FINAL REPORT:

TEMPLE STEEPLE FOR THE CHURCH OF JESUS CHRIST OF LATTER-DAY SAINTS

RVHB ENGINEERING

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EXECUTIVE SUMMARY

The Church of Jesus Christ of Latter-day Saints constructs temples throughout the world. This particular temple is to be built in an area of high seismic activity. The base structure of the temple has already been designed and RVHB Engineering has been assigned the task of designing the structural steel core of the temple steeple. The dimensions and layout of the steeple have already been completed by the architect.

The project has numerous non-technical constraints. These include architectural, sustainability and construction constraints. Architectural constraints require the use of heavy steel cladding and long high reaching windows. The architect requires that no steel shadows be visible through the windows. Sustainability requires that the steeple experience minimal damage during an earthquake and experience minimal repair time after the earthquake event. Construction restrained the choice of steel shapes to those locally available.

RVHB Engineering considered three lateral force resisting systems: Special Concentrically Braced Frames (SCBF), Moment Frames (MF), and Buckling Restrained Braced Frames (BRBF). The base shear for each of these systems was computed using the two stage approach outlined in ASCE (7-10). Design of the steeple as a non-structural component was also considered in the analysis.

The final design implemented BRBFs and small locally available steel shapes. RVHB Engineering felt that the higher cost of implementing BRBs was justified due to increased performance. Stone cladding will not be damaged due to buckling members and the post-earthquake repair will consist of replacing only the failed braces. The braced frames are configured in a diagonal orientation from the windows and span from the outside of each window to the window on the adjoining side.

Other members in the steeple were designed to the adjusted capacity of the brace in order to ensure that the brace fails before the other members. When selecting the size of the steel shapes deflection was considered and the final design including all HSS 3x3x1/4 shapes with a top floor deflection of 0.936 in. The final weight of the structural steel included in the steeple is 21 kip and the overall weight including cladding and the Angel Moroni is 98.8 kip.

INTRODUCTION

VISION STATEMENT

RVHB Engineering is dedicated to providing safe, reliable, sustainable, and innovative solutions to modern engineering problems. We commit to providing cost-effective designs tailored to client's individual needs. RVHB Engineering employs four qualified engineers in training who are committed to providing quality work in a timely manner.

PURPOSE

The Church of Jesus Christ of Latter-day Saints has over 14 million members worldwide. Temples are an important part in the worship services of these members and must be accessible to patrons in various locations throughout the world. In this circumstance, the temple must be designed to perform under the local seismic loads. The purpose of this project is to provide these members with a sustainable temple structure.

OBJECTIVE

Understanding the effect of earthquakes on structural systems is crucial when designing structures in areas with high seismic activity. By nature temples must be designed to endure gravity and horizontal loads due to ground motion while maintaining an aesthetic architecture. The steeple of one of these temples must be designed to meet seismic performance criteria at an optimal cost. The steeple must also fit the current architectural constraints

SCOPE OF WORK SUMMARY

A comparison between different seismic designs fitting current architectural requirements will be performed. Architectural constraints that will be used in analysis are exterior cladding, window placement and the statue of Angel Moroni. After preliminary consideration, three structural framing systems will be considered in the design. Two design approaches will be taken into consideration. A two-stage approach will be conducted in accordance with ASCE 7-10 Section 12.2.3.2. A component design in accordance with ASCS 7-10 Section 13 will also be considered.

Preliminary systems were analyzed under a Design Basis Earthquake and the chosen system was considered in the Maximum Considered Earthquake (MCE). Designs were modeled in Revit Structure and analyzed using SAP2000 structural analysis software. Cost for materials, labor, and construction equipment will be included in a cost analysis.

CONSTRAINTS

The main constraint in this project was Architectural. The dimensions of the steeple were previously designed and included eight large windows. Structural steel needed to be provided to support the stone cladding exterior of the steeple. At night the steeple will be lit with a single light source extending up a central tube. The architect specified that no steel shapes or shadows of steel shapes were to be seen through the windows.

Other constraints included Sustainability, Constructability, and Safety. Due to the importance of temples in LDS culture it was important that this structure be sustainable in a seismically active area. For this reason we sought to minimize post-earthquake repair time. The project sponsor also specified the importance of using local steel shapes, no larger than square HSS 4x4. Safety was also a primary consideration in this project, it was important that the stone cladding remain fixed to the steeple during an earthquake event. If members were to buckle and dislodge the cladding, it would pose a safety risk of falling on individuals evacuating the temple.

ANALYSIS

TOOLS UTILIZED

Modern engineering tools utilized for the completion of this project include: Mathcad, SAP2000, Revit Structure and Microsoft Excel. All calculations were done in Mathcad. These included determination of steeple weight, equivalent lateral forces, and lateral bracing design. Structural analysis was conducted in SAP2000. Internal forces and deflections were computed using this software. Modeling and structural plans were done in Revit Structure. Supporting calculations and tables were completed in Microsoft Excel.

COMPARASION OF ALTERNATIVES AND DESIGN APPROACHES

RESEARCH OF THREE ALTERNATIVES

The project sponsor indicated the need to research three seismic design alternatives and evaluated their feasibility of implementation within this project. Once a system was selected we were to develop the best alternative. The three lateral force resisting systems researched and considered prior to final design included: Special Concentrically Braced Frames (SCBF), Moment Frames (MF), and Buckling Restrained Braced Frames (BRBF).

