Detailed Project Description

We plan to install to install a ground mounted solar array at a private residence location at 30 Flicker Rd. The ground mount is for personnel electric usage for the residence and will only supplement power to that residence.

The ground mount is approximately 45'x 10' W x 17' H. The array will be located 21' North of the planned residence & garage eaves currently under construction. Construction will start in 2026 and will take about 2-3 weeks. The anticipated life expectancy of the solar panels is 25 years. To dispose the solar array, the solar panels, and racking system will be properly recycled through various vendors available but most likely the system will be continuously used by the property owners as long as someone is living there. The system may be revamped as needed in the future. Electrical power does currently exist at the site. There will not be a back-up generator installed or additional noise created from the system.

Valley County Planning and Zoning Department

219 N. Main
PO Box 1350
Cascade, ID 83611
www.co.valley.id.us
cherrick@co.valley.id.us
208-382-7115

Conditional Use Permit Application

TO BE COMPLETED BY THE PLANNING AND ZONING DEPARTMENT ☐ *Check #*_______ *or* ☐ *Cash or* ☒ *Card*

FILE # C.U.P. 25-032 FEE $ 250.00

ACCEPTED BY ____________ DEPOSIT ____________

CROSS REFERENCE FILE(S): ____________ DATE 11-17-2025

PROPOSED USE: Ground-mounted solar array for residential use

When an application has been submitted, it will be reviewed in order to determine compliance with application requirements.
A hearing date will be scheduled only after an application has been accepted as complete or if applicant requests the hearing in writing.

Applicant's Signature: Katrina Spencer **Date:** 11-14-2025

The following must be completed and submitted with the conditional use permit application:

☑ A detailed project description disclosing the purpose, strategy, and time frame of construction. Include a phasing plan if appropriate. Address fire mitigation, utilities, fencing, access, emissions, dust, noise, and outside storage.

☑ A plot plan, drawn to scale, showing the boundaries, dimensions, area of lot, existing and proposed utilities, streets, easements, parking, setbacks, and buildings.

☐ A landscaping plan, drawn to scale, showing elements such as trees, shrubs, ground covers, and vines. Include a plant list indicating the size, quantity, location and name (both botanical and common) of all plant material to be used.

☐ A site grading plan clearly showing the existing site topography and detailing the best management practices for surface water management, siltation, sedimentation, and blowing of dirt and debris caused by grading, excavation, open cuts, side slopes, and other site preparation and development.

☐ A lighting plan.

☑ Names and addresses of property owners within 300 feet of the property lines. Information can be obtained through the GIS Portal at www.co.valley.id.us. Only one copy of this list is required.

☑ Ten (10) copies of the application, project description, plot plan, landscaping plan, grading plan, and impact report are required.

☐ A Development Agreement may be required. Possible road mitigation should be discussed with Dan Coonce, Valley County Engineer (208-382-7195)

We recommend you review the Valley County Code online at www.co.valley.id.us
or at the Planning & Zoning Office at 219 North Main Street, Cascade, Idaho

Subject to Idaho Statute Title 55 Chapter 22 Underground Facilities Damage Prevention.

CONTACT INFORMATION

APPLICANT Katrina Spencer (Magic Valley Electric, LLC) PHONE 208-944-4931

Owner ☐ Purchaser ☐ Lessee ☐ Renter ☐

MAILING ADDRESS 395 Railway Street, Jerome, ID ZIP 83338

EMAIL kwilcox@thesolarteam.com

PROPERTY OWNER Kristen McClellan & Bruce Smith

MAILING ADDRESS 30 Flicker Road, McCall, ID ZIP 83638

EMAIL [redacted]

AGENT / REPRESENTATIVE ____________ PHONE ____________

MAILING ADDRESS ____________ ZIP ____________

EMAIL ____________

CONTACT PERSON (if different from above) ____________

MAILING ADDRESS ____________ ZIP ____________

EMAIL ____________ PHONE ____________

PROPERTY INFORMATION

ADDRESS OF SUBJECT PROPERTY 30 Flicker Road, McCall, ID 83638

PROPERTY DESCRIPTION (either lot, block & subdivision name or attach a recorded deed with a metes and bounds description.)
TAX NO. 19 IN SE4 SW4 S7 T17N R4E 108300 Lakefork Area Subdivisions

TAX PARCEL NUMBER(S) *RP* 17N04E076605

Quarter ______ Section 4 Township 17N Range 4E

1. PROPOSED USE: Residential ☑ Civic or Community ☐ Commercial ☐ Industrial ☐
2. SIZE OF PROPERTY 8.73 Acres ☑ or Square Feet ☐
3. EXISTING LAND USES AND STRUCTURES ON THE PROPERTY ARE AS FOLLOWS:
   Current residence being construction under seperate building permit.
4. ARE THERE ANY KNOWN HAZARDS ON OR NEAR THE PROPERTY (such as canals, hazardous material spills, and/or soil or water contamination)? If so, describe and give location: N/A
5. ADJACENT PROPERTIES HAVE THE FOLLOWING BUILDING TYPES AND/OR USES:
   North Residential
   South Residential (Southwest)
   East N/A
   West N/A

APPLICATION DETAILS

6. MAXIMUM PROPOSED STRUCTURE HEIGHT: 17'-7 3/4"

7. NON-RESIDENTIAL STRUCTURES OR ADDITIONS (If applicable):
   Number of Proposed Structures: ________ Number of Existing Structures: __________

Proposed Gross Square Feet		Existing Gross Square Feet	
1st Floor	_____________	1st Floor	_____________
2nd Floor	_____________	2nd Floor	_____________
Total	_____________	Total	_____________

8a. TYPE OF RESIDENTIAL USE (If applicable): Single family residence ☑ Multiple residences on one parcel ☐

8b. TYPE OF STRUCTURE: Stick-built ☐ Manufacture Home ☐ Mobile Home ☐ Tiny Home ☐ Other ☑ Ground mount Solar Array

8c. SQUARE FOOTAGE OF PROPOSED RESIDENTIAL STRUCTURES (If applicable): _________________

SQUARE FOOTAGE OF EXISTING RESIDENTIAL STRUCTURES: _______________________________

8d. DENSITY OF DWELLING UNITS PER ACRE: N/A

9. SITE DESIGN:
   Percentage of site devoted to building coverage: ________
   Percentage of site devoted to landscaping: ________
   Percentage of site devoted to roads or driveways: ________
   Percentage of site devoted to other uses: ________, describe: ____________________________
   Total: 100%

10. PARKING (If applicable):
   a. Handicapped spaces proposed: N/A
   b. Parking spaces proposed: N/A
   c. Number of compact spaces proposed: N/A
   d. Restricted parking spaces proposed: N/A
   e. Are you proposing off-site parking: N/A

Office Use Only
Handicapped spaces required: ___________
Parking spaces required: ________________
Number of compact spaces allowed: _______

11. SETBACKS:

	BUILDING Proposed	**Office Use Only** Required	PARKING Proposed	**Office Use Only** Required
Front	233			
Rear	632			
Side	128'			
Side Street	249'			

12. NUMBER OF EXISTING ROADS: ___________ Width: ________

   Existing roads will be: Publicly maintained? ☐ Privately Maintained? ☐ or Combination of both? ☐
   Existing road construction: Gravel ☐ Paved ☐ or Combination of both? ☐

13. NUMBER OF PROPOSED ROADS: _____________________ Proposed width: ___________________

   Proposed roads: Publicly maintained? ☐ Privately Maintained? ☐ or Combination of both? ☐
   Proposed road construction: Gravel ☐ Paved ☐ or Combination of both? ☐

14. ARE SHARED DRIVEWAYS PROPOSED? If so, please explain why. Yes ☐ No ☑

15. EXISTING UTILITIES ON THE PROPERTY ARE AS FOLLOWS:
Power, private well & septic

16. PROPOSED UTILITIES: ______
Proposed utility easement widths ______ Locations ______

17. SEWAGE WASTE DISPOSAL METHOD: Septic ☐ Central Sewage Treatment Facility ☐
Name: ______

18. POTABLE WATER SOURCE: Public ☐ Water Association ☐ Individua Well: ☑
If individual, has a test well been drilled? Yes Depth ______ Flow ______ Purity Verified? ______
Nearest adjacent well ______ Depth ______ Flow ______

19. DRAINAGE (Proposed method of on-site retention): ______
Any special drains? ______ (Please attach map)
Soil type(s): ______
(Information can be obtained from the Natural Resource Conservation Service: websoilsurvey.nrcs.usda.gov)
Stormwater Prevention Management Plan will need approval from Valley County Engineer.

20. IS ANY PORTION OF THE PROPERTY LOCATED IN A FLOODWAY OR 100-YR FLOODPLAIN? (Information can be obtained from the Planning & Zoning Office) Yes ☐ No ☑

21. DOES ANY PORTION OF THIS PARCEL HAVE SLOPES IN EXCESS OF 15%? Yes ☑ No ☑

21. ARE THERE WETLANDS LOCATED ON ANY PORTION OF THE PROPERTY? Yes ☐ No ☑

23. IS THERE ANY SITE GRADING OR PREPARATION PROPOSED? Yes ☐ No ☑
If yes, explain:

24a. ARE THERE ANY EXISTING IRRIGATION SYSTEMS? Yes ☐ No ☑
Are you proposing any alterations, improvements, extensions or new construction? Yes ☐ No ☑
If yes, explain: ______

24b. COMPLETE ATTACHED PLAN FOR IRRIGATION if you have water rights and are in an irrigation district. Submit letter from Irrigation District, if applicable.

25. COMPLETE ATTACHED WEED CONTROL AGREEMENT

26. COMPETE ATTACHED IMPACT REPORT

Irrigation Plan

(Idaho Code 31-3805)

This land: ☐ Has water rights available to it
☑ Is dry and has no water rights available to it.

Idaho Code 31-3805 states that when all or part of a subdivision is "located within the boundaries of an existing irrigation district or canal company, ditch association, or like irrigation water deliver entity … **no subdivision plat or amendment to a subdivision plat or any other plat or map recognized by the city or county for the division of land will be accepted, approved, and recorded unless:**"

A. The appropriate water rights and assessment of those water rights have been transferred from said lands or excluded from an irrigation entity by the owner; or

B. The owner filing the subdivision plat or amendment to a subdivision plat or map has provided for the division of land of underground tile or conduit for lots of one acre or less or a suitable system for lots of more than one acre which will deliver water to those landowners within the subdivision who are also within the irrigation entity with the appropriate approvals:

   1. For proposed subdivisions located within an area of city impact, both city and county zoning authorities must approve such irrigation system.

   2. For proposed subdivisions outside of negotiated areas of city impact, the delivery system must be approved by the Planning and Zoning Commission and the Board of County Commissioners with the advice of the irrigation entity charged with the delivery of water to said lands (e.g., irrigation district).

To better understand your irrigation request, we need to ask you a few questions. Additional pages can be added. A list of the map requirements follows the short questionnaire. **Any missing information may result in the delay of your request before the Planning and Zoning Commission and ultimately the approval of your irrigation plan by the Board of County Commissioners as part of final plat approval.**

1. Are you within an area of negotiated City Impact? ______ Yes ______ No

2. What is the name of the irrigation district/company and drainage entities servicing the property?

   Irrigation: ____________________

   Drainage: ____________________

3. How many acres is the property being subdivided? ____________________

4. What percentage of this property has water? ____________________

5. How many inches of water are available to the property? ____________________

6. How is the land currently irrigated? ☐ surface ☐ sprinkler ☐ irrigation well ☐ above ground pipe ☐ underground pipe

7. How is the land to be irrigated after it is subdivided? ☐ surface ☐ sprinkler ☐ irrigation well ☐ above ground pipe ☐ underground pipe

8. Describe how the head gate/pump connects to the canal and irrigated land and where ditches &/or pipes go.

   ____

   ____

9. Is there an irrigation easement(s) on the property? ☐ Yes ☐ No

10. How do you plan to retain storm and excess water on each lot? ________________________________

____

____

11. How do you plan to process this storm water and/or excess irrigation water prior to it entering the established drainage system? (i.e. oil, grease, contaminated aggregates)

____

____

____

Irrigation Plan Map Requirements

The irrigation plan **must be on a scalable map** and show all of the irrigation system including all supply and drainage structures and easements. Please include the following information on your map:

- ☐ All canals, ditches, and laterals with their respective names.
- ☐ Head gate location and/or point of delivery of water to the property by the irrigation entity.
- ☐ Pipe location and sizes, if any
- ☐ Rise locations and types, if any.
- ☐ Easements of all private ditches that supply adjacent properties (i.e. supply ditches and drainage ways).
- ☐ Slope of the property in various locations.
- ☐ Direction of water flow (use short arrows on your map to indicate water flow direction →).
- ☐ Direction of wastewater flow (use long arrows on your map to indicate wastewater direction ⟶).
- ☐ Location of drainage ponds or swales, if any where wastewater will be retained on property
- ☐ Other information: ____

Also, provide the following documentation:

- ☐ Legal description of the property.
- ☐ Proof of ownership.
- ☐ A written response from the irrigation entity and/or proof of agency notification.
- ☐ Copy of any water users' association agreement which shows water schedules and maintenance responsibilities.
- ☐ Copy of all new easements ready for recording (irrigation supply and drainage).
- ☐ If you are in a city area of impact, please include a copy of the approvals by the city planning and zoning commission and city council of your irrigation plan.

======================Applicant Acknowledgement======================

I, the undersigned, agree that prior to the Planning and Zoning Department accepting this application, I am responsible to have all the required information and site plans.

I further acknowledge that the irrigation system, as approved by the Planning and Zoning Commission and ultimately the Board of County Commissioners, must be <u>bonded</u> and/or <u>installed</u> prior to the recording of the plat or building permit.

Signed: ____ Date: ______/______/______

Applicant

VALLEY COUNTY

WEED CONTROL AGREEMENT

It shall be the duty and responsibility of all landowners to control noxious weeds on their land and property, in accordance with Idaho Statute 22-2407.

The purpose of this agreement is to establish a cooperative relationship between Valley County and the undersigned Cooperator to protect the natural and economic values in the Upper Payette River watershed from damages related to the invasion and expansion of infestations of noxious weeds and invasive plants. This is a cooperative effort to prevent, eradicate, contain and control noxious weeds and invasive plants on public and private lands in this area. Factors related to the spread of weeds are not related to ownership nor controllable at agency boundaries. This agreement formalizes the cooperative strategy for management of these weeds addressed in Valley County's Integrated Weed Management Plan.

In this continuing effort to control Noxious Weeds, Valley County Weed Control will consult with the undersigned Cooperator and outline weed identification techniques, present optional control methods and recommend proper land management practices.

The undersigned Cooperator acknowledges that he/she is aware of any potential or real noxious weed problems on his/her private property and agrees to control said weeds in a timely manner using proper land management principles.

Valley County Weed Department can be contacted at 208-382-7199.

By: Katrina Spencer
Applicant

By: *Valley County Weed Supervisor*

Date: 11-14-2025

IMPACT REPORT (from Valley County Code 9-5-3-D)

You may add information to the blanks below or attach additional sheets.

- **An impact report shall be required for all proposed Conditional Uses.**
- **Thoroughly answer all questions. Mark N/A if the question is not applicable to your application.**
- **The impact report shall address potential environmental, economic, and social impacts and how these impacts are to be minimized as follows:**

1. Traffic volume, character, and patterns including adequacy of existing or proposed street width, surfacing, alignment, gradient, and traffic control features or devices, and maintenance. Contrast existing with the changes the proposal will bring during construction and after completion, build-out, or full occupancy of the proposed development. Include pedestrian, bicycle, auto, and truck traffic.

   No additional traffic volume beyond what would be expected from the current construction.

2. Provision for the mitigation of impacts on housing affordability.

   N/A

3. Noise and vibration levels that exist and compare to those that will be added during construction, normal activities, and special activities. Include indoor and outdoor, day and night variations.

   Noise and vibration from excavating gound limited on weekdays Monday through Friday 8 am to 4 pm

4. Heat and glare that exist and that might be introduced from all possible sources such as autos in parking areas, outdoor lights, water or glass surfaces, buildings or outdoor activities.

   N/A , no additional heat or glare concerns will be created from the installation of a small residential ground mount.

5. Particulate emissions to the air including smoke, dust, chemicals, gasses, or fumes, etc., both existing and what may be added by the proposed uses.

   No emmisions are created from the installation of a small residential ground mount.

6. Water demand, discharge, supply source, and disposal method for potable uses, domestic uses, and fire protection. Identify existing surface water drainage, wetlands, flood prone areas and potential changes. Identify existing ground water and surface water quality and potential changes due to this proposal.

   N/A , no water is required for the installation or operation of a small residential ground mount.

7. Fire, explosion, and other hazards existing and proposed. Identify how activities on neighboring property may affect the proposed use.

   Small Ground mounted solar panels for personnel use pose very limited fire risk or hazard.The System has been reviewed and approved by Idaho Power and State DOPL electrical permitting that the proposed plan is following local and national electric code.

8. Removal of existing vegetation or effects thereon including disturbance of wetlands, general stability of soils, slopes, and embankments and the potential for sedimentation of disturbed soils.

   Current site location has already been scrubbed due to the construction of the residence currently underway. The ground mount is located close enough to the planned residence there is no concerns to soil, slopes and other potential for sedimation of distrubed soils.

9. Include practices that will be used to stabilize soils and restore or replace vegetation.

   Current site location has already been scrubbed due to the construction of the residence currently underway. The ground mount is located close enough to the planned residence there is no concerns to soil, slopes and other potential for sedimation of distrubed soils.

10. Soil characteristics and potential problems in regard to slope stability, embankments, building foundation, utility and road construction. Include suitability for supporting proposed landscaping.

    Current site location has already been scrubbed due to the construction of the residence currently underway. The ground mount is located close enough to the planned residence there is no concerns to soil, slopes and other potential for sedimation of distrubed soils.

11. Site grading or improvements including cuts and fills, drainage courses and impoundments, sound and sight buffers, landscaping, fencing, utilities, and open areas.

    Current site location has already been scrubbed due to the construction of the residence currently underway. Minimal amount of fill has been brought into the level the area where the ground mount will be installed.

12. Visibility from public roads, adjoining property, and buildings. Include what will be done to reduce visibility of all parts of the proposal but especially cuts and fills and buildings. Include the impacts of shadows from new features on neighboring property.

    The ground mount will be minimally visible to not visible at all from public roadways. The ground mount will be visible to the neighbors to the north, which are at a higher elevation than the proposed location which will decrease visibility to that neighbor.

13. Reasons for selecting the particular location including topographic, geographic and similar features, historic, adjoining land ownership or use, access to public lands, recreation, utilities, streets, etc., in order to illustrate compatibility with and opportunities presented by existing land uses or character.

    The area was selected due to the proximity to the home as well as the minimal excavation/trenching that would be required by selecting this location.

14. Approximation of increased revenue from change in property tax assessment, new jobs available to local residents, and increased local expenditures.

Value of property has yet to be assesed from new construction of this project and the current residence under construction.

15. Approximation of costs for additional public services, facilities, and other economic impacts.

There should be no additional cost to public services due to the addition of a privatley owned small residential ground mount.

16. State how the proposed development will impact existing developments providing the same or similar products or services.

There should be no impact to existing developments

17. State what natural resources or materials are available at or near the site that will be used in a process to produce a product and the impacts resulting from the depletion of the resource. Describe the process in detail and describe the impacts of each part.

N/A

18. What will be the impacts of a project abandoned at partial completion?

The foundation is a driven pile which requires no concrete, so they foundation posts could easily be removed and soil returned to its original state if project was abandonded.

19. Number of residential dwelling units, other buildings and building sites, and square footage or gross non-residential floor space to be available.

Please see building permit for residence if this information is requried.

20. Stages of development in geographic terms and proposed construction time schedule.

2-3 weeks of proposed construction time schedule

21. Anticipated range of sale, lease or rental prices for dwelling units, building or other site, or non-residential floor space in order to insure compatibility with adjacent land use and development.

N/A

Property Tax Exemption

New and expanding business ***may*** qualify for a property tax exemption for up to 5 years by meeting the qualifications in accordance with Idaho Code§ 63-602NN

Application must be filed with the Valley County Assessor's office before construction begins.

Protocols for qualifying property exemption in Valley County, Idaho:

- Application must be received prior to the start of construction (ex. Building Permits, excavation)
- Term of exemption, not to exceed 5 years, will be up to the discretion of the Valley County Board of Commissioners
- Retail sales business do not qualify
- Multi use may qualify excluding retail sale area
- Housing
    - Multi-family housing must have 5 units or more per structure.
    - Multi-Family housing units may qualify if more than one structure is built totaling 5 or more units
    - For local housing only (workforce)
    - Short term rentals not allowed
    - Units cannot be individually sold (e.g., no condominiums)
- Remodel and/or additions to existing businesses
    - Only the area of remodel/addition may qualify for exemption
    - Retail sales additions/remodel will not qualify

For further information regarding the 63-602NN application process and instructions, please contact the Valley County Assessor's office at 208-382-7126.

EHM Engineers, Inc.
BUILDING THE FUTURE ON A FOUNDATION OF EXCELLENCE

Date: November 3, 2025

To: Magic Valley Electric
Attn: Joey Richardson

From: Brian Martens, P.E.

Re: Smith Solar Foundation

Per your request EHM Engineers has reviewed the feasibility of supporting the approximate 45’ x 16’ solar array panel on (3) 8” schedule 40 steel pipes driven into the existing ground. The solar array is as documented in the attached Magic Valley Electric plans for Bruce Smith in McCall, Idaho. The vertical and horizontal loads the foundation was checked for were taken from the attached Project Details calculations prepared by MTSOLAR.

The solar array may be supported on the (3) pipe driven piles provided the pipe is driven 12’ minimum into existing undisturbed soil with a maximum of 9’ extended above finished grade. Please note this is slightly different from what is shown in the plans. The soil was assumed to be primarily fractured granite as indicated in the well log provided in the proximity of the new solar array. Lateral movement of the pipe at ground level of up to ½” could be expected under high design wind conditions.

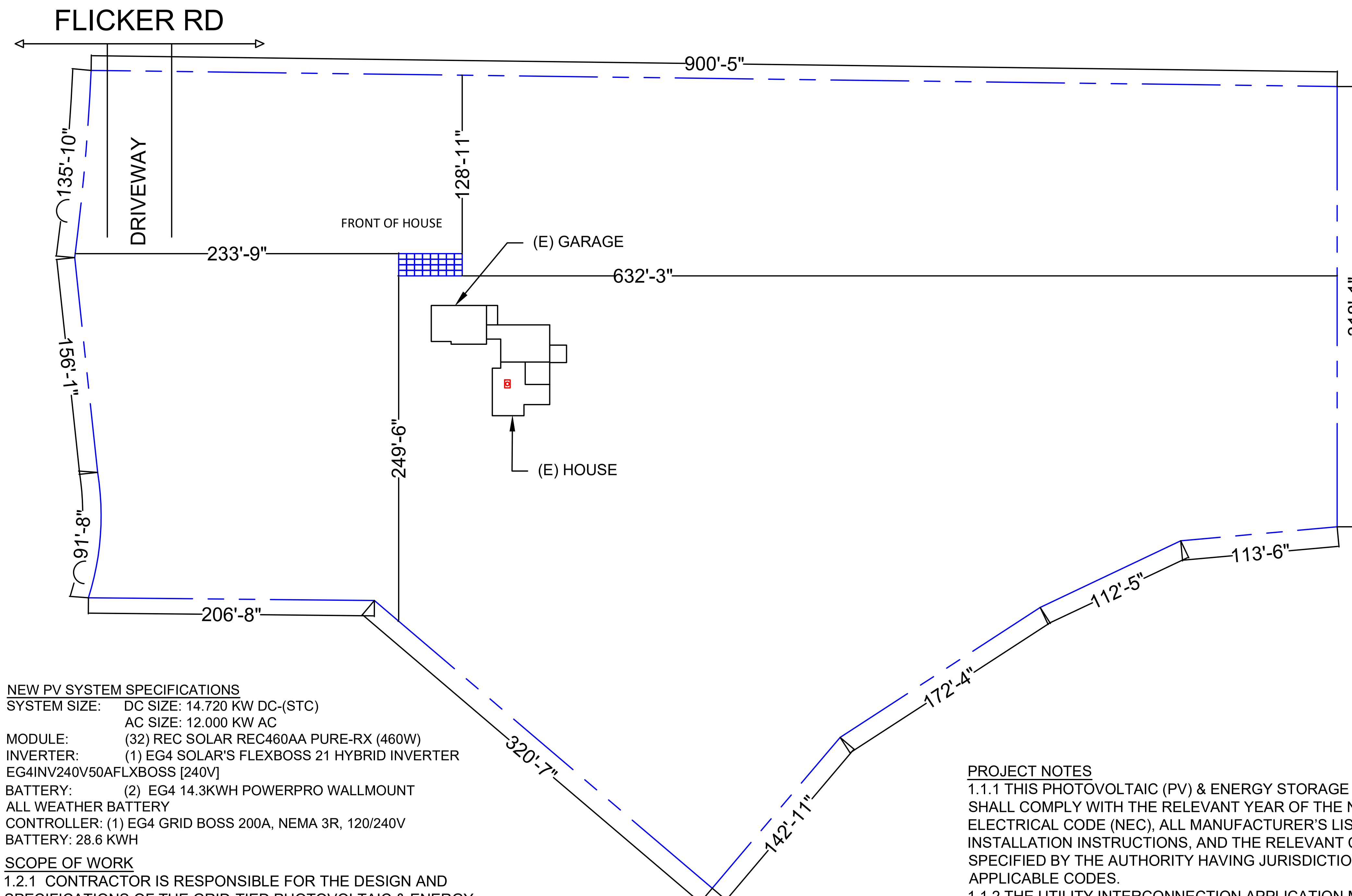
Please let me know if you have any questions or need additional information.

Respectfully,
EHM Engineers

PROFESSIONAL ENGINEER
REGISTERED
7778
11/03/2025
STATE OF IDAHO
BRIAN MARTENS

Brian Martens, P.E.

NEW PHOTOVOLTAIC GROUND MOUNT MOUNTED SYSTEM - 14.720 KW DC/12.000 KW AC
& ENERGY STORAGE SYSTEM - 28.6 KWH
30 FLICKER RD, MCCALL, ID 83638



NEW PV SYSTEM SPECIFICATIONS
SYSTEM SIZE: DC SIZE: 14.720 KW DC-(STC)
AC SIZE: 12.000 KW AC
MODULE: (32) REC SOLAR REC460AA PURE-RX (460W)
INVERTER: (1) EG4 SOLAR'S FLEXBOSS 21 HYBRID INVERTER EG4INV240V50AFLXBOSS [240V]
BATTERY: (2) EG4 14.3KWH POWERPRO WALLMOUNT ALL WEATHER BATTERY
CONTROLLER: (1) EG4 GRID BOSS 200A, NEMA 3R, 120/240V
BATTERY: 28.6 KWH

SCOPE OF WORK
1.2.1 CONTRACTOR IS RESPONSIBLE FOR THE DESIGN AND SPECIFICATIONS OF THE GRID-TIED PHOTOVOLTAIC & ENERGY STORAGE SYSTEM. THE CONTRACTOR WILL BE RESPONSIBLE FOR COLLECTION OF EXISTING ONSITE CONDITIONS TO DESIGN, SPECIFY, AND INSTALL THE GROUND MOUNT-MOUNTED PV SYSTEM AND ENERGY STORAGE SYSTEM DETAILED IN THIS DOCUMENT

N

1 PV-01 PROPERTY PLAN
SCALE:1" = 90'-0"

DESIGN CRITERIA
GROUND SNOW LOAD: 120 PSF
WIND SPEED: 115 MPH
WIND EXPOSURE: B
RISK CATEGORY: II

APPLICABLE CODES
ALL WORK SHALL CONFORM TO THE FOLLOWING CODES:
2018 INTERNATIONAL BUILDING CODE
2020 IDAHO RESIDENTIAL CODE
2018 INTERNATIONAL FIRE CODE
2020 NATIONAL ELECTRICAL CODE
AS ADOPTED BY VALLEY COUNTY

PROJECT NOTES
1.1.1 THIS PHOTOVOLTAIC (PV) & ENERGY STORAGE SYSTEM SHALL COMPLY WITH THE RELEVANT YEAR OF THE NATIONAL ELECTRICAL CODE (NEC), ALL MANUFACTURER'S LISTING AND INSTALLATION INSTRUCTIONS, AND THE RELEVANT CODES AS SPECIFIED BY THE AUTHORITY HAVING JURISDICTION'S (AHJ) APPLICABLE CODES.
1.1.2 THE UTILITY INTERCONNECTION APPLICATION MUST BE APPROVED AND THE PV & ENERGY STORAGE SYSTEM MUST BE INSPECTED PRIOR TO OPERATION
1.1.3 ALL PV & ENERGY STORAGE SYSTEM COMPONENTS; MODULES, UTILITY-INTERACTIVE INVERTERS, BATTERIES, AND SOURCE CIRCUIT COMBINER BOXES ARE IDENTIFIED AND LISTED FOR USE IN PHOTOVOLTAIC SYSTEMS AS REQUIRED BY NEC AND OTHER GOVERNING CODES
1.1.4 ALL SIGNAGE TO BE PLACED IN ACCORDANCE WITH LOCAL BUILDING CODE. IF EXPOSED TO SUNLIGHT, IT SHALL BE UV RESISTANT. ALL PLAQUES AND SIGNAGE WILL BE INSTALLED AS REQUIRED BY THE NEC AND AHJ.

SHEET INDEX

LEGEND

- PROPERTY LINE
- FENCE LINE

VICINITY MAP

SATELLITE MAP

CONTRACTOR

MAGIC VALLEY ELECTRIC
"The Power To Do It Right"

MAGIC VALLEY ELECTRIC, LLC
395 RAILWAY ST
JEROME, IDAHO 83338
PHONE - (208) 735-8990
LIC. NO. - ELE-C-33843
(ELECTRICAL - IDAHO), RCE-35670
(GENERAL CONTRACTOR - IDAHO)

PROJECT NAME & ADDRESS
BRUCE SMITH
30 FLICKER RD,
MCCALL, ID 83638

APN #: 1704076605
AHJ: VALLEY COUNTY
UTILITY: IDAHO POWER

SYSTEM DETAILS
14.720 KW DC-(STC) / 12.000 KW AC
(32) REC SOLAR REC460AA PURE-RX (460W)
(1) EG4 SOLAR'S FLEXBOSS 21 HYBRID INVERTER EG4INV240V50AFLXBOSS [240V]
(2) EG4 14.3KWH POWERPRO WALLMOUNT ALL WEATHER BATTERY
BATTERY: 28.6 KWH

REVISIONS

REV	DESCRIPTION	DATE

SHEET TITLE
COVER PAGE

DRAWN DATE	10/14/2025
DRAWN BY	ONS

SHEET NUMBER
PV-01

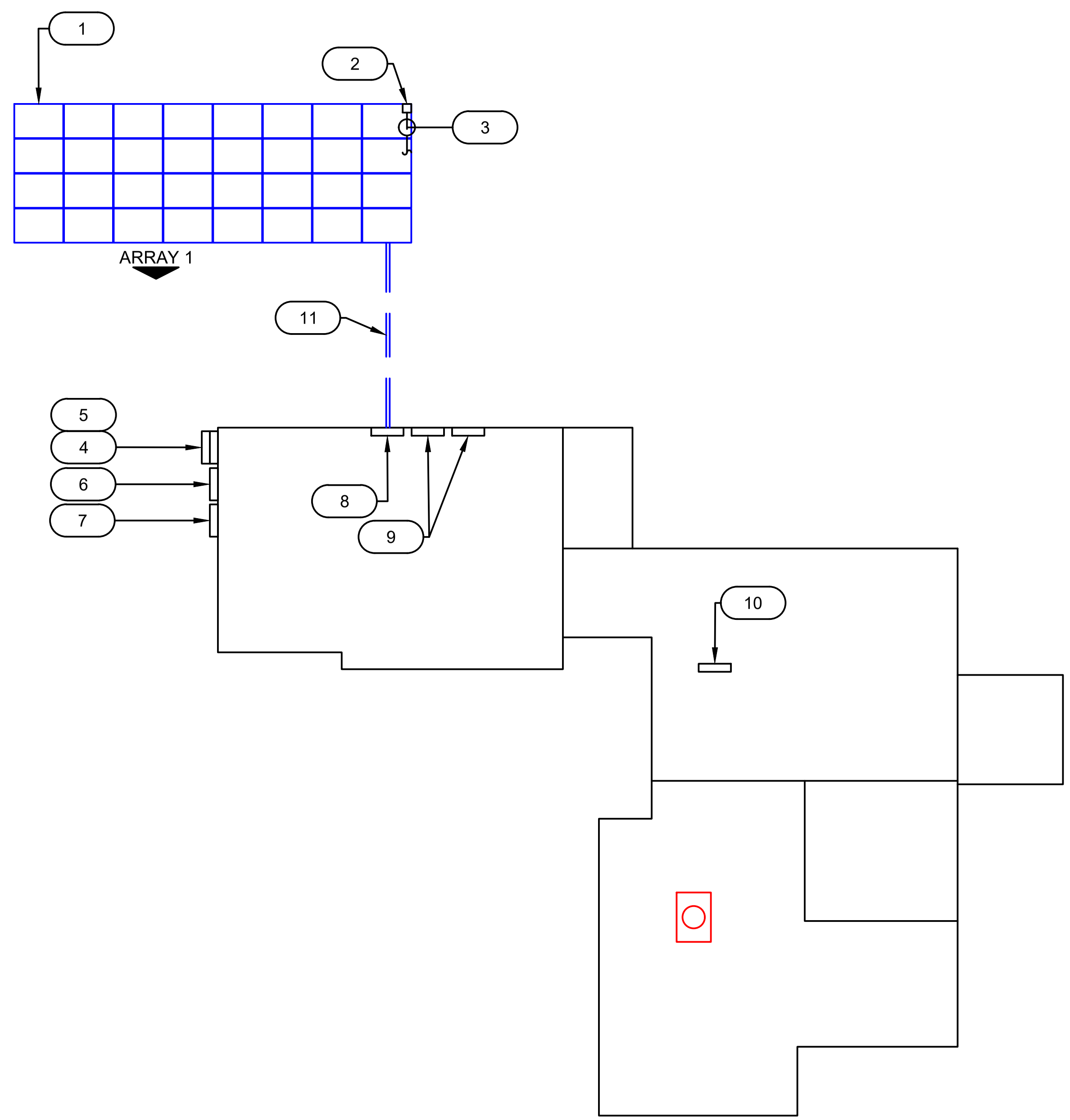
NOTES:

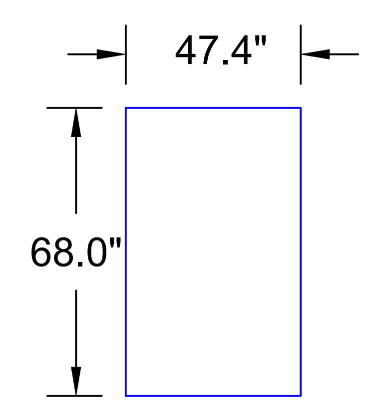
1. STRUCTURES, PATIO COVERS, AND/OR ADDITIONS BUILT WITHOUT PERMITS TO BE RESOLVED BY A SEPARATE PERMIT.

