") thick glass partition wall weight = 4.2 psf, 6.2 psf, and 7.4 psf, respectively. Solid wall weight with 1/2" thick mdf panels on both sides = 5.5 psf. Solid wall weight with 1/4" thick glass tiles on both sides = 8.4 psf.
4. Leveler locations at the base of the partition walls shall be placed at each end of the sill sections and at each vertical glass edge/joint for stick built applications not to exceed 48" O.C. spacing.
5. Steel stud tiebacks may be used for the bracing of the partition wall headers to the ceiling deck. Alternating steel stud tiebacks on each DIRTT y-bracket is recommended. Maximum spacing of tiebacks given on following sheets. Angle of tiebacks to be between 30 and 45 degrees from horizontal. Studs to be SSMA 250S162-33 designation (F_y = 33 ksi).
6. Steel wire tiebacks may be used for the bracing of the partition wall headers to the ceiling deck. Use (2) 12 gauge (Diameter = 0.106") galvanized, soft-annealed mild carbon steel wire tiebacks (ASTM A641) for each DIRTT brace with wires applied in 180 degree directions. Angle of tiebacks to be between 30 and 45 degrees from horizontal. Maximum spacing of tiebacks given on following sheets.

See the Following Table of Screw Max. O.C. Spacing's for Attaching DIRTT Aluminum Ceiling Track to the Bulkhead as Shown.

Assumed Wood Support Min. 1.5" Thick with Specific Gravity Equal to or Greater Than 0.42. Wood Designed and Supplied By Others.

Wood Screw O.C. Spacing (in inches) Given Wall Height (ft) and Screw Diameter

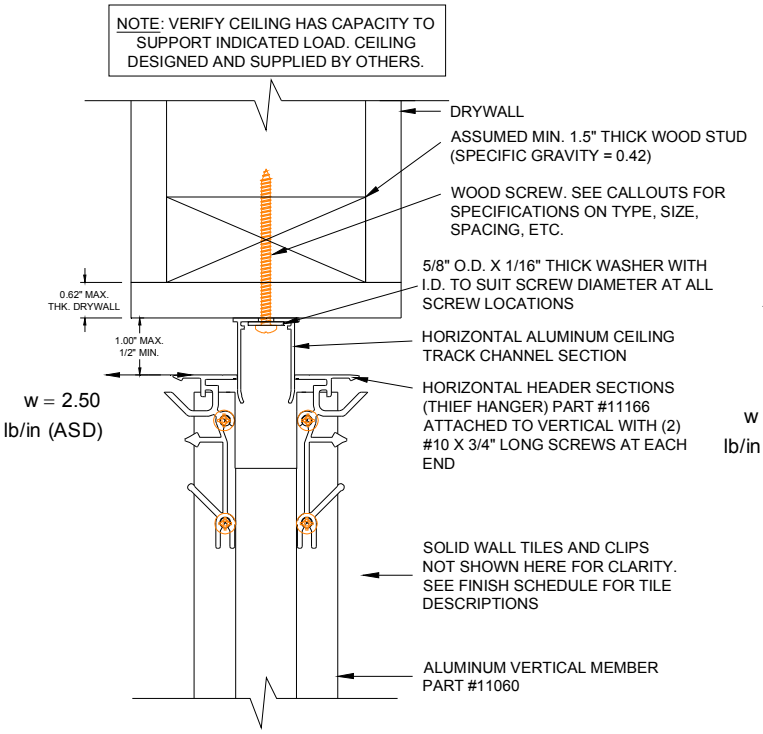
Wall Height (ft)	Screw Diameter #10	#12	#14
8	17	19	20.5
9	15	17	18
10	13.5	15	16.5
11	12.5	13.5	15
12	11.5	12.5	13.5