Special concentrically braced frames were considered as they provided the opportunity to utilized only locally available steel. Bracing could be constructed out of small members and be easily constructed on site. However the geometry of the steeple limited the size of the braced bay. Due to the small nature of the bays it was determined that this approach would significantly increase the weight of the structure. We considered the need for both tension and compression braces in each bay to resist seismic loading. Buckling was also an issue when dealing with the SCBF design. Braces that buckled and damage the exterior cladding would significantly increase the repair cost and affect the safety of the steeple during a seismic event.

Moment frames were considered as way to eliminate cross-bracing especially in the window areas. However after further consideration we determined that the steeple was too tall and skinny to make them work without large beam and column sizes. Time constraints also played a role in this consideration as we were unable to perform calculations supporting our assumptions.

The third system considered was the BRBs which consist of a small steel core encased in concrete. The concrete prevents the steel core from buckling in compression, facilitating both tension and compression yielding. The cyclic yielding dissipates the energy supplied by the earthquake. We determined that this was a suitable solution because the bays only required one member and the braces would fit diagonally in the corners outside of the windows. Although the braces are not locally available, they can be shipped to the site and assembled along with locally available steel. The rest of the structure could be designed so that failures will result in the braces themselves and not the other member, making post-earthquake repair minimal.

EVALUATION OF ALTERNATIVES AND DESIGN APPROACHES

The Steeple was analyzed using a two stage approach (ASCE 7-10 Section 12.2.3.2). The equivalent lateral force method was used to determine the forces acting on the steeple. The steeple was broken into two “stories” with the equivalent lateral forces acting on the top of each story. The forces acting at an elevation of 26 ft. and 42 ft. relative to the bottom of the steeple.

The results of the two stage approach are shown below in Table 1 for each of the three systems: MF, SCBF and BRBF. Supporting calculations for Table 1 are found in Appendix A. Moment frames and BRBFs resulted in the lowest design forces. RVHB selected BRBFs to design further.

The steeple was also analyzed as a component (ASCE 7-10 Chapter 13) with the equivalent force acting through the center of mass of the structure. The results from the component approach are included in Appendix B, the resultant force was 150 kips. This result furthered our decision to peruse a BRBF design as we could design for significantly lower forces using the two-stage approach. The acceleration response spectrum for the site was also plotted in accordance with ASCE 7-10 (Figure 1).

Table 1: Results from Equivalent Lateral Force Method

System	Level	w(kip)	h(ft.)	F_x	V_{base} (kip)
MF (R=8)	1	49.4	26	*5.45*	*14.85*
	2	49.4	42	*9.41*	
SCBF (R=6)	1	49.4	26	8.66	22.64
	2	49.4	42	13.98	
BRBF (R=8)	1	49.4	26	6.31	16.98
	2	49.4	42	10.67	

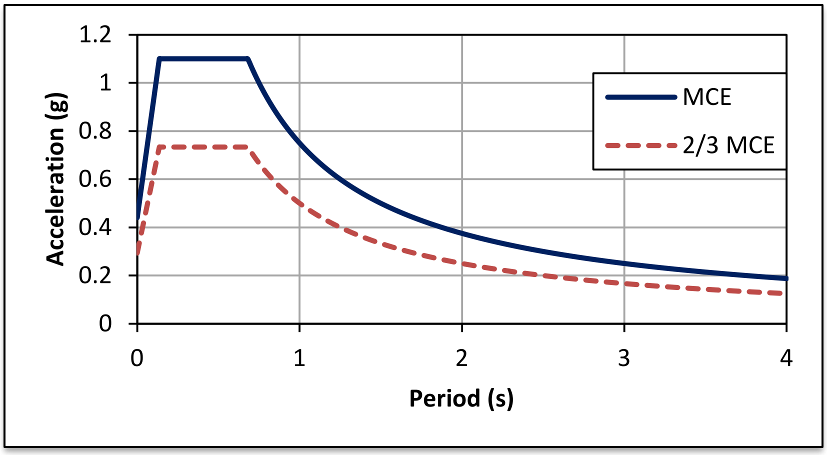


Figure 1: Site Specific Acceleration Response Spectra

RECOMMENDED FINAL DESIGN

SYSTEM GEOMETRY

Architectural requirements prohibited the placement of steel that would either be visible through the windows or cast a shadow when the steeple light from a single light source inside the steeple. For this reason we decided to work primary on the corners of the structure to provide lateral bracing. The design, shown in Figure 2 shows the bracing systems extending from the side of the window on one side to the near side of the window on the adjoining side. By insetting the bracing from the corner we were able to create “deeper” bays.

The orientation of the BRBs is symmetric on each side of the steeple. This is an important aspect to the design as it prevents excess torsion in the steeple. BRBs are stronger in compression than tension, for this reason it was important the braces on each symmetric side be either both in tension or both in compression.

