PROJECT DESCRIPTION

JOURNEYMAN INTERNATIONAL (JI) IS A UNITED-STATES BASED NONPROFIT THAT PROVIDES ARCHITECTURE, ENGINEERING, AND PROJECT MANAGEMENT SERVICES TO HUMANITARIAN AND DEVELOPMENT ORGANIZATIONS. THEY CONNECT UNIVERSITY STUDENTS AND PROFESSIONAL VOLUNTEERS WITH ORGANIZATIONS AROUND THE WORLD TO AFFORDABLY BRING GREATER VALUE TO PROJECTS THAT UPLIFT PEOPLE IN VULNERABLE CONTEXTS. THEY SEEK TO EMPOWER THE NEXT GENERATION OF HUMANITARIAN DESIGNERS BY GIVING STUDENTS AND PROFESSIONALS THE OPPORTUNITY, SKILLS, AND SUPPORT TO DESIGN REAL-WORLD PROJECTS THAT BENEFIT PEOPLE AND THE PLANET. THIS SPECIFIC PROJECT IS BEING COMPLETED IN PARTNERSHIP WITH THE HAITIAN AMERICAN CAUCUS AND THIRD LENS MINISTRIES.

ONLY ABOUT FORTY PERCENT OF HAITI'S POPULATION HAS ACCESS TO ELECTRICITY AND SIXTY PERCENT LIVES UNDER THE POVERTY LINE DUE TO LACK OF ECONOMIC OPPORTUNITY. THIS MAKES RECOVERING AND REBUILDING FROM SEISMIC EVENTS LIKE THE 2010 EARTHQUAKE IN HAITI NEARLY IMPOSSIBLE. THE PROJECT IS IN CROIX-DES-BOUQUETS, WHICH IS IN THE PORT-AU-PRINCE REGION OF HAITI.

THE HAC INNOVATION CENTER SEeks TO INCREASE ACCESS TO RESOURCES THAT ARE SPARCE BY PROVIDING THE COMMUNITY WITH ACCESS TO WIFI, ELECTRICITY, WATER, AND FRESH PRODUCE. IT WILL BE A WORKSPACE FOR YOUNG ENTREPRENEURS TO FOSTER THE SKILLS NEEDED TO CREATE THEIR OWN ECONOMIC OPPORTUNITIES AND SUPPORT THEMSELVES. THE GOAL IS RESILIENCY - OF THE COMMUNITY AND THIS BUILDING.

IN THE PRELIMINARY DESIGN PHASE, IT BECAME APPARENT THAT WIND AND SEISMIC DESIGN VALUES WERE NOT AVAILABLE VIA METHODS USED WHEN DESIGNING IN THE UNITED STATES. FOR THIS REASON, I USED HAITI'S NATIONAL BUILDING CODE (FOUND BY THE STUDENT ARCHITECT, HMWE THINN) FOR REGIONAL WIND AND SEISMIC DESIGN VALUES. THIS CODE WAS DEVELOPED IN 2012, SHORTLY AFTER THE MAJOR SEISMIC EVENT IN 2010. THIS (FRENCH) BUILDING CODE ALLOWED ME TO TAKE ADVANTAGE OF PAST LANGUAGE COURSES AS I NAVIGATED THE TEXT.
PROJECT DESCRIPTION (CONTINUED)

THIS PROJECT ENABLED ME TO LEARN MORE IN DEPTH ABOUT TRUSS DESIGN WITH LIMITED SIZE AND STRENGTH OF RECTANGULAR STEEL TUBING (HSS MEMBERS). I BECAME A BIT OF AN INVESTIGATOR WHEN IT CAME TO CONFINED MASONRY SHEAR WALL DESIGN, USING LOW STRENGTH CONCRETE, AND HAVING LIMITED MATERIAL AVAILABILITY.

CONSTRUCTION, TRANSPORTATION, AND COST WERE TAKEN INTO CONSIDERATION THROUGHOUT THE PROCESS AS I MADE DECISIONS ABOUT SIZE, SPACING, AND REDUNDANCY OF MATERIALS. I LEARNED TO FOCUS ON THE BIG PICTURE. CLEAR COMMUNICATION WITH THE STUDENT ARCHITECT WENT A LONG WAY AS WE ENGINEERED DESIGN SOLUTIONS FOR THE PROJECT AND ENSURED THAT THE COMMUNITY’S INTERESTS WERE ALWAYS PUT FIRST.

WHEN ALL ELSE FAILED (PERSONAL INVESTIGATION, REACHING OUT TO PEERS AND FELLOW ARCHITECTURAL ENGINEERING STUDENTS), I REACHED OUT TO MY FACULTY ADVISOR FOR ASSISTANCE. THIS GUIDANCE WAS INVALUABLE AND KEPT ME ON TRACK. OFTENTIMES, I WOULD GET CAUGHT UP IN SMALL DETAILS AND MY ADVISOR REMINDED ME TO STEP BACK AND REASSESS THE SITUATION.

WORKING WITH THE ARCHITECT AS MODIFICATIONS WERE BEING MADE WAS A UNIQUE EXPERIENCE. WE BOTH MADE COMPROMISES AND KEPT EACH OTHER POSTED WITH DESIGN CHANGES THROUGHOUT THE DURATION OF THE PROJECT. ONE CHALLENGE WAS DEVELOPING THE STRUCTURAL GRID FROM SOME ARCHITECTURAL DRAWINGS AND A RENDERED ARCHITECTURE MODEL. THE PROCESS WAS INCREDIBLY TEDIOUS, BUT TAUGHT ME SO MUCH ABOUT THE STRUCTURE ITSELF.

I AM GRATEFUL TO HAVE HAD THE OPPORTUNITY TO PERFORM THE STRUCTURAL DESIGN FOR THE HAC INNOVATION CENTER AND LOOK FORWARD TO STAYING IN TOUCH WITH THE LOCAL DESIGN TEAM.
PROJECT PRESENTATION SLIDES

FOR

HAITI HAC INNOVATION CENTER
CROIX-DES-BOUQUETS, HAITI

THIRD LENS MINITRIES - HAITIAN AMERICAN CAUCUS

15 JUNE 2021

PREPARED BY:
CLAIRED LEADER

JOURNEYMAN INTERNATIONAL
Summary

- New construction, single story
- Gravity:
  - R-Panel Metal Roofing
  - HSS Trusses
  - Concrete Beams
  - Concrete Columns
- Lateral:
  - (Confined Masonry) CMU Shear Walls
Journeyman International

Project Location: Haiti

- Nonprofit Organization
- Architecture, Engineering, and Project Management
- Connecting university students and volunteers with organizations around the world
Local Design Specifications

Figure 0.4.5.b – Spectre d’accélération pour une période de 0,2 s, pour 2 % de probabilité de dépassement dans 50 ans. Valeurs de dimensionnement (données USGS)
METAL R-PANEL
Designing with new materials
STEEL FRAMING SECTIONS

Designing with limited materials
MASSONRY BLOCKS
Designing with low-strength materials
REBAR
Designing with limited materials
Perforated CMU Wall

Concrete Columns with Woven Screen
Closing Thoughts

- Collaboration
- Independent research
- Communication with Architect
THANK YOU

Faculty Advisor: James Mwangi
Architectural Design: Hmwe Thinn
STRUCTURAL CALCULATIONS

FOR

HAITI HAC INNOVATION CENTER
CROIX-DES-BOUQUETS, HAITI

THIRD LENS MINITRIES - HAITIAN AMERICAN CAUCUS

15 JUNE 2021

PREPARED BY:
CLAIRE LEADER

JOURNEYMAN INTERNATIONAL
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>GENERAL REQUIREMENTS</td>
<td>GR</td>
</tr>
<tr>
<td>LOAD TAKE-OFF</td>
<td>W</td>
</tr>
<tr>
<td>TRUSS DESIGN</td>
<td>T</td>
</tr>
<tr>
<td>BEAM DESIGN</td>
<td>B</td>
</tr>
<tr>
<td>COLUMN DESIGN</td>
<td>C</td>
</tr>
<tr>
<td>LATERAL DESIGN</td>
<td>L</td>
</tr>
<tr>
<td>FOUNDATION DESIGN</td>
<td>F</td>
</tr>
</tbody>
</table>
TECHNICAL PROJECT DESCRIPTION
THIS ONE-STORY EDUCATIONAL BUILDING WILL SERVE CHILDREN AND YOUNG ADULTS IN CROIX-DES-BOUQUETS, HAITI BY PROVIDING THEM WITH ENTREPRENEUR AND TECHNOLOGY PROGRAMS. THE GRAVITY SYSTEM IS METAL R-PANEL ATOP HSS TRUSSES, REINFORCED CONCRETE BEAMS, AND REINFORCED CONCRETE COLUMNS. THE LATERAL SYSTEM IS COMPRISED OF REINFORCED CONCRETE MASONRY UNIT (CMU) SHEAR WALLS AND CONCRETE BEAM COLLECTORS. THE STRUCTURE IS SUPPORTED ON CONCRETE PAD FOOTINGS.