TRENCH NOTES:

1. 18" MINIMUM DEPTH OR BELOW FROST LINE.
2. 24" MINIMUM DEPTH FOR CONDUIT TRENCHED UNDER AREAS SUBJECT TO VEHICLE TRAFFIC.

FRONT OF HOUSE





N

1
PV-02

SITE PLAN

SCALE:1" = 20'-0"

LEGEND

- = MECHANICAL VENT
- = FLUE / PLUMBING VENT

1. (32) REC SOLAR REC460AA PURE-RX (460W) MODULES
2. JUNCTION BOX (NEMA 3R)
3. CONDUIT RUN; SURFACE MOUNTED (ACTUAL CONDUIT RUNS TO BE DETERMINED IN FIELD)
4. (E) UTILITY METER
5. (E) MAIN SERVICE PANEL
6. (N) EG4 GRID BOSS 200A, NEMA 3R, 120/240V
7. (N) AC DISCONNECT
8. (N) EG4 SOLAR'S FLEXBOSS 21 HYBRID INVERTER [240V]
9. (N) EG4 14.3KWH POWERPRO WALLMOUNT ALL WEATHER BATTERY (EG4LL48V100AODWMBV2)
10. (E) SUB SERVICE PANEL
11. (N) TRENCHING APPROX 20FT

GROUND-MOUNT ARRAY(S)

ARRAY 1	
ARRAY SLOPE	- 30°
AZIMUTH	- 180°
MODULE QTY.	- 32

CONTRACTOR

MAGIC VALLEY ELECTRIC "The Power To Do It Right"

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395 RAILWAY ST
JEROME, IDAHO 83338
PHONE - (208) 735-8990
LIC. NO. - ELE-C-33843
(ELECTRICAL - IDAHO), RCE-35670
(GENERAL CONTRACTOR - IDAHO)

PROJECT NAME & ADDRESS

BRUCE SMITH
30 FLICKER RD,
MCCALL, ID 83638

APN #: 1704076605
AHJ: VALLEY COUNTY
UTILITY: IDAHO POWER

SYSTEM DETAILS

14.720 KW DC-(STC) / 12.000 KW AC
(32) REC SOLAR REC460AA PURE-RX (460W)
(1) EG4 SOLAR'S FLEXBOSS 21 HYBRID INVERTER EG4INV240V50AFLXBOSS [240V]
(2) EG4 14.3KWH POWERPRO WALLMOUNT ALL WEATHER BATTERY
BATTERY: 28.6 KWH

REVISIONS

REV	DESCRIPTION	DATE

SHEET TITLE

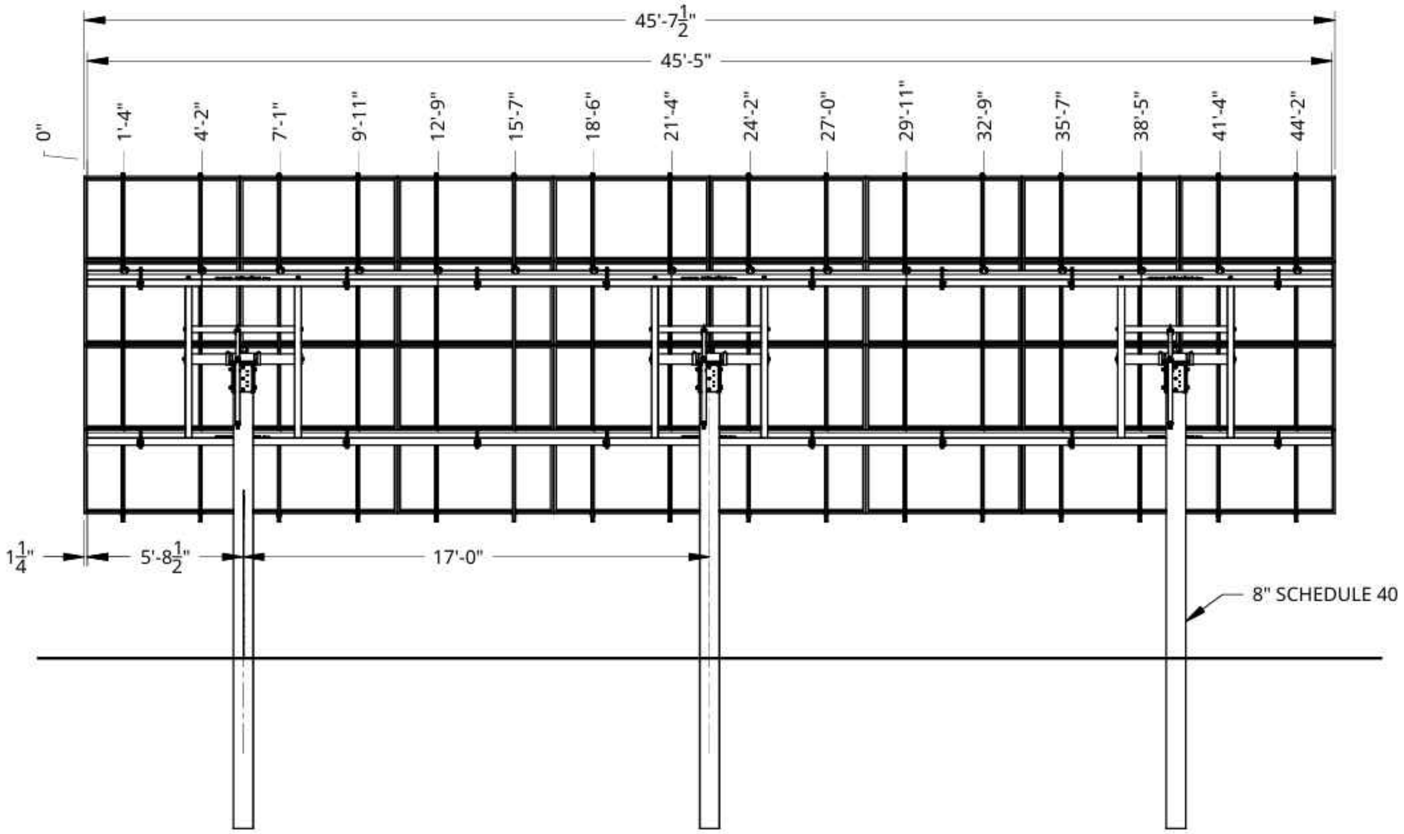
SITE PLAN

DRAWN DATE	10/14/2025
DRAWN BY	ONS

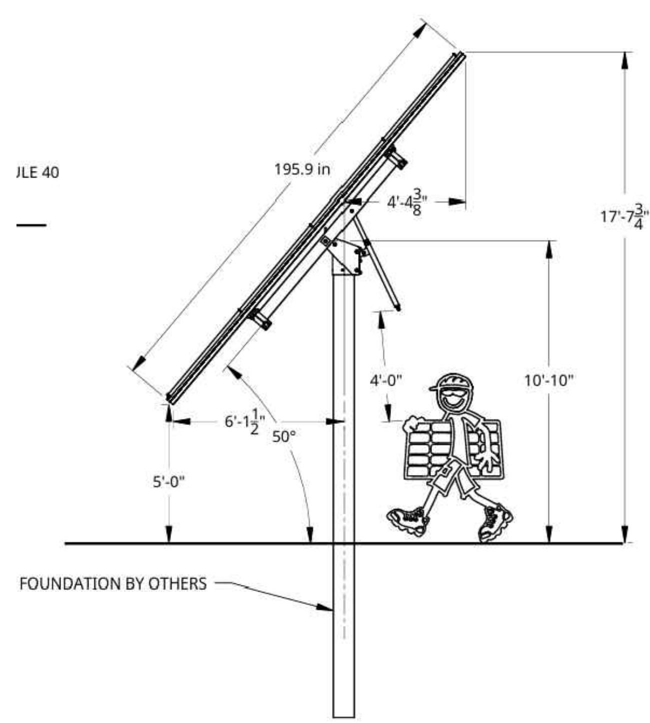
SHEET NUMBER

PV-02

TYPE OF RACKING :- MT SOLAR
ATTACHMENT :- MT SOLAR



1 PV-03 TOP VIEW
Scale: NTS



2 PV-03 SIDE VIEW
Scale: NTS

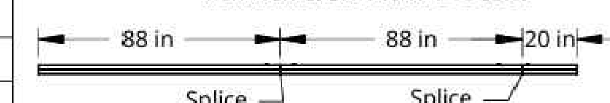
ITEM	QUANTITY	NAME	MASS
1	4	BEAM-SD-WING-24-INCHES	22.3 LB
2	8	BEAM-SD-SPLICE-57-INCHES	52 LB
3	6	BEAM-SD-CENTER-90-INCHES	74.9 LB
4	6	TUBE-5X3-SD-90IN	51.8 LB
5	3	PIPE-2.5IN-SD-45IN	11.9 LB
6	3	PIPE-4IN-SD-45IN	41.9 LB
7	6	LOCK-COLLAR-4	1.2 LB
8	3	POLECAP	42.5 LB
9	3	BACKPLATE-8	15.4 LB
10	3	LIFT-INSERT-8	8.5 LB
11	3	SCREW ADJUSTER	
12	8	BEAM-SPLICE-BOLT-KIT-SD	1.7 LB
13	8	TAMARACK-GROUND-LUG	0.1 LB
14	80	TAMARACK-50/50-CLAMP	0.1 LB
15	32	TAMARACK-RAIL-ADAPTER-WITH-BOLT	0.1 LB
16	16	TAMARACK-3.1-RAIL-CUT-195.9-INCHES	15.2 LB
17	32	BEAM-CLAMP-WITH-BOLTS	1.2 LB
18	3	BOLT-KIT-8-TOP-BEAM	N/A
19	3	PALLET-PACKAGING-MATERIALS	N/A

THIS CONFIGURATION SATISFIES THE REQUIREMENTS SET FORTH IN THE:
- 15TH ED. AISC STEEL DESIGN MANUAL

MATERIALS:
GR 5 BOLTS USED AT ALL CONNECTION LOCATIONS U.N.O
STEEL MATERIALS CONFORM TO THE FOLLOWING
- STEEL PIPE: Fy=50 KSI MIN.
- WIDE FLANGE SECTIONS: ASTM A992, Fy=50 KSI
- RECTANGULAR HSS SECTIONS: ASTM A500, GR C, Fy=50 KSI
- PLATES: ASTM A36 Fy=36 KSI

CONCRETE WORK:
TO BE IN ACCORDANCE WITH ACI 318-14
- CONCRETE SHALL HAVE A MINIMUM COMPRESSIVE STRENGTH OF (F'c) of 2500 PSI

Tamarack Rail Detail



ITEM	QUANTITY	NAME
1	32	TAMARACK-3.1-RAIL-CUT-88-INCHES
2	16	TAMARACK-3.1-RAIL-CUT-20-INCHES
3	32	TAMARACK 3.1 SPLICE
4	64	TAMARACK RAIL NUT
5	64	HEX BOLT 5/16-18 X 1

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(2) EG4 14.3KWH POWERPRO WALLMOUNT ALL WEATHER BATTERY
BATTERY: 28.6 KWH

REVISIONS

REV	DESCRIPTION	DATE

SHEET TITLE
ATTACHMENT PLAN & DETAILS

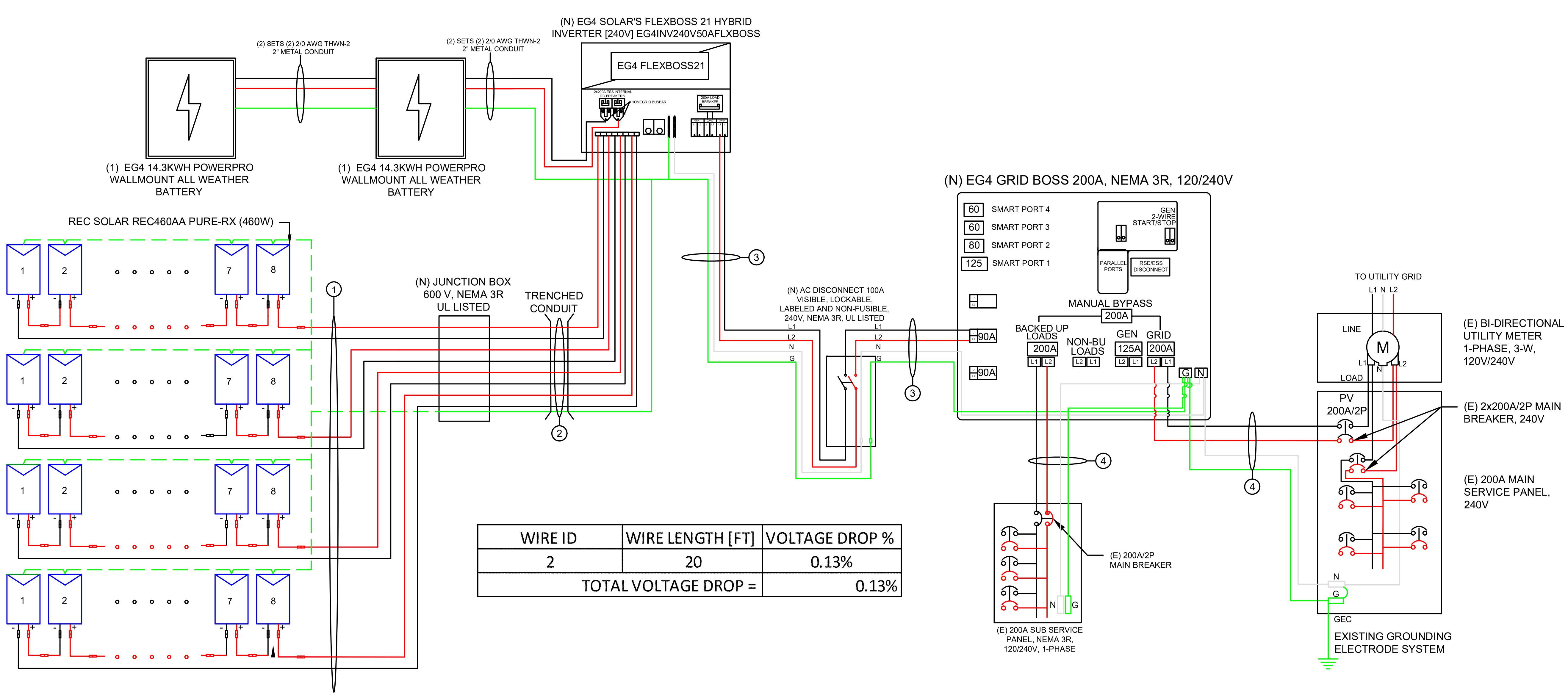
DRAWN DATE	10/14/2025
DRAWN BY	ONS

SHEET NUMBER
PV-03

INVERTER SPECIFICATIONS	
MANUFACTURER / MODEL #	EG4 SOLAR'S FLEXBOSS 21 HYBRID INVERTER [240V]
POWER RATING	12000W
CONT. OUPUT CURRENT	66.7 A
MAX INPUT CURRENT	67 A
MAX DC VOLTAGE	600V

SOLAR MODULE SPECIFICATIONS	
MANUFACTURER / MODEL #	REC SOLAR REC460AA PURE-RX (460W)
VMP	54.9 V
IMP	8.38 A
VOC	65.8 V
ISC	8.88 A
TEMP. COEFF. VOC	-0.24 %/°C

AMBIENT TEMPERATURE SPECIFICATIONS	
RECORD LOW TEMP	-26°C
AMBIENT TEMP (HIGH TEMP 2% AVG.)	29°C
MINIMUM CONDUIT HEIGHT ABOVE ROOF SURFACE	7/8"



WIRE ID	WIRE LENGTH [FT]	VOLTAGE DROP %
2	20	0.13%
	TOTAL VOLTAGE DROP =	0.13%

DESCRIPTION	FORMULA	RESULT
PV + ESS OVERCURRENT PROTECTION NEC 690.9(B)	TOTAL INVERTER + ESS OUTPUT CURRENT x 1.25 = (67.00)A x 1.25	83.38A (SELECTED OCP RATING = 200A)

WIRE ID	EXPECTED WIRE TEMP (°C)	TEMP DERATE (90 °C)	QTY OF CURRENT CARRYING CONDUCTORS	CONDUIT FILL DERATE	MINIMUM CONDUIT SIZE (TBD ON SITE)	WIRE GAUGE & TYPE	CONDUCTOR AMPACITY @ 90°C (A)	CONDUCTOR AMPACITY @ 75°C (A)	REQUIRED CIRCUIT CONDUCTOR AMPACITY (A)	ADJUSTED CONDUCTOR AMPACITY @ 90 °C (A)	NEUTRAL CONDUCTOR SIZE & TYPE	GROUND WIRE SIZE & TYPE
DC WIRE CALCULATION												
1	29	1	8	IN AIR	N/A	#10 AWG PV WIRE	40	35	13.86	40	NONE	#6 AWG BARE Cu
2	29	1	8	0.7	1" PVC	#10 THWN-2	40	35	13.86	28	NONE	#10 THWN-2
AC WIRE CALCULATION												
3	29	1	2	1	1" METAL	#4 THWN-2	95	85	83.38	95	#4 THWN-2	#8 THWN-2
4	29	1	2	1	2" METAL	#3/0 THWN-2	225	200	200	225	#3/0 THWN-2	#6 THWN-2

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BATTERY: 28.6 KWH

REVISIONS

REV	DESCRIPTION	DATE

SHEET TITLE
ELECTRICAL DIAGRAM

DRAWN DATE	10/14/2025
DRAWN BY	ONS

SHEET NUMBER
PV-04

GENERAL NOTES

SITE NOTES

2.1.1 A LADDER WILL BE IN PLACE FOR INSPECTION IN ACCORDANCE WITH OSHA REGULATIONS.
2.1.2 THE PV MODULES ARE CONSIDERED NON-COMBUSTIBLE AND THIS SYSTEM IS A UTILITY INTERACTIVE SYSTEM WITH STORAGE BATTERIES.
2.1.3 THE SOLAR PV INSTALLATION WILL NOT OBSTRUCT ANY PLUMBING, MECHANICAL, OR BUILDING ROOF VENTS.
2.1.4 PROPER ACCESS AND WORKING CLEARANCE AROUND EXISTING AND PROPOSED ELECTRICAL EQUIPMENT WILL BE PROVIDED IN ACCORDANCE WITH SECTION NEC 110.
2.1.5 ROOF COVERINGS SHALL BE DESIGNED, INSTALLED, AND MAINTAINED IN ACCORDANCE WITH THIS CODE AND THE APPROVED MANUFACTURER'S INSTRUCTIONS SUCH THAT THE ROOF COVERING SERVES TO PROTECT THE BUILDING OR STRUCTURE.

EQUIPMENT LOCATIONS

2.2.1 ALL EQUIPMENT SHALL MEET MINIMUM WORKING CLEARANCES IN ACCORDANCE WITH NEC 110.
2.2.2 WIRING SYSTEMS INSTALLED IN DIRECT SUNLIGHT MUST BE RATED FOR EXPECTED OPERATING TEMPERATURE AS SPECIFIED BY 2020 NATIONAL ELECTRICAL CODE.
2.2.3 JUNCTION AND PULL BOXES PERMITTED INSTALLED UNDER PV MODULES IN ACCORDANCE WITH NEC 690.
2.2.4 ALL EQUIPMENT SHALL BE INSTALLED ACCESSIBLE TO QUALIFIED PERSONNEL IN ACCORDANCE WITH NEC APPLICABLE CODES.
2.2.5 ALL COMPONENTS ARE LISTED FOR THEIR PURPOSE AND RATED FOR OUTDOOR USAGE WHEN APPROPRIATE.

STRUCTURAL NOTES

2.3.1 RACKING SYSTEM & PV ARRAY WILL BE INSTALLED IN ACCORDANCE WITH THE CODE-COMPLIANT INSTALLATION MANUAL. TOP CLAMPS REQUIRE A DESIGNATED SPACE BETWEEN MODULES, AND RAILS MUST ALSO EXTEND A MINIMUM DISTANCE BEYOND EITHER EDGE OF THE ARRAY/SUB-ARRAY, IN ACCORDANCE WITH RAIL MANUFACTURER’S INSTALLATION PRACTICES.
2.3.2 JUNCTION BOX WILL BE INSTALLED PER MANUFACTURER'S SPECIFICATIONS. IF ROOF-PENETRATING TYPE, IT SHALL BE FLASHED & SEALED PER LOCAL REQUIREMENTS.
2.3.3 ROOFTOP PENETRATIONS FOR PV RACEWAY WILL BE COMPLETED AND SEALED W/ APPROVED CHEMICAL SEALANT PER CODE BY A LICENSED CONTRACTOR.
2.3.4 ALL PV RELATED ROOF ATTACHMENTS TO BE SPACED NO GREATER THAN THE SPAN DISTANCE SPECIFIED BY THE RACKING MANUFACTURER OR PROFESSIONAL ENGINEERING GUIDANCE.
2.3.5 WHEN POSSIBLE, ALL PV RELATED RACKING ATTACHMENTS WILL BE STAGGERED AMONGST THE ROOF FRAMING MEMBERS.

WIRING & CONDUIT NOTES

2.4.1 ALL CONDUIT AND WIRE WILL BE LISTED AND APPROVED FOR THEIR PURPOSE. CONDUIT AND WIRE SPECIFICATIONS ARE BASED ON MINIMUM CODE REQUIREMENTS AND ARE NOT MEANT TO LIMIT UP-SIZING.
2.4.2 CONDUCTORS SIZED IN ACCORDANCE WITH THE NEC
2.4.3 AC CONDUCTORS TO BE COLORED OR MARKED PER NEC
2.4.4 LISTED OR LABELED EQUIPMENT SHALL BE INSTALLED AND USED IN ACCORDANCE WITH ANY INSTRUCTIONS INCLUDED IN THE LISTING OR LABELING PER NEC

GROUNDING NOTES

2.5.1 GROUNDING SYSTEM COMPONENTS SHALL BE LISTED FOR THEIR PURPOSE, AND GROUNDING DEVICES EXPOSED TO THE ELEMENTS SHALL BE RATED FOR SUCH USE.
2.5.2 PV EQUIPMENT SHALL BE GROUNDED IN ACCORDANCE WITH NEC 690 AND NEC TABLE 250.122.
2.5.3 METAL PARTS OF MODULE FRAMES, MODULE RACKING, AND ENCLOSURES CONSIDERED GROUNDED IN ACCORDANCE WITH NEC 250.
2.5.4 EQUIPMENT GROUNDING CONDUCTORS SHALL BE SIZED IN ACCORDANCE WITH NEC 690 AND INVERTER MANUFACTURER'S INSTALLATION PRACTICES
2.5.5 EACH MODULE WILL BE GROUNDED AS SHOWN IN MANUFACTURER DOCUMENTATION AND APPROVED BY THE AHJ.
2.5.6 THE GROUNDING CONNECTION TO A MODULE SHALL BE ARRANGED SUCH THAT THE REMOVAL OF A MODULE DOES NOT INTERRUPT A GROUNDING CONDUCTOR TO ANOTHER MODULE.
2.5.7 GROUNDING AND BONDING CONDUCTORS, IF INSULATED, SHALL BE COLORED GREEN OR MARKED GREEN IF #4 AWG OR LARGER PER NEC 250.
2.5.8 THE GROUNDING ELECTRODE SYSTEM COMPLIES WITH NEC 690 AND NEC 250. IF EXISTING SYSTEM IS INACCESSIBLE, OR INADEQUATE, A GROUNDING ELECTRODE SYSTEM PROVIDED IN ACCORDANCE WITH NEC 250, NEC 690 AND THE AHJ.
2.5.9 GROUND-FAULT DETECTION SHALL COMPLY WITH NEC 690 TO REDUCE FIRE HAZARDS

DISCONNECTION AND OVERCURRENT PROTECTION NOTES

2.6.1 DISCONNECTING SWITCHES SHALL BE WIRED SUCH THAT WHEN THE SWITCH IS OPENED THE CONDUCTORS REMAINING ENERGIZED ARE CONNECTED TO THE TERMINALS MARKED “LINE SIDE” (TYPICALLY THE UPPER TERMINALS).
2.6.2 DISCONNECTS TO BE ACCESSIBLE TO QUALIFIED UTILITY PERSONNEL, BE LOCKABLE, AND BE A VISIBLE-BREAK SWITCH
2.6.3 PV SYSTEM CIRCUITS INSTALLED ON OR IN HABITABLE BUILDINGS SHALL INCLUDE A RAPID SHUTDOWN FUNCTION TO REDUCE SHOCK HAZARD FOR EMERGENCY RESPONDERS IN ACCORDANCE WITH 690.
2.6.4 ALL OCPD RATINGS AND TYPES SPECIFIED ACCORDING TO NEC 690 AND 240.
2.6.5 INVERTER ON-GRID BRANCHES SHALL BE CONNECTED TO A SINGLE BREAKER OR GROUPED FUSE DISCONNECT(S) IN ACCORDANCE WITH NEC 110.
2.6.6 IF REQUIRED BY THE AHJ, SYSTEM WILL INCLUDE ARC-FAULT CIRCUIT PROTECTION IN ACCORDANCE WITH NEC 690 AND UL1699B.

INTERCONNECTION NOTES

2.7.1 LOAD SIDE INTERCONNECTION SHALL BE IN ACCORDANCE WITH NEC 705.
2.7.2 THE SUM OF THE UTILITY OCPD AND INVERTER CONTINUOUS OUTPUT MAY NOT EXCEED 120 PERCENT OF BUSBAR RATING PER NEC 705.
2.7.3 THE SUM OF 125 PERCENT OF THE POWER SOURCE(S) OUTPUT CIRCUIT CURRENT AND THE RATING OF THE OVERCURRENT DEVICE PROTECTING THE BUSBAR SHALL NOT EXCEED 120 PERCENT OF THE AMPACITY OF THE BUSBAR, PV DEDICATED BACKFEED BREAKERS MUST BE LOCATED OPPOSITE END OF THE BUS FROM THE UTILITY SOURCE OCPD PER NEC 705.
2.7.4 AT MULTIPLE ELECTRIC POWER SOURCES OUTPUT COMBINER PANEL, TOTAL RATING OF ALL OVERCURRENT PROTECTION DEVICES SHALL NOT EXCEED AMPACITY OF BUSBAR. HOWEVER, THE MAIN OVERCURRENT PROTECTION DEVICE MAY BE EXCLUDED IN ACCORDANCE WITH NEC 705.
2.7.5 FEEDER TAP INTERCONNECTION (LOAD SIDE) IN ACCORDANCE WITH NEC 705.
2.7.6 SUPPLY SIDE TAP INTERCONNECTION IN ACCORDANCE WITH TO NEC 705 WITH SERVICE ENTRANCE CONDUCTORS IN ACCORDANCE WITH NEC 230.
2.7.7 BACKFEEDING BREAKER FOR ELECTRIC POWER SOURCES OUTPUT IS EXEMPT FROM ADDITIONAL FASTENING PER NEC 705.

CONTRACTOR

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MCCALL, ID 83638

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AHJ: VALLEY COUNTY
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(2) EG4 14.3KWH POWERPRO WALLMOUNT ALL WEATHER BATTERY
BATTERY: 28.6 KWH

REVISIONS

REV	DESCRIPTION	DATE

SHEET TITLE
NOTES

DRAWN DATE	10/14/2025
DRAWN BY	ONS

SHEET NUMBER
PV-05

⚠WARNING
ELECTRICAL SHOCK HAZARD

TERMINALS ON THE LINE AND LOAD SIDES MAY BE ENERGIZED IN THE OPEN POSITION

LABEL LOCATION: COMBINER PANEL, AC DISCONNECT, POINT OF INTERCONNECTION
PER CODE: NEC 706.15(C)(4), NEC 690.13(B)

⚠WARNING
TURN OFF PHOTOVOLTAIC AC DISCONNECT PRIOR TO WORKING INSIDE PANEL

LABEL LOCATION: COMBINER PANEL(S), MAIN SERVICE DISCONNECT
PER CODE: NEC 110.27(C), OSHA 1910.145(f)(7)

PHOTOVOLTAIC POWER SOURCE

LABEL LOCATION: DC CONDUIT/RACEWAYS
PER CODE: NEC 690.31(D)(2)

SOLAR PV DC CIRCUIT

LABEL LOCATION: DC CONDUIT/RACEWAYS
PER CODE: NEC 690.31(D)(2)

PHOTOVOLTAIC SYSTEM AC DISCONNECT
RATED AC OUTPUT CURRENT: 83.38 A
NOMINAL OPERATING AC VOLTAGE: 240 V

LABEL LOCATION: AC DISCONNECT/POINT OF INTERCONNECTION
PER CODE: NEC 690.54

⚠WARNING DUAL POWER SOURCE
SECOND SOURCE IS PHOTOVOLTAIC SYSTEM

LABEL LOCATION: MAIN SERVICE DISCONNECT, PRODUCTION/NET METER
PER CODE: NEC 690.59, 705.12(C)

PV SYSTEM

DISCONNECT

LABEL LOCATION: AC DISCONNECT
PER CODE: NEC 690.13(B)

⚠WARNING
THIS EQUIPMENT FED BY MULTIPLE SOURCES:
TOTAL RATING OF ALL OVERCURRENT DEVICES EXCLUDING MAIN POWER SUPPLY SHALL NOT EXCEED AMPACITY OF BUSBAR

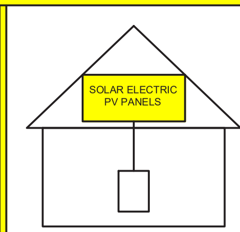
LABEL LOCATION: AC DISCONNECT
PER CODE: NEC 705.12(B)(3)(3)

⚠WARNING
POWER SOURCE OUTPUT CONNECTION. DO NOT RELOCATE THIS OVERCURRENT DEVICE.