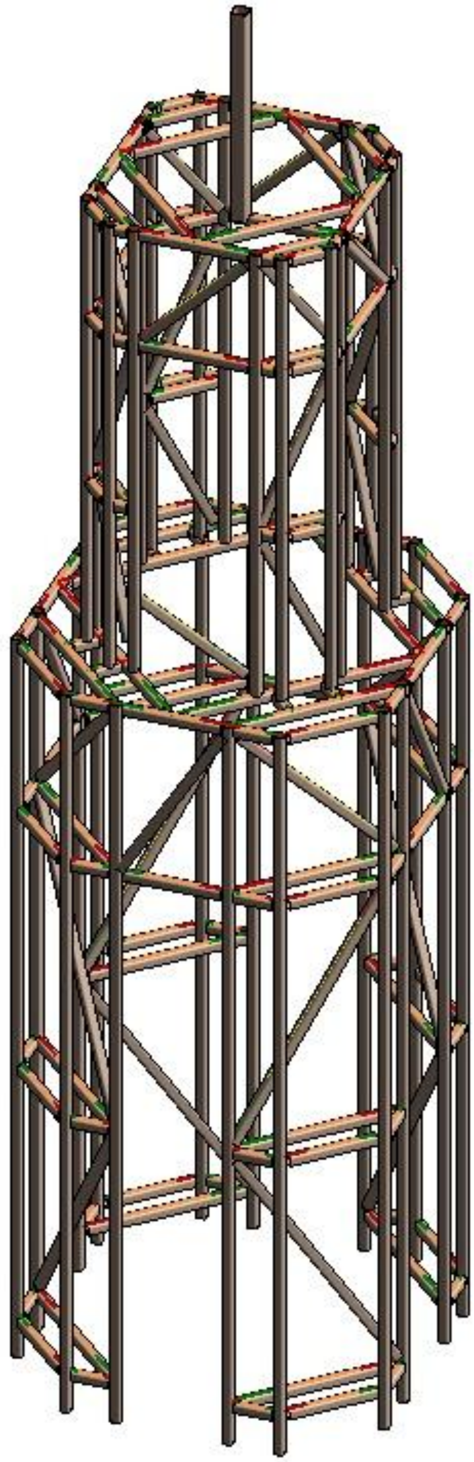


Figure 2: Structural Steel System Geometry using BRBs as diagonal bracing

BRBF FORCES SUMMARY

The BRBFs are designed for each story in the steeple. The braces in the lower section of the tower are designed resist the steeple base shear as determined previously from the equivalent lateral force method. These braces have a steel core area of 0.5 square inches and are designed for a tensile load of 23 kip. The braces in the top of the steeple are designed to resist the story shear in the second story. These braces have a steel core area of 0.3 square inches and are designed to resist a tensile load of 13.8 kip. (See Appendix C for supporting calculations).

The adjusted brace strength was also determined in accordance with current code specifications outlined in the AISC Seismic Design Manual. Values for β and ω were estimated. These values are determined through testing and are to be given by the manufacturer. We communicated with Star Seismic, based out of Utah and at the time of this report we have not received any estimated material properties. For complete design these values would not be estimated. From these assumptions we determined the adjusted brace strength in both tension and compression (see Appendix C for supporting calculations). The results are shown below in Table 2.

Table 2: BRBF Adjusted Brace Strength

	Adjusted Tensile Strength (kip)	Adjusted Compressive Strength (kip)
First Story	41.4	49.7
Second Story	26.9	35.0

MEMBER SIZES

Using the adjusted brace strength we were able to begin sizing other member sizes for the steeple. The connections for the BRBs were not designed as they are dependent on manufacturer testing. For simplicity we determined that the minimum member size to be used in the design to resist the adjusted brace strength loads transferred to the column from the BRB. The columns in the first story had an unbraced length of 9ft. We assumed a K value of 1 and determined the member sizes using Table 4-4 in the AISC Steel Construction Manual. This determined that the minimum size for these columns is an HSS 3x3x1/4, which has a capacity of 53.9 kip. For this project we applied this minimum to all members for simplicity.

DEFLECTION

After determining the minimum member sizes needed and the design restraints (HSS 4x4) we used SAP200 to perform a structural analysis of three steeples designed with different member sizes. The first two designs assumed that all shapes were the exact same (excluding diagonal bracing), one with HSS 4x4x5/16 shapes and the second with HSS 3x3x1/4 shapes. The third design included HSS 4x4x5/16 shapes in all columns and in the beams that transition the tower between the first and second story with HSS 3x3x1/4 shapes used at all other locations. Results from the software analysis are given in Table 3. Supporting tables and structural plans are included in Appendix D. From these results we determined that the final design should include all HSS 3x3x1/4 shapes with BRB diagonal bracing. This model was analyzed under the maximum considered earthquake and resulted in a deflection of 1.4 in. The maximum deflection specified by the sponsor at the top of the tower was 0.005H or 2.5 in.

Table 3: Deflections under Design Earthquake (2/3) MCE

Shape	Deflection (in)
HSS 4x4x5/16	0.358
HSS 3x3x1/4	0.936
Combination of Both Shapes	0.413

COST

RVHB provided the design work with a reasonable firm rate of $100 per hour. Bracing and steel prices were estimated using local manufacturers. Tables 4 provides brief summary of the estimated project costs. Table 5 indicates the savings expected from using the chosen design. These are the estimated repair costs to the damaged structure that are avoided by using the BRBs.