DESIGN CRITERIA
BUILDING TYPE: GROUP E (EDUCATIONAL)
DESIGN CODE: IBC 2018
WIND CRITERIA: CODE NATIONAL DU BATIMENT D'HAÏTI
SEISMIC CRITERIA: \( S_{DE} = 1.256 \)
\( R = 3.5 \) (SEISMIC MOD. FACTOR)
SEISMIC DESIGN CATEGORY: C
IMPORTANCE FACTOR \((I_e) = 1.0\)
RISK CATEGORY: II

MATERIAL SPECIFICATIONS (TYPICAL, UNLESS NOTED OTHERWISE)
CONCRETE MASONRY UNIT:
MATERIALS AND WORKMANSHIP PER ASTM
MATERIAL SPECIFICATIONS, TYP. UNO
SHEAR WALLS \( F'_c = 1000 \) PSI (6895 kN/m²)
COLUMNS \( F'_c = 1000 \) PSI
OTHER STRUCTURAL ELEMENTS \( F'_c = 1000 \) PSI

REINFORCING STEEL:
MATERIALS AND WORKMANSHIP PER ASTM
MATERIAL SPECIFICATIONS, TYP. UNO
REINFORCING STEEL PER ASTM A615 GRADE 40 (GRADE 280 METRIC)
WELDED REINFORCING STEEL PER ASTM A706

FOUNDATIONS:
ASSUME SITE CLASS D (DEFAULT)
ALL EXCAVATIONS, FILLING, BACKFILLING, AND SOIL COMPACTION
PER GEOTECHNICAL REPORT (NOT AVAILABLE)
ASSUMED ALLOWABLE SOIL BEARING PRESSURE = 5000 PSF
NOTE: 1/3 ALLOWABLE INCREASE FOR WIND AND SEISMIC
<table>
<thead>
<tr>
<th>MATERIAL SPECIFICATIONS (CONTINUED)</th>
<th>CONCRETE:</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATERIALS AND WORKMANSHIP PER ACI 318-19</td>
<td></td>
</tr>
<tr>
<td>MATERIAL SPECIFICATIONS, TYP. UNO</td>
<td></td>
</tr>
<tr>
<td>PAD FOOTINGS</td>
<td>$F'_c = 2000$ PSI (6895 kN/m$^2$)</td>
</tr>
<tr>
<td>SLAB ON GRADE</td>
<td>$F'_c = 2000$ PSI</td>
</tr>
<tr>
<td>CONTINUOUS FOOTINGS</td>
<td>$F'_c = 2000$ PSI</td>
</tr>
<tr>
<td>MAIN STRUCTURAL ELEMENTS</td>
<td>$F'_c = 2000$ PSI</td>
</tr>
</tbody>
</table>
BUILDING TYPE CLASSIFICATION

BUILDING USE AND OCCUPANCY
EDUCATIONAL BUILDING TO SERVE CHILDREN AND YOUNG ADULT
GROUP E (EDUCATIONAL)

TYPE OF CONSTRUCTION
TYPE #1 AND #2

ALLOWABLE BUILDING HEIGHT, STORIES, AND FLOOR AREAS
HEIGHT: 160 FT
STORIES: 5
AREA: UNLIMITED (UL)

<table>
<thead>
<tr>
<th>HEIGHT: 160 FT &gt; 15 FT</th>
<th>✓</th>
</tr>
</thead>
<tbody>
<tr>
<td>STORIES: 5 &gt; 1</td>
<td>✓</td>
</tr>
<tr>
<td>AREA: UL</td>
<td>✓</td>
</tr>
</tbody>
</table>

WIND AND SEISMIC CRITERIA
SEISMIC CLASSIFICATION ZONE: C (NEHRP)
Sx = 1.57 ; S1 = 0.58 (g = 9.81 m/s)
*DESIGN BASED UPON TO PORT-AU-PRINCE REGION
WIND CLASSIFICATION ZONE: III
WIND VELOCITY: 120 mph (54 m/s)
<table>
<thead>
<tr>
<th>Flat Loads (psf)</th>
<th>Governing Slope (degrees)</th>
<th>Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sloped Roof</td>
<td>22.38</td>
<td>1.082</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Description</th>
<th>R-Panel</th>
<th>Truss</th>
<th>Beam</th>
<th>Column</th>
<th>Lateral</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar Panels</td>
<td>4.33</td>
<td>4.33</td>
<td>4.33</td>
<td>4.33</td>
<td>4.33</td>
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<tr>
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<td>1.49</td>
<td>1.49</td>
<td>1.49</td>
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</tr>
<tr>
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<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>MEP</td>
<td>1.50</td>
<td>1.50</td>
<td>1.50</td>
<td>1.50</td>
<td>1.50</td>
</tr>
<tr>
<td>Trusses</td>
<td>4.00</td>
<td>4.00</td>
<td>4.00</td>
<td>4.00</td>
<td>4.00</td>
</tr>
<tr>
<td>Concrete Beams</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Concrete Columns</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CMU Walls</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Partition Walls</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Misc.</td>
<td>3.00</td>
<td>3.00</td>
<td>3.00</td>
<td>3.00</td>
<td>3.00</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>8.82</td>
<td>15.32</td>
<td>24.47</td>
<td>31.30</td>
<td>36.30</td>
</tr>
<tr>
<td><strong>Use</strong></td>
<td>9.00</td>
<td>16.00</td>
<td>25.00</td>
<td>32.00</td>
<td>37.00</td>
</tr>
</tbody>
</table>

**Live Load**

20 psf (Live load reduction allowed)

Solar Panels: 4 PSF before slope factor
Roof: 1.38 PSF before slope factor **Assumes 22-gage (heaviest) R-Panel**
Trusses:
Beams: (150 PCF)(1'x2')(Max Bm. Length)/(Trib Area) **Assumes beam depth of 2 feet**
CMU Walls: (150 PCF)(1')/(Trib Width)/(Trib Height) **Assumes max wall height of 14'8"**
Columns: (150 PCF)(1'x1')(Max Col. Height)/(Trib Area) **Assumes column size of 12"x12"**

Max Bm. Length = 20.95 FT  
Bm. Trib Area = 687.19 FT^2  
Bm. Trib Width = 32.81 FT  
Max Col. or Wall Height = 14.67 FT  
CMU Wall Trib Width = 6.56 FT  
Column Trib Area = 416.97 FT^2  
Reinf. Concrete Wt. = 150 PCF

**Flat Loads Walls**

<table>
<thead>
<tr>
<th>Description</th>
<th>CMU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use</td>
<td>115 psf</td>
</tr>
<tr>
<td>Total</td>
<td>115</td>
</tr>
<tr>
<td>Description</td>
<td>R-Panel</td>
</tr>
<tr>
<td>----------------------</td>
<td>---------</td>
</tr>
<tr>
<td>Solar Panels</td>
<td>207</td>
</tr>
<tr>
<td>Metal R-Panel</td>
<td>71.5</td>
</tr>
<tr>
<td>Insulation</td>
<td>47.9</td>
</tr>
<tr>
<td>MEP</td>
<td>71.8</td>
</tr>
<tr>
<td>Trusses</td>
<td>192</td>
</tr>
<tr>
<td>Concrete Beams</td>
<td></td>
</tr>
<tr>
<td>Concrete Columns</td>
<td></td>
</tr>
<tr>
<td>CMU Walls</td>
<td></td>
</tr>
<tr>
<td>Partition Walls</td>
<td></td>
</tr>
<tr>
<td>Misc.</td>
<td>144</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>422</td>
</tr>
<tr>
<td><strong>Use</strong></td>
<td><strong>431</strong></td>
</tr>
</tbody>
</table>

Live Load: 957.63 N/m² (Live load reduction allowed)
ROOF LIVE LOAD

Maximum Roof Slope = 22.38°
Assume 5:12 Pitch

[ASCE 7-16 § 4.8.2]

\[ L_0 = 20 \text{ psf} \]

\[ R_i = 1.0 \quad \text{(Assumption, Conservative)} \]
\[ R_z = 1.2 - 0.05F = 1.2 - 0.05(5) = 0.95 \]

\[ L_v = L_0 R_i R_z = (20 \text{ psf})(1)(0.95) = 19 \text{ psf} \]