LABEL LOCATION: POINT OF INTERCONNECTION
PER CODE: NEC 705.12(B)(3)(2)

SOLAR PV SYSTEM EQUIPPED WITH RAPID SHUTDOWN

TURN RAPID SHUTDOWN SWITCH TO THE "OFF" POSITION TO SHUT DOWN PV SYSTEM AND REDUCE SHOCK HAZARD IN THE ARRAY



LABEL LOCATION: MAIN SERVICE DISCONNECT
PER CODE: NEC 690.56(C)

MAIN PHOTOVOLTAIC SYSTEM DISCONNECT

LABEL LOCATION: MAIN SERVICE DISCONNECT, UTILITY METER
PER CODE: NEC 690.13(B)

RAPID SHUTDOWN SWITCH FOR SOLAR PV SYSTEM

LABEL LOCATION: RSD INITIATION DEVICE, AC DISCONNECT
PER CODE: NEC 690.56(C)(2)

⚠CAUTION
PHOTOVOLTAIC SYSTEM CIRCUIT IS BACKFED

LABEL LOCATION: MAIN SERVICE DISCONNECT
PER CODE: NEC 705.12(D), NEC 690.59

DO NOT DISCONNECT UNDER LOAD

LABEL LOCATION: MAIN SERVICE DISCONNECT
PER CODE: NEC 690.15(B) & NEC 690.33(D)(2)

MAXIMUM DC VOLTAGE

OF PV SYSTEM

LABEL LOCATION: DC DISCONNECT/INVERTER/PV DIST. EQUIPMENT
PER CODE: NEC 690.53

⚠WARNING
ELECTRICAL SHOCK HAZARD

TERMINALS ON BOTH LINE AND LOAD SIDES MAY BE ENERGIZED IN THE OPEN POSITION

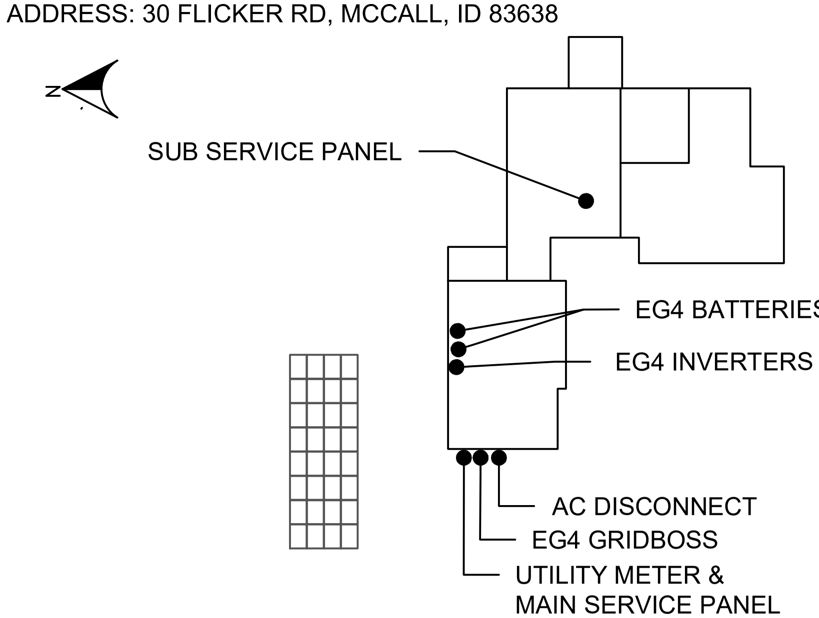
DC VOLTAGE IS ALWAYS PRESENT WHEN SOLAR MODULES ARE EXPOSED TO SUNLIGHT

LABEL LOCATION: DC DISCONNECT
PER CODE: NEC 690.13(B)

⚠WARNING
TRI POWER SOURCES
SECOND SOURCE IS
PHOTOVOLTAIC SYSTEM

CAUTION
MULTIPLE SOURCES OF POWER.
POWER TO THIS BUILDING IS ALSO SUPPLIED FROM THE FOLLOWING SOURCES WITH DISCONNECTS LOCATED AS SHOWN:

ADDRESS: 30 FLICKER RD, MCCALL, ID 83638



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BATTERY: 28.6 KWH

REVISIONS

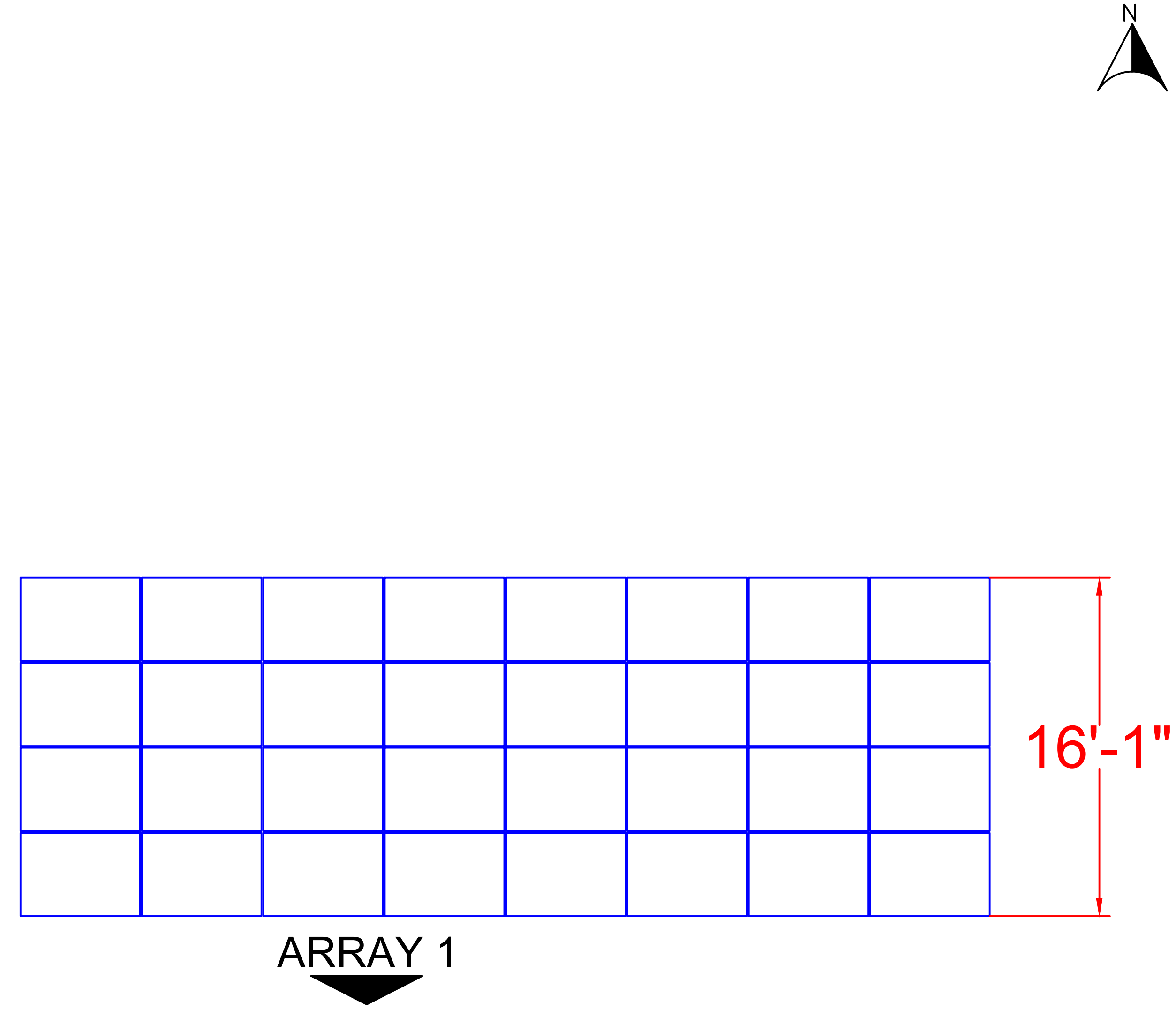
REV	DESCRIPTION	DATE

SHEET TITLE
WARNING LABELS

DRAWN DATE	10/14/2025
DRAWN BY	ONS

SHEET NUMBER
PV-06

	A	B	C	D	E	F
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						



**DIMENSIONS ARE 2D (FLAT)

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REVISIONS

REV	DESCRIPTION	DATE

SHEET TITLE
INSTALLATION RESOURCE

DRAWN DATE	10/14/2025
DRAWN BY	ONS

SHEET NUMBER
PV-07

REC ALPHA® PURE-RX SERIES

DATASHEET

450 - 470W

HETEROJUNCTION TECHNOLOGY

22.6% EFFICIENCY

>92% POWER IN YEAR 25

-0.24%/K TEMPERATURE COEFFICIENT OF P_{MAX}

REC 25 YEAR ProTrust WARRANTY ELIGIBLE

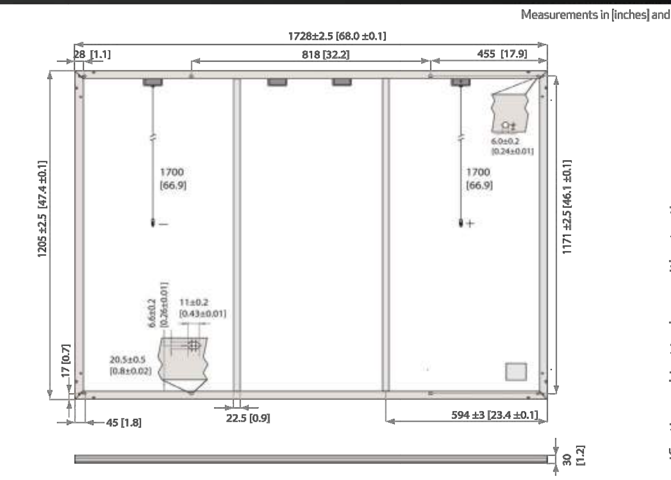
REC ALPHA® PURE-RX SERIES DATASHEET

REC SOLAR'S MOST TRUSTED

GENERAL DATA

Cell Type	88 half-cut bifacial REC heterojunction cells, with gapless technology
Glass	0.13 in solar glass with anti-reflective surface treatment in accordance with EN12150
Backsheet	Highly resistant polymer (Black)
Frame	Anodized aluminum (Black)
Junction Box	4-part, 4 bypass diodes, IP68 rated, in accordance with IEC 62790:2020
Connectors	Stäubli MC4 PV-KBT4/KST4 (12 AWG) in accordance with IEC 62852:2014, IP68 only when connected
Cable	12 AWG solar cable, 66.9 in (1.70 m) + 66.9 in (1.70 m) in accordance with EN50618:2014
Dimensions	68.0 x 47.4 x 1.2 in (22.4 ft²) / 1728 x 1205 x 30 mm (2.08 m²)
Weight	50.0 lb / 22.7 kg
Origin	Made in Singapore

Measurements in [inches] and mm



Specifications subject to change without notice.

ELECTRICAL DATA

	PRODUCT CODE*: RECXXXAA PURE-RX			
STC	Power Output - P_{MAX} (WP)	450	460	470
	Watt Class Sorting - (W)	0/+10	0/+10	0/+10
	Nominal Power Voltage - V_{MPP} (V)	54.3	54.9	55.4
	Nominal Power Current - I_{MPP} (A)	8.29	8.38	8.49
	Open Circuit Voltage - V_{OC} (V)	65.6	65.8	65.9
	Short Circuit Current - I_{SC} (A)	8.81	8.88	8.95
	Power Density (W/ft²)	20.1	20.5	21.0
	Panel Efficiency (%)	21.6	22.1	22.6
NMOT	Power Output - P_{MAX} (W_P)	343	350	358
	Nominal Power Voltage - V_{MPP} (V)	51.2	51.7	52.2
	Nominal Power Current - I_{MPP} (A)	6.70	6.77	6.86
	Open Circuit Voltage - V_{OC} (V)	61.8	62.0	62.1

Values at standard test conditions (STC: air mass AM 1.5, irradiance 1000 W/m², temperature 25°C), based on a production spread with a tolerance of P_{MAX}, V_{OC} & I_{SC} ±3% within one watt class. Nominal module operating temperature (NMOT: air mass AM 1.5, irradiance 800 W/m², temperature 20°C, windspeed 1 m/s). *Where xxx indicates the nominal power class (P_{MAX}) at STC above.

CERTIFICATIONS

ISO 14001; ISO9001; IEC45001; IEC62941	
IEC 61215:2021; IEC 61730:2023; UL 61730	
ISO 11925-2	Ignitability (EN 13501-1 Class E)
IEC 62716	Ammonia Resistance
IEC 61701	Salt Mist (SM6)
IEC 61215:2016	Hailstone (35mm)
UL 61730	Fire Type 2

Intertek

MODULE RATINGS

Module Operating Temperature [T98]§	158°F (70°C)
Min. Environmental Temperature	-40°F (-40°C)
System Voltage	1000 V
Maximum Test Load (4 Point Mounting, Front)*	+7000 Pa (1.02 lbs/in²)
Maximum Test Load (4 Point Mounting, Rear)*	-4000 Pa (0.58 lbs/in²)
Maximum Test Load (6 Point Mounting, Front)**	+8000 Pa (1.16 lbs/in²)
Maximum Test Load (6 Point Mounting, Rear)**	-6000 Pa (0.87 lbs/in²)
Max Series Fuse Rating	25 A
Max Reverse Current	25 A

Design load = Test load / 1.5 (safety factor)
§ 98th percentile operating temperature
* IEC61730/UL61730 certified. Refer to installation manual.
** Internal testing. Refer to installation manual.

TEMPERATURE RATINGS*

Nominal Module Operating Temperature	44 ± 2°C
Temperature coefficient of P_{MAX}	-0.24%/K
Temperature coefficient of V_{OC}	-0.24%/K
Temperature coefficient of I_{SC}	0.04%/K

*The temperature coefficients stated are linear values

DELIVERY INFORMATION

Panels per Pallet	33
Panels per 40 ft GP/high cube container	594 (18 Pallets)
Panels per 53 ft truck	792 (24 Pallets)

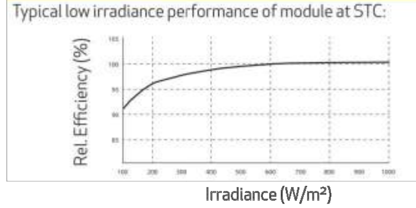
WARRANTY

	Standard	REC ProTrust	
Installed by an REC Certified Professional	No	Yes	Yes
System Size	All	<25 kW	25-500 kW
Product Warranty (yrs)	20	25	25
Power Warranty (yrs)	25	25	25
Labor Warranty (yrs)	0	25	10
Power in Year 1	98%	98%	98%
Annual Degradation	0.25%	0.25%	0.25%
Power in Year 25	92%	92%	92%

REC ProTrust Warranty applies only for i) REC panels installed by an REC Certified Solar Professional, and ii) panels have been registered by the installer with REC. Subject to System Size and further conditions. See www.recgroup.com for details.

LOW LIGHT BEHAVIOR

Typical low irradiance performance of module at STC:



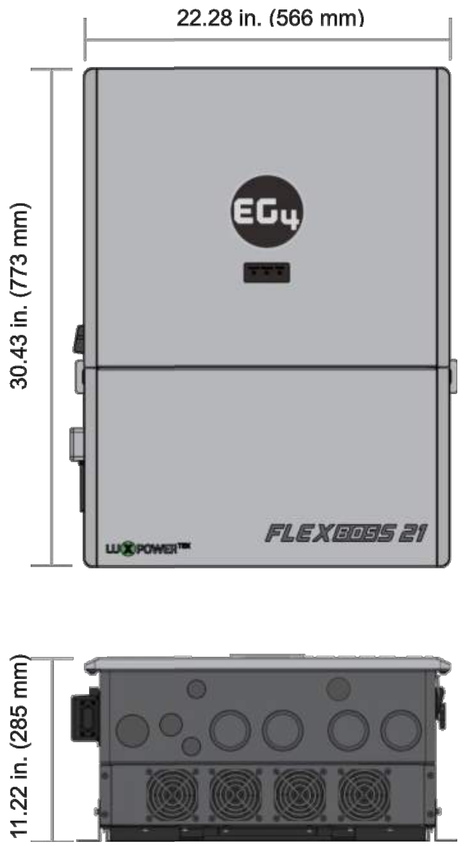
Available from:

Founded in 1996, REC Group is an international pioneering solar energy company dedicated to empowering consumers with clean, affordable solar power. As Solar's Most Trusted, REC is committed to high quality, innovation, and a low carbon footprint in the solar materials and solar panels it manufactures. Headquartered in Norway with operational headquarters in Singapore, REC also has regional hubs in North America, Europe, and Asia-Pacific.

REC Solar PTE. LTD.
20 Tuas South Ave. 14
Singapore 637312
post@recgroup.com
www.recgroup.com

REC

REF: PM-DS-12-06-REV-4.3/BUL EN 12.2024



EG4® FLEXBOSS21 HYBRID INVERTER

The EG4 FlexBOSS21 is a versatile 48V split-phase, hybrid inverter/charger that offers the same dependable power as the 18kPV with enhanced flexibility. Powerful enough to start a 5-ton AC unit, the FlexBOSS21 supports up to 21kW of PV input. Capable of paralleling up to 16 units together, the FlexBOSS21 has an impressive total output of 256kW. Able to provide 16kW of continuous output power with PV & battery, and up to 12kW continuous output by using battery alone. Three individual MPPTs give users optimal control over their solar needs, while the updated EG4 monitoring software allows for convenient total remote management, complete with mobile notifications and remote setting. Seamless interaction with the EG4 GridBOSS gives users control over the entire Energy Storage System (ESS).

HIGH FREQUENCY SPLIT-PHASE DESIGN

*10-YEAR WARRANTY

REMOTE ADJUSTMENT VIA EG4 SOFTWARE

ALL-IN-ONE HYBRID INVERTER

Capable of running entirely off grid, using grid electricity, and selling power back to the grid.

UP TO 600VDC INPUT

The extra high voltage enables lower cable sizing for the 3 MPPTs and a maximum recommended PV input of 21kW, eliminating the need for a combiner box.

PLUG-IN WI-FI DEVICE

Enables wireless connection between our monitoring platform and the FlexBOSS21 through the EG4® app or EG4 Monitor system for remote system management.

CLOSED-LOOP COMMUNICATIONS

Able to communicate with EG4 48V batteries and other battery brands. A battery firmware update is required for closed-loop communications with LifePower4 batteries.

RAPID SHUTDOWN

The FlexBOSS21 is CSA C22.2#330:2017 and NEC 690.12 ready with its built-in RSD capabilities.

VERSION 1.2.6 | INFORMATION SUBJECT TO CHANGE WITHOUT NOTICE.
MODEL#: IV-16000-HYB-AW-FX-**XX** (**XX** is a number between 00-99)

*For information regarding warranty registration on EG4® Electronics products, please navigate to https://eg4electronics.com/warranty/ and select the corresponding product to begin the registration process.

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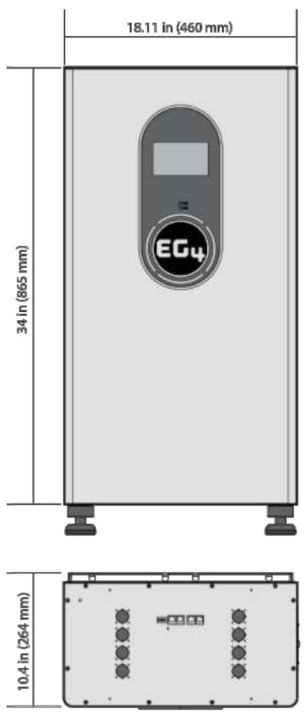
EG4 ELECTRONICS

TECHNICAL SPECIFICATIONS

INVERTER	
MODEL	IV-16000-HYB-AW-FX-XX
CEC MODEL #	IV-16000-HYB-AW-FX-XX {240V} | IV-16000-HYB-AW-FX-XX {208V}
TYPE	Hybrid
DESIGN TOPOLOGY	High Frequency – Transformerless
AC SYSTEM	
NOMINAL VOLTAGE	120/240 or 208 VAC
FREQUENCY	50/60Hz
PHASE SUPPORT	1ø
AC OUT	
NOMINAL OUTPUT VOLTAGE	120/240 VAC; 120/208 VAC (L1/L2/N required)
MAX. CONTINUOUS OUTPUT	66.7A | 16kW
MAX. CONTINUOUS OUTPUT – BATTERY ONLY	50A | 6kW
MAX. CONTINUOUS OUTPUT – WITH PV & GRID @25C	66.7A | 16kW
PEAK POWER	24000W (.5 sec) | 18000W (1 sec) | 15000W (6 min) | 13200W (12 min)
LOCKED ROTOR AMPS (LRA)	195A
MAX. CONTINUOUS OUTPUT PER-LEG	50A | 6kW
POWER FACTOR	.99 @ Full Load
MAX. PASS-THRU CURRENT FROM GRID	90A
REACTIVE POWER ADJUST RANGE	+0.8/-0.8
THD V	<5%
MAX. APPARENT POWER WITH BATTERY	12kVA
MAX. APPARENT POWER WITH PV & GRID	16kVA
AC IN	
NOMINAL GRID VOLTAGE	120/240 VAC | 120/208 VAC (L1/L2/N required)
MAX. GRID INPUT POWER TO INVERTER (W/ OUT PASS-THRU)	50A | 12kW
MAX. GRID CIRCUIT RATING (W/ PASS-THRU)	90A
MAX. INPUT SHORT CIRCUIT CURRENT RATING	10kA
BATTERY	
NOMINAL VOLTAGE	51.2 VDC
OPERATING VOLTAGE RANGE	40 – 60 VDC
MAX. CHARGE CURRENT (DC AMPS)	250 ADC
MAX. DISCHARGE CURRENT (DC AMPS)	250 ADC
BATTERY CHARGE/DISCHARGE RIPPLE CURRENT	<5%
COMPATIBLE BATTERIES	See www.eg4electronics.com
RECOMMENDED MIN. CAPACITY PER INVERTER	600Ah



EG4® WALLMOUNT INDOOR 280Ah LITHIUM BATTERY

The WallMount Indoor 280Ah batteries are ideal for low-voltage residential indoor energy storage applications. The batteries use lithium iron phosphate cells with the highest safety performance and an intelligent Battery Management System (BMS) that can monitor and record the voltage of each cell along with the current, voltage, and temperature of the module in real-time. The BMS also contains a passive balance function and an advanced battery control method, both of which improve the performance of the battery pack.

BUILT-IN 200A BMS | INTEGRATED 600A BUSBARS | 82.6MWh LIFETIME PRODUCTION* | *10 YEAR WARRANTY >8000 CYCLES @ 80% DOD

ON-BOARD LCD TOUCH SCREEN
Easy to see BMS monitoring, and selectable closed-loop communications with EG4, Schneider, Sol-Ark, Victron, Growatt, Megarevo, Luxpower, and Deye inverters.

DUAL ON-BOARD FIRE ARRESTORS
Offer fail-safe protection against thermal runaway.

INTEGRATED SELF-HEATING FEATURE
Internal heating keeps cells operating during cold temperatures.

INTEGRATED BUSBARS
The battery design comes manufactured with 600A internal busbars with multiple terminals (4 positive & 4 negative) eliminating the need for external busbars when paralleling batteries and/or multiple inverters.

INNOVATIVE EMERGENCY STOP FUNCTION
The optional ESS disconnect can shut down all batteries and inverters (if equipped with rapid shut down capability) with the press of a button.

THE PERFECT PARTNER TO EG4 INVERTERS
The optional conduit box mates up directly to the connection ports of EG4 inverters allowing a sleek and efficient installation. For other inverters or stand-alone battery installation, the conduit box plugs should be installed.

VERSION 1.1.7 | INFORMATION SUBJECT TO CHANGE WITHOUT NOTICE.
MODEL #: WM-48|280-LL-00 / WM-48-280-1-IN-LL-00

*For information regarding warranty registration on EG4® Electronics products, please navigate to https://eg4electronics.com/warranty/ and select the corresponding product to begin the registration process.

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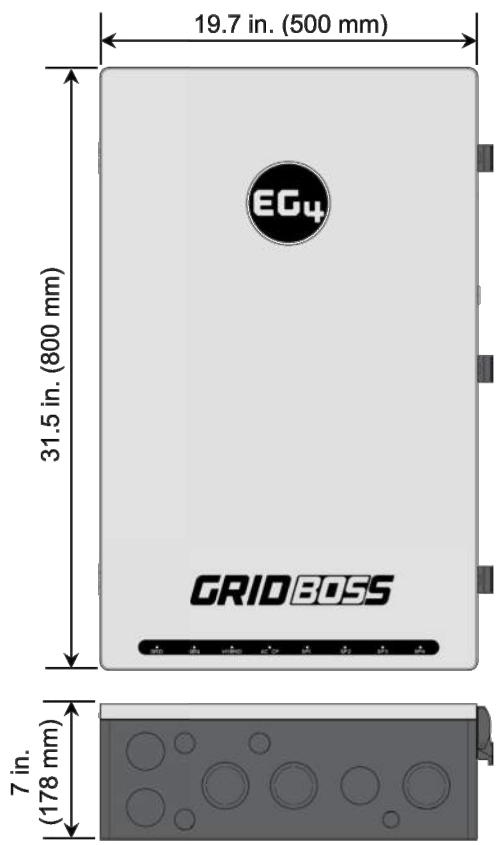
EG4 ELECTRONICS

TECHNICAL SPECIFICATIONS

MODULE OPERATING PARAMETERS			
PARAMETER	BMS		RECOMMENDED SETTING
TOTAL ENERGY CAPACITY	14.3kWh @25C, 100% SOC		-
VOLTAGE	51.2V		-
CAPACITY	280Ah		-
CHARGING VOLTAGE (BULK/ABSORB)	56.0V (+/-0.8V)		56.2V (+/-0.2V)
FLOAT	-		54V (+/-0.2V)
SOC CUTOFF	-		20%*
CHARGING CURRENT	140A (Max. continuous)		60 – 140A
DISCHARGING CURRENT	140A (Max. continuous) 200A (Max. continuous for 30 min)		60 – 140A
BMS PARAMETERS			
CHARGE	SPEC	DELAY	RECOVERY
CELL VOLTAGE PROTECTION	3.8V	1 sec	3.45V
MODULE VOLTAGE PROTECTION	60.0V	1 sec	55.2V
OVER CHARGING CURRENT 1	>205A	10 sec	-
OVER CHARGING CURRENT 2	>225A	3 sec	-
TEMPERATURE PROTECTION	<23°F or >158°F <-5°C or >70°C	1 sec	>32°F or <140°F >0°C or <60°C
DISCHARGE	SPEC	DELAY	RECOVERY
CELL VOLTAGE PROTECTION	2.3V	1 sec	3.1V
MODULE VOLTAGE PROTECTION	44.8V	1 sec	48V
OVER-CHARGING CURRENT 1	>205A	10 sec	60 sec
OVER-CHARGING CURRENT 2	>300A	3 sec	60 sec
SHORT CIRCUIT	>600A	<0.1 mS	-
TEMPERATURE PROTECTION	<-4°F or >167°F <-20°C or >75°C	1 sec	>14°F or <149°F >-10°C or <65°C
PCB TEMP PROTECTION	>230°F (>110°C)	1 sec	@ <176°F (<80°C)
GENERAL SPECIFICATIONS			
PARAMETER	SPEC		CONDITION
CELL BALANCE	120mA	Passive Balance	Cell Voltage Difference >40mV
TEMPERATURE ACCURACY	3%	Cycle Measurement	Measuring Range -40°F to ≈212°F (-40°C to ≈100°C)
VOLTAGE ACCURACY	0.5%	Cycle Measurement	For Cells & Module
CURRENT ACCURACY	3%	Cycle Measurement	Measuring Range -200A - 200A
SOC	5%	-	Integral Calculation
POWER CONSUMPTION	Sleep & Off Mode	<300uA	Storage/Transport/Standby
POWER CONSUMPTION	Operating Mode	<25mA	Charging/Discharging
COMMUNICATION PORTS	RS485/CAN		Can be customized
BATTERY HEATER SPECIFICATIONS			
PARAMETER	SPEC		CONDITION
VOLTAGE	56V		-
POWER CONSUMPTION	224W		-
INTERNAL BATTERY TEMPERATURE	≤32°F (0°C)/≥41°F (5°C)		Heat On/Heat Off

*EG4 recommends this value be set no lower than 20% to maintain the recommended 80% depth of discharge.



EG4® GRID BOSS

MICRO-GRID INTERCONNECTION DEVICE (MID)

The EG4 GridBOSS Micro-Grid Interconnection Device (MID) simplifies Energy Storage Systems (ESS) by consolidating multiple components into a single, innovative unit. It replaces traditional elements such as the point of common connection, back-fed breakers, feeder taps, tap breakers, supply-side taps, transfer switches, and dedicated combiner panels for grid-in, grid-out, and generator input. As a versatile solution, the GridBOSS serves as the service entrance equipment* when paired with the utility meter, providing a single point of connection for utilities, hybrid inverters, generators, smart loads, and AC-coupled inverters.

200A SERVICE ENTRANCE*

4 CONFIGURABLE SMART PORTS

INTEGRATED GENERATOR SUPPORT

CENTRALIZED ESS CONTROL

Provides a single point of connection for utility, hybrid inverters, generators, smart loads, and AC-coupled inverters.

REDUCED ESS COMPLEXITY

Replaces up to 10 components with one unit, including point of common connection, back-fed breakers, feeder taps, feeder tap breakers, supply side taps & breakers, transfer switches, and dedicated combiner panels for grid-in, load/EPS, and generator input.

SERVICE ENTRANCE RATED

200 Amp service entrance with a 22 kAIC main breaker, acts as service entrance equipment in conjunction with a utility meter and a 200A Eaton breaker CSR2200N (CSR25K).

REMOTE MONITORING

Enable remote monitoring, configuration, and firmware updates through the EG4 mobile app or online monitoring system.

SMART PORTS

Includes load shedding, which disconnects loads during low battery voltage and reconnects on high voltage. Power shedding connects loads when at full SOC and PV flow and disconnects on low SOC or PV loss.

*When used with an Eaton 200A main breaker (model CSR2200N), US only.

MODEL #: MI-200-2P-HYB-AW-01 / MI-200-2P-HYB-AW-02 / MI-200-2P-HYB-AW-03

EG4 ELECTRONICS

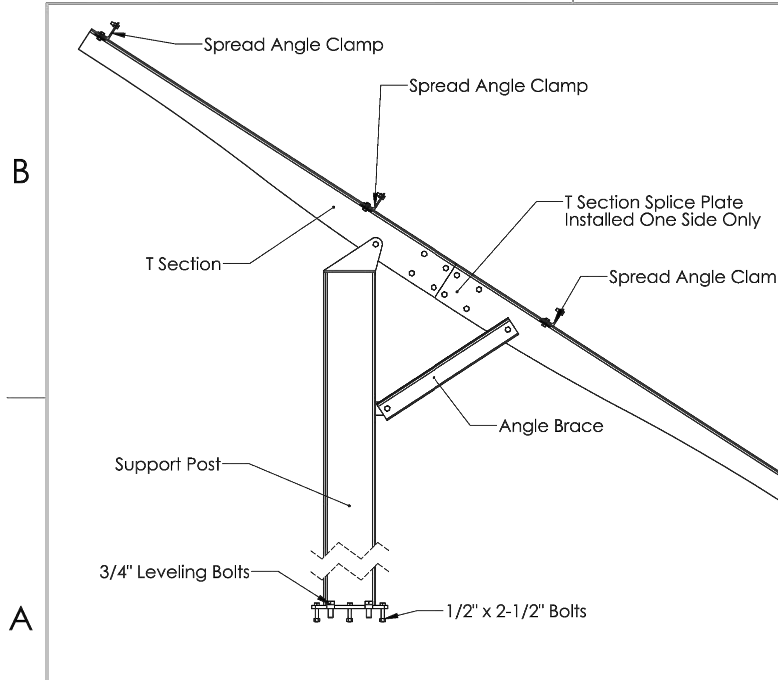
TECHNICAL SPECIFICATIONS

GRID	
NOMINAL AC VOLTAGE	120/240 VAC (L1/L2/N required)
FREQUENCY	60 Hz
MAXIMUM CURRENT	200A
SERVICE ENTRANCE RATED	22kAIC with 200A Eaton CSR2200N (CSR25K) breaker*
GENERATOR	
NOMINAL VOLTAGE	120/240 VAC (L1/L2/N required)
FREQUENCY	60 Hz
MAXIMUM CURRENT	125A
NON-BACKUP	
NOMINAL VOLTAGE	120/240 VAC (L1/L2/N required)
FREQUENCY	60 Hz
MAXIMUM CURRENT	200A
BACKUP	
NOMINAL VOLTAGE	120/240 VAC (L1/L2/N required)
FREQUENCY	60 Hz
MAXIMUM CURRENT	200A
HYBRID	
NUMBER OF PORTS	3
NOMINAL VOLTAGE	120/240 VAC (L1/L2/N required)
FREQUENCY	60 Hz
MAXIMUM CURRENT PER PORT	90A**
SUPPORTED INVERTERS	EG4® 12kPV, 18kPV, FlexBOSS18, FlexBOSS21***
SMART PORTS	
NUMBER OF PORTS	4
NOMINAL VOLTAGE	120/240 VAC (L1/L2/N required)
FREQUENCY	60 Hz
MAXIMUM CURRENT PER PORT	1: 125A | 2: 80A | 3: 60A | 4: 60A
GENERAL DATA	
COMMUNICATION INTERFACE	RS485/Wi-Fi/CAN
IDLE CONSUMPTION	~55W
TRANSFER TIME	~25 ms
INTERNAL BUS RATING	350A (software limited to 200A)
INTERNAL FUSE RATING	315A
OPERATING ALTITUDE	<6561 ft (<2000 m)
RELATIVE HUMIDITY	0 – 100%
OUTDOOR RATING	NEMA 3R
OPERATING AMBIENT TEMPERATURE RANGE	-40°F – 113°F (-40°C – 45°C)
PRODUCT DIMENSIONS (H×W×D)	31.5×19.7×7 in (800×500×178 mm)
UNIT WEIGHT	55 lbs. (25 kg)
STANDARD WARRANTY	10-year standard warranty****

*US only.
**Install a properly sized breaker for the attached inverter: 50A - 12kPV | 70A - 18kPV, FlexBOSS18 | 90A -FlexBOSS21.
***Third-party inverters are not supported and cannot be connected to the hybrid ports.
****For information regarding warranty registration on EG4® Electronics products, please navigate to https://eg4electronics.com/warranty/ and select the corresponding product to begin the registration process.