Table 4: Estimated Project Cost

Design Work (15, 6hr weeks @ 100/hr.)	$ 9,000.00
Bracing	$ 4,000.00
Steel ($1000/ton)	$ 8,750.00
Labor	$ 4,000.00
Total	$ 25,750.00

Table 5: Estimated Savings

Damaged Cladding (Avoided)	$ 1,050.00
Replacement of Steel (Avoided)	$ 1,750.00
Replacement of Braces (Avoided)	$ 1,000.00
Labor Repair (Avoided)	$ 1,000.00
Total	$ 4,800.00

REFERENCES

American Institute of Steel Construction. Steel construction Manual. 14th Edition. (2011).

American Institute of Steel Construction and Structural Steel Education Council. Seismic Design Manual. (2006)

American Society of Civil Engineers. ASCE 7-10 -Minimum Design Loads for Buildings and. Other Structures. (2010)

Appendix A

Equivalent Lateral Force Method

materials

$P_{clad} := 22psf$ *Force/Area of stone cladding*

$P_{ss} := 10psf$ *Force/Area of material behind cladding*

$\gamma_{roof} := 145psf$ *Unit weight of concrete roof*

$t_{stoneclad} := 4cm$ $4cm \cdot 170pcf = 22.310 \cdot psf$ *Stone cladding thickness*

$t_{stonedome} := 5cm$ $Wt_{StoneDome} := 5cm \cdot 170pcf$ *Stone dome thickness*

$W_{moroni} := 700lbf$ $Wt_{StoneDome} = 27.887 \cdot psf$ *Statue weight*

member properties

$A_{col} := 15in^2$ *Cross-sectional area of columns*

$A_{beam} := 10in^2$ *Cross-sectional area of beams*

$A_{brace} := 5in^2$ *Cross-sectional area of bracing*

$wlf_{col} := 52\frac{lbf}{ft}$ $15in^2 \cdot 495pcf = 51.562 \cdot plf$ *Weight/linear foot of columns*

$wlf_{beam} := 34\frac{lbf}{ft}$ $10in^2 \cdot 495pcf = 34.375 \cdot plf$ *Weight/linear foot of beams*

$wlf_{brace} := 17\frac{lbf}{ft}$ $5in^2 \cdot 495pcf = 17.188 \cdot plf$ *Weight/linear foot of bracing*

geometry

$h_{st} := 42ft$ *Steeple Height*

$w_{gd} := 15ft$ *Greater width dimension*

$w_{ld} := 12ft$ *Lesser width dimension*

$L_{gbeam} := 15ft$ *Greater beam length*

$L_{lbeam} := 12ft$ *Lesser beam length*

$L_{gbrace} := 17ft$ *Greater brace length*

$L_{lbrace} := 14ft$ *Lesser brace length*

$H_{col} := 38ft$ *Column height*

$n_{col} := 8$ *Number of columns*

$n_{gbeam} := 4$ *Number of greater beams*

$n_{lbeam} := 4$ *Number of lesser beams*

$n_{gbrace} := 4$ *Number of greater braces*

$n_{lbrace} := 4$ *Number of lesser braces*

Determine Structure Mass

$A_{exwall} := h_{st} \cdot 2\left(w_{gd} + w_{ld}\right) = 2268\,ft^2$ *Total area of exterior wall*

$W_{exwall} := P_{clad} \cdot A_{exwall} = 49.896 \cdot kip$ *Weight of exterior wall*

$W_{ss} := P_{ss} \cdot A_{exwall} = 22.680 \cdot kip$ *Weight of material behind cladding*

$W_{stonedome} := 3910lbf$ *Weight of stone dome*

$r := 1.44m$

$A_{Sphere} := \frac{4 \cdot \pi r^2}{2} = 140.241\,ft^{2.000}$

$Wt_{Dome} := A_{Sphere} \cdot Wt_{StoneDome}$

$Wt_{Dome} = 3910.920 \cdot lbf$

Weight of beams:

$W_{beam} := \left(L_{lbeam} \cdot n_{lbeam} + L_{gbeam} \cdot n_{gbeam}\right) \cdot wlf_{beam} = 3.672 \cdot kip$

Weight of columns:

$W_{col} := \left(H_{col} \cdot n_{col}\right) \cdot wlf_{col} = 15.808 \cdot kip$

Weight of braces:

$W_{brace} := \left(L_{lbrace} \cdot n_{lbrace} + L_{gbrace} \cdot n_{gbrace}\right) \cdot wlf_{brace} = 2.108 \cdot kip$

Structure Weight:

$W_{struct} := W_{beam} + W_{col} + W_{brace} = 21.588 \cdot kip$

Total Weight:

$W_{sum} := W_{struct} + W_{exwall} + W_{moroni} + W_{stonedome} + W_{ss} = 98.8 \cdot kip$

Determine Base Shear

$I_e := 1.25$ *Seismic importance factor*

$R_{MF} := 8$ *Response factor for Moment frame*

$R_{SCB} := 6$ $R := \begin{pmatrix} 8 \\ 6 \\ 8 \end{pmatrix}$ *Response factor for Special Con. frame*