**Keep** \[ L_v = 20 \text{ psf} \] *(Reduction is minimal)*
TRUSS LOADING

APPROXIMATE DEPTH WITH VULCRAFT—UVG JOIST & GIRDER MANUAL
- TRUSS DESIGN WILL BE DONE WITH HSS MEMBERS
- TYPICAL K-SERIES ROOF TRUSS USED FOR INITIAL DESIGN BASIS
- ONLINE VULCRAFT DESIGN TOOLS — 2' DEPTH FOR 30' SPAN

APPROXIMATE UNIT WEIGHT — FOR LOAD TAKE-OFF
- 2' DEEP, LARGE SPAN K-SERIES TRUSS
- ABOUT 4' SPACING
- $\frac{154}{4} \text{ lb} = 3.75 \text{ psf} \rightarrow 4\text{ psf}$

FROM LOAD TAKE-OFF: $W_D = 16.0 \text{ psf} ; W_L = 20.0 \text{ psf}$

$W_{dp} = 1.2W_d = 19.2 \text{ psf}$

$W_{lp} = 1.6W_l = 32.0 \text{ psf}$

TRUSS PROFILE DESCRIPTION
- CHOOSE THE WORST CASE OF EACH MAIN PROFILE TYPE
- FOR SIMPLE CONSTRUCTION, USE SAME SIZE HSS FOR ALL TRUSS MEMBERS
- TRY HSS4x2-1/2x1/4 (HSS101.6x63.5x6.4)
2. SUPPORTS - T32

TRIBUTARY WIDTH: 1.5m \rightarrow 4.92ft

DISTRIBUTED DEAD LOAD: \omega_d(1.5m) = 94.5\,\text{psf}

DISTRIBUTED LIVE LOAD: \omega_l(1.5m) = 157.5\,\text{psf}

\text{Resollve into point loads & joints for analysis in SAP2000}

\omega_n = \omega_d + \omega_l

\begin{align*}
p_0 &= 94.5\,\text{psf} \times (1.5m) = 401.6\,k = 0.4016\,k \\
p_c &= 157.5\,\text{psf} \times (1.5m) = 669.4\,k = 0.6694\,k
\end{align*}

CHECK DEFLECTION: L/180 = 214''/180 = 1.19'' > 0.7857'' : OK FOR \Delta

CHECK AXIAL TENSION & COMPRESSION [AISC T4-3, T5-4]

HSS 4\times2\times\frac{3}{4} - L_{net} = 50'1.03 = 438' - 5

\begin{align*}
\phi_p &= 71.2\,k > 4.6k \\
\phi_c &= 120\,k > 4.9k
\end{align*}

: OK in tension & compr.
3 SUPPORTS - T1

TRIBUTARY WIDTH: 2.0m → 6.56 ft

DISTRIBUTED DEAD LOAD: \( w_{\text{d}} (6.56\text{ft}) = 126.0 \text{plf} \) 

DISTRIBUTED LIVE LOAD: \( w_{\text{l}} (6.56\text{ft}) = 210.0 \text{plf} \)

\[ P = \left\{ \begin{array}{c}
126.0 \text{plf} \times \left( \frac{525}{656} \right) = 525 \text{plf} = 0.525 \text{plf} \\
210.0 \text{plf} \times \left( \frac{875}{656} \right) = 875 \text{plf} = 0.875 \text{plf}
\end{array} \right\} 
\]

\[ P = P_1 + P_2 \]

CHECK DEFLECTION: \( L/180 = 250/180 = 1.39'' > 0.1742'' \) \( \therefore \text{OK for } \Delta \)

CHECK AXIAL TENSION & COMPRESSION [AISC T4-3, T5-4]

HSS 4x2x\( \frac{3}{4} \) → \( L_{\text{rms}} = \frac{12k \times 1.05}{320} = 429 \approx 5 \)

\[ \phi P = 71.2^\circ \gg 12.0^\circ \]

\[ \phi P = 12.0^\circ \gg 6.17^\circ \] \( \therefore \text{OK in tension & compression} \)

HSS 4x2\( \frac{3}{4} \) x 4
2. SUPPORTS WITH CANTILEVER - T3 [SHORTER BACKSPAN]

TRIBUTARY WIDTH: 1.5m → 4.92 ft

DISTRIBUTED DEAD LOAD: \( w_{d}\) (9.92 ft) = 94.5 plf

DISTRIBUTED LIVE LOAD: \( w_{l}\) (4.92 ft) = 157.5 plf

\[
\begin{align*}
P &= (94.5\text{ plf})(9.92\text{ ft}) = 0.275^2 \rightarrow P = P + P \quad P = (157.5\text{ plf})(9.92\text{ ft}) = 0.460^2
\end{align*}
\]

CHECK DEFLECTION: \( L/180 = 250^\circ/180 = 1.39" > 0.151" : OK FOR \( \Delta \)

CHECK AXIAL TENSION & COMPRESSION [AISC T4-3, T5-4]

HSS 4 x 2 x 1/4 → \( L_{e,w} = 5^\circ/103 = 4.29 \cdot 5 \)

\( \Phi P = 71.2^\circ > 8.84^\circ \)

\( \Phi R = 12.0^\circ > 7.28 \): OK IN TENSION & COMPR.

HSS 4 x 2 1/2 x 1/4
MAIN GIRDER TRUSS — T41

TRIBUTARY WIDTH: 5.65m → 18.54 ft

DISTRIBUTED DEAD LOAD: \( \omega_{d}(18.54\text{ft}) = 336.0 \text{plf} \)

DISTRIBUTED LIVE LOAD: \( \omega_{l}(18.54\text{ft}) = 595.3 \text{plf} \)

Resolve into point loads at joints for analysis in SAP2000

— See below —

\[
P_o = \left(336.0 \text{plf}\right) \left(16\frac{1}{2}\text{ft}\right) = 1.514 \text{kip}
\]

\[
P = \left(595.3 \text{plf}\right) \left(16\frac{1}{2}\text{ft}\right) = 2.371 \text{kip}
\]

AXIAL

CHECK DEFLECTION: \( L/180 = 576"/180 = 3.2" > 0.81" \) :: OK for \( \Delta \)

CHECK AXIAL TENSION & COMPRESSION [AISC T4-3, T5-4]

HSS 4x2x\( \frac{3}{4} \) —

\[
L_{Ax} = \frac{4 \times 10.03}{41.2} = 4.12 \rightarrow 5
\]

\[
\phi P = \frac{71.2}{63.4} > 63.4 \text{kip}
\]

\[
\phi P > 12.0 > > 27.4 \text{kip} \) :: OK in tension & comp

HSS 4x2\( \frac{1}{2} \)x\( \frac{3}{4} \)
TRUSS SCHEDULE (METRIC)

SEE TRUSS DETAILS IN STRUCTURAL DRAWINGS FOR DETAIL REFERENCES AND LABELS OF H1, H2, L1, AND L2

NOTE: ALL MEASUREMENTS WERE DETERMINED BY SIMILAR TRIANGLES, STRUCTURAL DRAWINGS IN REVIT, AND ARCHITECTURAL RHINO MODEL.

<table>
<thead>
<tr>
<th>LABEL</th>
<th>REF.</th>
<th>H1 (m)</th>
<th>H2 (m)</th>
<th>L1 (m)</th>
<th>L2 (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>1</td>
<td>1.24</td>
<td>-</td>
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<tr>
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<td>2</td>
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<td>-</td>
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*IMPERIAL: HSS4x2-1/2x1/4
TRUSS SCHEDULE (METRIC)

SEE TRUSS DETAILS IN STRUCTURAL DRAWINGS FOR DETAIL REFERENCES AND LABELS OF H1, H2, L1, AND L2

NOTE: ALL MEASUREMENTS WERE DETERMINED BY SIMILAR TRIANGLES, STRUCTURAL DRAWINGS IN REVIT, AND ARCHITECTURAL RHINO MODEL.