MTS GROUND MOUNT

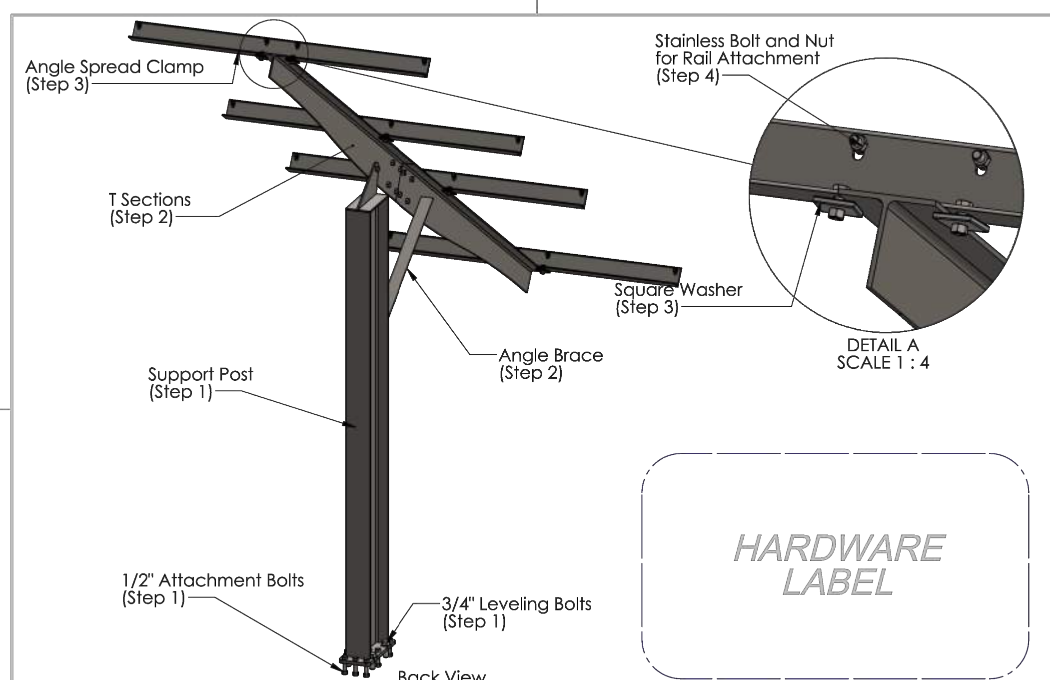
www.mtsolar.us 844-687-6527 sales@mtsolar.us



ITEM NO.	PART NUMBER	QTY.
1	Driven Pile	1
2	Support Post	1
3	T Section	2
4	Splice Plate	1
5	Angle Brace	1
6	Spread Angle Clamp	4
7	HBOLT 0.7500-10x2x1.75-N	4
8	HBOLT 0.5000-13x2.5x1.25-N	8
9	HNUT 0.5000-13-D-N	19
10	HBOLT 0.5000-13x1.25x1.25-N	11
11	HBOLT 0.3750-16x1x1-N	24
12	HNUT 0.3750-16-D-N	24
13	Square Washer	8

	NAME	DATE
DRAWN		
CHECKED		
ENG APPR.		
MFG APPR.		

TITLE:
SIZE A DWG. NO. Ground Mount Install Diagram REV
SCALE: 1:16 SHEET 1 OF 2



	NAME	DATE
DRAWN		
CHECKED		
ENG APPR.		
MFG APPR.		

TITLE:
SIZE A DWG. NO. Ground Mount Install Diagram REV
SCALE: 1:16 SHEET 2 OF 2

Project Details

Project Name: Mclellan-Smith 4x8 - V1Jb

Location: 30 Flicker Rd, McCall, ID 83638, USA

Unique ID: 3P-17-8TOP-SD-24-L-4Hx8W-IE89

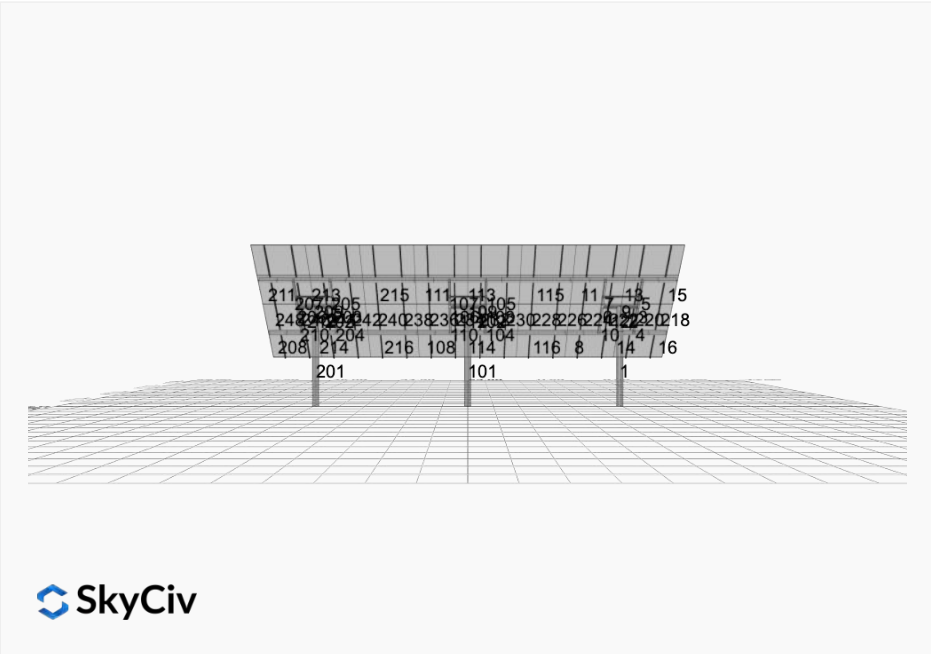
Dealer: ______________________________

Date: Mon Jul 28 2025

Number of Modules: 32

Number of Poles: 3

Date Sold: ______________________________



Array Dimensions N/S	15.97 ft
Array Dimensions E/W	46.00 ft
Winter Tilt Angle	50
Front Edge Clearance	5 ft

MT Solar Bill of Materials (3P-17-8TOP-SD-24-L-4Hx8W-IE89)

Part	Short Description	BOM Qty
MTS-PC-8	8IN Pole Cap Assembly	3
MTS-HF-SD	H-Frame Assembly-SD	3
MTS-SD-Wing-24	24IN SD Wing	4
MTS-SD-Splice-57	57IN SD Splice	8
MTS-CLAMP-HOOK-4PK	Hook Clamp	8

Rail Bill of Materials

Part	Qty
Rails (192in)	16
Rail Attachment	32
Module Mid Clamp	48
Module End Clamp	32
Ground Lug	8

Site Details:

Site Address: 30 Flicker Rd, McCall, ID 83638, USA

Array Specification

Duty Classification:	SD
Module Width:	47.40 in
Module Length:	68.00in
Number of Rows:	4
Number of Columns:	8
Total Number of Modules:	32
Winter Tilt Angle:	50
Front Edge Clearance:	5
Total Array Height at Tilt:	17.23 ft
Total Frame Length:	45.50 ft
Module Info/Notes:	REC 420
Array Dimensions N/S:	15.97 ft
Array Dimensions E/W:	46.00 ft
Rail Length:	191.60 in
Rail Spacing:	2.88 ft

Support Specifications

Pole Size:	8in Pipe Sch 40
Pole Length above Grade:	11.12 ft
Number of Poles:	3
Pole Spacing:	17 ft

Foundation Specifications

Foundation Type:	Square
Foundation Dimensions:	48 x 48 in
Foundation Depth (below grade):	Pile 1: 5.75 ft Pile 2: 6.25 ft Pile 3: 5.75 ft
Foundation Volume:	10.519 y^3

Site Info

Risk Category:	I
Exposure:	C
Soil Classification:	sand
Site Location:	30 Flicker Rd, McCall, ID 83638, USA
Wind Speed:	97 mph
Snow Load:	99.56 psf

Design Disclaimer

This software should be used for preliminary designs and should not be used as a final design unless reviewed, verified and designed by a qualified structural engineer.