$R_{BRB} := 8$ *Response factor for Buckling-restrained brace frame*

$S_{DS} := 1.1g$ *Design spectral response acceleration*

$S_{D1} := 0.75g$ *Design spectral response accel. at 1sec*

$h_n := h_{st} = 42.000\,ft$

Approximate period parameters:

$C_{tMF} := 0.028$

$C_{tSCB} := 0.02$ $C_t := \begin{pmatrix} 0.028 \\ 0.02 \\ 0.03 \end{pmatrix}$ *Values for C_t from Table 12.8-2*

$C_{tBRB} := 0.03$

$x_{MF} := 0.8$ *Values for x from Table 12.8-2*

$x_{SCB} := 0.75$ $x := \begin{pmatrix} 0.8 \\ 0.75 \\ 0.75 \end{pmatrix}$

$x_{BRB} := 0.75$

$C_u := 1.4$ *Value from Table 12.8-1*

Estimated fundamental periods:

$$T_a := \begin{bmatrix} C_{tMF} \cdot \left(\frac{h_n}{ft}\right)^{x_{MF}} \\ C_{tSCB} \cdot \left(\frac{h_n}{ft}\right)^{x_{SCB}} \\ C_{tBRB} \cdot \left(\frac{h_n}{ft}\right)^{x_{BRB}} \end{bmatrix} s = \begin{pmatrix} 0.557 \\ 0.330 \\ 0.495 \end{pmatrix} s$$

Fundamental periods:

$$T_{MF} := C_u \cdot \left[C_{tMF} \cdot \left(\frac{h_n}{ft}\right)^{x_{MF}} \right] \cdot s = 0.780\,s \qquad T_{SCB} := C_u \cdot \left[C_{tSCB} \cdot \left(\frac{h_n}{ft}\right)^{x_{SCB}} \right] \cdot s = 0.462\,s$$

$$T_{BRB} := C_u \cdot \left[C_{tBRB} \cdot \left(\frac{h_n}{ft}\right)^{x_{BRB}} \right] \cdot s = 0.693\,s$$

Seismic response coefficient:

$$C_{sMF} := \frac{\frac{S_{D1}}{g}}{\frac{T_{MF}}{s} \cdot \left(\frac{R_{MF}}{I_e}\right)} = 0.1503 \qquad C_{sSCB} := \frac{\frac{S_{D1}}{g}}{\frac{T_{SCB}}{s} \cdot \left(\frac{R_{SCB}}{I_e}\right)} = 0.3382$$

$$C_{sBRB} := \frac{\frac{S_{D1}}{g}}{\frac{T_{BRB}}{s} \cdot \left(\frac{R_{BRB}}{I_e}\right)} = 0.1691 \qquad V_{bs} := \begin{pmatrix} C_{sMF} \\ C_{sSCB} \\ C_{sBRB} \end{pmatrix} \cdot W_{sum} = \begin{pmatrix} 14.847 \\ 33.409 \\ 16.705 \end{pmatrix} \cdot kip$$

k values:

$$k_{MF} := \frac{\left(\frac{T_{MF}}{s} - 0.5\right)}{2} + 1 = 1.1398 \qquad k_{SCB} := 1 \qquad k_{BRB} := \frac{\left(\frac{T_{BRB}}{s} - 0.5\right)}{2} + 1 = 1.0965$$

Results Summary

Steeple ELF						
System	Level	w(kip)	h(ft)	wh^k	Cvx	Fx
MF	1	49.4	26	2025	0.367	*5.45*
(R=8)	2	49.4	42	3499	0.633	*9.41*
SCBF	1	49.4	26	1284	0.382	8.66
(R=6)	2	49.4	42	2075	0.618	13.98
BRBF	1	49.4	26	1759	0.371	6.31
(R=8)	2	49.4	42	2976	0.629	10.67

Appendix B

Seismic Demands on Nonstructural Components

Caclulations in accordance with ACSE 7-10 13.3.1

$I_p := 1.25 \quad S_{DS} := 1.1 \quad S_{D1} := 0.75$ *Given information:*

$a_p := 2.5 \quad R_p := 2.5$ *Factors taken from table 13.5-1*

$z := 37\text{ft} \quad h := 42\text{ft}$ *From steeple geometry*

$W_p := 98.8\text{kip}$ *Weight of Steeple (see Appendix A)*

$$F_p := \frac{0.4 \cdot a_p \cdot S_{DS} \cdot W_p}{\left(\frac{R_p}{I_p}\right)} \cdot \left(1 + 2 \cdot \frac{z}{h}\right) = 150.082 \cdot \text{kip}$$ *Eq. 13.3-1*

$F_{pmin} := 0.3 \cdot S_{DS} \cdot I_p \cdot W_p = 40.755 \cdot \text{kip}$ *Eq. 13.3-2*

$F_{pmax} := 1.6 \cdot S_{DS} \cdot I_p \cdot W_p = 217.36 \cdot \text{kip}$ *Eq. 13.3-3*

$F_p = 150 \cdot \text{kip}$ *Fp to be used in design if designed as component*

Appendix C
Design of Buckling Restrained Braced Fram (BRBF)

Braces in the First Story

$P_{u1} := 17kip$ *Demand for resolving the horizontal base shear in the direction of the brace*