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**TRUSS SCHEDULE:**

(IMPERIAL)

**CHECK FOR 8' CLEARANCE:**

MAXIMUM H1 = 6.58'  
14.67' - 6.58' = 8' (OK)

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<th>L1 (ft)</th>
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**LABEL**

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**ALL TRUSS MEMBERS ARE HSS101.6x63.5x6.4**

*IMPERIAL: HSS4x2.1/2x1/4*
REINFORCED CONCRETE BEAM DESIGN

ASSUMPTIONS:
* SEE GEN. REQUIREMENTS FOR METRIC EQUIVALENTS
* WORST CASE BEAM = 12" x 24" x 20.95'

\[ f'_c = 1000 \text{ psi} \]
\[ f_y = 40 \text{ psi (REINFORCING BAR)} \]

LOADING:
\[ W_G = 25.0 \text{ PSF (FROM LOAD TABLES)} \]
\[ W_L = 20.0 \text{ PSF (FROM LOAD TABLES)} \]
\[ W_u = 1.2D + 1.6L = 1.2(25\text{PSF})+1.6(20\text{PSF}) = 62.0 \text{ PSF} \]
\[ W_{L,DISTRIBUTED} = (62\text{PSF})(20.95') = 1.30 \text{ kips/ft} \]

\[ M_u = \frac{W_{u,d}}{8} = \frac{(1.30)(20.95')}{8} = 71.3 \text{ kip-ft} \]

ESTIMATE STEEL REINFORCEMENT (cover = 1.5"):
\[ A_s = \frac{M_u}{(f_y)d} = \frac{(71.3\text{kip-ft} \times 12"/1')}{(0.9 \times 40\text{kpsi} \times 21'')} = 1.13 \text{in}^2 \]

TRY 4-#5 REBAR
\[ A_s = 1.24 \text{in}^2 > A_{s,MIN} \]
\[ A_{s,MIN} = 0.0008(12"\times 24") = 0.2304 \text{in}^2 \]

CHECK CAPACITY > DEMAND:
\[ a = \frac{A_s f_y}{(0.85 f'_c b)} = \frac{(1.24 \text{in}^2)(40\text{kpsi})}{(0.85 \times 1.0\text{kpsi} \times 12'')} = 4.86" \]
\[ \phi M_n = A_s f_y (d-a/2) = 1.24 \text{in}^2 \times 40\text{kpsi} \times (21" - 4.86"/2)/12" = 76.75 \text{ kip-ft} > M_u \]

USE 4-#5 REINFORCING BAR FOR FLEXURE (4-#16 in metric units)
REINFORCED CONCRETE BEAM DESIGN

SHEAR DESIGN - STIRRUPS:

\[ V_{u,\text{MAX}} = W_v l/2 = 1.30 \times 20.95/2 = 13.6 \text{ kips} \]

\[ S_{\text{MAX}} = d/2 = 21''/2 = 10.5'' \quad \text{USE 10'' o/c (25 cm o/c)} \]

TRY 2-LEGGED #3 STIRRUPS (#10 in metric units)

\[ \phi V_a = 0.75 \left[ \left( \frac{2 f_y}{1000 \text{ksi}} \right) \left( \frac{d}{12''} \right) + \frac{2 f_y A}{100 \text{ksi} \times 10''} \right] = 28.1'' > V_a = 13.6'' \]

USE 2-LEGGED #3 (#10 metric) at 10'' (25 cm) o/c

DEFLECTION CHECK:

\[ h_{\text{MIN}} = l/16 = (20.95'')(12''/1')/16 = 15.7'' < 24'' \]

\[ [0.4 + (40\text{ksi})/(100\text{ksi})] = 9.6'' < 24'' \]

NO NEED TO CHECK DEFLECTION

DESIGN SUMMARY:

![Beam Section Diagram]

2-LEGGED #3 (#10m) STIRRUPS @ 10'' (25cm) o/c

4-#5 (#16m) LONGITUDINAL BARS

4.5'' (12cm) COVER
REINFORCED CONCRETE COLUMN DESIGN - GRAVITY LOADING

ASSUMPTIONS:
* SEE GEN. REQUIREMENTS FOR METRIC EQUIVALENTS
* TYPICAL COLUMN = 12"x12" (ACTUAL = 35cmx35cm)
f'_c = 1000 psi ; CLEAR COVER = 1.5"
f_y = 40 psi (REINFORCING BAR)

LOADING:
W_D = 25.0 PSF (FROM LOAD TABLES)
W_L = 20.0 PSF (FROM LOAD TABLES)
W_U = 1.2D + 1.6L = 1.2(25PSF)+1.6(20PSF) = 62.0 PSF

GOVERNING A_TRIBUTARY = 3.25m x 4.6m = 14.96m^2 (A_TRIBUTARY = 161.03ft^2)
P_U = (62PSF)(161.03ft^2) = 9.98 kips

M_U,BEAM = W_U/11 = (1.30)(20.95)^2/11 = 51.9 kip-ft

SPColumn INPUT VALUES FOR COLUMN:
M_u = M_y = 71.3 kip-ft
P_U = 9.98 kips

SPColumn OUTPUT:
USE 4-#5 (#16m) REBAR EQUALLY SPACED
1. Section
1.1. Shape and Properties

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<tr>
<td>Depth</td>
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<tr>
<td>$I_x$</td>
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<tr>
<td>$I_y$</td>
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<tr>
<td>$Y_o$</td>
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1.2. Section Figure

![Section Figure](image)

Rectangular 13.78 x 13.78 in 1.96% reinf.

Figure 1: Column section

2. Reinforcement
2.1. Bar Set: ASTM A615

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2.2. Confinement and Factors

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</table>
For larger bars #4 ties

Capacity Reduction Factors
Axial compression, (a) 0.8
Tension controlled $\phi$, (b) 0.9
Compression controlled $\phi$, (c) 0.65

2.3. Arrangement
Pattern All sides equal
Bar layout Rectangular
Cover to Transverse bars
Clear cover 1.5 in
Bars 12 #5
Total steel area, $A_s$ 3.72 in$^2$
Rho 1.96 %
Minimum clear spacing 2.51 in

3. Factored Loads and Moments with Corresponding Capacity Ratios
NOTE: Calculations are based on "Critical Capacity" Method.

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4. Diagrams

4.1. PM at $\theta=0$ [deg]
SEISMIC GROUND MOTION VALUES \[\text{[ASCE 7-16 §11.4]}\]

\[S_b = 1.57 > 1.5 \quad \left\{ f_c = 1.2 \right. \]

\[S_r = 0.58 \quad \left\{ f_S (S_r = 0.5) = 1.5 \right. \]

\[f_S (S_r > 0.6) = 1.4 \]

\[f_S = 1.42 \]

\[S_{hs} = f_c S_b = 1.2 (1.57) = 1.884 \]

\[S_{mi} = f_S S_r = 1.42 (0.58) = 0.8236 \]

\[S_{qs} = \frac{2}{3} S_{hs} = \frac{2}{3} (1.884) \]

\[S_{qs} = 1.256 \]

\[S_{qs} = 0.549067 \]

SEISMIC DESIGN CATEGORY (SDC)

- RISK CATEGORY: II
  - \( I_a = 1.0 \) (SEISMIC)
  - SHORT PERIOD SDC: D
  - 1-5 PERIOD SDC: D

SDC: D

PERIOD DETERMINATION \[\text{[ASCE 7-16 §12.8.2]}\]

\[T_a = C_e k_a = 0.02 (14.5)^{0.5} \quad \left[ \text{ASCE 7-16 T15.4.2} \right] \]

\[T_a = 0.198613 s \]
**Seismic Base Shear**  
\[ C_s = \frac{S_{\text{eq}}}{(R/I_n)} = \frac{1.256}{35/10} = 0.3589 \]  
(\text{I. Constraints not applied because 1-story structure})

<table>
<thead>
<tr>
<th>E/W Walls</th>
<th>N/S Walls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grid</td>
<td>Length (m)</td>
</tr>
<tr>
<td>A</td>
<td>27.98</td>
</tr>
<tr>
<td>B</td>
<td>2.97</td>
</tr>
<tr>
<td>C</td>
<td>5.75</td>
</tr>
<tr>
<td>D</td>
<td>15.1</td>
</tr>
<tr>
<td>E</td>
<td>2.15</td>
</tr>
<tr>
<td>F</td>
<td>2.15</td>
</tr>
<tr>
<td>G</td>
<td>2.15</td>
</tr>
<tr>
<td>H</td>
<td>2.15</td>
</tr>
<tr>
<td>I</td>
<td>4.4</td>
</tr>
<tr>
<td>J</td>
<td>32.3</td>
</tr>
<tr>
<td>K</td>
<td>0</td>
</tr>
<tr>
<td>L</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Sum = 97.1 ft = 318.57 ft  
Sum = 107.0 ft = 351.08 ft

\( V = C_s W \)

\( V_{\text{eq}} = 0.3589 \times 358.4^k \)

\( V_{\text{eq}} = 128.61^k \)

\( V_{\text{eq}} = 141.74^k \)

Effective Seismic Height = 7.5 ft  
Wall Thickness = 1 ft  
Weight of Concrete = 150 pcf