NOTES

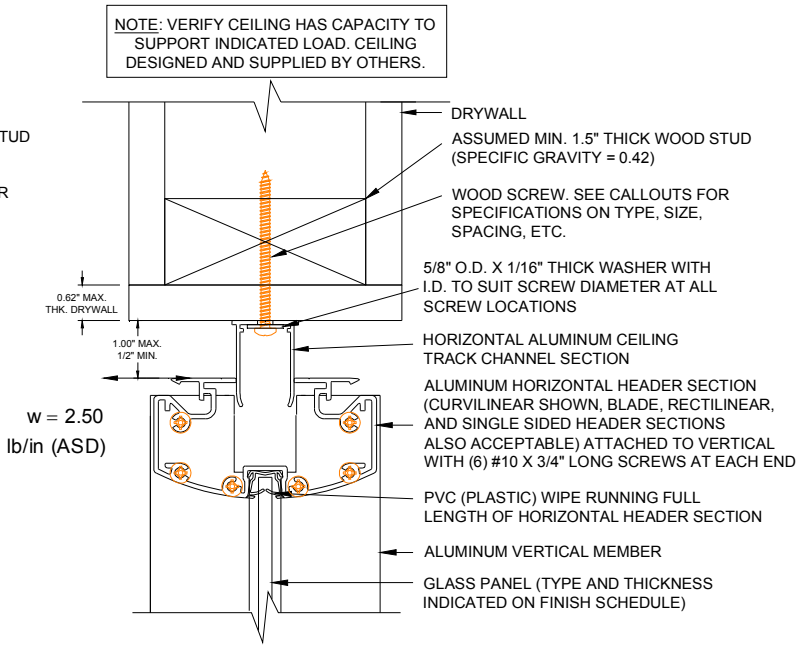
1) O.C. ANCHOR SPACING'S REPORTED IN THE TABLE MAY BE DOUBLED BY USING (2) SCREWS AT EACH ANCHOR LOCATION. EXAMPLE: (1) #10 SCREW SPACED AT 12.5" O.C. FOR A 11' TALL WALL CAN BE SPACED SO THAT (2) #10 SCREWS EXIST AT 25" O.C.

2) WOOD SCREWS TO BE MINIMUM 2.5" LONG WITH MIN. 1.5" THREAD ENGAGEMENT INTO WOOD MEMBER. #14 WOOD SCREWS TO HAVE MIN. Fyb = 70 KSI. #12 AND #10 WOOD SCREWS TO HAVE MIN. Fyb = 80 KSI. MIN. SPACING BETWEEN SCREWS = 5*D, MIN. SCREW DISTANCE FROM EDGE OF WOOD = 2.5*D, AND MIN. SCREW DISTANCE FROM END OF WOOD MEMBER = 10*D, WHERE D = SCREW DIAMETER. USE INDICATED STEEL WASHER SIZE PER SCREW AS SHOWN.

3) USE MINIMUM OF (2) SCREWS (OR GROUPS OF SCREWS IF DOUBLING UP ANCHORS PER NOTE 1 ABOVE) AT GIVEN MAX. O.C. SPACING PER CEILING TRACK SECTION. SCREW MAX. DISTANCE FROM ENDS/SPLICES OF CEILING TRACK = 6".



Solid Wall Bulkhead Header Section Anchor Details



Glass Wall Bulkhead Header Section Anchor Details

See the Following Table of Screw Max. O.C. Spacing's for Attaching DIRTT Aluminum Ceiling Track to the Bulkhead as Shown.

Assumed Min. 20 Gauge (0.0359" Thick) Steel (Fy = 33 ksi) Designed and Supplied By Others.

Self-Drilling/Self-Tapping Screw O.C. Spacing (in inches) Given Wall Height (ft) and Screw Diameter			
Wall Height (ft)	Screw Diameter #10	#12	1/4"
8	13	15	17
9	11.5	13	15
10	10.5	12	13.5
11	9.5	10.5	12.5
12	8.5	9.5	11.5