$F_{ysc} := 46ksi$ *Assumed Value for yeild strength of the steel core*

$\phi := 0.9$ *For LRFD, AISC Seismic Design Manual (2006) pg 6.1-55*

$A_{sc1} := \dfrac{\phi \cdot P_{u1}}{F_{ysc}} = 0.333 \cdot in^2$ *AISC Seismic Design Manual (2006), eq 16-1*

$A_{sc1} := 0.5in^2$

$P_{ysc1} := F_{ysc} \cdot A_{sc1} = 23 \cdot kip$ *AISC Seismic Design Manual (2006), eq 16-1*

Braces in the Second Story

$P_{u2} := 10kip$ *Demand for resolving the horizontal base shear in the direction of the brace*

$A_{sc2} := \dfrac{\phi \cdot P_{u2}}{F_{ysc}} = 0.196 \cdot in^2$ *AISC Seismic Design Manual (2006), eq 16-1*

$A_{sc2} := 0.3in^2$

$P_{ysc2} := F_{ysc} \cdot A_{sc2} = 13.8 \cdot kip$ *AISC Seismic Design Manual (2006), eq 16-1*

Adjusted Brace Strength in Compression

First Story

$R_y := 1.5$ *AISC Seismic Design Manual (2006), Table I-6-1*

$\beta := 1.2$ *Estimation , generally determined through testing*

$\omega := 1.2$ *Estimation , generally determined through testing*

$P_{C1} := \beta \cdot \omega \cdot R_y \cdot P_{ysc1} = 49.7 \cdot kip$ *Adjusted Brace Strength in Compression*

Second Story

$\beta_2 := 1.3$ *Estimation , generally determined through testing*

$\omega_2 := 1.3$ *Estimation , generally determined through testing*

$P_{C2} := \beta_2 \cdot \omega_2 \cdot R_y \cdot P_{ysc2} = 35 \cdot kip$ *Adjusted Brace Strength in Compression*

Adjusted Brace Strength in Tension

First Story

$P_{T1} := \omega \cdot R_y \cdot P_{ysc1} = 41.4 \cdot kip$ *Adjusted Brace Strength in Tension*

Second Story

$P_{T2} := \omega_2 \cdot R_y \cdot P_{ysc2} = 26.9 \cdot kip$ *Adjusted Brace Strength in Tension*