**Seismic Wall Weight**

| E/W | 358.39 kips |
| N/S | 394.97 kips |
NORTH/SOUTH DIRECTION

STRIP WEIGHT - REFERENCE ROOF FRAMING PLAN FOR DIMENSIONS AND LOAD TABLES FOR UNIT WEIGHT VALUES

STRIP 1: \[1'(115 \text{PSF}(7.5') + 37 \text{PSF}(65.6168')+115 \text{PSF}(7.5')) = 4.153\text{klf}\]
STRIP 2: \[1'(115 \text{PSF}(7.5') + 37 \text{PSF}(18.4711')+115 \text{PSF}(7.5')) = 2.408\text{kfl}\]
STRIP 3: \[1'(115 \text{PSF}(7.5') + 37 \text{PSF}(11.0236')+115 \text{PSF}(7.5')) = 2.133\text{kfl}\]
STRIP 4: \[1'(115 \text{PSF}(7.5') + 37 \text{PSF}(52.0013')+115 \text{PSF}(7.5')) = 3.649\text{kfl}\]
STRIP 5: \[1'(115 \text{PSF}(7.5') + 37 \text{PSF}(12.0079')+115 \text{PSF}(7.5')) = 2.169\text{kfl}\]
STRIP 6: \[1'(115 \text{PSF}(7.5') + 37 \text{PSF}(31.0696')+115 \text{PSF}(7.5')) = 2.875\text{kfl}\]
STRIP 7: \[1'(115 \text{PSF}(7.5') + 37 \text{PSF}(20.9318')+115 \text{PSF}(7.5')) = 2.499\text{kfl}\]

POINT LOADS FROM PARALLEL WALLS (CUT - WORST CASE)

*note: \(Ax=1.00\), therefore no multiplication factor is applied

\(P1 = P2 = P7 = P8 = 115 \text{PSF}(61.122') = 7.029\text{kips}\)
\(P3 = P6 = 115 \text{PSF}(8.9567') = 1.030\text{kips}\)
\(P4 = P5 = 115 \text{PSF}(12.0079') = 1.381\text{kips}\)
NORTH/SOUTH DIRECTION

RECTIONS AT WALLS
P1 = P8 = 4.153klf(13.12')(1/2) + 7.029k = 34.28 kips
P2 = 4.153klf(13.12')(1/2) + 2.408klf(13.94') + 7.029k = 67.86 kips
P3 = P6 = 3.649klf(9.02') + 2.408klf(4.92') + 1.030k = 51.14 kips
P4 = P5 = 2.169klf(4.92')(1/2) + 1.381k = 6.72 kips
P7 = 4.153klf(13.12')(1/2) + 2.499klf(13.94') + 7.029k = 69.12 kips

USE WORST CASE REACTION FOR N/S SHEAR WALL DESIGN
= 69.12 kips PER GRIDLINE
EAST/WEST DIRECTION

STRIP WEIGHT - REFERENCE ROOF FRAMING PLAN FOR DIMENSIONS AND LOAD TABLES FOR UNIT WEIGHT VALUES

STRIP 1: 1'([115PSF(7.5') + 37PSF(45.9318')+115PSF(7.5')] = 3.424klf
STRIP 2: 1'([115PSF(7.5') + 37PSF(41.0105')+115PSF(7.5')] = 3.242klf
STRIP 3: 1'([115PSF(7.5') + 37PSF(9.0223')+115PSF(7.5')] = 2.058klf
STRIP 4: 1'([115PSF(7.5') + 37PSF(49.2454')+115PSF(7.5')] = 3.547klf
STRIP 5: 1'([115PSF(7.5') + 37PSF(56.2992')+115PSF(7.5')] = 3.808klf
STRIP 6: 1'([115PSF(7.5') + 37PSF(63.353')+115PSF(7.5')] = 4.069klf
STRIP 7: 1'([115PSF(7.5') + 37PSF(13.1234')+115PSF(7.5')] = 2.211klf

POINT LOADS FROM PARALLEL WALLS (CUT - WORST CASE)

*note: Ax=1.00, therefore no multiplication factor is applied

P1 = 115PSF(45.9318') = 5.282k
P2 = 115PSF(18.8648') = 2.169k
P3 = P4 = 115PSF(7.0538') = 8.112k
P5 = 115PSF(7.6115') = 8.753k
EAST/WEST DIRECTION

REATIONS AT WALLS
P1 = 3.424klf(9.25')(1/2) + 5.282k = 21.12 kips
P2 = 3.424klf(2.76') + 3.242klf(6.50') + 2.058klf(2.46') + 3.547klf(4.27') + 2.169k = 44.99 kips
P3 = 3.547klf(6.73') + 3.808klf(4.07') + 4.069klf(1.44') + 8.112k = 53.33 kips
P4 = 4.069klf(5.51') + 3.808klf(4.07') + 3.547klf(0.44') + 8.112k = 47.60 kips
P5 = 3.547klf(4.51') + 8.753k = 26.33 kips

USE WORST CASE REACTION FOR E/W SHEAR WALL DESIGN
= 53.33 kips PER GRIDLINE
CMU SHEAR WALL DESIGN

ASSUMPTIONS:
*SEE GEN. REQUIREMENTS FOR METRIC EQUIVALENTS
12x8x16" (300x200x400mm) DOUBLE CELL
\( f'_m = 1000 \text{ psi} \)
\( S_{DS} = 1.256 \)
\( f_r = 40 \text{ psi (REINFORCING BAR)} \)

LOADING DEMAND PER GRIDLINE:

\[ N/S = 69.12 \text{ kips} \]

USE N/S FORCES FOR ALL DESIGN - EASE OF CONSTRUCTION
\[ E/W = 53.33 \text{ kips} \]

\[ W_{WALL} = (115 \text{ PSF})(14.67')(L_{WALL}) = (115 \text{ PSF})(14.67')(6.56168') = 11.067 \text{ kips} \]
\[ W_D = (37 \text{ PSF})(14.67') = 0.543 \text{ kips} \]
\[ W_L = (20 \text{ PSF})(14.67') = 0.293 \text{ kips} \]

LOAD COMBINATIONS (ASCE 7-16, IBC 2018):
\[ P_U = (1.2 + 0.2S_{DS})D + \rho Q_e/1.4 + 0.5L + 0.2S \]
\[ = (1.2 + 0.2\times1.256)[(0.543k)(6.56') + 11.067k] + 0.5((0.293k)(6.56')] \]
\[ P_U = 22.19 \text{ kips} \]
\[ P_U = (0.9 - 0.2S_{DS})D + \rho Q_e/1.4 + 1.6H \]
\[ = (0.9 - 0.2\times1.256)[(0.543k)(6.56') + 11.067k] \]
\[ P_U = 9.49 \text{ kips} \]

GOVERNS
\[ V_U = \rho Q_e/1.4 = 1.0(69.12k)/1.4 \]
\[ V_U = 49.37 \text{ kips} \]
\[ M_U = M_{OVERTURNING} = V_U L_0 = (49.37 \text{ kips})(14.67') \]
\[ M_U = 724.1 \text{ kip-ft} \]

\[ d = (6.56')(12"/1') - 8" = 70.74" \]
\[ \phi P_n = P_U ; \phi V_n = V_U ; \phi M_n = M_U \]
\[ P_n = (P_U)/0.9 = 9.49k/0.9 = 10.55 \text{ kips} \]
\[ V_n = (V_U)/0.9 = 49.37k/0.9 = 54.86 \text{ kips} \]
\[ M_n = (M_U)/0.9 = 724.1k/0.9 = 804.6 \text{ kip-ft} \]
CMU SHEAR WALL DESIGN

LOADING DIAGRAM:

CONCRETE BEAM AND COLUMNS
:: 2' x 1' COLUMNS

CONFINED MASONRY SHEAR WALLS
:: ASSUME COLUMNS TAKE ALL FLEXURE, SO CALCULATE TENSION AND COMPRESSION MOMENT COUPLE DEMAND

CMU BLOCKS, RUNNING BOND

SOLVE FOR TENSION AND COMPRESSION:

\[ \sum M_t = 0: (8.56')C - (6.56 washer)P_u - (14.67')V_u = 0 \]
\[ C = 99.3k \]

\[ \uparrow \sum F_y = 0: 99.3k - 10.55k + T = 0 \rightarrow T = -88.7k \]

COLUMNS TAKE ALL FLEXURAL CAPACITY, CHECK COLUMNS FOR GRAVITY LOADS

SPColumn INPUT VALUES FOR COLUMN IN COMPRESSION:

\[ M_{ux} = M_{uy} = 71.3 \text{ kip-ft} \]
\[ P_u = 99.3 \text{ kips ( > TENSION VALUE = 88.7 kips) } \]

RESULTS: 6-#5 BARS EQUALLY SPACED (24" side)
2-#5 BARS EQUALLY SPACED (12" side)
1. General Information