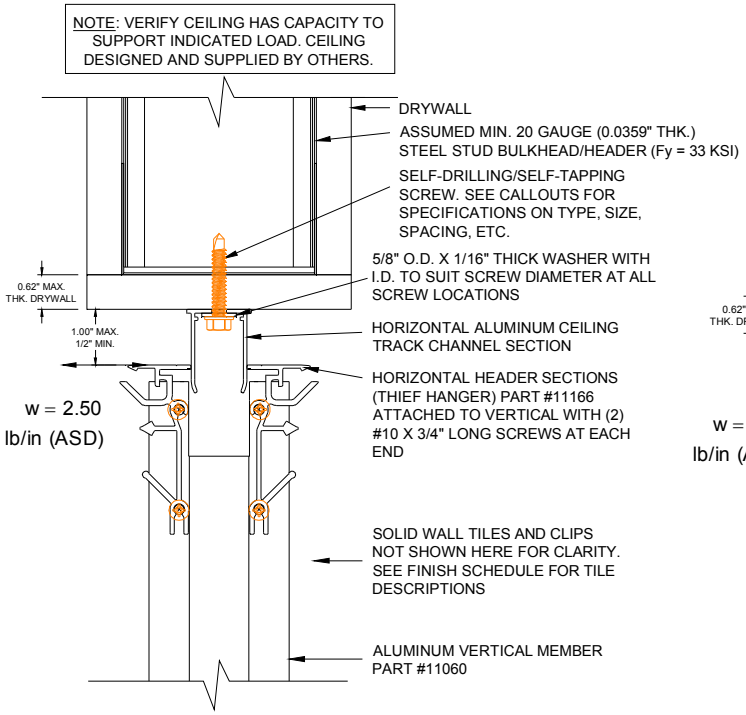
NOTES

1) O.C. ANCHOR SPACING'S REPORTED IN THE TABLE MAY BE DOUBLED BY USING (2) SCREWS AT EACH ANCHOR LOCATION. EXAMPLE: (1) #12 SCREW SPACED AT 12" O.C. FOR A 10' TALL WALL CAN BE SPACED SO THAT (2) #12 SCREWS EXIST AT 24" O.C.

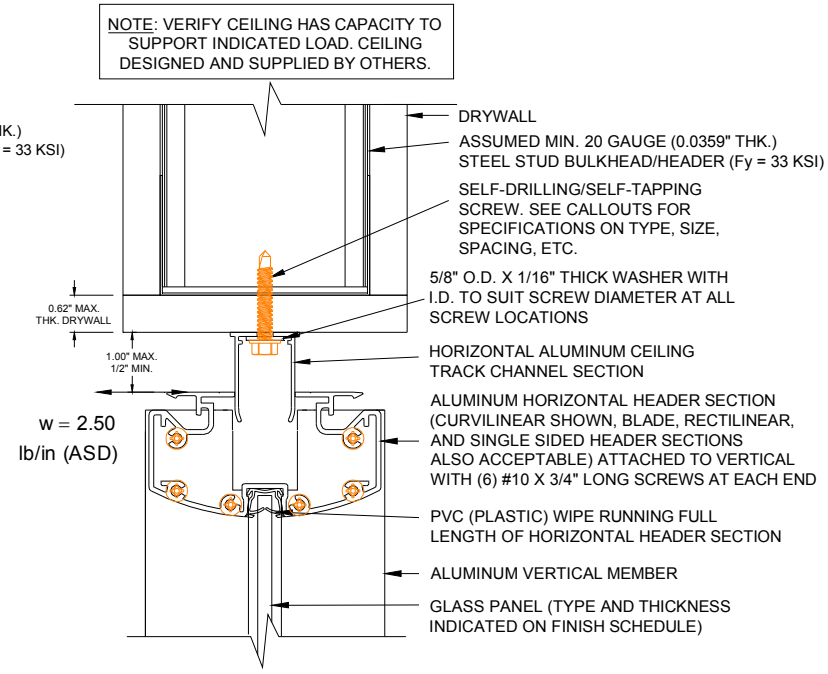
2) MIN. SPACING BETWEEN SCREWS = 3*D AND MIN. SPACING OF SCREWS FROM EDGE OF STUD = 1.5*D, WHERE D = SCREW DIAMETER. MIN. SCREW YIELD STRENGTH Fy = 65 KSI.

3) **PENETRATION OF SCREWS THROUGH JOINED MATERIAL SHOULD NOT BE LESS THAN 3 EXPOSED THREADS**

4) ***USE MINIMUM OF (2) SCREWS (OR GROUPS OF SCREWS IF DOUBLING UP ANCHORS PER NOTE 1 ABOVE) AT GIVEN MAX. O.C. SPACING PER CEILING TRACK SECTION. SCREW MAX. DISTANCE FROM ENDS/SPLICES OF CEILING TRACK = 6".***