Member sizes to be used for columns

$KL := 9ft$

$P_U := P_{C1} = 49.7 \cdot kip$

Pick HSS 3 x 3 x 1/4

$\phi P_n := 53.4kip$ *AISC Steel Construction Manual (2006), Table 4-4*

Appendix D

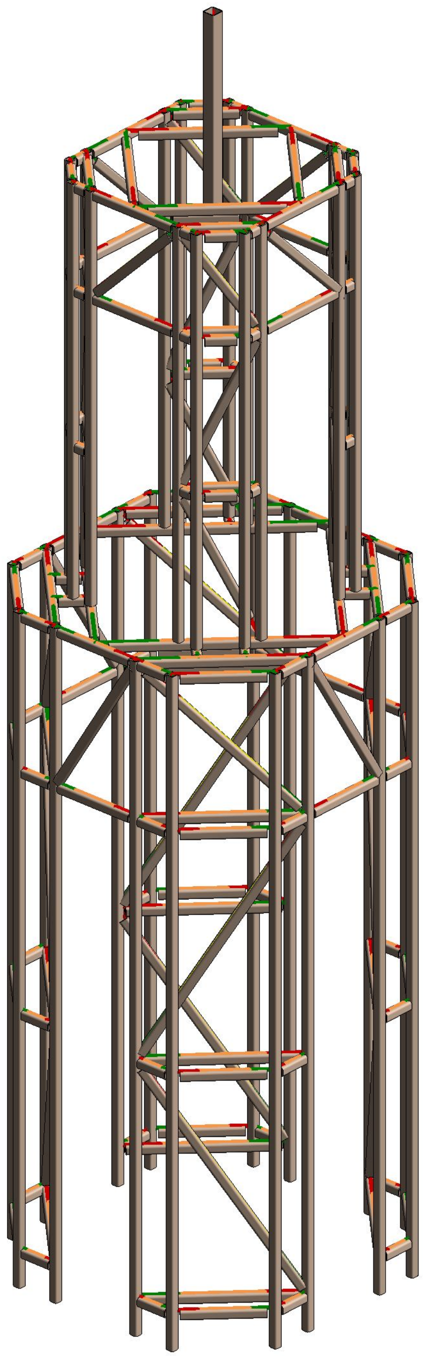
SAP2000 Results and Structural Plans

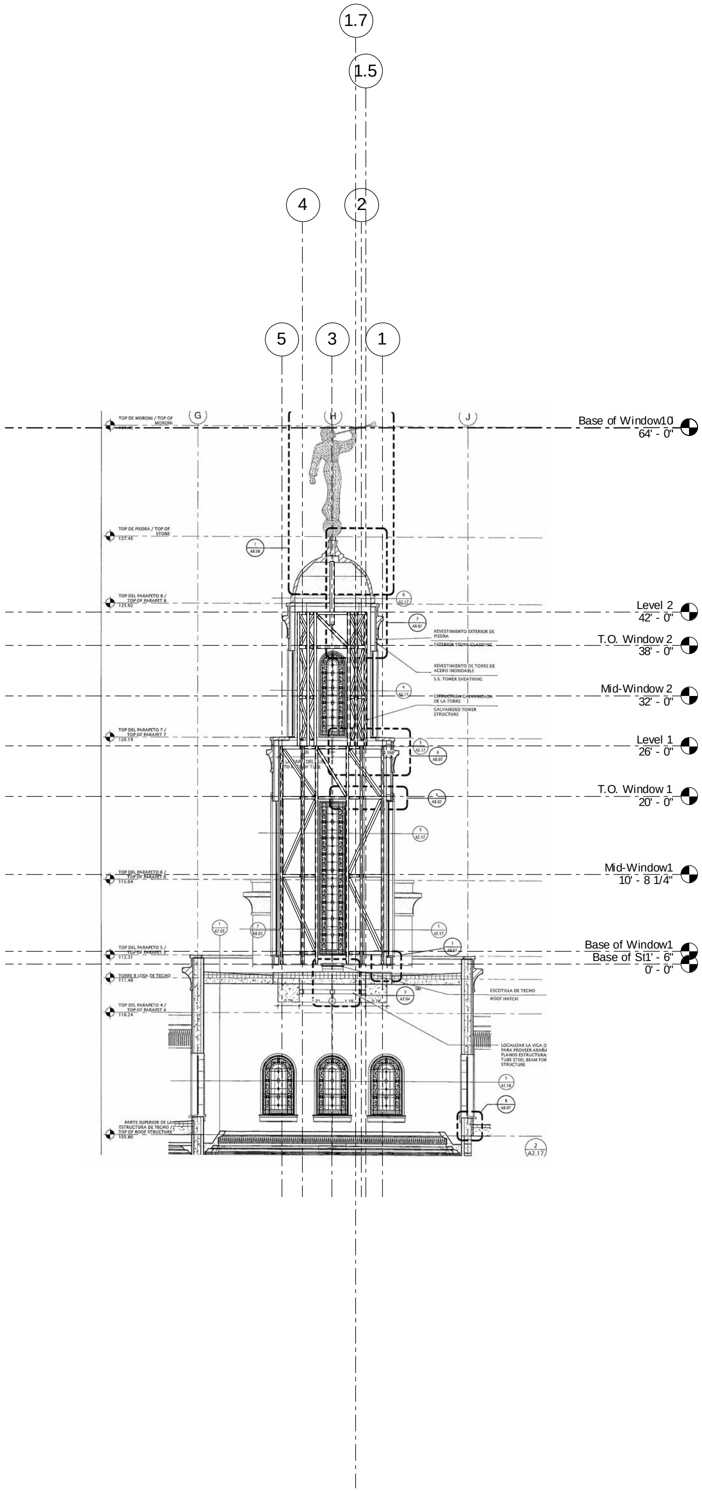
TABLE: Joint Displacements								
Joint	**OutputCase**	**CaseType**	**U1**	**U2**	**U3**	**R1**	**R2**	**R3**
Text	Text	Text	in	in	in	Radians	Radians	Radians
1	LF	LinStatic	0.000	0.000	0.000	-0.001	0.001	0.000
2	LF	LinStatic	0.188	0.188	0.011	0.001	0.000	0.000
3	LF	LinStatic	0.187	0.186	0.011	0.001	-0.001	0.000
4	LF	LinStatic	0.000	0.000	0.000	-0.001	0.001	0.000
5	LF	LinStatic	0.010	0.010	0.001	0.000	0.001	0.000
6	LF	LinStatic	0.013	0.012	0.001	-0.001	0.000	0.000
7	LF	LinStatic	0.093	0.112	-0.026	0.000	0.000	0.000
8	LF	LinStatic	0.111	0.093	0.010	-0.001	0.000	0.000
9	LF	LinStatic	0.105	0.093	0.002	0.000	0.000	0.000
10	LF	LinStatic	0.093	0.105	-0.005	0.000	0.001	0.000
11	LF	LinStatic	0.161	0.161	0.010	0.000	0.000	0.000
12	LF	LinStatic	0.164	0.163	0.010	0.000	0.000	0.000
13	LF	LinStatic	0.000	0.000	0.000	-0.003	0.005	0.002
14	LF	LinStatic	0.000	0.000	0.000	-0.005	0.002	0.001
15	LF	LinStatic	0.000	0.000	0.000	-0.001	0.001	0.000
16	LF	LinStatic	0.000	0.000	0.000	-0.001	0.001	0.000
17	LF	LinStatic	0.000	0.000	0.000	-0.003	0.005	-0.002
18	LF	LinStatic	0.000	0.000	0.000	-0.005	0.002	-0.001
19	LF	LinStatic	0.000	0.000	0.000	-0.001	0.001	0.000
20	LF	LinStatic	0.000	0.000	0.000	-0.001	0.001	0.000
21	LF	LinStatic	0.659	0.664	-0.155	-0.002	0.003	0.000
22	LF	LinStatic	0.661	0.662	0.088	-0.002	0.002	0.000
23	LF	LinStatic	0.194	0.195	0.139	-0.002	0.000	0.000
24	LF	LinStatic	0.663	0.663	0.143	-0.002	0.002	0.000
25	LF	LinStatic	0.000	0.000	0.000	-0.001	0.001	0.000
26	LF	LinStatic	0.186	0.186	-0.014	0.001	-0.001	0.000
27	LF	LinStatic	0.188	0.188	-0.014	0.001	0.000	0.000
28	LF	LinStatic	0.000	0.000	0.000	-0.001	0.001	0.000
29	LF	LinStatic	0.013	0.012	-0.001	-0.001	0.000	0.000
30	LF	LinStatic	0.010	0.010	-0.001	0.000	0.001	0.000
35	LF	LinStatic	0.163	0.164	-0.012	-0.001	0.000	0.000
36	LF	LinStatic	0.161	0.161	-0.012	0.000	0.000	0.000
37	LF	LinStatic	0.661	0.661	0.141	-0.002	0.002	0.000
38	LF	LinStatic	0.193	0.194	0.140	-0.002	0.002	0.000
39	LF	LinStatic	0.663	0.663	0.088	-0.002	0.002	0.000
40	LF	LinStatic	0.195	0.195	0.150	0.003	0.001	0.000
41	LF	LinStatic	0.186	0.190	-0.045	0.004	0.001	0.000
42	LF	LinStatic	0.189	0.189	-0.047	0.000	-0.004	0.000
43	LF	LinStatic	0.189	0.189	0.036	0.000	-0.002	0.000
44	LF	LinStatic	0.187	0.190	0.034	0.003	0.001	0.000
45	LF	LinStatic	0.187	0.187	0.027	0.003	0.000	0.000
46	LF	LinStatic	0.188	0.188	0.028	0.000	0.000	0.000
47	LF	LinStatic	0.013	0.010	0.003	-0.001	0.001	0.000
48	LF	LinStatic	0.012	0.010	0.001	0.000	0.001	0.000