<table>
<thead>
<tr>
<th>File Name</th>
<th>c:\users\claire\desktop\ji haiti column 1.col</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project</td>
<td>---</td>
</tr>
<tr>
<td>Column</td>
<td>---</td>
</tr>
<tr>
<td>Engineer</td>
<td>---</td>
</tr>
<tr>
<td>Code</td>
<td>ACI 318-19</td>
</tr>
<tr>
<td>Bar Set</td>
<td>ASTM A615</td>
</tr>
<tr>
<td>Units</td>
<td>English</td>
</tr>
<tr>
<td>Run Option</td>
<td>Investigation</td>
</tr>
<tr>
<td>Run Axis</td>
<td>X - axis</td>
</tr>
<tr>
<td>Slenderness</td>
<td>Not Considered</td>
</tr>
<tr>
<td>Column Type</td>
<td>Structural</td>
</tr>
<tr>
<td>Capacity Method</td>
<td>Critical capacity</td>
</tr>
</tbody>
</table>

2. Material Properties

2.1. Concrete

<table>
<thead>
<tr>
<th>Type</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>$f'_c$</td>
<td>2 ksi</td>
</tr>
<tr>
<td>$E_c$</td>
<td>2549.12 ksi</td>
</tr>
<tr>
<td>$f_c$</td>
<td>1.7 ksi</td>
</tr>
<tr>
<td>$\epsilon_u$</td>
<td>0.003 in/in</td>
</tr>
<tr>
<td>$\beta_1$</td>
<td>0.85</td>
</tr>
</tbody>
</table>

2.2. Steel

<table>
<thead>
<tr>
<th>Type</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>$f_y$</td>
<td>40 ksi</td>
</tr>
<tr>
<td>$E_s$</td>
<td>29000 ksi</td>
</tr>
<tr>
<td>$\epsilon_{yt}$</td>
<td>0.00137931 in/in</td>
</tr>
</tbody>
</table>

3. Section

3.1. Shape and Properties

<table>
<thead>
<tr>
<th>Type</th>
<th>Rectangular</th>
</tr>
</thead>
<tbody>
<tr>
<td>Width</td>
<td>24 in</td>
</tr>
<tr>
<td>Depth</td>
<td>12 in</td>
</tr>
<tr>
<td>$A_g$</td>
<td>288 in²</td>
</tr>
<tr>
<td>$I_x$</td>
<td>3456 in⁴</td>
</tr>
<tr>
<td>$I_y$</td>
<td>13824 in⁴</td>
</tr>
<tr>
<td>$r_x$</td>
<td>3.4641 in</td>
</tr>
<tr>
<td>$r_y$</td>
<td>6.9282 in</td>
</tr>
<tr>
<td>$X_o$</td>
<td>0 in</td>
</tr>
<tr>
<td>$Y_o$</td>
<td>0 in</td>
</tr>
</tbody>
</table>
1. Section
1.1. Shape and Properties

<table>
<thead>
<tr>
<th>Type</th>
<th>Rectangular</th>
</tr>
</thead>
<tbody>
<tr>
<td>Width</td>
<td>12 in</td>
</tr>
<tr>
<td>Depth</td>
<td>24 in</td>
</tr>
<tr>
<td>$A_g$</td>
<td>288 in$^2$</td>
</tr>
<tr>
<td>$I_x$</td>
<td>13824 in$^4$</td>
</tr>
<tr>
<td>$I_y$</td>
<td>3456 in$^4$</td>
</tr>
<tr>
<td>$r_x$</td>
<td>6.9282 in</td>
</tr>
<tr>
<td>$r_y$</td>
<td>3.4641 in</td>
</tr>
<tr>
<td>$X_o$</td>
<td>0 in</td>
</tr>
<tr>
<td>$Y_o$</td>
<td>0 in</td>
</tr>
</tbody>
</table>

**THIS SPColumn OUTPUT IS FOR BENDING IN THE FIRST AXIS**

1.2. Section Figure

![Section Figure](image)

Rectangular 12 x 24 in 1.51% reinf.

Figure 1: Column section

2. Reinforcement
2.1. Bar Set: ASTM A615

<table>
<thead>
<tr>
<th>Bar</th>
<th>Diameter</th>
<th>Area</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>in</td>
<td>in$^2$</td>
</tr>
<tr>
<td>#3</td>
<td>0.38</td>
<td>0.11</td>
</tr>
<tr>
<td>#6</td>
<td>0.75</td>
<td>0.44</td>
</tr>
<tr>
<td>#9</td>
<td>1.13</td>
<td>1.00</td>
</tr>
<tr>
<td>#14</td>
<td>1.69</td>
<td>2.25</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Bar</th>
<th>Diameter</th>
<th>Area</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>in</td>
<td>in$^2$</td>
</tr>
<tr>
<td>#4</td>
<td>0.50</td>
<td>0.20</td>
</tr>
<tr>
<td>#7</td>
<td>0.88</td>
<td>0.60</td>
</tr>
<tr>
<td>#10</td>
<td>1.27</td>
<td>1.27</td>
</tr>
<tr>
<td>#18</td>
<td>2.26</td>
<td>4.00</td>
</tr>
</tbody>
</table>

2.2. Confinement and Factors

<table>
<thead>
<tr>
<th>Confinement type</th>
<th>Tied</th>
</tr>
</thead>
<tbody>
<tr>
<td>For #5 bars or less</td>
<td>#3 ties</td>
</tr>
</tbody>
</table>
For larger bars

<table>
<thead>
<tr>
<th>Capacity Reduction Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Axial compression, (a)</td>
</tr>
<tr>
<td>Tension controlled $\phi$, (b)</td>
</tr>
<tr>
<td>Compression controlled $\phi$, (c)</td>
</tr>
</tbody>
</table>

2.3. Arrangement

<table>
<thead>
<tr>
<th>Pattern</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sides different</td>
</tr>
<tr>
<td>Bar layout</td>
</tr>
<tr>
<td>Rectangular</td>
</tr>
<tr>
<td>Cover to</td>
</tr>
<tr>
<td>Transverse bars</td>
</tr>
<tr>
<td>Clear cover</td>
</tr>
<tr>
<td>---</td>
</tr>
<tr>
<td>Bars</td>
</tr>
<tr>
<td>---</td>
</tr>
</tbody>
</table>

| Total steel area, $A_s$            |
| 4.34 in²                           |

| Rho                                |
| 1.51 %                             |

Minimum clear spacing 3.18 in

2.4. Bars Provided

<table>
<thead>
<tr>
<th>Bars</th>
<th>Clear cover</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>in</td>
</tr>
<tr>
<td>Top</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>#5</td>
</tr>
<tr>
<td></td>
<td>1.5</td>
</tr>
<tr>
<td>Bottom</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>#5</td>
</tr>
<tr>
<td></td>
<td>1.5</td>
</tr>
<tr>
<td>Left</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>#5</td>
</tr>
<tr>
<td></td>
<td>1.5</td>
</tr>
<tr>
<td>Right</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>#5</td>
</tr>
<tr>
<td></td>
<td>1.5</td>
</tr>
</tbody>
</table>

3. Factored Loads and Moments with Corresponding Capacity Ratios

NOTE: Calculations are based on "Critical Capacity" Method.

<table>
<thead>
<tr>
<th>No.</th>
<th>Demand Parameters at Capacity</th>
<th>Capacity Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$P_u$ kip</td>
<td>$M_{ux}$ k-ft</td>
</tr>
<tr>
<td>1</td>
<td>99.30</td>
<td>71.30</td>
</tr>
</tbody>
</table>
4. Diagrams

4.1. PM at θ=0 [deg]

PM at 0.0 [deg]

**General Information**
- Project: ---
- Column: ---
- Engineer: ---
- Code: ACI 318-19
- Bar Set: ASTM A615
- Units: English
- Run Option: Investigation
- Run Axis: X - axis
- Sturdiness: Not Considered
- Column Type: Structural
- Capacity Method: Critical capacity

**Materials**
- $f_c$: 2 ksi
- $E_c$: 25400 ksi
- $f_y$: 40 ksi
- $E_s$: 29000 ksi

**Section**
- Type: Rectangular
- Width: 12 in
- Depth: 24 in
- $A_s$: 288 in²
- $I_s$: 13624 in⁴
- $I_y$: 3456 in⁴

**Reinforcement**
- Pattern: Sticks different
- Bar layout: Rectangular
- Cover to: Transverse bars
- Clear cover: ---
- Bars: ---
- Confinement type: Tied

**Dimensions**
- Total steel area, $A_s$: 4.34 in²
- Rho: 1.51%
- Min. clear spacing: 3.18 in

**Capacity**

<table>
<thead>
<tr>
<th>No.</th>
<th>$P_m$</th>
<th>$M_m$</th>
<th>$\phi P_m$</th>
<th>$\phi M_m$</th>
<th>Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>99.3</td>
<td>71.3</td>
<td>0.00</td>
<td>124.12</td>
<td>0.57</td>
</tr>
</tbody>
</table>

Max. Capacity Ratio: 0.57

**Note:**

THIS SPColumn OUTPUT IS FOR BENDING IN THE FIRST AXIS
3.2. Section Figure

Figure 1: Column section

Rectangular 24 x 12 in 1.72% reinf.