AutoDesigner Input


```
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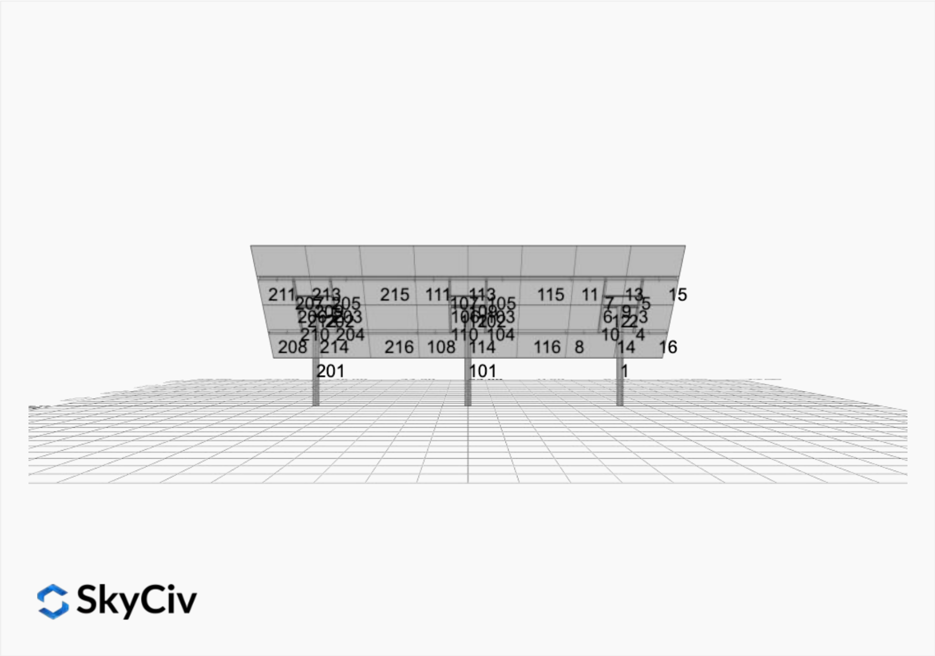
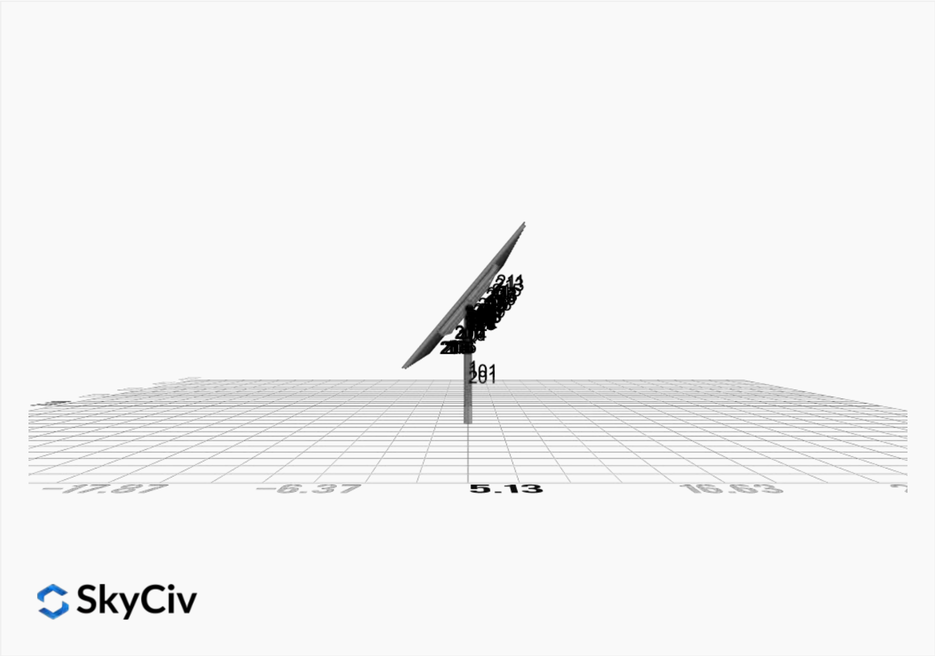
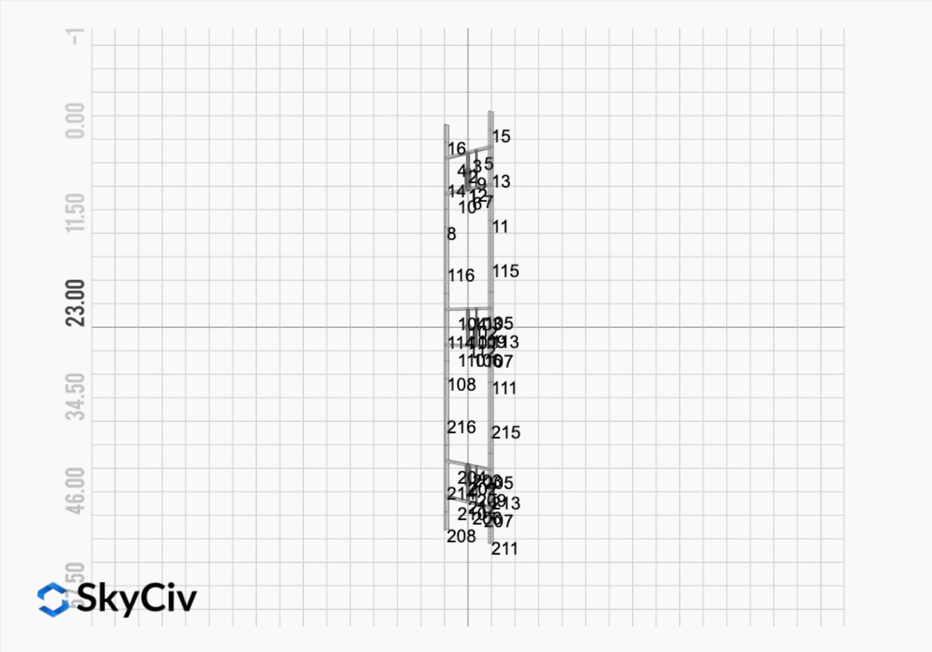
Design Notes:

- AISC Deflection checks are set to L/1 due to structure design intent
- Foundation Soil Parameters used in this Autodesign are all estimates, proper geotechnical reports are required to confirm soil profiles
- Wind speeds, snow loads and other site specific results are based on ASCE 7 2016
- Steel frame design checks are based on AISC 360 2016 (LRFD)
- Foundation Design and Sizing is approximate only



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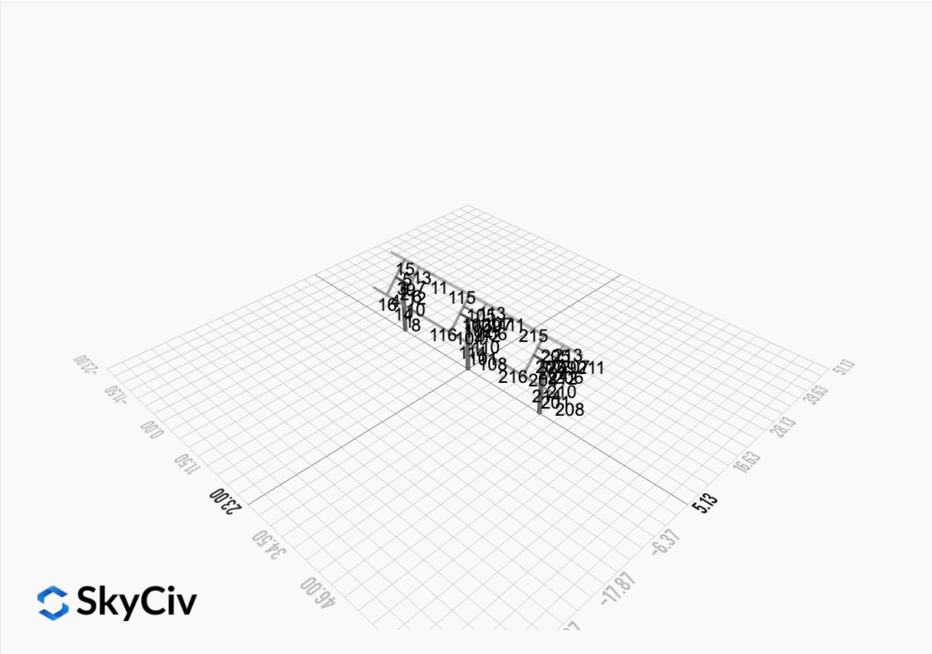
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-6.37
-17.87
15
13
11
115
116
108
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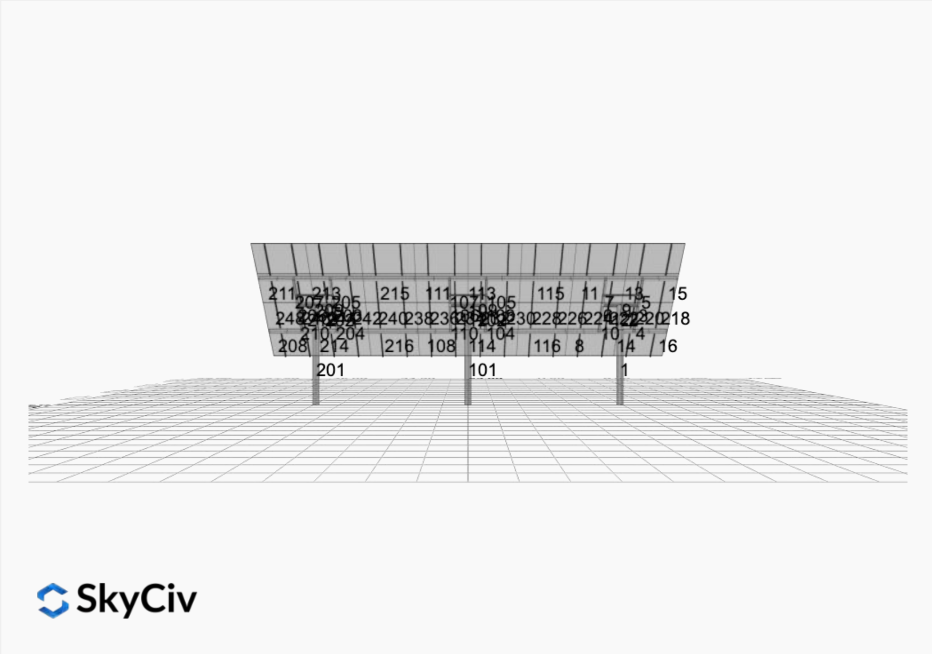
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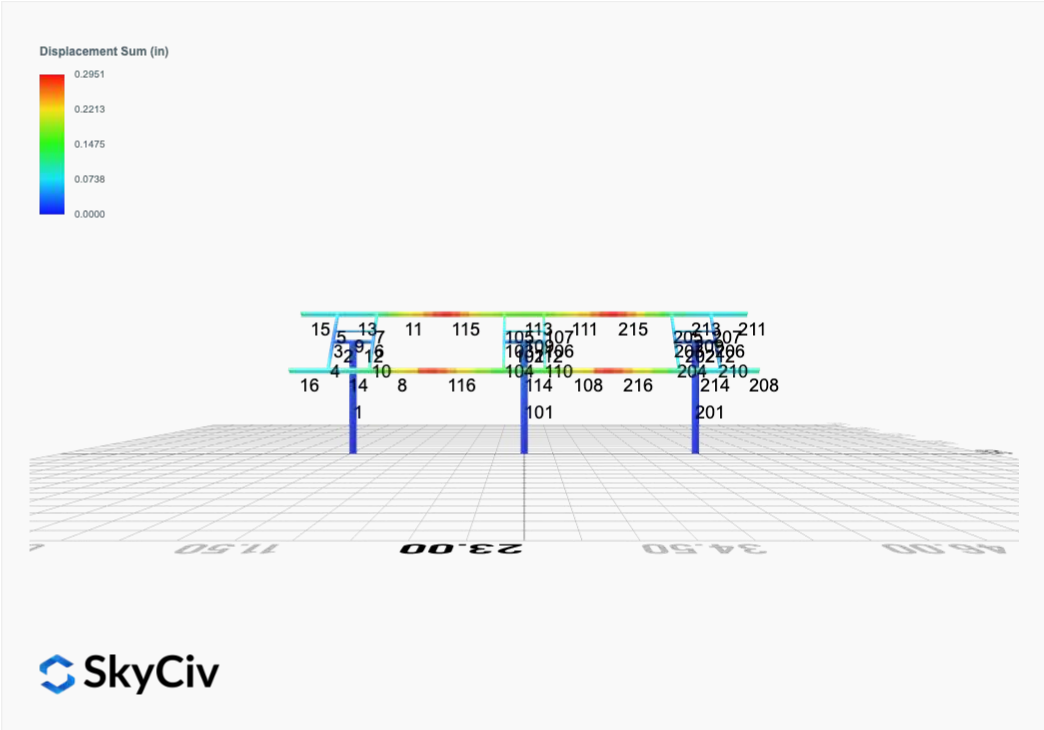
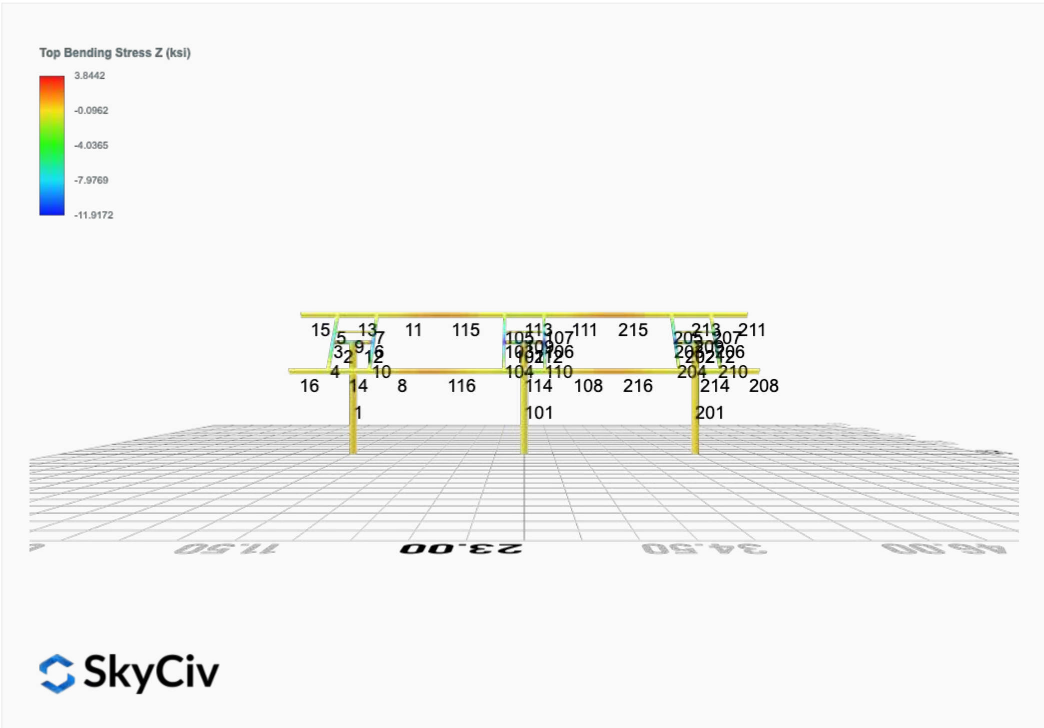
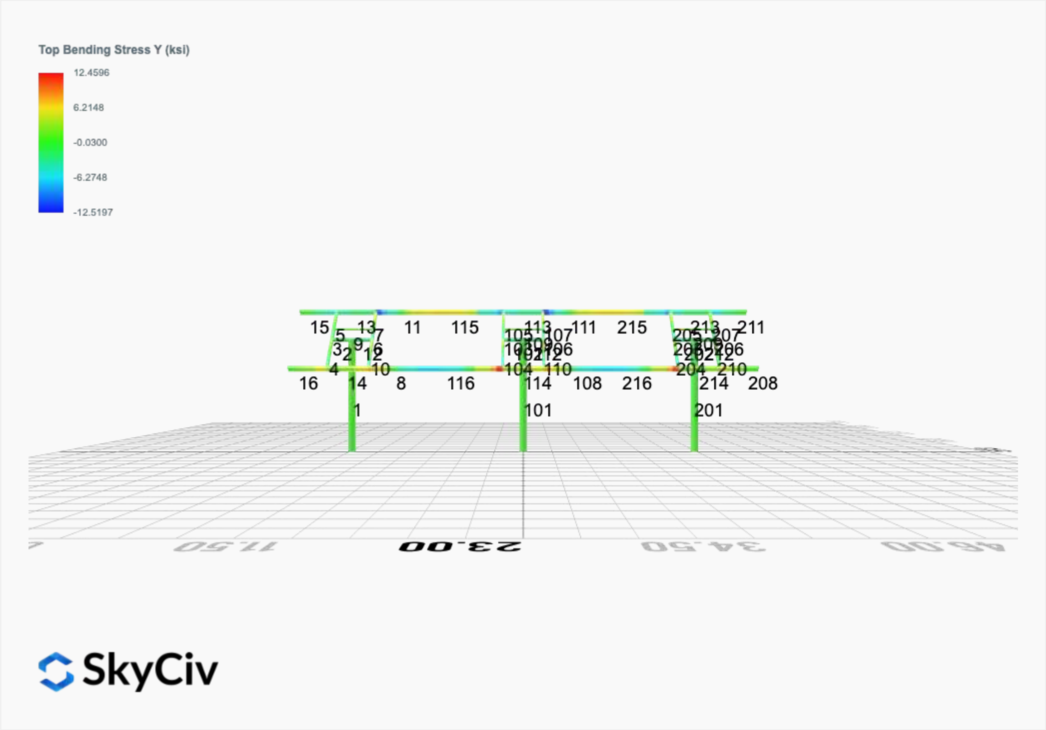
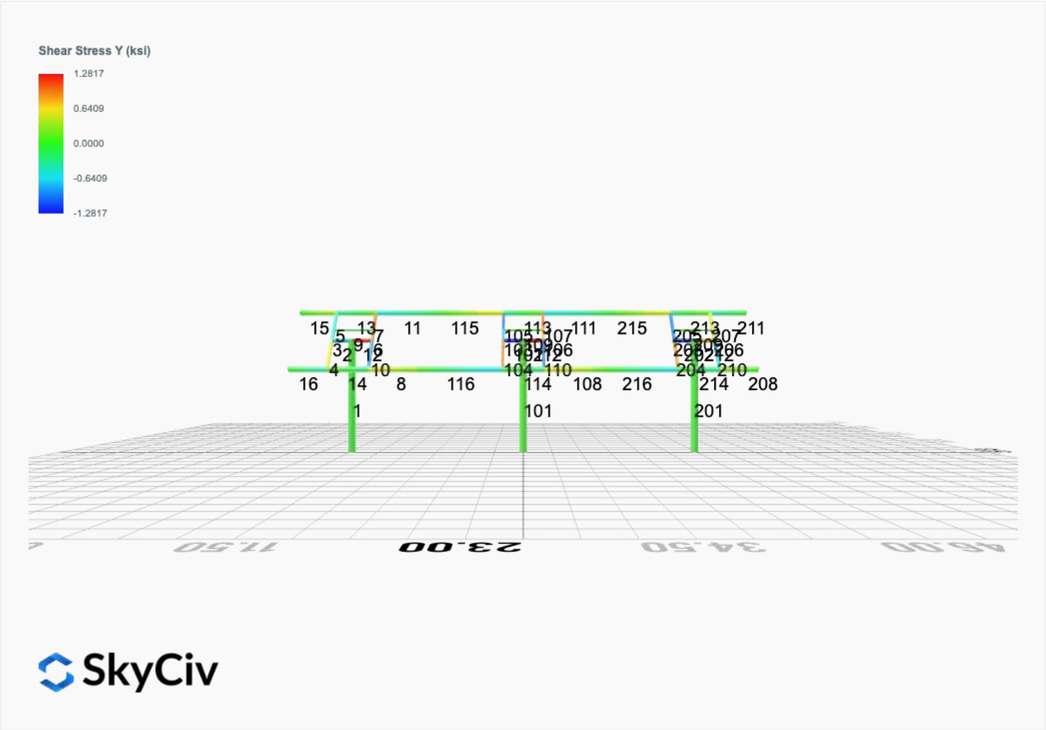
101
1
SkyCiv

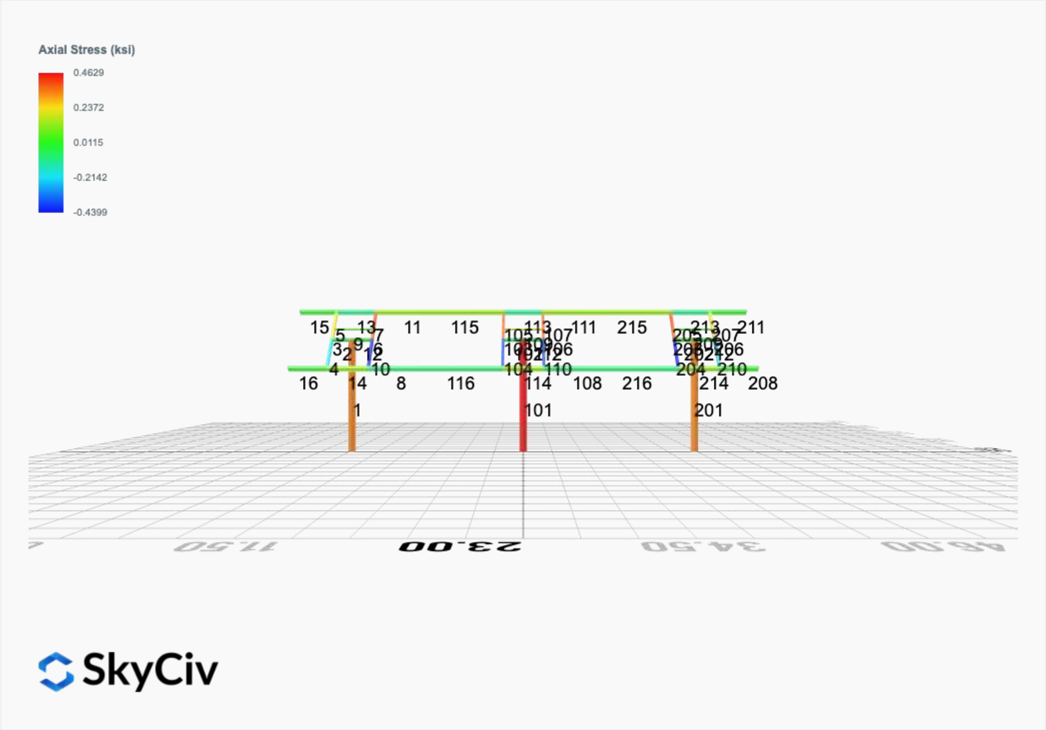
FEM Results (Envelope Worst Case for each member)






Top Bending Stress Y (ksi)
12.4596
6.2148
-0.0300
-6.2748
-12.5197
23.00


Shear Stress Y (ksi)
1.2817
0.6409
0.0000
-0.6409
-1.2817
23.00


Axial Stress (ksi)
0.4629
0.2372
0.0115
-0.2142
-0.4399

Reaction Forces for Foundation 1 (Node ID#1), (kip, kip-ft)

ASD Load Combination Results

Name	Fx	Fy	Fz	Mx	My	Mz
ULS: 1. D	0.0126	1.7822	0.0450	0.1440	-0.0488	-0.1123
ULS: 2. D + L	0.0126	1.7822	0.0450	0.1440	-0.0488	-0.1123
ULS: 3. D + (S or Lr or R)	0.0428	4.9506	0.1538	0.4927	-0.1678	-0.4022
ULS: 3. D + (S or Lr or R)	0.0126	1.7822	0.0450	0.1440	-0.0488	-0.1123
ULS: 4. D + 0.75L + 0.75(S or Lr or R)	0.0353	4.1585	0.1266	0.4055	-0.1380	-0.3297
ULS: 4. D + 0.75L + 0.75(S or Lr or R)	0.0126	1.7822	0.0450	0.1440	-0.0488	-0.1123
ULS: 5b. D + 0.7E	0.0126	1.7822	0.0450	0.1440	-0.0488	-0.1123
ULS: 6b. D + 0.75L + 0.75(0.7)E + 0.75S	0.0353	4.1585	0.1266	0.4055	-0.1380	-0.3297
ULS: 8. 0.6D + 0.7E	0.0075	1.0693	0.0270	0.0864	-0.0293	-0.0674
ULS: 5a. D + 0.6W_Wind downforce Case A only	-1.7798	3.2568	0.1344	0.4059	-0.5615	20.0643
ULS: 5a. D + 0.6W_Wind downforce Case B only	0.0126	1.7822	0.0450	0.1440	-0.0488	-0.1123
ULS: 5a. D + 0.6W_Wind uplift Case A only	1.8036	0.3081	-0.0433	-0.1145	0.4581	-19.9911
ULS: 5a. D + 0.6W_Wind uplift Case B only	0.0126	1.7822	0.0450	0.1440	-0.0488	-0.1123
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case A only	-1.3090	5.2645	0.1937	0.6019	-0.5226	14.8027
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case B only	0.0353	4.1585	0.1266	0.4055	-0.1380	-0.3297
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case A only	1.3785	3.0529	0.0604	0.2116	0.2421	-15.2388
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case B only	0.0353	4.1585	0.1266	0.4055	-0.1380	-0.3297
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case A only	-1.3317	2.8881	0.1121	0.3404	-0.4333	15.0202
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case B only	0.0126	1.7822	0.0450	0.1440	-0.0488	-0.1123
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case A only	1.3558	0.6766	-0.0212	-0.0499	0.3314	-15.0214
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case B only	0.0126	1.7822	0.0450	0.1440	-0.0488	-0.1123
ULS: 7. 0.6D + 0.6W_Wind downforce Case A only	-1.7848	2.5439	0.1164	0.3483	-0.5420	20.1092
ULS: 7. 0.6D + 0.6W_Wind downforce Case B only	0.0075	1.0693	0.0270	0.0864	-0.0293	-0.0674
ULS: 7. 0.6D + 0.6W_Wind uplift Case A only	1.7985	-0.4048	-0.0613	-0.1721	0.4776	-19.9461
ULS: 7. 0.6D + 0.6W_Wind uplift Case B only	0.0075	1.0693	0.0270	0.0864	-0.0293	-0.0674

Worst Case Reactions LRFD

These calculations are taken directly from the FEA via SkyCiv and are used in the Concrete Checks of the Foundatino Module.
Note: Worst case values are assumed as downforce wind load cases.

Result	Value (kip, kip-ft)
Axial	8.4375
Shear X	-3.0168
Shear Z	0.3044
Moment X	0.9562
Moment Y (Twist)	0.9786
Moment Z	33.8114

Worst Case Reactions ASD

These results are taken from the worst case values in the above table and are used in the Soil Checks in the Foundation Module.
Note: Worst case values are assumed as downforce wind load cases.

Result	Value (kip, kip-ft)
Axial	5.2645
Shear X	-1.8036
Shear Z	0.1937
Moment X	0.6019
Moment Y (Twist)	0.5615
Moment Z	20.1092

Reaction Forces for Foundation 2 (Node ID#101), (kip, kip-ft)

ASD Load Combination Results

Name	Fx	Fy	Fz	Mx	My	Mz
ULS: 1. D	-0.0252	2.0810	0.0000	0.0000	0.0000	0.2724
ULS: 2. D + L	-0.0252	2.0810	0.0000	0.0000	0.0000	0.2724
ULS: 3. D + (S or Lr or R)	-0.0857	5.9690	0.0000	-0.0000	0.0000	0.9182
ULS: 3. D + (S or Lr or R)	-0.0252	2.0810	0.0000	0.0000	0.0000	0.2724
ULS: 4. D + 0.75L + 0.75(S or Lr or R)	-0.0706	4.9970	0.0000	-0.0000	0.0000	0.7568

Name	Fx	Fy	Fz	Mx	My	Mz
ULS: 4. D + 0.75L + 0.75(S or Lr or R)	-0.0252	2.0810	0.0000	0.0000	0.0000	0.2724
ULS: 5b. D + 0.7E	-0.0252	2.0810	0.0000	0.0000	0.0000	0.2724
ULS: 6b. D + 0.75L + 0.75(0.7)E + 0.75S	-0.0706	4.9970	0.0000	-0.0000	0.0000	0.7568
ULS: 8. 0.6D + 0.7E	-0.0151	1.2486	0.0000	0.0000	0.0000	0.1635
ULS: 5a. D + 0.6W_Wind downforce Case A only	-2.1641	3.9345	0.0000	0.0000	0.0000	24.0285
ULS: 5a. D + 0.6W_Wind downforce Case B only	-0.0252	2.0810	0.0000	0.0000	0.0000	0.2724
ULS: 5a. D + 0.6W_Wind uplift Case A only	2.1165	0.2265	0.0000	0.0000	0.0000	-23.1130
ULS: 5a. D + 0.6W_Wind uplift Case B only	-0.0252	2.0810	0.0000	0.0000	0.0000	0.2724
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case A only	-1.6748	6.3871	0.0000	-0.0000	0.0000	18.5738
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case B only	-0.0706	4.9970	0.0000	-0.0000	0.0000	0.7568
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case A only	1.5357	3.6061	0.0000	-0.0000	0.0000	-16.7823
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case B only	-0.0706	4.9970	0.0000	-0.0000	0.0000	0.7568
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case A only	-1.6294	3.4711	0.0000	0.0000	0.0000	18.0895
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case B only	-0.0252	2.0810	0.0000	0.0000	0.0000	0.2724
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case A only	1.5811	0.6901	0.0000	0.0000	0.0000	-17.2667
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case B only	-0.0252	2.0810	0.0000	0.0000	0.0000	0.2724
ULS: 7. 0.6D + 0.6W_Wind downforce Case A only	-2.1540	3.1021	0.0000	0.0000	0.0000	23.9195
ULS: 7. 0.6D + 0.6W_Wind downforce Case B only	-0.0151	1.2486	0.0000	0.0000	0.0000	0.1635
ULS: 7. 0.6D + 0.6W_Wind uplift Case A only	2.1266	-0.6059	0.0000	0.0000	0.0000	-23.2220
ULS: 7. 0.6D + 0.6W_Wind uplift Case B only	-0.0151	1.2486	0.0000	0.0000	0.0000	0.1635

Worst Case Reactions LRFD

These calculations are taken directly from the FEA via SkyCiv and are used in the Concrete Checks of the Foundatino Module.
Note: Worst case values are assumed as downforce wind load cases.

Result	Value (kip, kip-ft)
Axial	10.2615
Shear X	-3.6217
Shear Z	0.0000
Moment X	0.0001
Moment Y (Twist)	0.0002
Moment Z	40.7720

Worst Case Reactions ASD

These results are taken from the worst case values in the above table and are used in the Soil Checks in the Foundation Module.
Note: Worst case values are assumed as downforce wind load cases.

Result	Value (kip, kip-ft)
Axial	6.3871
Shear X	-2.1641
Shear Z	0.0000
Moment X	-0.0000
Moment Y (Twist)	0.0000
Moment Z	24.0285

Reaction Forces for Foundation 3 (Node ID#201), (kip, kip-ft)

ASD Load Combination Results

Name	Fx	Fy	Fz	Mx	My	Mz
ULS: 1. D	0.0126	1.7822	-0.0450	-0.1440	0.0488	-0.1122
ULS: 2. D + L	0.0126	1.7822	-0.0450	-0.1440	0.0488	-0.1122
ULS: 3. D + (S or Lr or R)	0.0428	4.9506	-0.1538	-0.4927	0.1678	-0.4022
ULS: 3. D + (S or Lr or R)	0.0126	1.7822	-0.0450	-0.1440	0.0488	-0.1122
ULS: 4. D + 0.75L + 0.75(S or Lr or R)	0.0353	4.1585	-0.1266	-0.4055	0.1381	-0.3297
ULS: 4. D + 0.75L + 0.75(S or Lr or R)	0.0126	1.7822	-0.0450	-0.1440	0.0488	-0.1122
ULS: 5b. D + 0.7E	0.0126	1.7822	-0.0450	-0.1440	0.0488	-0.1122
ULS: 6b. D + 0.75L + 0.75(0.7)E + 0.75S	0.0353	4.1585	-0.1266	-0.4055	0.1381	-0.3297
ULS: 8. 0.6D + 0.7E	0.0075	1.0693	-0.0270	-0.0864	0.0293	-0.0673
ULS: 5a. D + 0.6W_Wind downforce Case A only	-1.7798	3.2568	-0.1344	-0.4059	0.5615	20.0643
ULS: 5a. D + 0.6W_Wind downforce Case B only	0.0126	1.7822	-0.0450	-0.1440	0.0488	-0.1122
ULS: 5a. D + 0.6W_Wind uplift Case A only	1.8035	0.3081	0.0433	0.1145	-0.4581	-19.9910
ULS: 5a. D + 0.6W_Wind uplift Case B only	0.0126	1.7822	-0.0450	-0.1440	0.0488	-0.1122

Name	Fx	Fy	Fz	Mx	My	Mz
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case A only	-1.3090	5.2644	-0.1937	-0.6019	0.5226	14.8027
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case B only	0.0353	4.1585	-0.1266	-0.4055	0.1381	-0.3297
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case A only	1.3785	3.0529	-0.0604	-0.2117	-0.2421	-15.2388
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case B only	0.0353	4.1585	-0.1266	-0.4055	0.1381	-0.3297
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case A only	-1.3317	2.8881	-0.1121	-0.3404	0.4333	15.0202
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind downforce Case B only	0.0126	1.7822	-0.0450	-0.1440	0.0488	-0.1122
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case A only	1.3558	0.6766	0.0212	0.0499	-0.3314	-15.0213
ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R)_Wind uplift Case B only	0.0126	1.7822	-0.0450	-0.1440	0.0488	-0.1122
ULS: 7. 0.6D + 0.6W_Wind downforce Case A only	-1.7848	2.5439	-0.1164	-0.3483	0.5420	20.1092
ULS: 7. 0.6D + 0.6W_Wind downforce Case B only	0.0075	1.0693	-0.0270	-0.0864	0.0293	-0.0673
ULS: 7. 0.6D + 0.6W_Wind uplift Case A only	1.7985	-0.4048	0.0613	0.1721	-0.4776	-19.9461
ULS: 7. 0.6D + 0.6W_Wind uplift Case B only	0.0075	1.0693	-0.0270	-0.0864	0.0293	-0.0673

Worst Case Reactions LRFD

These calculations are taken directly from the FEA via SkyCiv and are used in the Concrete Checks of the Foundatino Module.
Note: Worst case values are assumed as downforce wind load cases.

Result	Value (kip, kip-ft)
Axial	8.4375
Shear X	-3.0167
Shear Z	-0.3044
Moment X	-0.9562
Moment Y (Twist)	0.9787
Moment Z	33.8117

Worst Case Reactions ASD

These results are taken from the worst case values in the above table and are used in the Soil Checks in the Foundation Module.
Note: Worst case values are assumed as downforce wind load cases.

Result	Value (kip, kip-ft)
Axial	5.2644
Shear X	-1.8035
Shear Z	-0.1937
Moment X	-0.6019
Moment Y (Twist)	0.5615
Moment Z	20.1092

Project Details

Design Code:	AISC 360-16 LRFD
Provision:	LRFD
Country:	United States
User Name:	sales@mtsolar.us
Unit System:	imperial

Design Input Information

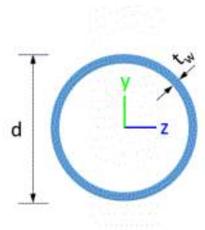
Design Factors

Φ_t	Φ_c	Φ_b	Φ_v
0.9	0.9	0.9	0.9

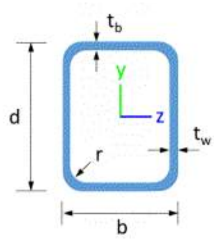
Design Materials

ID	E (ksi)	F_y (ksi)	F_u (ksi)
1	29000	50	65

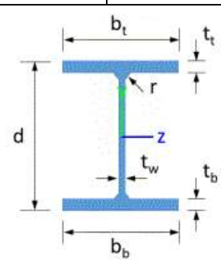
Section Dimensions



ID	Name	d (in)	t_w (in)					
1	2in Pipe Sch 40	2.38	0.15					
4	4in Pipe Sch 40	4.50	0.24					
9	8in Pipe Sch 40	8.63	0.32					



ID	Name	d (in)	b (in)	t_w (in)	t_b (in)	r (in)		
15	HSS5x3x1/8	5.00	3.00	0.12	0.12	0.12		



ID	Name	d (in)	t_w (in)	b_t (in)	b_b (in)	t_t (in)	t_b (in)	r (in)
18	W6x9	5.90	0.17	3.94	3.94	0.21	0.21	0.25

Section Properties

ID	Name	A (in^2)	J (in^4)	I_{yp} (in^4)	I_{zp} (in^4)	I_w (in^6)	S_{yp} (in^3)	S_{zp} (in^3)

1	2in Pipe Sch 40	1.07	1.33	0.67	0.67	0.00	0.76	0.76
4	4in Pipe Sch 40	3.17	14.47	7.23	7.23	0.00	4.31	4.31
9	8in Pipe Sch 40	8.40	144.98	72.49	72.49	0.00	22.21	22.21
15	HSS5x3x1/8	1.77	6.02	2.75	6.03	0.51	2.07	2.93
18	W6x9	2.68	0.04	2.20	16.40	17.70	1.72	6.23

Member Properties

Member ID	Section ID	K_zL (ft)	K_yL (ft)	L_b(ft)	C_b	LST	LSC	LD
1	9	23.34	23.34	11.12	-	300	200	1
2	4	2.00	1.30	2.00	-	300	200	1
3	15	0.92	0.92	1.42	1.18,1.18,1.18,1.18,1.18,1.18,1.17,1.18,1.16,1.18,1.17,1.18,1.17,1.18,1.17,1.18,1.18,1.18,1.18,1.18,1.16,1.18,1.17,1.18,1.17,1.18	300	200	1
4	15	2.44	2.44	3.75	1.68,1.68,1.68,1.67,1.68,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68,1.67,1.67,1.68,1.67,1.67,1.68,1.65,1.68,1.67,1.68,1.66,1.68	300	200	1
5	15	1.52	1.52	2.33	1.68,1.67,1.68,1.67,1.67,1.68,1.67,1.67,1.66,1.67,1.67,1.68,1.66,1.68,1.67,1.67,1.67,1.67,1.67,1.68,1.65,1.68,1.67,1.68,1.66,1.68	300	200	1
6	15	0.92	0.92	1.42	1.19,1.18,1.19,1.18,1.19,1.19,1.18,1.18,1.18,1.18,1.18,1.19,1.18,1.19,1.18,1.18,1.18,1.18,1.18,1.19,1.18,1.19,1.18,1.19,1.18,1.19	300	200	1
7	15	1.52	1.52	2.33	1.68,1.67,1.68,1.67,1.67,1.68,1.67,1.67,1.66,1.67,1.67,1.68,1.66,1.68,1.67,1.67,1.67,1.67,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68	300	200	1
8	18	1.33	1.33	2.05	1.33,1.33,1.33,1.33,1.33,1.33,1.32,1.33,1.32,1.33,1.32,1.33,1.32,1.33,1.32,1.33,1.33,1.33,1.32,1.33,1.32,1.33,1.32,1.33,1.32,1.33	300	200	1
9	1	2.60	2.60	4.00	-	300	200	1
10	15	2.44	2.44	3.75	1.68,1.68,1.68,1.67,1.68,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68,1.67,1.67,1.68,1.67,1.67,1.68,1.65,1.68,1.67,1.68,1.66,1.68	300	200	1
11	18	1.33	1.33	2.05	1.35,1.35,1.35,1.35,1.35,1.35,1.37,1.35,1.42,1.35,1.38,1.35,1.39,1.35,1.36,1.35,1.32,1.35,1.37,1.35,1.42,1.35,1.38,1.35,1.39,1.35	300	200	1
12	4	1.30	1.30	2.00	-	300	200	1
13	18	4.88	4.00	7.50	1.17,1.17,1.17,1.17,1.17,1.17,1.16,1.17,1.14,1.17,1.16,1.17,1.15,1.17,1.17,1.17,1.19,1.17,1.16,1.17,1.14,1.17,1.16,1.17,1.15,1.17	300	200	1
14	18	4.88	4.00	7.50	1.17,1.17,1.17,1.17,1.17,1.17,1.16,1.17,1.15,1.17,1.16,1.17,1.16,1.17,1.17,1.17,1.17,1.17,1.16,1.17,1.15,1.17,1.16,1.17,1.16,1.17	300	200	1
15	18	4.20	4.20	2.00	2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33	300	200	1
16	18	4.20	4.20	2.00	2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33	300	200	1
101	9	23.34	23.34	11.12	-	300	200	1
102	4	1.30	1.30	2.00	-	300	200	1
103	15	0.92	0.92	1.42	1.18,1.18,1.18,1.18,1.18,1.18,1.18,1.18,1.17,1.18,1.18,1.18,1.18,1.18,1.18,1.18,1.18,1.18,1.18,1.18,1.17,1.18,1.18,1.18,1.18,1.18	300	200	1
104	15	2.44	2.44	3.75	1.68,1.67,1.68,1.67,1.68,1.68,1.67,1.67,1.66,1.67,1.67,1.68,1.66,1.68,1.67,1.67,1.67,1.67,1.67,1.68,1.65,1.68,1.67,1.68,1.66,1.68	300	200	1
105	15	1.52	1.52	2.33	1.67,1.67,1.67,1.67,1.67,1.67,1.67,1.67,1.66,1.67,1.67,1.67,1.66,1.67,1.67,1.67,1.67,1.67,1.67,1.67,1.66,1.67,1.67,1.67,1.66,1.67	300	200	1
106	15	0.92	0.92	1.42	1.18,1.18,1.18,1.18,1.18,1.18,1.18,1.18,1.17,1.18,1.18,1.18,1.18,1.18,1.18,1.18,1.18,1.18,1.18,1.18,1.17,1.18,1.18,1.18,1.18,1.18	300	200	1
107	15	1.52	1.52	2.33	1.67,1.67,1.67,1.67,1.67,1.67,1.67,1.67,1.66,1.67,1.67,1.67,1.66,1.67,1.67,1.67,1.67,1.67,1.67,1.67,1.66,1.67,1.67,1.67,1.66,1.67	300	200	1
108	18	1.33	1.33	2.05	1.63,1.63,1.63,1.63,1.63,1.63,1.56,1.63,1.45,1.63,1.55,1.63,1.51,1.63,1.60,1.63,1.74,1.63,1.56,1.63,1.46,1.63,1.55,1.63,1.52,1.63	300	200	1
109	1	2.60	2.60	4.00	-	300	200	1
110	15	2.44	2.44	3.75	1.68,1.67,1.68,1.67,1.68,1.68,1.67,1.67,1.66,1.67,1.67,1.68,1.66,1.68,1.67,1.67,1.67,1.67,1.67,1.68,1.65,1.68,1.67,1.68,1.66,1.68	300	200	1
111	18	1.33	1.33	2.05	1.54,1.54,1.54,1.54,1.54,1.54,1.39,1.54,1.23,1.54,1.37,1.54,1.30,1.54,1.46,1.54,1.91,1.54,1.40,1.54,1.23,1.54,1.37,1.54,1.32,1.54	300	200	1
112	4	1.30	1.30	2.00	-	300	200	1

113	18	4.88	4.00	7.50	1.06,1.06,1.06,1.06,1.06,1.06,1.07,1.06,1.30,1.06,1.08,1.06,1.10,1.06,1.07,1.06,1.05,1.06,1.07,1.06,1.29,1.06,1.08,1.06,1.09,1.06	300	200	1
114	18	4.88	4.00	7.50	1.05,1.05,1.05,1.05,1.05,1.06,1.05,1.07,1.05,1.06,1.05,1.06,1.05,1.06,1.05,1.05,1.06,1.05,1.07,1.05,1.06,1.05,1.06,1.05	300	200	1
115	18	4.84	4.84	7.45	1.13,1.13,1.13,1.13,1.13,1.13,1.11,1.13,1.07,1.13,1.10,1.13,1.09,1.13,1.12,1.13,1.18,1.13,1.11,1.13,1.07,1.13,1.10,1.13,1.09,1.13	300	200	1
116	18	4.84	4.84	7.45	1.14,1.14,1.14,1.14,1.14,1.14,1.13,1.14,1.12,1.14,1.13,1.14,1.13,1.14,1.14,1.14,1.16,1.14,1.13,1.14,1.12,1.14,1.13,1.14,1.13,1.14	300	200	1
201	9	23.34	23.34	11.12	-	300	200	1
202	4	1.30	1.30	2.00	-	300	200	1
203	15	0.92	0.92	1.42	1.19,1.18,1.19,1.18,1.19,1.19,1.18,1.18,1.18,1.18,1.18,1.19,1.18,1.19,1.18,1.18,1.18,1.18,1.18,1.19,1.18,1.19,1.18,1.19,1.18,1.19	300	200	1
204	15	2.44	2.44	3.75	1.68,1.68,1.68,1.67,1.68,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68,1.67,1.67,1.68,1.67,1.67,1.68,1.65,1.68,1.67,1.68,1.66,1.68	300	200	1
205	15	1.52	1.52	2.33	1.68,1.67,1.68,1.67,1.67,1.68,1.67,1.67,1.66,1.67,1.67,1.68,1.66,1.68,1.67,1.67,1.67,1.67,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68	300	200	1
206	15	0.92	0.92	1.42	1.18,1.18,1.18,1.18,1.18,1.18,1.17,1.18,1.16,1.18,1.17,1.18,1.17,1.18,1.17,1.18,1.18,1.18,1.18,1.18,1.16,1.18,1.17,1.18,1.17,1.18	300	200	1
207	15	1.52	1.52	2.33	1.68,1.67,1.68,1.67,1.67,1.68,1.67,1.67,1.66,1.67,1.67,1.68,1.66,1.68,1.67,1.67,1.67,1.67,1.67,1.68,1.65,1.68,1.67,1.68,1.66,1.68	300	200	1
208	18	4.20	4.20	2.00	2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33	300	200	1
209	1	2.60	2.60	4.00	-	300	200	1
210	15	2.44	2.44	3.75	1.68,1.68,1.68,1.67,1.68,1.68,1.67,1.68,1.66,1.68,1.67,1.68,1.66,1.68,1.67,1.67,1.68,1.67,1.67,1.68,1.65,1.68,1.67,1.68,1.66,1.68	300	200	1
211	18	4.20	4.20	2.00	2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33,2.33	300	200	1
212	4	2.00	1.30	2.00	-	300	200	1
213	18	4.88	4.00	7.50	1.17,1.17,1.17,1.17,1.17,1.17,1.16,1.17,1.14,1.17,1.16,1.17,1.15,1.17,1.17,1.17,1.19,1.17,1.16,1.17,1.14,1.17,1.16,1.17,1.15,1.17	300	200	1
214	18	4.88	4.00	7.50	1.17,1.17,1.17,1.17,1.17,1.17,1.16,1.17,1.15,1.17,1.16,1.17,1.16,1.17,1.17,1.17,1.17,1.17,1.16,1.17,1.15,1.17,1.16,1.17,1.16,1.17	300	200	1
215	18	4.84	4.84	7.45	1.09,1.09,1.09,1.09,1.09,1.09,1.10,1.09,1.12,1.09,1.10,1.09,1.11,1.09,1.10,1.09,1.08,1.09,1.10,1.09,1.12,1.09,1.10,1.09,1.11,1.09	300	200	1
216	18	4.84	4.84	7.45	1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.08,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09,1.09	300	200	1

Member Design Capacity

Member ID	$\Phi_t P_n$ (kip)	$\Phi_c P_n$ (kip)	$\Phi_b M_{zn}$ (k-ft)	$\Phi_b M_{yn}$ (k-ft)	$\Phi_v V_{yn}$ (kip)	$\Phi_v V_{zn}$ (kip)
1	377.97	194.43	83.29	83.29	113.39	113.39
2	142.83	140.22	16.17	16.17	42.85	42.85
3	79.65	74.89	10.99	6.26	29.14	16.61
4	79.65	72.84	10.99	6.26	29.14	16.61
5	79.65	74.30	10.99	6.26	29.14	16.61
6	79.65	74.89	10.99	6.26	29.14	16.61
7	79.65	74.30	10.99	6.26	29.14	16.61
8	120.60	115.40	23.36	6.45	30.09	45.74
9	48.35	43.11	2.85	2.85	14.51	14.51
10	79.65	72.84	10.99	6.26	29.14	16.61
11	120.60	115.40	23.36	6.45	30.09	45.74
12	142.83	141.72	16.17	16.17	42.85	42.85
13	120.60	84.03	20.05	6.45	30.09	45.74
14	120.60	84.03	20.30	6.45	30.09	45.74
15	120.60	96.18	23.36	6.45	30.09	45.74
16	120.60	96.18	23.36	6.45	30.09	45.74
101	377.97	194.43	83.29	83.29	113.39	113.39

101	377.97	194.43	83.29	83.29	113.39	113.39
102	142.83	141.72	16.17	16.17	42.85	42.85
103	79.65	74.89	10.99	6.26	29.14	16.61
104	79.65	72.84	10.99	6.26	29.14	16.61
105	79.65	74.30	10.99	6.26	29.14	16.61
106	79.65	74.89	10.99	6.26	29.14	16.61
107	79.65	74.30	10.99	6.26	29.14	16.61
108	120.60	115.40	23.36	6.45	30.09	45.74
109	48.35	43.11	2.85	2.85	14.51	14.51
110	79.65	72.84	10.99	6.26	29.14	16.61
111	120.60	115.40	23.36	6.45	30.09	45.74
112	142.83	141.72	16.17	16.17	42.85	42.85
113	120.60	84.03	18.45	6.45	30.09	45.74
114	120.60	84.03	18.49	6.45	30.09	45.74
115	120.60	84.26	18.84	6.45	30.09	45.74
116	120.60	84.26	19.75	6.45	30.09	45.74
201	377.97	194.43	83.29	83.29	113.39	113.39
202	142.83	141.72	16.17	16.17	42.85	42.85
203	79.65	74.89	10.99	6.26	29.14	16.61
204	79.65	72.84	10.99	6.26	29.14	16.61
205	79.65	74.30	10.99	6.26	29.14	16.61
206	79.65	74.89	10.99	6.26	29.14	16.61
207	79.65	74.30	10.99	6.26	29.14	16.61
208	120.60	96.18	23.36	6.45	30.09	45.74
209	48.35	43.11	2.85	2.85	14.51	14.51
210	79.65	72.84	10.99	6.26	29.14	16.61
211	120.60	96.18	23.36	6.45	30.09	45.74
212	142.83	140.22	16.17	16.17	42.85	42.85
213	120.60	84.03	20.04	6.45	30.09	45.74
214	120.60	84.03	20.31	6.45	30.09	45.74
215	120.60	84.26	19.08	6.45	30.09	45.74
216	120.60	84.26	19.17	6.45	30.09	45.74

Design Ratio

Member ID	P	M_z	M_y	V_y	V_z	(P,M_z,M_y)	Worst LC	KL/r	δ	Status
1	0.043	0.406	0.029	0.027	0.003	0.431	#13	0.477	Not Required	Pass
2	0.001	0.301	0.158	0.077	0.032	0.413	#21	0.079	Not Required	Pass
3	0.014	0.470	0.098	0.046	0.019	0.574	#21	0.044	Not Required	Pass
4	0.012	0.463	0.150	0.047	0.029	0.610	#21	0.078	Not Required	Pass
5	0.014	0.292	0.123	0.047	0.022	0.310	#21	0.073	Not Required	Pass
6	0.021	0.608	0.214	0.062	0.049	0.832	#21	0.044	Not Required	Pass
7	0.022	0.378	0.276	0.060	0.053	0.441	#21	0.073	Not Required	Pass
8	0.003	0.093	0.127	0.032	0.019	0.220	#21	0.088	Not Required	Pass
9	0.002	0.039	0.090	0.003	0.004	0.102	#13	0.198	Not Required	Pass
10	0.021	0.587	0.260	0.059	0.047	0.773	#21	0.078	Not Required	Pass
11	0.004	0.092	0.124	0.034	0.019	0.218	#21	0.088	Not Required	Pass
12	0.001	0.451	0.219	0.111	0.042	0.605	#21	0.052	Not Required	Pass
13	0.006	0.097	0.376	0.046	0.026	0.438	#21	0.265	Not Required	Pass
14	0.006	0.095	0.372	0.045	0.026	0.420	#21	0.177	Not Required	Pass
15	0.000	0.019	0.056	0.015	0.008	0.075	#21	Not Required	Not Required	Pass