Solid Wall Bulkhead Header Section Anchor Details



Glass Wall Bulkhead Header Section Anchor Details

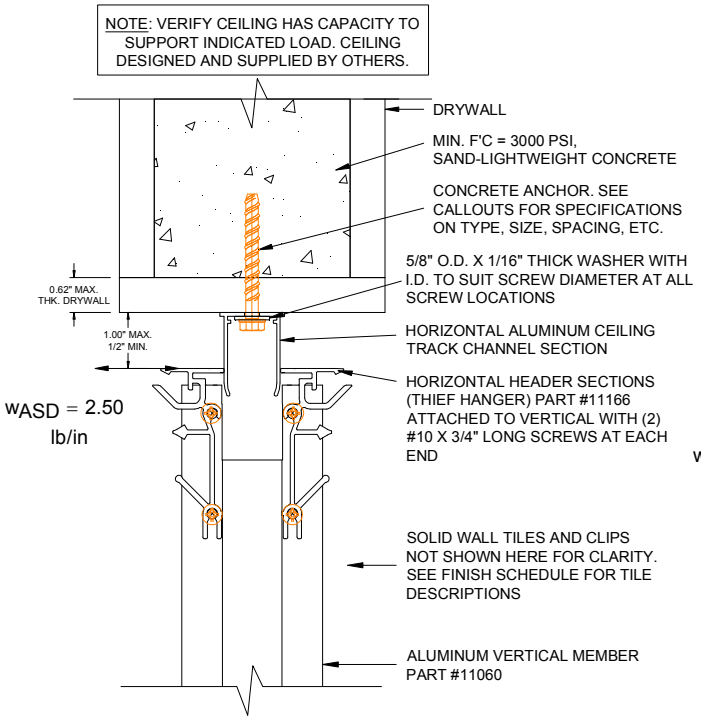
See the Following Table of Screw Max. O.C. Spacing's for Attaching DIRTT Aluminum Ceiling Track to the Bulkhead as Shown.

Assumed f'c = 3000 psi, Sand-Lightweight Concrete Designed and Supplied By Others.

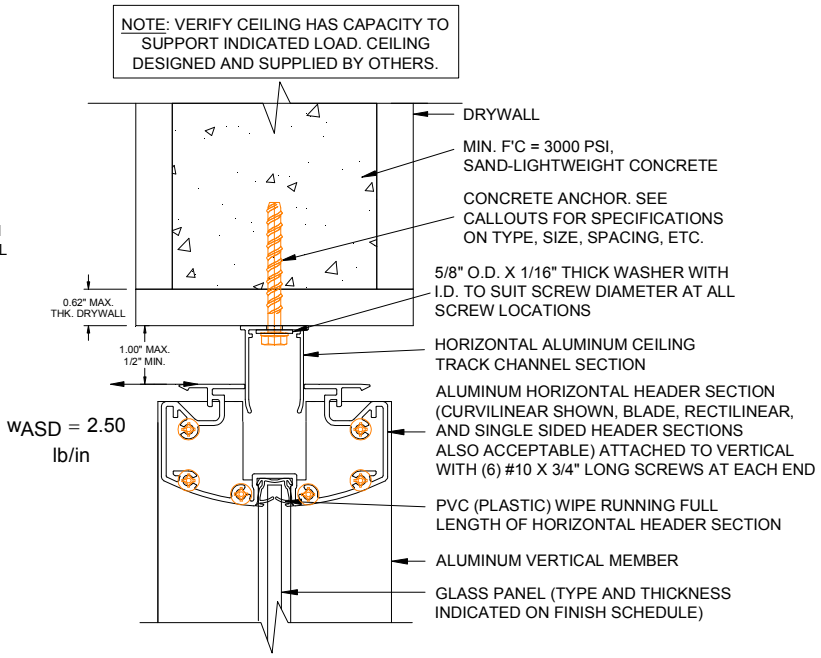
Table D: Concrete Screw O.C. Spacing (inches) Given Wall Height (ft)	
Wall Height (ft)	Anchor Spacing (in)
8	31
9	28
10	25
11	22
12	21

Use 1/4" Diameter Hilti Kwik HUS-EZ (KH-EZ) Anchor to Attach the DIRTT Aluminum Ceiling Track to the Bulkhead as Shown. Use a Minimum of (2) Anchors at Given Maximum O.C. Spacings per Ceiling Track Section. Max. Anchor Distance From Ends/Splices of Ceiling Track = 6". Use Indicated Steel Washer Size per Anchor as Shown.

(Anchors to have Min. Yield Strength Fy = 65 ksi)
f'c = 3000 psi Min. Embedment = 2.5",
Minimum Distance From Edge of Concrete = 5"
Minimum Slab Thickness = 4-1/8"



Solid Wall Bulkhead Header Section Anchor Details



Glass Wall Bulkhead Header Section Anchor Details