4. Reinforcement

4.1. Bar Set: ASTM A615

<table>
<thead>
<tr>
<th>Bar</th>
<th>Diameter (in)</th>
<th>Area (in²)</th>
<th>Bar</th>
<th>Diameter (in)</th>
<th>Area (in²)</th>
<th>Bar</th>
<th>Diameter (in)</th>
<th>Area (in²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>#3</td>
<td>0.38</td>
<td>0.11</td>
<td>#4</td>
<td>0.50</td>
<td>0.20</td>
<td>#5</td>
<td>0.63</td>
<td>0.31</td>
</tr>
<tr>
<td>#6</td>
<td>0.75</td>
<td>0.44</td>
<td>#7</td>
<td>0.88</td>
<td>0.60</td>
<td>#8</td>
<td>1.00</td>
<td>0.79</td>
</tr>
<tr>
<td>#9</td>
<td>1.13</td>
<td>1.00</td>
<td>#10</td>
<td>1.27</td>
<td>1.27</td>
<td>#11</td>
<td>1.41</td>
<td>1.56</td>
</tr>
<tr>
<td>#14</td>
<td>1.69</td>
<td>2.25</td>
<td>#18</td>
<td>2.26</td>
<td>4.00</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4.2. Confinement and Factors

Confinement type: Tied
- For #5 bars or less: #3 ties
- For larger bars: #4 ties

Capacity Reduction Factors
- Axial compression, (a): 0.8
- Tension controlled $\phi$, (b): 0.9
- Compression controlled $\phi$, (c): 0.65

4.3. Arrangement

<table>
<thead>
<tr>
<th>Pattern</th>
<th>Sides different</th>
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<tbody>
<tr>
<td>Bar layout</td>
<td>Rectangular</td>
</tr>
<tr>
<td>Cover to</td>
<td>Transverse bars</td>
</tr>
<tr>
<td>Clear cover</td>
<td>---</td>
</tr>
<tr>
<td>Bars</td>
<td>---</td>
</tr>
<tr>
<td>Total steel area, $A_s$</td>
<td>4.96 in²</td>
</tr>
<tr>
<td>Rho</td>
<td>1.72 %</td>
</tr>
<tr>
<td>Minimum clear spacing</td>
<td>1.91 in</td>
</tr>
</tbody>
</table>
### 4.4. Bars Provided

<table>
<thead>
<tr>
<th></th>
<th>Bars</th>
<th>Clear cover</th>
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<tbody>
<tr>
<td>Top</td>
<td>6</td>
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</tr>
<tr>
<td></td>
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</tr>
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<td>Bottom</td>
<td>6</td>
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</tr>
<tr>
<td></td>
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<td>#5</td>
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<td>Right</td>
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<tr>
<td></td>
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NOTE: Calculations are based on "Critical Capacity" Method.

### 5. Factored Loads and Moments with Corresponding Capacity Ratios

<table>
<thead>
<tr>
<th>No.</th>
<th>Demand</th>
<th>Capacity</th>
<th>Parameters at Capacity</th>
<th>Capacity Ratio</th>
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<tr>
<td></td>
<td>$P_u$</td>
<td>$M_{ux}$</td>
<td>$\phi P_u$</td>
<td>$\phi M_{ux}$</td>
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<tr>
<td>-----</td>
<td>--------</td>
<td>----------</td>
<td>-------------</td>
<td>-------------</td>
</tr>
<tr>
<td>1</td>
<td>99.30</td>
<td>71.30</td>
<td>129.61</td>
<td>78.27</td>
</tr>
</tbody>
</table>

THIS SPColumn OUTPUT IS FOR BENDING IN THE SECOND AXIS
6. Diagrams

6.1. PM at θ=0 [deg]

---

General Information
Project ---
Column ---
Engineer ---
Code ACI 318-19
Bar Set ASTM A615
Units English
Run Option Investigation
Run Axis X - axis
Stiffness Not Considered
Column Type Structural
Capacity Method Critical capacity

Materials
f_c' 2 ksi
E_c 2549.12 ksi

f_y 40 ksi
E_y 29000 ksi

Section
Type Rectangular
Width 24 in
Depth 12 in
A_y 288 in²
I_y 3456 in⁴
I_y 13824 in⁴

Reinforcement
Pattern St-bars different
Bar layout Rectangular
Cover to Transverse bars
Clear cover ---
Bars ---

Confinement type Tied
Total steel area, A_s 4.96 in²
Rho 1.72 %
Min. clear spacing 1.91 in

---

PM at 0.0 [deg]

<table>
<thead>
<tr>
<th>No.</th>
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<th>M_p</th>
<th>ϕP_y</th>
<th>ϕM_p</th>
<th>Capacity</th>
</tr>
</thead>
<tbody>
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<td>71.3</td>
<td>129.61</td>
<td>78.27</td>
<td>0.88</td>
</tr>
</tbody>
</table>

Max. Capacity Ratio: 0.88

---

THIS SPColumn OUTPUT IS FOR BENDING IN THE SECOND AXIS
CMU SHEAR WALL DESIGN

NOMINAL AXIAL STRENGTH OF WALL

\[ r = \frac{4}{\sqrt{12}} = 12''/\sqrt{12} = 3.46'' \quad ; \quad \frac{H}{r} = \frac{11.625'' \times 12.5''}{3.46''} = 50.8 < 99 \]

\[ P_n = 0.80(0.80(A_n)f_m'(1 - (h/(140r))^3)) \]
\[ = 0.80(0.80)(11.625'')(7.625'')(1 - (50.8/140))^3] \]

\[ P_n = 49.26 \text{ kips} \]

\[ \phi P_n = 0.9(49.26k) = 44.33 \text{ kips} > P_u = 10.55 \text{ kips} \]

NOMINAL SHEAR STRENGTH

\[ V_n = (V_{nm} + V_{ns}) \gamma \frac{1.0}{1.10} \text{ (FULLY GRAUTED)} \]

\[ V_{nm} = \left( (4 - 1.75(\frac{d}{d_{ew}})(12'')(14.67'')(125'')/200000 + 0.25 (99')(1000') \right)/1000 \]

\[ V_{nm} = 30.35'' \quad \text{(EQUATION 9-20)} \]

\[ V_{ns} = 0.5 \left( \frac{A_o}{S} \right) f_y d_y = 0.5 \left( \frac{0.625}{4} \right)(40)(15.625') = 48.44'' \quad \text{(EQUATION 9-21)} \]

\[ V_n = V_{nm} + V_{ns} = 78.8'' > V_u = 54.9'' \]

ADDITIONAL SDC-BASED REQUIREMENTS

(AREA/LENGTH)(MINIMUM HORIZONTAL REINFORCEMENT)

\[ = 0.0007(11.625'')(12'') = 0.09765 \text{ in}^2/\text{ft} \]

MAXIMUM SPACING < 6.58'/3 = 26.32'' USE 24'' o/c

TRY #5 AT 24'' o/c (ANCHORED AROUND VERTICAL STEEL AT ENDS)

USE SAME VERTICAL STEEL AS HORIZONTAL

\[ (0.62\text{ in}^2)/(2') = 0.31 \text{ in}^2/\text{ft} > 0.09765\text{in}^2/\text{ft} \]

TOTAL MINIMUM REINFORCEMENT = 0.002(11.625'')(12'') = 0.279\text{in}^2/\text{ft}^2

REQUIRED VERTICAL REINFORCEMENT = 0.279 - 0.09765 = 0.18 \text{ in}^2/\text{ft}^2

2 - #5 BARS AT EACH END: 4(0.31\text{in}^2)/2' = 0.62 \text{ in}^2/\text{ft} > 0.18 \text{ in}^2/\text{ft}
SPREAD FOOTING DESIGN

ALLOWABLE BEARING PRESSURE = 5000 PSF
12"x12" REINFORCED CONCRETE COLUMN
P_u = 9.98 kips (SEE PAGE C1)

ESTIMATE SIZE OF FOOTING:

\[ A_{req} = \frac{P_u}{\text{BEARING PRESSURE}} = \frac{(9.98k)/(5\text{ksf})}{1.996\text{ft}^2} \]