16	0.000	0.019	0.056	0.015	0.008	0.075	#21	Not Required	Not Required	Pass
101	0.053	0.490	0.000	0.032	0.000	0.509	#13	0.477	Not Required	Pass
102	0.002	0.462	0.233	0.115	0.042	0.637	#21	0.052	Not Required	Pass
103	0.021	0.661	0.175	0.066	0.035	0.845	#21	0.044	Not Required	Pass
104	0.020	0.667	0.276	0.067	0.049	0.888	#21	0.078	Not Required	Pass
105	0.021	0.411	0.283	0.066	0.055	0.477	#21	0.073	Not Required	Pass
106	0.021	0.661	0.175	0.066	0.035	0.845	#21	0.044	Not Required	Pass
107	0.021	0.411	0.283	0.066	0.055	0.477	#21	0.073	Not Required	Pass
108	0.003	0.075	0.120	0.037	0.019	0.188	#21	0.088	Not Required	Pass
109	0.008	0.033	0.060	0.001	0.000	0.094	#21	0.198	Not Required	Pass
110	0.020	0.667	0.276	0.067	0.049	0.888	#21	0.078	Not Required	Pass
111	0.004	0.087	0.120	0.036	0.019	0.198	#21	0.088	Not Required	Pass
112	0.002	0.462	0.233	0.115	0.042	0.637	#21	0.052	Not Required	Pass
113	0.006	0.123	0.390	0.049	0.026	0.499	#21	0.265	Not Required	Pass
114	0.007	0.147	0.388	0.050	0.026	0.516	#21	0.265	Not Required	Pass
115	0.006	0.145	0.221	0.036	0.019	0.368	#21	0.321	Not Required	Pass
116	0.003	0.137	0.221	0.037	0.019	0.359	#21	0.321	Not Required	Pass
201	0.043	0.406	0.029	0.027	0.003	0.431	#13	0.477	Not Required	Pass
202	0.001	0.451	0.219	0.111	0.042	0.605	#21	0.052	Not Required	Pass
203	0.021	0.608	0.214	0.062	0.049	0.832	#21	0.044	Not Required	Pass
204	0.021	0.587	0.260	0.059	0.047	0.773	#21	0.078	Not Required	Pass
205	0.022	0.378	0.276	0.060	0.053	0.441	#21	0.073	Not Required	Pass
206	0.014	0.470	0.098	0.046	0.019	0.574	#21	0.044	Not Required	Pass
207	0.014	0.292	0.123	0.047	0.022	0.310	#21	0.073	Not Required	Pass
208	0.000	0.019	0.056	0.015	0.008	0.075	#21	Not Required	Not Required	Pass
209	0.002	0.039	0.090	0.003	0.004	0.102	#13	0.198	Not Required	Pass
210	0.012	0.463	0.150	0.047	0.029	0.610	#21	0.078	Not Required	Pass
211	0.000	0.019	0.056	0.015	0.008	0.075	#21	Not Required	Not Required	Pass
212	0.001	0.301	0.158	0.077	0.032	0.413	#21	0.079	Not Required	Pass
213	0.006	0.097	0.376	0.046	0.026	0.438	#21	0.177	Not Required	Pass
214	0.006	0.095	0.372	0.045	0.026	0.420	#21	0.265	Not Required	Pass
215	0.006	0.148	0.221	0.034	0.019	0.372	#21	0.321	Not Required	Pass
216	0.003	0.144	0.221	0.032	0.019	0.366	#21	0.321	Not Required	Pass

Definitions

Φ_t	Safety factor for tensile
Φ_c	Safety factor for compression
Φ_b	Safety factor for flexure
Φ_v	Safety factor for shear
E	Modulus of elasticity
F_y	Specified minimum yield stress
F_u	Specified minimum tensile strength
A	Cross-sectional area
J	Torsional constant
I_{yp}	Moment of inertia about the Y axes
I_{zp}	Moment of inertia about the Z axes
I_w	Warping constant
S_{yp}	Plastic section modulus about the Y axis
S_{zp}	Plastic section modulus about the Z axis
KL	Effective length
C_b	Buckling modification factor (from all load combinations)
L_b	Length between braced points
LST	Limited slenderness for tension
LSC	Limited slenderness for compression
LD	Limited deflection
P_n	Nominal axial strength (tension/comresssion)

M_n	Nominal flexural strength (about Z/Y axis)
V_n	Nominal shear strength (along Z/Y axis)
P	Design ratio in case of axial force
M_z	Design ratio in case of bending about Z axis
M_y	Design ratio in case of bending about Y axis
V_y	Design ratio in case of shear along Y axis
V_z	Design ratio in case of shear along Z axis
(P, M_z, M_y)	Design ratio in case of axial force and bending action
KL/r	Design ratio in case of section slenderness
δ	Design ratio in case of member deflection
OK	Capacity is provided
NG	Capacity is not provided

REFERENCES	CALCULATIONS	RESULTS

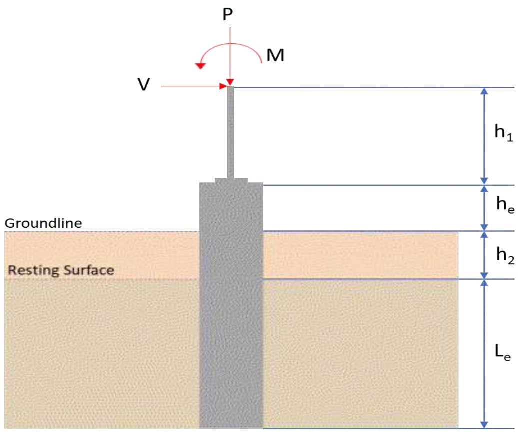
SkyCiv Foundation Design

Pile Foundation

Design Information :

Design code : IBC 2021 (International Building Code)
Unit System : Imperial

Pile Input



Geometry

Pile shape: rectangular
$b = 48$ in - Pile width
$D = 48$ in - Pile depth
$L = 5.75$ ft - Total pile length
$h_1 = 0$ ft - Lateral load height from the top of the pile,
$h_2 = 0$ ft - Depth to resisting surface
$h_e = 0$ ft - Length of pile above the ground

Tabulation of Soil Parameters

Layer	Label	Allowable Bearing Pressure (q_a) (psf)	Allowable Lateral Pressure (R) (psf/ft)
1	Sand, silty sand, clayey sand, silty gravel & clayey gravel	2000.000	150.000

Tabulation of Loads

Load Component	ASD	LRFD
P (kip)	5.264	8.437
V_x (kip)	-1.804	-3.017
V_z (kip)	0.194	0.304
M_x (kipft)	0.602	0.956
M_z (kipft)	20.109	33.811

Material Properties

$f'_{ck} = 2.5$ ksi - Concrete strength,

Required depth to resist lateral loads (ASD)

H - Point of application of the lateral load

$$H = h_1 + h_2 + h_e$$

$$H = (0 \text{ ft}) + (0 \text{ ft}) + (0 \text{ ft})$$

$$H = 0 \text{ ft}$$

Considering x-direction:

H_o - Lateral force per length of pile,

$$H_o = \frac{V_x}{1.57\, D}$$

$$H_o = \frac{(-1.804 \text{ kip})}{1.57 \times (48 \text{ in})}$$

$$H_o = -0.28726 \text{ kip/ft}$$

M_o - Moment per length of pile,

$$M_o = \frac{M_z + (V_x\,H)}{1.57\,D}$$

$$M_o = \frac{(20.109\text{ kipft}) + ((-1.804\text{ kip}) \times (0\text{ ft}))}{1.57 \times (48\text{ in})}$$

$$M_o = 3.2021\text{ kipft/ft}$$

Required depth of embedment in earth:

$$L_x^3 - \left(14.14 \times \frac{H_o \times L_x}{R}\right) - \left(18.85 \times \frac{M_o}{R}\right) = 0$$

Solving the cubic equation:
$L_{e,x} = 5.4533\text{ ft}$ - Required depth in x-direction,

Considering z-direction:

H_o - Lateral force per length of pile,

$$H_o = \frac{V_z}{1.57\,b}$$

$$H_o = \frac{(0.194\text{ kip})}{1.57 \times (48\text{ in})}$$

$$H_o = 0.030892\text{ kip/ft}$$

M_o - Moment per length of pile,

$$M_o = \frac{M_x + (V_z\,H)}{1.57\,b}$$

$$M_o = \frac{(0.602\text{ kipft}) + ((0.194\text{ kip}) \times (0\text{ ft}))}{1.57 \times (48\text{ in})}$$

$$M_o = 0.09586\text{ kipft/ft}$$

Required depth of embedment in earth:

$$L_z^3 - \left(14.14 \times \frac{H_o \times L_z}{R}\right) - \left(18.85 \times \frac{M_o}{R}\right) = 0$$

Solving the cubic equation:
$L_{e,z} = 2.2831\text{ ft}$ - Required depth in z-direction,

Minimum embedded depth required:

$L_{e,req}$ - Depth of pile required,

$$L_{e,req} = MAX[L_{e,x}, L_{e,z}]$$

$$L_{e,req} = MAX[(5.4533\text{ ft}), (2.2831\text{ ft})]$$

$$L_{e,req} = 5.453\text{ ft}$$

L_e - Actual embedded length of pile,

$$L_e = L - h_e - h_2$$

$$L_e = (5.75\text{ ft}) - (0\text{ ft}) - (0\text{ ft})$$

$$L_e = 5.75\text{ ft}$$

$Ratio$ - Embedded depth

$$Ratio = \frac{L_{e,req}}{L_e}$$

$$Ratio = \frac{(5.453\text{ ft})}{(5.75\text{ ft})}$$

$$Ratio = 0.94835$$

Status: **PASS**
Ratio: **0.950**

End-bearing Capacity (ASD)

A - Pile cross-section area

$$A = b\,D$$

$$A = (48\text{ in}) \times (48\text{ in})$$

$$A = 16\text{ ft}^2$$

q - End-bearing pressure

$$q = \frac{P_v}{A}$$

$$q = \frac{(5.264\ \mathrm{kip})}{(16\ \mathrm{ft}^2)}$$

$$q = 0.329\ \mathrm{kip/ft}^2$$

Check bearing capacity ratio:

$Ratio$ - Capacity

$$Ratio = \frac{q}{q_a}$$

$$Ratio = \frac{\left(0.329\ \mathrm{kip/ft}^2\right)}{(2000\ \mathrm{psf})}$$

$$Ratio = 0.1645$$

Status: **PASS**
Ratio: **0.160**

Czerniak

Lateral Soil Pressure (ASD):

L/D - Length to least lateral dimension ratio,

$$L/D = \frac{L}{D}$$

$$L/D = \frac{(5.75\ \mathrm{ft})}{(48\ \mathrm{in})}$$

$$L/D = 1.4375$$

Since L/D $\leq$ 10,

Pile is short.

Considering x-direction:

$H_o = -0.28726\ \mathrm{kip/ft}$ - Lateral force per length of pile,
$M_o = 3.2021\ \mathrm{kipft/ft}$ - Overturning moment per length of pile,
a - Distance from resting surface to pivot point,

$$a = \frac{(4\,M_o\,L_e) + \left(3\,H_o\,L_e^2\right)}{(6\,M_o) + (4\,H_o\,L_e)}$$

$$a = \frac{(4 \times (3.2021\ \mathrm{kipft/ft}) \times (5.75\ \mathrm{ft})) + \left(3 \times (-0.28726\ \mathrm{kip/ft}) \times (5.75\ \mathrm{ft})^2\right)}{(6 \times (3.2021\ \mathrm{kipft/ft})) + (4 \times (-0.28726\ \mathrm{kip/ft}) \times (5.75\ \mathrm{ft}))}$$

$$a = 3.9559\ \mathrm{ft}$$

p - Earth pressure against the pile at distance a/2 from resting surface,

$$p = \frac{0.75\,[(4\,M_o) + (3\,H_o\,L_e)]^2}{L_e^2\,[(3\,M_o) + (2\,H_o\,L_e)]}$$

$$p = \frac{0.75 \times [(4 \times (3.2021\ \mathrm{kipft/ft})) + (3 \times (-0.28726\ \mathrm{kip/ft}) \times (5.75\ \mathrm{ft}))]^{\,2}}{(5.75\ \mathrm{ft})^2 \times [(3 \times (3.2021\ \mathrm{kipft/ft})) + (2 \times (-0.28726\ \mathrm{kip/ft}) \times (5.75\ \mathrm{ft}))]}$$

$$p = 0.22196\ \mathrm{kip/ft}^2$$

s - Earth pressure against the pile at distance L_e,

$$s = \frac{6\,[(2\,M_o) + (H_o\,L_e)]}{L_e^2}$$

$$s = \frac{6 \times [(2 \times (3.2021\ \mathrm{kipft/ft})) + ((-0.28726\ \mathrm{kip/ft}) \times (5.75\ \mathrm{ft}))]}{(5.75\ \mathrm{ft})^2}$$

$$s = 0.86244\ \mathrm{kip/ft}^2$$

Check lateral soil pressure capacity:

p_a - Allowable lateral soil pressure at depth a/2,

$$p_a = R\,\frac{a}{2}$$

$$p_a = (150\ \mathrm{psf/ft}) \times \frac{(3.9559\ \mathrm{ft})}{2}$$

$$p_a = 0.2967\ \mathrm{kip/ft}^2$$

$Ratio$ - Lateral soil capacity

$$Ratio = \frac{p}{p_a}$$

$$Ratio = \frac{\left(0.22196\ \mathrm{kip/ft^2}\right)}{\left(0.2967\ \mathrm{kip/ft^2}\right)}$$

$$Ratio = 0.7481$$

Status: **PASS**
Ratio: **0.750**

p_s - Allowable lateral soil pressure at depth L_e,

$$p_s = R\,L_e$$

$$p_s = (150\ \mathrm{psf/ft}) \times (5.75\ \mathrm{ft})$$

$$p_s = 0.8625\ \mathrm{kip/ft^2}$$

$Ratio$ - Lateral soil capacity

$$Ratio = \frac{s}{p_s}$$

$$Ratio = \frac{\left(0.86244\ \mathrm{kip/ft^2}\right)}{\left(0.8625\ \mathrm{kip/ft^2}\right)}$$

$$Ratio = 0.99993$$

Status: **PASS**
Ratio: **1.000**

Considering z-direction:

$H_o = 0.030892\ \mathrm{kip/ft}$ - Lateral force per length of pile,
$M_o = 0.09586\ \mathrm{kipft/ft}$ - Overturning moment per length of pile,
a - Distance from resting surface to pivot point,

$$a = \frac{(4\,M_o\,L_e) + \left(3\,H_o\,L_e^2\right)}{(6\,M_o) + (4\,H_o\,L_e)}$$

$$a = \frac{(4 \times (0.09586\ \mathrm{kipft/ft}) \times (5.75\ \mathrm{ft})) + \left(3 \times (0.030892\ \mathrm{kip/ft}) \times (5.75\ \mathrm{ft})^2\right)}{(6 \times (0.09586\ \mathrm{kipft/ft})) + (4 \times (0.030892\ \mathrm{kip/ft}) \times (5.75\ \mathrm{ft}))}$$

$$a = 4.0981\ \mathrm{ft}$$

p - Earth pressure against the pile at distance a/2 from resting surface,

$$p = \frac{0.75\,[(4\,M_o) + (3\,H_o\,L_e)]^2}{L_e^2\,[(3\,M_o) + (2\,H_o\,L_e)]}$$

$$p = \frac{0.75 \times [(4 \times (0.09586\ \mathrm{kipft/ft})) + (3 \times (0.030892\ \mathrm{kip/ft}) \times (5.75\ \mathrm{ft}))]^2}{(5.75\ \mathrm{ft})^2 \times [(3 \times (0.09586\ \mathrm{kipft/ft})) + (2 \times (0.030892\ \mathrm{kip/ft}) \times (5.75\ \mathrm{ft}))]}$$

$$p = 0.029629\ \mathrm{kip/ft^2}$$

s - Earth pressure against the pile at distance L_e,

$$s = \frac{6\,[(2\,M_o) + (H_o\,L_e)]}{L_e^2}$$

$$s = \frac{6 \times [(2 \times (0.09586\ \mathrm{kipft/ft})) + ((0.030892\ \mathrm{kip/ft}) \times (5.75\ \mathrm{ft}))]}{(5.75\ \mathrm{ft})^2}$$

$$s = 0.067027\ \mathrm{kip/ft^2}$$

Check lateral soil pressure capacity:

p_a - Allowable lateral soil pressure at depth a/2,

$$p_a = R\,\frac{a}{2}$$

$$p_a = (150\ \mathrm{psf/ft}) \times \frac{(4.0981\ \mathrm{ft})}{2}$$

$$p_a = 0.30736\ \mathrm{kip/ft^2}$$

$Ratio$ - Lateral soil capacity

$$Ratio = \frac{p}{p_a}$$

$$Ratio = \frac{\left(0.029629\ \mathrm{kip/ft^2}\right)}{\left(0.30736\ \mathrm{kip/ft^2}\right)}$$

$$Ratio = 0.0964$$

Status: **PASS**
Ratio: **0.100**

p_s - Allowable lateral soil pressure at depth L_e,

$$p_s = R\,L_e$$

$$p_s = (150\ \mathrm{psf/ft}) \times (5.75\ \mathrm{ft})$$

$$p_s = 0.8625\ \mathrm{kip/ft^2}$$

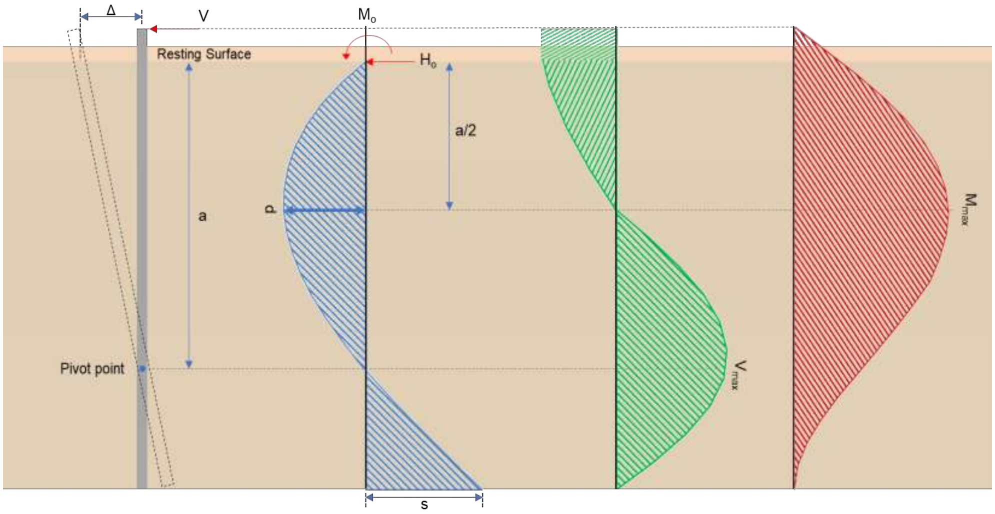
$Ratio$ - Lateral soil capacity

$$Ratio = \frac{s}{p_s}$$

$$Ratio = \frac{(0.067027\ \mathrm{kip/ft^2})}{(0.8625\ \mathrm{kip/ft^2})}$$

$$Ratio = 0.077713$$

Status: **PASS**
Ratio: **0.080**



Pile Rotation
Pressure Diagram
Shear Diagram
Moment Diagram

Shear force and Bending moment (x-direction, LRFD)

H_o - Lateral force per length of pile,

$$H_o = \frac{V_x}{1.57\,D}$$

$$H_o = \frac{(-3.017\ \mathrm{kip})}{1.57 \times (48\ \mathrm{in})}$$

$$H_o = -0.48041\ \mathrm{kip/ft}$$

M_o - Moment per length of pile,

$$M_o = \frac{M_z + (V_x\,H)}{1.57\,D}$$

$$M_o = \frac{(33.811\ \mathrm{kipft}) + ((-3.017\ \mathrm{kip}) \times (0\ \mathrm{ft}))}{1.57 \times (48\ \mathrm{in})}$$

$$M_o = 5.3839\ \mathrm{kipft/ft}$$

E - Distance from lateral load to resisting surface,

$$E = \frac{M_o}{H_o}$$

$$E = \frac{(5.3839\ \mathrm{kipft/ft})}{(-0.48041\ \mathrm{kip/ft})}$$

$$E = 11.207\ \mathrm{ft}$$

a - Distance from resting surface to pivot point,

$$a = \frac{(4\,M_o\,L_e) + \left(3\,H_o\,L_e^2\right)}{(6\,M_o) + (4\,H_o\,L_e)}$$

$$a = \frac{(4 \times (5.3839\ \mathrm{kipft/ft}) \times (5.75\ \mathrm{ft})) + \left(3 \times (-0.48041\ \mathrm{kip/ft}) \times (5.75\ \mathrm{ft})^2\right)}{}$$

$$a = \frac{}{(6 \times (5.3839 \text{ kipft/ft})) + (4 \times (-0.48041 \text{ kip/ft}) \times (5.75 \text{ ft}))}$$

$$a = 3.9555 \text{ ft}$$

V_{max} - Max shear force located at depth a,

$$V_{max} = (H_o\, D) \left[1 - \left[3 \left(\frac{4\,E}{L_e} + 3\right) \left(\frac{a}{L_e}\right)^2\right] + \left[4 \left(\frac{3\,E}{L_e} + 2\right) \left(\frac{a}{L_e}\right)^3\right]\right]$$

$$V_{max} = ((-0.48041 \text{ kip/ft}) \times (48 \text{ in})) \times \left[1 - \left[3 \times \left(\frac{4 \times (11.207 \text{ ft})}{(5.75 \text{ ft})} + 3\right) \times \left(\frac{(3.9555 \text{ ft})}{(5.75 \text{ ft})}\right)^2\right] + \left[4 \times \left(\frac{3 \times (11.207 \text{ ft})}{(5.75 \text{ ft})} + 2\right) \times \left(\frac{(3.9555 \text{ ft})}{(5.75 \text{ ft})}\right)^3\right]\right]$$

$$V_{max} = 7.8958 \text{ kip}$$

M_{max} - Max bending moment located at depth a/2,

$$M_{max} = (H_o\, D\, L_e) \left[\left(\frac{E}{L_e} + \frac{a}{2\,L_e}\right) - \left[\left(\frac{4\,E}{L_e} + 3\right) \left(\frac{a}{2\,L_e}\right)^3\right] + \left[\left(\frac{3\,E}{L_e} + 2\right) \left(\frac{a}{2\,L_e}\right)^4\right]\right]$$

$$M_{max} = ((-0.48041 \text{ kip/ft}) \times (48 \text{ in}) \times (5.75 \text{ ft})) \times \left[\left(\frac{(11.207 \text{ ft})}{(5.75 \text{ ft})} + \frac{(3.9555 \text{ ft})}{2 \times (5.75 \text{ ft})}\right) - \left[\left(\frac{4 \times (11.207 \text{ ft})}{(5.75 \text{ ft})} + 3\right) \times \left(\frac{(3.9555 \text{ ft})}{2 \times (5.75 \text{ ft})}\right)^3\right] + \left[\left(\frac{3 \times (11.207 \text{ ft})}{(5.75 \text{ ft})} + 2\right) \times \left(\frac{(3.9555 \text{ ft})}{2 \times (5.75 \text{ ft})}\right)^4\right]\right]$$

$$M_{max} = 21.696 \text{ kipft}$$

Shear force and Bending moment (z-direction, LRFD)

H_o - Lateral force per length of pile,

$$H_o = \frac{V_z}{1.57\,b}$$

$$H_o = \frac{(0.304 \text{ kip})}{1.57 \times (48 \text{ in})}$$

$$H_o = 0.048408 \text{ kip/ft}$$

M_o - Moment per length of pile,

$$M_o = \frac{M_x + (V_z\, H)}{1.57\,b}$$

$$M_o = \frac{(0.956 \text{ kipft}) + ((0.304 \text{ kip}) \times (0 \text{ ft}))}{1.57 \times (48 \text{ in})}$$

$$M_o = 0.15223 \text{ kipft/ft}$$

E - Distance from lateral load to resisting surface,

$$E = \frac{M_o}{H_o}$$

$$E = \frac{(0.15223 \text{ kipft/ft})}{(0.048408 \text{ kip/ft})}$$

$$E = 3.1447 \text{ ft}$$

a - Distance from resting surface to pivot point,

$$a = \frac{(4\,M_o\,L_e) + \left(3\,H_o\,L_e^2\right)}{(6\,M_o) + (4\,H_o\,L_e)}$$

$$a = \frac{(4 \times (0.15223 \text{ kipft/ft}) \times (5.75 \text{ ft})) + \left(3 \times (0.048408 \text{ kip/ft}) \times (5.75 \text{ ft})^2\right)}{(6 \times (0.15223 \text{ kipft/ft})) + (4 \times (0.048408 \text{ kip/ft}) \times (5.75 \text{ ft}))}$$

$$a = 4.0966 \text{ ft}$$

V_{max} - Max shear force located at depth a,

$$V_{max} = (H_o\, b) \left[1 - \left[3 \left(\frac{4\,E}{L_e} + 3\right) \left(\frac{a}{L_e}\right)^2\right] + \left[4 \left(\frac{3\,E}{L_e} + 2\right) \left(\frac{a}{L_e}\right)^3\right]\right]$$

$$V_{max} = ((0.048408\ \text{kip/ft}) \times (48\ \text{in})) \times \left[1 - \left[3 \times \left(\frac{4 \times (3.1447\ \text{ft})}{(5.75\ \text{ft})} + 3\right) \times \left(\frac{(4.0966\ \text{ft})}{(5.75\ \text{ft})}\right)^2\right] + \left[4 \times \left(\frac{3 \times (3.1447\ \text{ft})}{(5.75\ \text{ft})} + 2\right) \times \left(\frac{(4.0966\ \text{ft})}{(5.75\ \text{ft})}\right)^3\right]\right]$$

$$V_{max} = 0.31622\ \text{kip}$$

M_{max} - Max bending moment located at depth a/2,

$$M_{max} = (H_o\, b\, L_e)\left[\left(\frac{E}{L_e} + \frac{a}{2\, L_e}\right) - \left[\left(\frac{4\, E}{L_e} + 3\right)\left(\frac{a}{2\, L_e}\right)^3\right] + \left[\left(\frac{3\, E}{L_e} + 2\right)\left(\frac{a}{2\, L_e}\right)^4\right]\right]$$

$$M_{max} = ((0.048408\ \text{kip/ft}) \times (48\ \text{in}) \times (5.75\ \text{ft})) \times \left[\left(\frac{(3.1447\ \text{ft})}{(5.75\ \text{ft})} + \frac{(4.0966\ \text{ft})}{2 \times (5.75\ \text{ft})}\right) - \left[\left(\frac{4 \times (3.1447\ \text{ft})}{(5.75\ \text{ft})} + 3\right) \times \left(\frac{(4.0966\ \text{ft})}{2 \times (5.75\ \text{ft})}\right)^3\right] + \left[\left(\frac{3 \times (3.1447\ \text{ft})}{(5.75\ \text{ft})} + 2\right) \times \left(\frac{(4.0966\ \text{ft})}{2 \times (5.75\ \text{ft})}\right)^4\right]\right]$$

$$M_{max} = 0.80972\ \text{kipft}$$

Minimum Reinforcement Check (LRFD)

Parameters:

$f'_{ck} = 2.5\ \text{ksi}$ - Concrete strength,
$f_{yk} = 60\ \text{ksi}$ - Longitudinal reinforcement strength,
$\phi = 0.65$ - Reduction factor for axial strength,
Table 22.4.2.1 $\alpha = 0.8$ - Alpha factor for axial strength,
$A_g = 2304\ \text{in}^2$ - Gross area of concrete,

Longitudinal reinforcement:

Required reinforcement due to axial load, $A_{st,required}$

22.4.2.2, 10.6.1.1 $A_{st,required}$

$$A_{st,required} = Min\left[\frac{\frac{P}{\phi\,\alpha} - (0.85\, f'_{ck}\, A_g)}{f_{yk} - (0.85\, f'_{ck})}, (0.08\, A_g)\right]$$

$$A_{st,required} = Min\left[\frac{\frac{(8.437\ \text{kip})}{(0.65)\times(0.8)} - (0.85 \times (2.5\ \text{ksi}) \times (2304\ \text{in}^2))}{(60\ \text{ksi}) - (0.85 \times (2.5\ \text{ksi}))}, (0.08 \times (2304\ \text{in}^2))\right]$$

$$A_{st,required} = -84.316\ \text{in}^2$$

A_{min} - Governing minimum reinforcement area,

$$A_{min} = Max\left[A_{st,required}, (0.0018\, A_g)\right]$$

$$A_{min} = Max\left[(-84.316\ \text{in}^2), (0.0018 \times (2304\ \text{in}^2))\right]$$

$$A_{min} = 4.1472\ \text{in}^2$$

n_{rebar} - Required number of reinforcement,

$$n_{rebar} = \frac{A_{min}}{A_{rebar}}$$

$$n_{rebar} = \frac{(4.1472\ \text{in}^2)}{(0.3068\ \text{in}^2)}$$

$$n_{rebar} = 14$$

A_{st} - Actual total reinforcement area,

$$A_{st} = n_{rebar}\, \frac{\pi\, d_{bar}^2}{4}$$

$$A_{st} = (14) \times \frac{\pi \times (0.625\ \text{in})^2}{4}$$

$$A_{st} = 4.2951\ \text{in}^2$$

$Ratio$ - Capacity

$$Ratio = \frac{A_{min}}{A_{st}}$$

$$Ratio = \frac{(4.1472\ \text{in}^2)}{(4.2951\ \text{in}^2)}$$

$$Ratio = 0.96556$$

Status: PASS
Ratio: 0.970

25.2.3 s_{rebar} - Minimum spacing of reinforcement,

$$s_{rebar} = Max\left[1.5, \left(1.5\ d_{bar}\right)\right]$$

$$s_{rebar} = Max\left[1.5, \left(1.5 \times (0.625\ \text{in})\right)\right]$$

$$s_{rebar} = 1.5\ \text{in}$$

Ties:

25.7.2.2 Since longitudinal reinforcement is $\leq$ No. 10ø: Use #3(0.375 in)

25.7.2.1 s_{ties} - Maximum spacing of ties,

$$s_{ties} = Min\left[\left(16\ d_{bar}\right), \left(48\ d_{ties}\right), Min\left(D, b\right)\right]$$

$$s_{ties} = Min\left[\left(16 \times (0.625\ \text{in})\right), \left(48 \times (0.375\ \text{in})\right), Min\left((48\ \text{in}), (48\ \text{in})\right)\right]$$

$$s_{ties} = 10\ \text{in}$$

Summary:

Main reinforcement: **14 - #5 (0.625 in)**
Ties: **#3(0.375 in) - 10 in**

Axial Compression Strength (ACI 318-19, LRFD)

22.4.2.2 ϕP_N - Allowable axial compressive strength

$$\phi P_N = \phi\ 0.80\ \left[\left(0.85\ f'_{ck}\ \left[A_g - A_{st}\right]\right) + \left(f_{yk}\ A_{st}\right)\right]$$

$$\phi P_N = (0.65) \times 0.80 \times \left[\left(0.85 \times (2.5\ \text{ksi}) \times \left[\left(2304\ \text{in}^2\right) - \left(4.2951\ \text{in}^2\right)\right]\right) + \left((60\ \text{ksi}) \times \left(4.2951\ \text{in}^2\right)\right)\right]$$

$$\phi P_N = 2675.2\ \text{kip}$$

$Ratio$ - Capacity

$$Ratio = \frac{P}{\phi P_N}$$

$$Ratio = \frac{(8.437\ \text{kip})}{(2675.2\ \text{kip})}$$

$$Ratio = 0.0031538$$

Status: PASS
Ratio: 0.000

Shear Strength (ACI 318-19, LRFD)

Parameters:

$b_w = 48\ \text{in}$ - Effective width,

22.5.2.2 d - Effective depth

$$d = 0.80\ D$$

$$d = 0.80 \times (48\ \text{in})$$

$$d = 38.4\ \text{in}$$

22.5.5.1.3 λ_s - size effect modification factor

$$\lambda_s = MIN\left[\sqrt{\frac{2}{1 + \frac{d}{10}}}, 1\right]$$

$$\lambda_s = MIN\left[\sqrt{\frac{2}{1 + \frac{(38.4\ \text{in})}{10}}}, 1\right]$$

$$\lambda_s = 0.64282$$

The following variables were converted to be consistent with empirical formula $f'_{ck} = 2.5\ \text{ksi} \rightarrow 2500\ \text{psi}$,

22.5.5.1.1 $V_{c,max}$ - Max shear strength of concrete

$$V_{c,max} = 5\ \lambda_s\ \sqrt{f'_{ck}}\ b_w\ d$$

$$V_{c,max} = 5 \times (0.64282) \times \sqrt{(2500\ \text{psi})} \times (48\ \text{in}) \times (38.4\ \text{in})$$

$$V_{c,max} = 296.21 \text{ kip}$$