LENGTH = WIDTH = \sqrt{1.996} = 1.41 ft --- TRY 0.5m x 0.5m SQUARE FOOTING (20"x20")

CHECK FOOTING PROPERTIES:

\[ c = 0.5(20" - 12") = 4" \]
\[ d = 2.2\sqrt{\left(\frac{P_u}{A_{FtG}}\right)c^2} = 2.2\sqrt{(9.98/2.78)(4/12)^2} = 1.04" \]
\[ d + 4" = 5.04" < 6" \text{ N.G.} \]

USE 36"x36" FTG INSTEAD (ABOUT 1.0mx1.0m)

\[ c = 0.5(36" - 12") = 12" \]
\[ d = 2.2\sqrt{(9.98/9)(12/12)^2} = 2.32" \]
\[ d + 4" = 6.32" > 6" \text{ O.K.} \]

DETERMINE REINFORCEMENT:

\[ A_g = 0.0018bh = 0.0018(6.32")(36") = 0.41\text{in}^2 \]

USE 4-#3 (#10 in metric units)

\[ A_g = 0.44\text{in}^2 \]

STRENGTH CHECK - 9.98k/9ft^2 = 1.11ksf < 5.0ksf

CHECK BEAM SHEAR:

\[ V_u \geq f_{su}(c - d) = 1.11\text{ksf}(12"-6.32")/12 = 0.52 \text{kips} \]
\[ \phi V_n = \phi(2)\sqrt{f'_{c}}bd = 0.75*2*\sqrt{1000\text{psi}}*(12")*(6.32") = 3.60 \text{kips} > V_u = 0.52 \text{kips} \]
SPREAD FOOTING DESIGN

CHECK PUNCHING SHEAR:
1) BASE - 
\[ 4 \frac{f_c}{f_y} = 4 \sqrt[2]{2000} = 178.9 \text{kPa} \]

2) COLUMN SHAPE - 
\[ (2 + \frac{4}{B_C})^{1/3} = \frac{B_C}{12} \leq 2.0 \]
\[ (2 + 4) \frac{12}{2000} = 268.35 \text{kPa} \]

3) COLUMN LOCATION - 
\[ (2 + \frac{4d}{b})^{1/3} = (2 + \frac{4 \times 6.32}{169.3}) \sqrt[12]{2000} = 153.4 \text{kPa} \]

\[ b_2 = 2 \left[ (L + d) + (L + d) \right] \]
\[ l = 4 \left[ 36.0 + 6.32 \right] \]
\[ b_2 = 169.3 \text{in} \]

\[ \phi V_n = 0.75 (153.4 \text{kPa})(169.3 \text{in})(6.32 \text{in}) = 123.1 \text{k}\text{ft} > V_n = 54.9 \text{k}\text{ft} \]

CHECK FLEXURE:
\[ M_0 = 0.5(1.11)(1.0^2) = 0.55 \text{kip-ft} \]
\[ \phi M_n = \phi_A f_y (d - a/2) = 0.9(0.44 \times 40)(6.32 - 1.73/2) \]
\[ = 86.4 \text{kip-inches} = 7.20 \text{kip-ft} > M_0 \]

USE 1.0m x 1.0m SPREAD FOOTING FOR ALL ISOLATED COLUMNS WITH 4-#10(metric) BARS EACH WAY
STRUCTURAL DRAWINGS

FOR

HAITI HAC INNOVATION CENTER
CROIX-DES-BOUQUETS, HAITI

THIRD LENS MINITRIES - HAITIAN AMERICAN CAUCUS

15 JUNE 2021

PREPARED BY:
CLAIRE LEADER

NOT FOR CONSTRUCTION
TO BE REVIEWED AND
APPROVED BY IN-COUNTRY
STRUCTURAL ENGINEER

JOURNEYMAN INTERNATIONAL
REINFORCEMENT

1. REINFORCING TO CONFORM TO THE FOLLOWING, UNLESS OTHERWISE NOTED:

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>TYPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>REINFORCING STEEL U.N.O.</td>
<td>ASTM A615, 40 KSI (GRADE 280m)</td>
</tr>
</tbody>
</table>

2. REINFORCING BARS SHALL HAVE THE FOLLOWING MINIMUM COVERAGE. PLACE BARS AS NEAR TO THE CONCRETE SURFACE AS THESE MINIMUMS PERMIT WHEREVER POSSIBLE UNLESS NOTED OTHERWISE:

<table>
<thead>
<tr>
<th>MIN. CONCRETE COVER</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 cm</td>
</tr>
<tr>
<td>5 cm</td>
</tr>
<tr>
<td>2 cm</td>
</tr>
</tbody>
</table>

3. BARS SHALL BE FIRMLY SUPPORTED AND ACCURATELY PLACED AS REQUIRED BY THE A.C.I. STANDARDS, USING TIE AND SUPPORT BARS IN ADDITION TO REINFORCEMENT SHOWN WHERE NECESSARY FOR FIRM AND ACCURATE PLACING. ALL DOWELS SHALL BE ACCURATELY SET IN PLACE BEFORE PLACING CONCRETE.

4. DRAWINGS SHOW TYPICAL REINFORCING CONDITIONS. CONTRACTOR SHALL PREPARE DETAILED PLACEMENT DRAWINGS OF ALL CONDITIONS SHOWING QUANTITY, SPACING, SIZE, CLEARANCES, LAPS, INTERSECTIONS AND COVERAGE REQUIRED BY STRUCTURAL DETAILS, APPLICABLE CODE AND TRADE STANDARDS. CONTRACTOR SHALL NOTIFY REINFORCING INSPECTOR OF ANY ADJUSTMENTS FROM TYPICAL CONDITIONS THAT ARE PROPOSED IN PLACEMENT DRAWINGS TO FACILITATE FIELD PLACEMENT OF REINFORCING STEEL AND CONCRETE.

FORMWORK

1. BEFORE STARTING CONSTRUCTION, THE CONTRACTOR SHALL DEVELOP A PROCEDURE AND SCHEDULE FOR REMOVAL OF CONCRETE FORMS AND SHORES. CONCRETE FORMS AND SHORES SHALL BE REMOVED IN SUCH A MANNER AS TO NOT IMPAIR THE SAFETY AND SERVICEABILITY OF THE STRUCTURE. IN ADDITION TO THE ABOVE REQUIREMENTS, REMOVAL OF FORMS SHALL BE NO SOONER THAN THE FOLLOWING:

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>REMOVE FORMS NO SOONER THAN</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOTTOM FORMS AND SHORES FOR MILDLY REINFORCED SLABS, BEAMS AND GIRDER</td>
<td>7 DAYS</td>
</tr>
<tr>
<td>SIDE FORMS FOR BEAMS AND GIRDER</td>
<td>72 HOURS</td>
</tr>
<tr>
<td>COLUMNS AND WALLS</td>
<td>72 HOURS</td>
</tr>
<tr>
<td>FOOTINGS, PILE CAPS, AND GRADE BEAMS</td>
<td>48 HOURS</td>
</tr>
</tbody>
</table>

2. PROVIDE CURING WHERE FORMS ARE REMOVED IN LESS THAN 7 DAYS, INCLUDING BUT NOT LIMITED TO WALLS, COLUMNS, AND UNDERSIDE OF ELEVATED SLABS.
#10 REINFORCING BAR @ 1.0m o.c., TYP.

35cm LENGTH PER PLAN

2-LEGGED #10 TIES @ 25cm o.c.

#16 LONGITUDINAL REINF. BARS, EQUALLY SPACED

4.0cm COVER TYP.

2-LEGGED #10 STIRRUPS @ 25cm o.c.

4 - #16 LONGITUDINAL BARS

0.70

0.35

DRAWINGS TO BE REVIEWED BY IN-COUNTRY ENGINEER AND ARCHITECT.

DRAWINGS NOT FOR CONSTRUCTION.

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HAITI HAC INNOVATION CENTER

REVISIONS

DESCRIPTION:

DATE:

DRAWN BY: CML

CHECKED BY:

PLOT DATE:

6/14/2021

5:29:02 PM

SHEET NAME:

GENERAL DETAILS

SCALE:

As indicated

SHEET NO.: S3.0
# Metric Truss Schedule

(REF. = REFERENCE DETAIL NUMBER)

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<th>H2 (m)</th>
<th>L1 (m)</th>
<th>L2 (m)</th>
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# Imperial Truss Schedule

(REF. = REFERENCE DETAIL NUMBER)

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<th>H2 (ft)</th>
<th>L1 (ft)</th>
<th>L2 (ft)</th>
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<td>7.38</td>
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*IMPERIAL: H554x2-1/2x1/4