The following variables were converted to be consistent with empirical formula $f'_{ck} = 2.5 \text{ ksi} \rightarrow 2500 \text{ psi}$, $P = 8.437 \text{ kip} \rightarrow 8437 \text{ lbf}$,

22.5.5.1.1(a) $V_{c,a}$ - Shear strength of concrete (a)

$$V_{c,a} = \left[2\,\lambda_s\,\sqrt{f'_{ck}} + \frac{P}{6\,A_g}\right]\,b_w\,d$$

$$V_{c,a} = \left[2 \times (0.64282) \times \sqrt{(2500 \text{ psi})} + \frac{(8437 \text{ lbf})}{6 \times (2304 \text{ in}^2)}\right] \times (48 \text{ in}) \times (38.4 \text{ in})$$

$$V_{c,a} = 119.61 \text{ kip}$$

The following variables were converted to be consistent with empirical formula $f'_{ck} = 2.5 \text{ ksi} \rightarrow 2500 \text{ psi}$,

22.5.5.1.2 $V_{c,b}$ - Shear strength of concrete (b)

$$V_{c,b} = \left[2\,\lambda_s\,\sqrt{f'_{ck}} + \left(0.05\,f'_{ck}\right)\right]\,b_w\,d$$

$$V_{c,b} = \left[2 \times (0.64282) \times \sqrt{(2500 \text{ psi})} + (0.05 \times (2500 \text{ psi}))\right] \times (48 \text{ in}) \times (38.4 \text{ in})$$

$$V_{c,b} = 348.89 \text{ kip}$$

V_c - Governing shear strength of concrete

$$V_c = Min\left[V_{c,max}, V_{c,a}, V_{c,b}\right]$$

$$V_c = Min\left[(296.21 \text{ kip}), (119.61 \text{ kip}), (348.89 \text{ kip})\right]$$

$$V_c = 119.61 \text{ kip}$$

The following variables were converted to be consistent with empirical formula $f'_{ck} = 2.5 \text{ ksi} \rightarrow 2500 \text{ psi}$,

22.5.1.2 $V_{s,a}$ - Shear strength of steel (a)

$$V_{s,a} = 8\,\sqrt{f'_{ck}}\,b_w\,d$$

$$V_{s,a} = 8 \times \sqrt{(2500 \text{ psi})} \times (48 \text{ in}) \times (38.4 \text{ in})$$

$$V_{s,a} = 737.28 \text{ kip}$$

A_v - Ties rebar area,

$$A_v = \frac{\pi\,d_{ties}^2}{4}$$

$$A_v = \frac{\pi \times (0.375 \text{ in})^2}{4}$$

$$A_v = 0.11045 \text{ in}^2$$

22.5.8.5.3 $V_{s,b}$ - Shear strength of steel (b)

$$V_{s,b} = \frac{2\,A_v\,f_{ywk}\,d}{s_{ties}}$$

$$V_{s,b} = \frac{2 \times \left(0.11045 \text{ in}^2\right) \times (60 \text{ ksi}) \times (38.4 \text{ in})}{(10 \text{ in})}$$

$$V_{s,b} = 50.894 \text{ kip}$$

V_s - Governing shear strength of steel

$$V_s = MIN\left[V_{s,a}, V_{s,b}\right]$$

$$V_s = MIN\left[(737.28 \text{ kip}), (50.894 \text{ kip})\right]$$

$$V_s = 50.894 \text{ kip}$$

22.5.1.1 ϕV_n - Allowable shear strength

$$\phi V_n = \phi\,\left(V_c + V_s\right)$$

$$\phi V_n = (0.65) \times ((119.61 \text{ kip}) + (50.894 \text{ kip}))$$

$$\phi V_n = 110.83 \text{ kip}$$

Considering x-direction:

$V_{max} = 7.8958 \text{ kip}$ - Maximum shear force in the x-direction,
$Ratio$ - Capacity

$$Ratio = \frac{V_{max}}{\phi V_n}$$

$$Ratio = \frac{(7.8958 \text{ kip})}{(110.83 \text{ kip})}$$

$$Ratio = 0.071244$$

Status: **PASS**
Ratio: **0.070**

Considering z-direction:

$V_{max} = 0.31622$ kip - Maximum shear force in the z-direction,
$Ratio$ - Capacity

$$Ratio = \frac{V_{max}}{\phi V_n}$$

$$Ratio = \frac{(0.31622 \text{ kip})}{(110.83 \text{ kip})}$$

$$Ratio = 0.0028533$$

Status: **PASS**
Ratio: **0.000**

Flexural Strength (ACI 318-19, LRFD)

S_m - Section modulus

$$S_m = \frac{b\,D^2}{6}$$

$$S_m = \frac{(48 \text{ in}) \times (48 \text{ in})^2}{6}$$

$$S_m = 18432 \text{ in}^3$$

$\lambda = 1$ - Concrete modification factor (Normal concrete),
Allowable flexural strength:
M_n shall be the lesser of:
$\phi M_{n,1}$

$$\phi M_{n,1} = \phi \times 5 \times \lambda \times \sqrt{(f_c')} \times S_m$$

$$\phi M_{n,1} = 0.65 \times 5 \times 1 \times \sqrt{(2.5ksi)} \times 18432.001in^3$$

$$\phi M_{n,1} = 249.600kipft$$

14.5.2.1b $\phi M_{n,2}$

$$\phi M_{n,2} = \phi\; 0.85\; f_{ck}'\; S_m$$

$$\phi M_{n,2} = (0.65) \times 0.85 \times (2.5 \text{ ksi}) \times \left(18432 \text{ in}^3\right)$$

$$\phi M_{n,2} = 2121.6 \text{ kipft}$$

Therefore,
ϕM_n - Allowable flexural strength,

$$\phi M_n = MIN[\phi M_{n,1}, \phi M_{n,2}]$$

$$\phi M_n = MIN[(249.6 \text{ kipft}), (2121.6 \text{ kipft})]$$

$$\phi M_n = 249.6 \text{ kipft}$$

Considering x-direction:

$M_{max} = 21.696$ kipft - Maximum moment in the x-direction,
$Ratio$ - Capacity

$$Ratio = \frac{M_{max}}{\phi M_n}$$

$$Ratio = \frac{(21.696 \text{ kipft})}{(249.6 \text{ kipft})}$$

$$Ratio = 0.086922$$

Status: **PASS**
Ratio: **0.090**

Considering z-direction:

$M_{max} = 0.80972$ kipft - Maximum moment in the z-direction,
$Ratio$ - Capacity

$$Ratio = \frac{M_{max}}{\phi M_n}$$

	$$Ratio = \frac{(0.80972\ \text{kipft})}{(249.6\ \text{kipft})}$$ $$Ratio = 0.0032441$$	Status: **PASS** Ratio: **0.000**

REFERENCES	CALCULATIONS	RESULTS

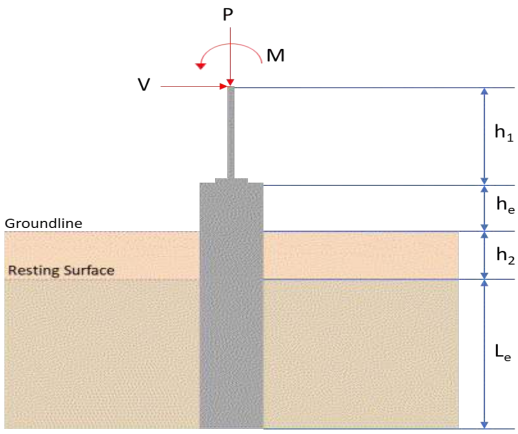
SkyCiv Foundation Design

Pile Foundation

Design Information :

Design code : IBC 2021 (International Building Code)
Unit System : Imperial

Pile Input



Geometry

Pile shape: rectangular

$b = 48$ in - Pile width

$D = 48$ in - Pile depth

$L = 5.75$ ft - Total pile length

$h_1 = 0$ ft - Lateral load height from the top of the pile,

$h_2 = 0$ ft - Depth to resisting surface

$h_e = 0$ ft - Length of pile above the ground

Tabulation of Soil Parameters

Layer	Label	Allowable Bearing Pressure (q_a) (psf)	Allowable Lateral Pressure (R) (psf/ft)
1	Sand, silty sand, clayey sand, silty gravel & clayey gravel	2000.000	150.000

Tabulation of Loads

Load Component	ASD	LRFD
P (kip)	5.264	8.437
V_x (kip)	-1.804	-3.017
V_z (kip)	-0.194	-0.304
M_x (kipft)	-0.602	-0.956
M_z (kipft)	20.109	33.812

Material Properties

$f'_{ck} = 2.5$ ksi - Concrete strength,

Required depth to resist lateral loads (ASD)

H - Point of application of the lateral load

$$H = h_1 + h_2 + h_e$$

$$H = (0\text{ ft}) + (0\text{ ft}) + (0\text{ ft})$$

$$H = 0\text{ ft}$$

Considering x-direction:

H_o - Lateral force per length of pile,

$$H_o = \frac{V_x}{1.57\,D}$$

$$H_o = \frac{(-1.804\text{ kip})}{1.57 \times (48\text{ in})}$$

$$H_o = -0.28726\text{ kip/ft}$$

M_o - Moment per length of pile,

$$M_o = \frac{M_z + (V_x\, H)}{1.57\, D}$$

$$M_o = \frac{(20.109 \text{ kipft}) + ((-1.804 \text{ kip}) \times (0 \text{ ft}))}{1.57 \times (48 \text{ in})}$$

$$M_o = 3.2021 \text{ kipft/ft}$$

Required depth of embedment in earth:

$$L_x^3 - \left(14.14 \times \frac{H_o \times L_x}{R}\right) - \left(18.85 \times \frac{M_o}{R}\right) = 0$$

Solving the cubic equation:
$L_{e,x} = 5.4533 \text{ ft}$ - Required depth in x-direction,

Considering z-direction:

H_o - Lateral force per length of pile,

$$H_o = \frac{V_z}{1.57\, b}$$

$$H_o = \frac{(-0.194 \text{ kip})}{1.57 \times (48 \text{ in})}$$

$$H_o = -0.030892 \text{ kip/ft}$$

M_o - Moment per length of pile,

$$M_o = \frac{M_x + (V_z\, H)}{1.57\, b}$$

$$M_o = \frac{(0.602 \text{ kipft}) + ((-0.194 \text{ kip}) \times (0 \text{ ft}))}{1.57 \times (48 \text{ in})}$$

$$M_o = 0.09586 \text{ kipft/ft}$$

Required depth of embedment in earth:

$$L_z^3 - \left(14.14 \times \frac{H_o \times L_z}{R}\right) - \left(18.85 \times \frac{M_o}{R}\right) = 0$$

Solving the cubic equation:
$L_{e,z} = 1.6618 \text{ ft}$ - Required depth in z-direction,

Minimum embedded depth required:

$L_{e,req}$ - Depth of pile required,

$$L_{e,req} = MAX[L_{e,x}, L_{e,z}]$$

$$L_{e,req} = MAX[(5.4533 \text{ ft}), (1.6618 \text{ ft})]$$

$$L_{e,req} = 5.453 \text{ ft}$$

L_e - Actual embedded length of pile,

$$L_e = L - h_e - h_2$$

$$L_e = (5.75 \text{ ft}) - (0 \text{ ft}) - (0 \text{ ft})$$

$$L_e = 5.75 \text{ ft}$$

$Ratio$ - Embedded depth

$$Ratio = \frac{L_{e,req}}{L_e}$$

$$Ratio = \frac{(5.453 \text{ ft})}{(5.75 \text{ ft})}$$

$$Ratio = 0.94835$$

Status: **PASS**
Ratio: **0.950**

End-bearing Capacity (ASD)

A - Pile cross-section area

$$A = b\, D$$

$$A = (48 \text{ in}) \times (48 \text{ in})$$

$$A = 16 \text{ ft}^2$$

q - End-bearing pressure

$$q = \frac{P_v}{A}$$

$$q = \frac{(5.264\ \text{kip})}{(16\ \text{ft}^2)}$$

$$q = 0.329\ \text{kip/ft}^2$$

Check bearing capacity ratio:

$Ratio$ - Capacity

$$Ratio = \frac{q}{q_a}$$

$$Ratio = \frac{\left(0.329\ \text{kip/ft}^2\right)}{(2000\ \text{psf})}$$

$$Ratio = 0.1645$$

Status: **PASS**
Ratio: **0.160**

Czerniak

Lateral Soil Pressure (ASD):

L/D - Length to least lateral dimension ratio,

$$L/D = \frac{L}{D}$$

$$L/D = \frac{(5.75\ \text{ft})}{(48\ \text{in})}$$

$$L/D = 1.4375$$

Since L/D $\leq$ 10,

Pile is short.

Considering x-direction:

$H_o = -0.28726\ \text{kip/ft}$ - Lateral force per length of pile,
$M_o = 3.2021\ \text{kipft/ft}$ - Overturning moment per length of pile,
a - Distance from resting surface to pivot point,

$$a = \frac{(4\,M_o\,L_e) + \left(3\,H_o\,L_e^2\right)}{(6\,M_o) + (4\,H_o\,L_e)}$$

$$a = \frac{(4 \times (3.2021\ \text{kipft/ft}) \times (5.75\ \text{ft})) + \left(3 \times (-0.28726\ \text{kip/ft}) \times (5.75\ \text{ft})^2\right)}{(6 \times (3.2021\ \text{kipft/ft})) + (4 \times (-0.28726\ \text{kip/ft}) \times (5.75\ \text{ft}))}$$

$$a = 3.9559\ \text{ft}$$

p - Earth pressure against the pile at distance a/2 from resting surface,

$$p = \frac{0.75\,[(4\,M_o) + (3\,H_o\,L_e)]^2}{L_e^2\,[(3\,M_o) + (2\,H_o\,L_e)]}$$

$$p = \frac{0.75 \times [(4 \times (3.2021\ \text{kipft/ft})) + (3 \times (-0.28726\ \text{kip/ft}) \times (5.75\ \text{ft}))]^{\ 2}}{(5.75\ \text{ft})^2 \times [(3 \times (3.2021\ \text{kipft/ft})) + (2 \times (-0.28726\ \text{kip/ft}) \times (5.75\ \text{ft}))]}$$

$$p = 0.22196\ \text{kip/ft}^2$$

s - Earth pressure against the pile at distance L_e,

$$s = \frac{6\,[(2\,M_o) + (H_o\,L_e)]}{L_e^2}$$

$$s = \frac{6 \times [(2 \times (3.2021\ \text{kipft/ft})) + ((-0.28726\ \text{kip/ft}) \times (5.75\ \text{ft}))]}{(5.75\ \text{ft})^2}$$

$$s = 0.86244\ \text{kip/ft}^2$$

Check lateral soil pressure capacity:

p_a - Allowable lateral soil pressure at depth a/2,

$$p_a = R\,\frac{a}{2}$$

$$p_a = (150\ \text{psf/ft}) \times \frac{(3.9559\ \text{ft})}{2}$$

$$p_a = 0.2967\ \text{kip/ft}^2$$

$Ratio$ - Lateral soil capacity

$$Ratio = \frac{p}{p_a}$$

$$Ratio = \frac{\left(0.22196\ \mathrm{kip/ft^2}\right)}{\left(0.2967\ \mathrm{kip/ft^2}\right)}$$

$$Ratio = 0.7481$$

Status: **PASS**
Ratio: **0.750**

p_s - Allowable lateral soil pressure at depth L_e,

$$p_s = R\,L_e$$

$$p_s = (150\ \mathrm{psf/ft}) \times (5.75\ \mathrm{ft})$$

$$p_s = 0.8625\ \mathrm{kip/ft^2}$$

$Ratio$ - Lateral soil capacity

$$Ratio = \frac{s}{p_s}$$

$$Ratio = \frac{\left(0.86244\ \mathrm{kip/ft^2}\right)}{\left(0.8625\ \mathrm{kip/ft^2}\right)}$$

$$Ratio = 0.99993$$

Status: **PASS**
Ratio: **1.000**

Considering z-direction:

$H_o = -0.030892\ \mathrm{kip/ft}$ - Lateral force per length of pile,
$M_o = 0.09586\ \mathrm{kipft/ft}$ - Overturning moment per length of pile,
a - Distance from resting surface to pivot point,

$$a = \frac{(4\,M_o\,L_e) + \left(3\,H_o\,L_e^2\right)}{(6\,M_o) + (4\,H_o\,L_e)}$$

$$a = \frac{(4 \times (0.09586\ \mathrm{kipft/ft}) \times (5.75\ \mathrm{ft})) + \left(3 \times (-0.030892\ \mathrm{kip/ft}) \times (5.75\ \mathrm{ft})^2\right)}{(6 \times (0.09586\ \mathrm{kipft/ft})) + (4 \times (-0.030892\ \mathrm{kip/ft}) \times (5.75\ \mathrm{ft}))}$$

$$a = 4.0981\ \mathrm{ft}$$

p - Earth pressure against the pile at distance a/2 from resting surface,

$$p = \frac{0.75\,[(4\,M_o) + (3\,H_o\,L_e)]^2}{L_e^2\,[(3\,M_o) + (2\,H_o\,L_e)]}$$

$$p = \frac{0.75 \times [(4 \times (0.09586\ \mathrm{kipft/ft})) + (3 \times (-0.030892\ \mathrm{kip/ft}) \times (5.75\ \mathrm{ft}))]^2}{(5.75\ \mathrm{ft})^2 \times [(3 \times (0.09586\ \mathrm{kipft/ft})) + (2 \times (-0.030892\ \mathrm{kip/ft}) \times (5.75\ \mathrm{ft}))]}$$

$$p = -0.0074859\ \mathrm{kip/ft^2}$$

s - Earth pressure against the pile at distance L_e,

$$s = \frac{6\,[(2\,M_o) + (H_o\,L_e)]}{L_e^2}$$

$$s = \frac{6 \times [(2 \times (0.09586\ \mathrm{kipft/ft})) + ((-0.030892\ \mathrm{kip/ft}) \times (5.75\ \mathrm{ft}))]}{(5.75\ \mathrm{ft})^2}$$

$$s = 0.0025574\ \mathrm{kip/ft^2}$$

Check lateral soil pressure capacity:

p_a - Allowable lateral soil pressure at depth a/2,

$$p_a = R\,\frac{a}{2}$$

$$p_a = (150\ \mathrm{psf/ft}) \times \frac{(4.0981\ \mathrm{ft})}{2}$$

$$p_a = 0.30736\ \mathrm{kip/ft^2}$$

$Ratio$ - Lateral soil capacity

$$Ratio = \frac{p}{p_a}$$

$$Ratio = \frac{\left(-0.0074859\ \mathrm{kip/ft^2}\right)}{\left(0.30736\ \mathrm{kip/ft^2}\right)}$$

$$Ratio = -0.024356$$

Status: **PASS**
Ratio: **-0.020**

p_s - Allowable lateral soil pressure at depth L_e,

$$p_s = R\,L_e$$

$$p_s = (150\ \mathrm{psf/ft}) \times (5.75\ \mathrm{ft})$$

$$p_s = 0.8625\ \mathrm{kip/ft^2}$$

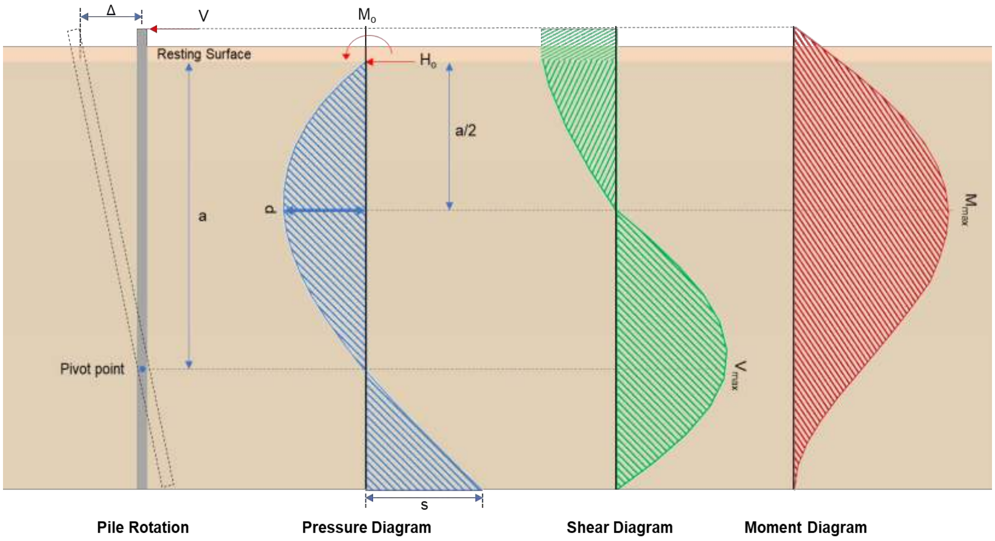
$Ratio$ - Lateral soil capacity

$$Ratio = \frac{s}{p_s}$$

$$Ratio = \frac{(0.0025574\ \mathrm{kip/ft^2})}{(0.8625\ \mathrm{kip/ft^2})}$$

$$Ratio = 0.0029651$$

Status: **PASS**
Ratio: **0.000**



Shear force and Bending moment (x-direction, LRFD)

H_o - Lateral force per length of pile,

$$H_o = \frac{V_x}{1.57\,D}$$

$$H_o = \frac{(-3.017\ \mathrm{kip})}{1.57 \times (48\ \mathrm{in})}$$

$$H_o = -0.48041\ \mathrm{kip/ft}$$

M_o - Moment per length of pile,

$$M_o = \frac{M_z + (V_x\,H)}{1.57\,D}$$

$$M_o = \frac{(33.812\ \mathrm{kipft}) + ((-3.017\ \mathrm{kip}) \times (0\ \mathrm{ft}))}{1.57 \times (48\ \mathrm{in})}$$

$$M_o = 5.3841\ \mathrm{kipft/ft}$$

E - Distance from lateral load to resisting surface,

$$E = \frac{M_o}{H_o}$$

$$E = \frac{(5.3841\ \mathrm{kipft/ft})}{(-0.48041\ \mathrm{kip/ft})}$$

$$E = 11.207\ \mathrm{ft}$$

a - Distance from resting surface to pivot point,

$$a = \frac{(4\,M_o\,L_e) + \left(3\,H_o\,L_e^2\right)}{(6\,M_o) + (4\,H_o\,L_e)}$$

$$a = \frac{(4 \times (5.3841\ \mathrm{kipft/ft}) \times (5.75\ \mathrm{ft})) + \left(3 \times (-0.48041\ \mathrm{kip/ft}) \times (5.75\ \mathrm{ft})^2\right)}{}$$

$$a = \frac{}{(6 \times (5.3841\ \text{kipft/ft})) + (4 \times (-0.48041\ \text{kip/ft}) \times (5.75\ \text{ft}))}$$

$$a = 3.9555\ \text{ft}$$

V_{max} - Max shear force located at depth a,

$$V_{max} = (H_o\ D) \left[1 - \left[3 \left(\frac{4\,E}{L_e} + 3\right) \left(\frac{a}{L_e}\right)^2\right] + \left[4 \left(\frac{3\,E}{L_e} + 2\right) \left(\frac{a}{L_e}\right)^3\right]\right]$$

$$V_{max} = ((-0.48041\ \text{kip/ft}) \times (48\ \text{in})) \times \left[1 - \left[3 \times \left(\frac{4 \times (11.207\ \text{ft})}{(5.75\ \text{ft})} + 3\right) \times \left(\frac{(3.9555\ \text{ft})}{(5.75\ \text{ft})}\right)^2\right] + \left[4 \times \left(\frac{3 \times (11.207\ \text{ft})}{(5.75\ \text{ft})} + 2\right) \times \left(\frac{(3.9555\ \text{ft})}{(5.75\ \text{ft})}\right)^3\right]\right]$$

$$V_{max} = 7.896\ \text{kip}$$

M_{max} - Max bending moment located at depth a/2,

$$M_{max} = (H_o\ D\ L_e) \left[\left(\frac{E}{L_e} + \frac{a}{2\,L_e}\right) - \left[\left(\frac{4\,E}{L_e} + 3\right) \left(\frac{a}{2\,L_e}\right)^3\right] + \left[\left(\frac{3\,E}{L_e} + 2\right) \left(\frac{a}{2\,L_e}\right)^4\right]\right]$$

$$M_{max} = ((-0.48041\ \text{kip/ft}) \times (48\ \text{in}) \times (5.75\ \text{ft})) \times \left[\left(\frac{(11.207\ \text{ft})}{(5.75\ \text{ft})} + \frac{(3.9555\ \text{ft})}{2 \times (5.75\ \text{ft})}\right) - \left[\left(\frac{4 \times (11.207\ \text{ft})}{(5.75\ \text{ft})} + 3\right) \times \left(\frac{(3.9555\ \text{ft})}{2 \times (5.75\ \text{ft})}\right)^3\right] + \left[\left(\frac{3 \times (11.207\ \text{ft})}{(5.75\ \text{ft})} + 2\right) \times \left(\frac{(3.9555\ \text{ft})}{2 \times (5.75\ \text{ft})}\right)^4\right]\right]$$

$$M_{max} = 21.696\ \text{kipft}$$

Shear force and Bending moment (z-direction, LRFD)

H_o - Lateral force per length of pile,

$$H_o = \frac{V_z}{1.57\,b}$$

$$H_o = \frac{(-0.304\ \text{kip})}{1.57 \times (48\ \text{in})}$$

$$H_o = -0.048408\ \text{kip/ft}$$

M_o - Moment per length of pile,

$$M_o = \frac{M_x + (V_z\ H)}{1.57\,b}$$

$$M_o = \frac{(0.956\ \text{kipft}) + ((-0.304\ \text{kip}) \times (0\ \text{ft}))}{1.57 \times (48\ \text{in})}$$

$$M_o = 0.15223\ \text{kipft/ft}$$

E - Distance from lateral load to resisting surface,

$$E = \frac{M_o}{H_o}$$

$$E = \frac{(0.15223\ \text{kipft/ft})}{(-0.048408\ \text{kip/ft})}$$

$$E = 3.1447\ \text{ft}$$

a - Distance from resting surface to pivot point,

$$a = \frac{(4\,M_o\,L_e) + \left(3\,H_o\,L_e^2\right)}{(6\,M_o) + (4\,H_o\,L_e)}$$

$$a = \frac{(4 \times (0.15223\ \text{kipft/ft}) \times (5.75\ \text{ft})) + \left(3 \times (-0.048408\ \text{kip/ft}) \times (5.75\ \text{ft})^2\right)}{(6 \times (0.15223\ \text{kipft/ft})) + (4 \times (-0.048408\ \text{kip/ft}) \times (5.75\ \text{ft}))}$$

$$a = 4.0966\ \text{ft}$$

V_{max} - Max shear force located at depth a,

$$V_{max} = (H_o\ b) \left[1 - \left[3 \left(\frac{4\,E}{L_e} + 3\right) \left(\frac{a}{L_e}\right)^2\right] + \left[4 \left(\frac{3\,E}{L_e} + 2\right) \left(\frac{a}{L_e}\right)^3\right]\right]$$

$$V_{max} = ((-0.048408 \text{ kip/ft}) \times (48 \text{ in})) \times \left[1 - \left[3 \times \left(\frac{4 \times (3.1447 \text{ ft})}{(5.75 \text{ ft})} + 3\right) \times \left(\frac{(4.0966 \text{ ft})}{(5.75 \text{ ft})}\right)^2\right] + \left[4 \times \left(\frac{3 \times (3.1447 \text{ ft})}{(5.75 \text{ ft})} + 2\right) \times \left(\frac{(4.0966 \text{ ft})}{(5.75 \text{ ft})}\right)^3\right]\right]$$

$$V_{max} = 0.31622 \text{ kip}$$

M_{max} - Max bending moment located at depth a/2,

$$M_{max} = (H_o\, b\, L_e) \left[\left(\frac{E}{L_e} + \frac{a}{2\, L_e}\right) - \left[\left(\frac{4\, E}{L_e} + 3\right) \left(\frac{a}{2\, L_e}\right)^3\right] + \left[\left(\frac{3\, E}{L_e} + 2\right) \left(\frac{a}{2\, L_e}\right)^4\right]\right]$$

$$M_{max} = ((-0.048408 \text{ kip/ft}) \times (48 \text{ in}) \times (5.75 \text{ ft})) \times \left[\left(\frac{(3.1447 \text{ ft})}{(5.75 \text{ ft})} + \frac{(4.0966 \text{ ft})}{2 \times (5.75 \text{ ft})}\right) - \left[\left(\frac{4 \times (3.1447 \text{ ft})}{(5.75 \text{ ft})} + 3\right) \times \left(\frac{(4.0966 \text{ ft})}{2 \times (5.75 \text{ ft})}\right)^3\right] + \left[\left(\frac{3 \times (3.1447 \text{ ft})}{(5.75 \text{ ft})} + 2\right) \times \left(\frac{(4.0966 \text{ ft})}{2 \times (5.75 \text{ ft})}\right)^4\right]\right]$$

$$M_{max} = 0.80972 \text{ kipft}$$

Minimum Reinforcement Check (LRFD)

Parameters:

$f'_{ck} = 2.5 \text{ ksi}$ - Concrete strength,
$f_{yk} = 60 \text{ ksi}$ - Longitudinal reinforcement strength,
$\phi = 0.65$ - Reduction factor for axial strength,
Table 22.4.2.1 $\alpha = 0.8$ - Alpha factor for axial strength,
$A_g = 2304 \text{ in}^2$ - Gross area of concrete,

Longitudinal reinforcement:

Required reinforcement due to axial load, $A_{st,required}$

22.4.2.2, 10.6.1.1 $A_{st,required}$

$$A_{st,required} = Min\left[\frac{\frac{P}{\phi\, \alpha} - (0.85\, f'_{ck}\, A_g)}{f_{yk} - (0.85\, f'_{ck})}, (0.08\, A_g)\right]$$

$$A_{st,required} = Min\left[\frac{\frac{(8.437 \text{ kip})}{(0.65)\times(0.8)} - (0.85 \times (2.5 \text{ ksi}) \times (2304 \text{ in}^2))}{(60 \text{ ksi}) - (0.85 \times (2.5 \text{ ksi}))}, (0.08 \times (2304 \text{ in}^2))\right]$$

$$A_{st,required} = -84.316 \text{ in}^2$$

A_{min} - Governing minimum reinforcement area,

$$A_{min} = Max\left[A_{st,required}, (0.0018\, A_g)\right]$$

$$A_{min} = Max\left[(-84.316 \text{ in}^2), (0.0018 \times (2304 \text{ in}^2))\right]$$

$$A_{min} = 4.1472 \text{ in}^2$$

n_{rebar} - Required number of reinforcement,

$$n_{rebar} = \frac{A_{min}}{A_{rebar}}$$

$$n_{rebar} = \frac{(4.1472 \text{ in}^2)}{(0.3068 \text{ in}^2)}$$

$$n_{rebar} = 14$$

A_{st} - Actual total reinforcement area,

$$A_{st} = n_{rebar}\, \frac{\pi\, d_{bar}^2}{4}$$

$$A_{st} = (14) \times \frac{\pi \times (0.625 \text{ in})^2}{4}$$

$$A_{st} = 4.2951 \text{ in}^2$$

$Ratio$ - Capacity

$$Ratio = \frac{A_{min}}{A_{st}}$$

$$Ratio = \frac{(4.1472 \text{ in}^2)}{(4.2951 \text{ in}^2)}$$

	$$Ratio = 0.96556$$	Status: PASS Ratio: 0.970
25.2.3	s_{rebar} - Minimum spacing of reinforcement, $$s_{rebar} = Max\left[1.5, (1.5\ d_{bar})\right]$$ $$s_{rebar} = Max\left[1.5, (1.5 \times (0.625\ \text{in}))\right]$$ $$s_{rebar} = 1.5\ \text{in}$$ **Ties:**	
25.7.2.2 25.7.2.1	Since longitudinal reinforcement is $\leq$ No. 10ø: Use #3(0.375 in) s_{ties} - Maximum spacing of ties, $$s_{ties} = Min\left[(16\ d_{bar}), (48\ d_{ties}), Min\left(D, b\right)\right]$$ $$s_{ties} = Min\left[(16 \times (0.625\ \text{in})), (48 \times (0.375\ \text{in})), Min\left((48\ \text{in}), (48\ \text{in})\right)\right]$$ $$s_{ties} = 10\ \text{in}$$ **Summary:** Main reinforcement: **14 - #5 (0.625 in)** Ties: **#3(0.375 in) - 10 in**	
22.4.2.2	**Axial Compression Strength (ACI 318-19, LRFD)** ϕP_N - Allowable axial compressive strength $$\phi P_N = \phi\ 0.80\ \left[\left(0.85\ f'_{ck}\ \left[A_g - A_{st}\right]\right) + \left(f_{yk}\ A_{st}\right)\right]$$ $$\phi P_N = (0.65) \times 0.80 \times \left[\left(0.85 \times (2.5\ \text{ksi}) \times \left[\left(2304\ \text{in}^2\right) - \left(4.2951\ \text{in}^2\right)\right]\right) + \left((60\ \text{ksi}) \times \left(4.2951\ \text{in}^2\right)\right)\right]$$ $$\phi P_N = 2675.2\ \text{kip}$$ $Ratio$ - Capacity $$Ratio = \frac{P}{\phi P_N}$$ $$Ratio = \frac{(8.437\ \text{kip})}{(2675.2\ \text{kip})}$$ $$Ratio = 0.0031538$$	Status: PASS Ratio: 0.000
22.5.2.2 22.5.5.1.3 22.5.5.1.1	**Shear Strength (ACI 318-19, LRFD)** **Parameters:** $b_w = 48\ \text{in}$ - Effective width, d - Effective depth $$d = 0.80\ D$$ $$d = 0.80 \times (48\ \text{in})$$ $$d = 38.4\ \text{in}$$ λ_s - size effect modification factor $$\lambda_s = MIN\left[\sqrt{\frac{2}{1 + \frac{d}{10}}}, 1\right]$$ $$\lambda_s = MIN\left[\sqrt{\frac{2}{1 + \frac{(38.4\ \text{in})}{10}}}, 1\right]$$ $$\lambda_s = 0.64282$$ The following variables were converted to be consistent with empirical formula $f'_{ck} = 2.5\ \text{ksi} \rightarrow 2500\ \text{psi}$, $V_{c,max}$ - Max shear strength of concrete $$V_{c,max} = 5\ \lambda_s\ \sqrt{f'_{ck}}\ b_w\ d$$ $$V_{c,max} = 5 \times (0.64282) \times \sqrt{(2500\ \text{psi})} \times (48\ \text{in}) \times (38.4\ \text{in})$$	

$$V_{c,max} = 296.21\ \mathrm{kip}$$

The following variables were converted to be consistent with empirical formula $f'_{ck} = 2.5\ \mathrm{ksi} \rightarrow 2500\ \mathrm{psi}$, $P = 8.437\ \mathrm{kip} \rightarrow 8437\ \mathrm{lbf}$,

22.5.5.1.1(a) $V_{c,a}$ - Shear strength of concrete (a)

$$V_{c,a} = \left[2\ \lambda_s\ \sqrt{f'_{ck}} + \frac{P}{6\ A_g}\right]\ b_w\ d$$

$$V_{c,a} = \left[2 \times (0.64282) \times \sqrt{(2500\ \mathrm{psi})} + \frac{(8437\ \mathrm{lbf})}{6 \times (2304\ \mathrm{in}^2)}\right] \times (48\ \mathrm{in}) \times (38.4\ \mathrm{in})$$

$$V_{c,a} = 119.61\ \mathrm{kip}$$

The following variables were converted to be consistent with empirical formula $f'_{ck} = 2.5\ \mathrm{ksi} \rightarrow 2500\ \mathrm{psi}$,

22.5.5.1.2 $V_{c,b}$ - Shear strength of concrete (b)

$$V_{c,b} = \left[2\ \lambda_s\ \sqrt{f'_{ck}} + \left(0.05\ f'_{ck}\right)\right]\ b_w\ d$$

$$V_{c,b} = \left[2 \times (0.64282) \times \sqrt{(2500\ \mathrm{psi})} + (0.05 \times (2500\ \mathrm{psi}))\right] \times (48\ \mathrm{in}) \times (38.4\ \mathrm{in})$$

$$V_{c,b} = 348.89\ \mathrm{kip}$$

V_c - Governing shear strength of concrete

$$V_c = Min\left[V_{c,max}, V_{c,a}, V_{c,b}\right]$$

$$V_c = Min\left[(296.21\ \mathrm{kip}), (119.61\ \mathrm{kip}), (348.89\ \mathrm{kip})\right]$$

$$V_c = 119.61\ \mathrm{kip}$$

The following variables were converted to be consistent with empirical formula $f'_{ck} = 2.5\ \mathrm{ksi} \rightarrow 2500\ \mathrm{psi}$,

22.5.1.2 $V_{s,a}$ - Shear strength of steel (a)

$$V_{s,a} = 8\ \sqrt{f'_{ck}}\ b_w\ d$$

$$V_{s,a} = 8 \times \sqrt{(2500\ \mathrm{psi})} \times (48\ \mathrm{in}) \times (38.4\ \mathrm{in})$$

$$V_{s,a} = 737.28\ \mathrm{kip}$$

A_v - Ties rebar area,

$$A_v = \frac{\pi\ d_{ties}^2}{4}$$

$$A_v = \frac{\pi \times (0.375\ \mathrm{in})^2}{4}$$

$$A_v = 0.11045\ \mathrm{in}^2$$

22.5.8.5.3 $V_{s,b}$ - Shear strength of steel (b)

$$V_{s,b} = \frac{2\ A_v\ f_{ywk}\ d}{s_{ties}}$$

$$V_{s,b} = \frac{2 \times \left(0.11045\ \mathrm{in}^2\right) \times (60\ \mathrm{ksi}) \times (38.4\ \mathrm{in})}{(10\ \mathrm{in})}$$

$$V_{s,b} = 50.894\ \mathrm{kip}$$

V_s - Governing shear strength of steel

$$V_s = MIN\left[V_{s,a}, V_{s,b}\right]$$

$$V_s = MIN\left[(737.28\ \mathrm{kip}), (50.894\ \mathrm{kip})\right]$$

$$V_s = 50.894\ \mathrm{kip}$$

22.5.1.1 ϕV_n - Allowable shear strength

$$\phi V_n = \phi\ \left(V_c + V_s\right)$$

$$\phi V_n = (0.65) \times ((119.61\ \mathrm{kip}) + (50.894\ \mathrm{kip}))$$

$$\phi V_n = 110.83\ \mathrm{kip}$$

Considering x-direction:

$V_{max} = 7.896\ \mathrm{kip}$ - Maximum shear force in the x-direction,
$Ratio$ - Capacity

$$Ratio = \frac{V_{max}}{\phi V_n}$$

	$$Ratio = \frac{(7.896\text{ kip})}{(110.83\text{ kip})}$$ $$Ratio = 0.071246$$	Status: **PASS** Ratio: **0.070**
	Considering z-direction: $V_{max} = 0.31622\text{ kip}$ - Maximum shear force in the z-direction, $Ratio$ - Capacity $$Ratio = \frac{V_{max}}{\phi V_n}$$ $$Ratio = \frac{(0.31622\text{ kip})}{(110.83\text{ kip})}$$ $$Ratio = 0.0028533$$	Status: **PASS** Ratio: **0.000**
14.5.2.1b	**Flexural Strength (ACI 318-19, LRFD)** S_m - Section modulus $$S_m = \frac{b\,D^2}{6}$$ $$S_m = \frac{(48\text{ in}) \times (48\text{ in})^2}{6}$$ $$S_m = 18432\text{ in}^3$$ $\lambda = 1$ - Concrete modification factor (Normal concrete), Allowable flexural strength: M_n shall be the lesser of: $\phi M_{n,1}$ $$\phi M_{n,1} = \phi \times 5 \times \lambda \times \sqrt{(f'_c)} \times S_m$$ $$\phi M_{n,1} = 0.65 \times 5 \times 1 \times \sqrt{(2.5ksi)} \times 18432.001in^3$$ $$\phi M_{n,1} = 249.600kipft$$ $\phi M_{n,2}$ $$\phi M_{n,2} = \phi\, 0.85\, f'_{ck}\, S_m$$ $$\phi M_{n,2} = (0.65) \times 0.85 \times (2.5\text{ ksi}) \times \left(18432\text{ in}^3\right)$$ $$\phi M_{n,2} = 2121.6\text{ kipft}$$ Therefore, ϕM_n - Allowable flexural strength, $$\phi M_n = MIN[\phi M_{n,1}, \phi M_{n,2}]$$ $$\phi M_n = MIN[(249.6\text{ kipft}), (2121.6\text{ kipft})]$$ $$\phi M_n = 249.6\text{ kipft}$$ **Considering x-direction:** $M_{max} = 21.696\text{ kipft}$ - Maximum moment in the x-direction, $Ratio$ - Capacity $$Ratio = \frac{M_{max}}{\phi M_n}$$ $$Ratio = \frac{(21.696\text{ kipft})}{(249.6\text{ kipft})}$$ $$Ratio = 0.086924$$	Status: **PASS** Ratio: **0.090**
	Considering z-direction: $M_{max} = 0.80972\text{ kipft}$ - Maximum moment in the z-direction, $Ratio$ - Capacity $$Ratio = \frac{M_{max}}{\phi M_n}$$	

	$$Ratio = \frac{(0.80972 \text{ kipft})}{(249.6 \text{ kipft})}$$ $$Ratio = 0.0032441$$	Status: **PASS** Ratio: **0.000**

REFERENCES	CALCULATIONS	RESULTS

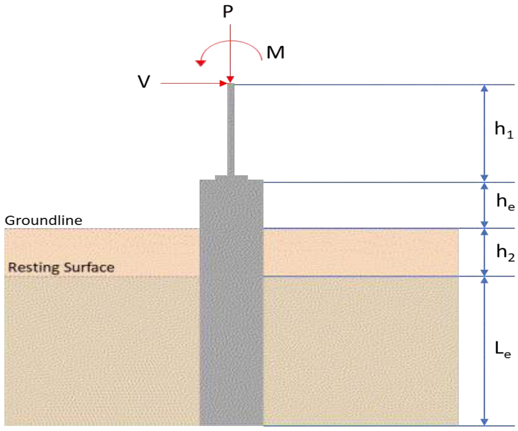
SkyCiv Foundation Design

Pile Foundation

Design Information :

Design code : IBC 2021 (International Building Code)
Unit System : Imperial

Pile Input



Geometry

Pile shape: rectangular

$b = 48\ \mathrm{in}$ - Pile width

$D = 48\ \mathrm{in}$ - Pile depth

$L = 6.25\ \mathrm{ft}$ - Total pile length

$h_1 = 0\ \mathrm{ft}$ - Lateral load height from the top of the pile,

$h_2 = 0\ \mathrm{ft}$ - Depth to resisting surface

$h_e = 0\ \mathrm{ft}$ - Length of pile above the ground

Tabulation of Soil Parameters

Layer	Label	Allowable Bearing Pressure (q_a) (psf)	Allowable Lateral Pressure (R) (psf/ft)
1	Sand, silty sand, clayey sand, silty gravel & clayey gravel	2000.000	150.000

Tabulation of Loads

Load Component	ASD	LRFD
P (kip)	6.387	10.261
V_x (kip)	-2.164	-3.622
V_z (kip)	0.000	0.000
M_x (kipft)	0.000	0.000
M_z (kipft)	24.029	40.772

Material Properties

$f'_{ck} = 2.5\ \mathrm{ksi}$ - Concrete strength,

Required depth to resist lateral loads (ASD)

H - Point of application of the lateral load

$$H = h_1 + h_2 + h_e$$

$$H = (0\ \mathrm{ft}) + (0\ \mathrm{ft}) + (0\ \mathrm{ft})$$

$$H = 0\ \mathrm{ft}$$

Considering x-direction:

H_o - Lateral force per length of pile,

$$H_o = \frac{V_x}{1.57\ D}$$

$$H_o = \frac{(-2.164\ \mathrm{kip})}{1.57 \times (48\ \mathrm{in})}$$

$$H_o = -0.34459\ \mathrm{kip/ft}$$

M_o - Moment per length of pile,

$$M_o = \frac{M_z + (V_x\, H)}{1.57\, D}$$

$$M_o = \frac{(24.029 \text{ kipft}) + ((-2.164 \text{ kip}) \times (0 \text{ ft}))}{1.57 \times (48 \text{ in})}$$

$$M_o = 3.8263 \text{ kipft/ft}$$

Required depth of embedment in earth:

$$L_x^3 - \left(14.14 \times \frac{H_o \times L_x}{R}\right) - \left(18.85 \times \frac{M_o}{R}\right) = 0$$

Solving the cubic equation:
$L_{e,x} = 5.7258 \text{ ft}$ - Required depth in x-direction,

Considering z-direction:

$L_{e,z} = 0 \text{ ft}$ - Required depth in z-direction,

Minimum embedded depth required:

$L_{e,req}$ - Depth of pile required,

$$L_{e,req} = MAX[L_{e,x}, L_{e,z}]$$

$$L_{e,req} = MAX[(5.7258 \text{ ft}), (0 \text{ ft})]$$

$$L_{e,req} = 5.726 \text{ ft}$$

L_e - Actual embedded length of pile,

$$L_e = L - h_e - h_2$$

$$L_e = (6.25 \text{ ft}) - (0 \text{ ft}) - (0 \text{ ft})$$

$$L_e = 6.25 \text{ ft}$$

$Ratio$ - Embedded depth

$$Ratio = \frac{L_{e,req}}{L_e}$$

$$Ratio = \frac{(5.726 \text{ ft})}{(6.25 \text{ ft})}$$

$$Ratio = 0.91616$$

Status: **PASS**
Ratio: **0.920**

End-bearing Capacity (ASD)

A - Pile cross-section area

$$A = b\, D$$

$$A = (48 \text{ in}) \times (48 \text{ in})$$

$$A = 16 \text{ ft}^2$$

q - End-bearing pressure

$$q = \frac{P_v}{A}$$

$$q = \frac{(6.387 \text{ kip})}{(16 \text{ ft}^2)}$$

$$q = 0.3992 \text{ kip/ft}^2$$

Check bearing capacity ratio:

$Ratio$ - Capacity

$$Ratio = \frac{q}{q_a}$$

$$Ratio = \frac{(0.3992 \text{ kip/ft}^2)}{(2000 \text{ psf})}$$

$$Ratio = 0.1996$$

Status: **PASS**
Ratio: **0.200**

Czerniak

Lateral Soil Pressure (ASD):

L/D - Length to least lateral dimension ratio,

$$L/D = \frac{L}{D}$$

$$L/D = \frac{(6.25\ \mathrm{ft})}{(48\ \mathrm{in})}$$

$$L/D = 1.5625$$

Since L/D $\leq$ 10,

Pile is short.

Considering x-direction:

$H_o = -0.34459\ \mathrm{kip/ft}$ - Lateral force per length of pile,
$M_o = 3.8263\ \mathrm{kipft/ft}$ - Overturning moment per length of pile,
a - Distance from resting surface to pivot point,

$$a = \frac{(4\,M_o\,L_e) + \left(3\,H_o\,L_e^2\right)}{(6\,M_o) + (4\,H_o\,L_e)}$$

$$a = \frac{(4 \times (3.8263\ \mathrm{kipft/ft}) \times (6.25\ \mathrm{ft})) + \left(3 \times (-0.34459\ \mathrm{kip/ft}) \times (6.25\ \mathrm{ft})^2\right)}{(6 \times (3.8263\ \mathrm{kipft/ft})) + (4 \times (-0.34459\ \mathrm{kip/ft}) \times (6.25\ \mathrm{ft}))}$$

$$a = 4.3088\ \mathrm{ft}$$

p - Earth pressure against the pile at distance a/2 from resting surface,

$$p = \frac{0.75\,[(4\,M_o) + (3\,H_o\,L_e)]^2}{L_e^2\,[(3\,M_o) + (2\,H_o\,L_e)]}$$

$$p = \frac{0.75 \times [(4 \times (3.8263\ \mathrm{kipft/ft})) + (3 \times (-0.34459\ \mathrm{kip/ft}) \times (6.25\ \mathrm{ft}))]^{\ 2}}{(6.25\ \mathrm{ft})^2 \times [(3 \times (3.8263\ \mathrm{kipft/ft})) + (2 \times (-0.34459\ \mathrm{kip/ft}) \times (6.25\ \mathrm{ft}))]}$$

$$p = 0.20941\ \mathrm{kip/ft^2}$$

s - Earth pressure against the pile at distance L_e,

$$s = \frac{6\,[(2\,M_o) + (H_o\,L_e)]}{L_e^2}$$

$$s = \frac{6 \times [(2 \times (3.8263\ \mathrm{kipft/ft})) + ((-0.34459\ \mathrm{kip/ft}) \times (6.25\ \mathrm{ft}))]}{(6.25\ \mathrm{ft})^2}$$

$$s = 0.84463\ \mathrm{kip/ft^2}$$

Check lateral soil pressure capacity:

p_a - Allowable lateral soil pressure at depth a/2,

$$p_a = R\,\frac{a}{2}$$

$$p_a = (150\ \mathrm{psf/ft}) \times \frac{(4.3088\ \mathrm{ft})}{2}$$

$$p_a = 0.32316\ \mathrm{kip/ft^2}$$

$Ratio$ - Lateral soil capacity

$$Ratio = \frac{p}{p_a}$$

$$Ratio = \frac{\left(0.20941\ \mathrm{kip/ft^2}\right)}{\left(0.32316\ \mathrm{kip/ft^2}\right)}$$

$$Ratio = 0.64801$$

Status: **PASS**
Ratio: **0.650**

p_s - Allowable lateral soil pressure at depth L_e,

$$p_s = R\,L_e$$

$$p_s = (150\ \mathrm{psf/ft}) \times (6.25\ \mathrm{ft})$$

$$p_s = 0.9375\ \mathrm{kip/ft^2}$$

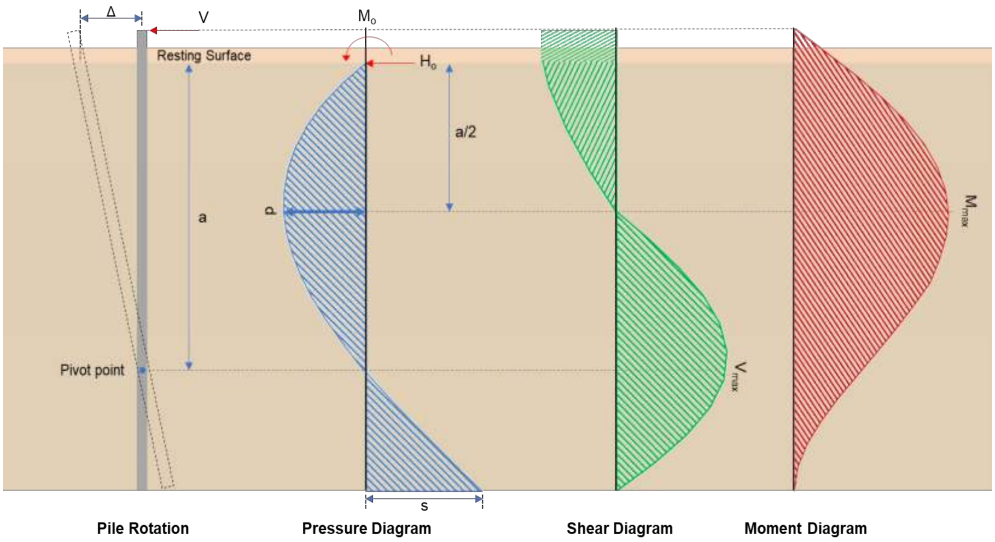
$Ratio$ - Lateral soil capacity

$$Ratio = \frac{s}{p_s}$$

$$Ratio = \frac{\left(0.84463\ \mathrm{kip/ft^2}\right)}{\left(0.9375\ \mathrm{kip/ft^2}\right)}$$

$$Ratio = 0.90094$$

Status: PASS
Ratio: 0.900



Shear force and Bending moment (x-direction, LRFD)

H_o - Lateral force per length of pile,

$$H_o = \frac{V_x}{1.57\,D}$$

$$H_o = \frac{(-3.622\text{ kip})}{1.57 \times (48\text{ in})}$$

$$H_o = -0.57675\text{ kip/ft}$$

M_o - Moment per length of pile,

$$M_o = \frac{M_z + (V_x\,H)}{1.57\,D}$$

$$M_o = \frac{(40.772\text{ kipft}) + ((-3.622\text{ kip}) \times (0\text{ ft}))}{1.57 \times (48\text{ in})}$$

$$M_o = 6.4924\text{ kipft/ft}$$

E - Distance from lateral load to resisting surface,

$$E = \frac{M_o}{H_o}$$

$$E = \frac{(6.4924\text{ kipft/ft})}{(-0.57675\text{ kip/ft})}$$

$$E = 11.257\text{ ft}$$

a - Distance from resting surface to pivot point,

$$a = \frac{(4\,M_o\,L_e) + \left(3\,H_o\,L_e^2\right)}{(6\,M_o) + (4\,H_o\,L_e)}$$

$$a = \frac{(4 \times (6.4924\text{ kipft/ft}) \times (6.25\text{ ft})) + \left(3 \times (-0.57675\text{ kip/ft}) \times (6.25\text{ ft})^2\right)}{(6 \times (6.4924\text{ kipft/ft})) + (4 \times (-0.57675\text{ kip/ft}) \times (6.25\text{ ft}))}$$

$$a = 4.3074\text{ ft}$$

V_{max} - Max shear force located at depth a,

$$V_{max} = (H_o\,D)\left[1 - \left[3\left(\frac{4\,E}{L_e} + 3\right)\left(\frac{a}{L_e}\right)^2\right] + \left[4\left(\frac{3\,E}{L_e} + 2\right)\left(\frac{a}{L_e}\right)^3\right]\right]$$

$$V_{max} = ((-0.57675\text{ kip/ft}) \times (48\text{ in})) \times \left[1 - \left[3 \times \left(\frac{4 \times (11.257\text{ ft})}{(6.25\text{ ft})} + 3\right) \times \left(\frac{(4.3074\text{ ft})}{(6.25\text{ ft})}\right)^2\right] + \left[4 \times \left(\frac{3 \times (11.257\text{ ft})}{(6.25\text{ ft})} + 2\right) \times \left(\frac{(4.3074\text{ ft})}{(6.25\text{ ft})}\right)^3\right]\right]$$

$$V_{max} = 8.8744 \text{ kip}$$

M_{max} - Max bending moment located at depth a/2,

$$M_{max} = (H_o\, D\, L_e) \left[\left(\frac{E}{L_e} + \frac{a}{2\, L_e}\right) - \left[\left(\frac{4\, E}{L_e} + 3\right) \left(\frac{a}{2\, L_e}\right)^3\right] + \left[\left(\frac{3\, E}{L_e} + 2\right) \left(\frac{a}{2\, L_e}\right)^4\right]\right]$$

$$M_{max} = ((-0.57675 \text{ kip/ft}) \times (48 \text{ in}) \times (6.25 \text{ ft})) \times \left[\left(\frac{(11.257 \text{ ft})}{(6.25 \text{ ft})} + \frac{(4.3074 \text{ ft})}{2 \times (6.25 \text{ ft})}\right) - \left[\left(\frac{4 \times (11.257 \text{ ft})}{(6.25 \text{ ft})} + 3\right) \times \left(\frac{(4.3074 \text{ ft})}{2 \times (6.25 \text{ ft})}\right)^3\right] + \left[\left(\frac{3 \times (11.257 \text{ ft})}{(6.25 \text{ ft})} + 2\right) \times \left(\frac{(4.3074 \text{ ft})}{2 \times (6.25 \text{ ft})}\right)^4\right]\right]$$

$$M_{max} = 26.423 \text{ kipft}$$

Minimum Reinforcement Check (LRFD)

Parameters:

$f'_{ck} = 2.5 \text{ ksi}$ - Concrete strength,
$f_{yk} = 60 \text{ ksi}$ - Longitudinal reinforcement strength,
$\phi = 0.65$ - Reduction factor for axial strength,
Table 22.4.2.1 $\alpha = 0.8$ - Alpha factor for axial strength,
$A_g = 2304 \text{ in}^2$ - Gross area of concrete,

Longitudinal reinforcement:

Required reinforcement due to axial load, $A_{st,required}$

22.4.2.2, 10.6.1.1 $A_{st,required}$

$$A_{st,required} = Min\left[\frac{\frac{P}{\phi\, \alpha} - (0.85\, f'_{ck}\, A_g)}{f_{yk} - (0.85\, f'_{ck})}, (0.08\, A_g)\right]$$

$$A_{st,required} = Min\left[\frac{\frac{(10.261 \text{ kip})}{(0.65) \times (0.8)} - \left(0.85 \times (2.5 \text{ ksi}) \times (2304 \text{ in}^2)\right)}{(60 \text{ ksi}) - (0.85 \times (2.5 \text{ ksi}))}, \left(0.08 \times (2304 \text{ in}^2)\right)\right]$$

$$A_{st,required} = -84.255 \text{ in}^2$$

A_{min} - Governing minimum reinforcement area,

$$A_{min} = Max\left[A_{st,required}, (0.0018\, A_g)\right]$$

$$A_{min} = Max\left[\left(-84.255 \text{ in}^2\right), \left(0.0018 \times (2304 \text{ in}^2)\right)\right]$$

$$A_{min} = 4.1472 \text{ in}^2$$

n_{rebar} - Required number of reinforcement,

$$n_{rebar} = \frac{A_{min}}{A_{rebar}}$$

$$n_{rebar} = \frac{(4.1472 \text{ in}^2)}{(0.3068 \text{ in}^2)}$$

$$n_{rebar} = 14$$

A_{st} - Actual total reinforcement area,

$$A_{st} = n_{rebar} \frac{\pi\, d_{bar}^2}{4}$$

$$A_{st} = (14) \times \frac{\pi \times (0.625 \text{ in})^2}{4}$$

$$A_{st} = 4.2951 \text{ in}^2$$

Ratio - Capacity

$$Ratio = \frac{A_{min}}{A_{st}}$$

$$Ratio = \frac{(4.1472 \text{ in}^2)}{(4.2951 \text{ in}^2)}$$

$$Ratio = 0.96556$$

Status: **PASS**
Ratio: **0.970**

25.2.3 s_{rebar} - Minimum spacing of reinforcement,

$$s_{rebar} = Max\left[1.5, (1.5\, d_{bar})\right]$$

$$s_{rebar} = Max\left[1.5, (1.5 \times (0.625 \text{ in}))\right]$$

$$s_{rebar} = 1.5 \text{ in}$$

Ties:

25.7.2.2 Since longitudinal reinforcement is $\leq$ No. 10⌀: Use #3(0.375 in)

25.7.2.1 s_{ties} - Maximum spacing of ties,

$$s_{ties} = Min\left[(16\, d_{bar}), (48\, d_{ties}), Min\,(D, b)\right]$$

$$s_{ties} = Min\left[(16 \times (0.625 \text{ in})), (48 \times (0.375 \text{ in})), Min\,((48 \text{ in}), (48 \text{ in}))\right]$$

$$s_{ties} = 10 \text{ in}$$

Summary:

Main reinforcement: **14 - #5 (0.625 in)**
Ties: **#3(0.375 in) - 10 in**

Axial Compression Strength (ACI 318-19, LRFD)

22.4.2.2 ϕP_N - Allowable axial compressive strength

$$\phi P_N = \phi\, 0.80\, \left[\left(0.85\, f'_{ck}\, \left[A_g - A_{st}\right]\right) + \left(f_{yk}\, A_{st}\right)\right]$$

$$\phi P_N = (0.65) \times 0.80 \times \left[\left(0.85 \times (2.5 \text{ ksi}) \times \left[\left(2304 \text{ in}^2\right) - \left(4.2951 \text{ in}^2\right)\right]\right) + \left((60 \text{ ksi}) \times \left(4.2951 \text{ in}^2\right)\right)\right]$$

$$\phi P_N = 2675.2 \text{ kip}$$

$Ratio$ - Capacity

$$Ratio = \frac{P}{\phi P_N}$$

$$Ratio = \frac{(10.261 \text{ kip})}{(2675.2 \text{ kip})}$$

$$Ratio = 0.0038356$$

Status: **PASS**
Ratio: **0.000**

Shear Strength (ACI 318-19, LRFD)

Parameters:

$b_w = 48 \text{ in}$ - Effective width,

22.5.2.2 d - Effective depth

$$d = 0.80\, D$$

$$d = 0.80 \times (48 \text{ in})$$

$$d = 38.4 \text{ in}$$

22.5.5.1.3 λ_s - size effect modification factor

$$\lambda_s = MIN\left[\sqrt{\frac{2}{1 + \frac{d}{10}}}, 1\right]$$

$$\lambda_s = MIN\left[\sqrt{\frac{2}{1 + \frac{(38.4 \text{ in})}{10}}}, 1\right]$$

$$\lambda_s = 0.64282$$

The following variables were converted to be consistent with empirical formula $f'_{ck} = 2.5 \text{ ksi} \rightarrow 2500 \text{ psi}$,

22.5.5.1.1 $V_{c,max}$ - Max shear strength of concrete

$$V_{c,max} = 5\, \lambda_s\, \sqrt{f'_{ck}}\, b_w\, d$$

$$V_{c,max} = 5 \times (0.64282) \times \sqrt{(2500 \text{ psi})} \times (48 \text{ in}) \times (38.4 \text{ in})$$

$$V_{c,max} = 296.21 \text{ kip}$$

The following variables were converted to be consistent with empirical formula $f'_{ck} = 2.5 \text{ ksi} \rightarrow 2500 \text{ psi}$, $P = 10.261 \text{ kip} \rightarrow 10261 \text{ lbf}$,

22.5.5.1.1(a) $V_{c,a}$ - Shear strength of concrete (a)

$$V_{c,a} = \left[2\, \lambda_s\, \sqrt{f'_{ck}} + \frac{P}{6\, A_g}\right]\, b_w\, d$$

$$V_{c,a} = \left[2 \times (0.64282) \times \sqrt{(2500\text{ psi})} + \frac{(10261\text{ lbf})}{6 \times (2304\text{ in}^2)}\right] \times (48\text{ in}) \times (38.4\text{ in})$$

$$V_{c,a} = 119.85\text{ kip}$$

The following variables were converted to be consistent with empirical formula $f'_{ck} = 2.5\text{ ksi} \rightarrow 2500\text{ psi}$,

22.5.5.1.2 $V_{c,b}$ - Shear strength of concrete (b)

$$V_{c,b} = \left[2\,\lambda_s\,\sqrt{f'_{ck}} + \left(0.05\,f'_{ck}\right)\right]\,b_w\,d$$

$$V_{c,b} = \left[2 \times (0.64282) \times \sqrt{(2500\text{ psi})} + (0.05 \times (2500\text{ psi}))\right] \times (48\text{ in}) \times (38.4\text{ in})$$

$$V_{c,b} = 348.89\text{ kip}$$

V_c - Governing shear strength of concrete

$$V_c = Min\left[V_{c,max}, V_{c,a}, V_{c,b}\right]$$

$$V_c = Min\left[(296.21\text{ kip}), (119.85\text{ kip}), (348.89\text{ kip})\right]$$

$$V_c = 119.85\text{ kip}$$

The following variables were converted to be consistent with empirical formula $f'_{ck} = 2.5\text{ ksi} \rightarrow 2500\text{ psi}$,

22.5.1.2 $V_{s,a}$ - Shear strength of steel (a)

$$V_{s,a} = 8\,\sqrt{f'_{ck}}\,b_w\,d$$

$$V_{s,a} = 8 \times \sqrt{(2500\text{ psi})} \times (48\text{ in}) \times (38.4\text{ in})$$

$$V_{s,a} = 737.28\text{ kip}$$

A_v - Ties rebar area,

$$A_v = \frac{\pi\,d_{ties}^2}{4}$$

$$A_v = \frac{\pi \times (0.375\text{ in})^2}{4}$$

$$A_v = 0.11045\text{ in}^2$$

22.5.8.5.3 $V_{s,b}$ - Shear strength of steel (b)

$$V_{s,b} = \frac{2\,A_v\,f_{ywk}\,d}{s_{ties}}$$

$$V_{s,b} = \frac{2 \times \left(0.11045\text{ in}^2\right) \times (60\text{ ksi}) \times (38.4\text{ in})}{(10\text{ in})}$$

$$V_{s,b} = 50.894\text{ kip}$$

V_s - Governing shear strength of steel

$$V_s = MIN\left[V_{s,a}, V_{s,b}\right]$$

$$V_s = MIN\left[(737.28\text{ kip}), (50.894\text{ kip})\right]$$

$$V_s = 50.894\text{ kip}$$

22.5.1.1 ϕV_n - Allowable shear strength

$$\phi V_n = \phi\,\left(V_c + V_s\right)$$

$$\phi V_n = (0.65) \times ((119.85\text{ kip}) + (50.894\text{ kip}))$$

$$\phi V_n = 110.99\text{ kip}$$

Considering x-direction:

$V_{max} = 8.8744\text{ kip}$ - Maximum shear force in the x-direction,
$Ratio$ - Capacity

$$Ratio = \frac{V_{max}}{\phi V_n}$$

$$Ratio = \frac{(8.8744\text{ kip})}{(110.99\text{ kip})}$$

$$Ratio = 0.07996$$

Status: **PASS**
Ratio: **0.080**

14.5.2.1b	**Flexural Strength (ACI 318-19, LRFD)** S_m - Section modulus $$S_m = \frac{b\,D^2}{6}$$ $$S_m = \frac{(48\text{ in}) \times (48\text{ in})^2}{6}$$ $$S_m = 18432\text{ in}^3$$ $\lambda = 1$ - Concrete modification factor (Normal concrete), Allowable flexural strength: M_n shall be the lesser of: $\phi M_{n,1}$ $$\phi M_{n,1} = \phi \times 5 \times \lambda \times \sqrt{(f'_c)} \times S_m$$ $$\phi M_{n,1} = 0.65 \times 5 \times 1 \times \sqrt{(2.5ksi)} \times 18432.001 in^3$$ $$\phi M_{n,1} = 249.600 kipft$$ $\phi M_{n,2}$ $$\phi M_{n,2} = \phi\, 0.85\, f'_{ck}\, S_m$$ $$\phi M_{n,2} = (0.65) \times 0.85 \times (2.5\text{ ksi}) \times \left(18432\text{ in}^3\right)$$ $$\phi M_{n,2} = 2121.6\text{ kipft}$$ Therefore, ϕM_n - Allowable flexural strength, $$\phi M_n = MIN[\phi M_{n,1}, \phi M_{n,2}]$$ $$\phi M_n = MIN[(249.6\text{ kipft}), (2121.6\text{ kipft})]$$ $$\phi M_n = 249.6\text{ kipft}$$ **Considering x-direction:** $M_{max} = 26.423\text{ kipft}$ - Maximum moment in the x-direction, $Ratio$ - Capacity $$Ratio = \frac{M_{max}}{\phi M_n}$$ $$Ratio = \frac{(26.423\text{ kipft})}{(249.6\text{ kipft})}$$ $$Ratio = 0.10586$$	Status: **PASS** Ratio: **0.110**