49	LF	LinStatic	0.025	0.080	0.003	-0.003	0.000	-0.001
50	LF	LinStatic	0.071	0.038	-0.005	0.000	0.001	-0.002
51	LF	LinStatic	0.186	0.193	0.015	0.000	0.000	0.000
52	LF	LinStatic	0.189	0.189	-0.023	-0.001	-0.002	0.000
53	LF	LinStatic	0.189	0.188	-0.034	0.000	0.000	0.000
54	LF	LinStatic	0.186	0.186	-0.033	0.005	0.000	0.000
55	LF	LinStatic	0.000	0.000	0.000	-0.003	0.002	0.001
56	LF	LinStatic	0.185	0.192	-0.008	0.000	0.000	0.000
57	LF	LinStatic	0.188	0.189	0.003	0.000	0.000	0.000
58	LF	LinStatic	0.000	0.000	0.000	-0.003	0.003	0.001
59	LF	LinStatic	0.025	0.052	-0.001	-0.002	0.000	0.001
60	LF	LinStatic	0.039	0.038	0.000	-0.001	0.001	0.001
61	LF	LinStatic	0.163	0.153	-0.007	0.000	0.001	0.000
62	LF	LinStatic	0.155	0.161	0.003	-0.001	0.000	0.000
67	LF	LinStatic	0.000	0.000	0.000	-0.003	0.003	-0.001
68	LF	LinStatic	0.188	0.189	-0.006	-0.001	0.000	0.000
69	LF	LinStatic	0.186	0.191	0.005	0.000	0.000	0.000
70	LF	LinStatic	0.000	0.000	0.000	-0.003	0.002	-0.001
71	LF	LinStatic	0.194	0.196	0.145	-0.001	0.002	0.000
72	LF	LinStatic	0.195	0.195	0.144	-0.002	-0.003	0.000
73	LF	LinStatic	0.195	0.195	0.150	-0.001	0.000	0.000
74	LF	LinStatic	0.661	0.666	-0.137	-0.002	0.002	0.000
79	LF	LinStatic	0.012	0.010	-0.002	0.000	0.001	0.000
80	LF	LinStatic	0.013	0.010	-0.003	-0.001	0.001	0.000
85	LF	LinStatic	0.163	0.152	0.018	0.000	0.000	0.000
86	LF	LinStatic	0.154	0.161	-0.021	0.000	0.000	0.000
87	LF	LinStatic	0.025	0.052	0.001	-0.002	0.000	-0.001
88	LF	LinStatic	0.039	0.038	-0.001	-0.001	0.001	-0.001
89	LF	LinStatic	0.185	0.192	-0.021	0.000	0.000	0.000
90	LF	LinStatic	0.191	0.189	0.017	-0.001	0.000	0.000
91	LF	LinStatic	0.070	0.038	0.004	0.000	0.001	0.002
92	LF	LinStatic	0.025	0.080	-0.004	-0.003	0.000	0.001
93	LF	LinStatic	0.153	0.161	0.016	0.000	0.000	0.000
94	LF	LinStatic	0.163	0.152	-0.022	0.000	0.001	0.000
99	LF	LinStatic	0.160	0.161	-0.025	0.000	0.000	0.000
100	LF	LinStatic	0.185	0.193	-0.052	0.000	0.003	0.000
101	LF	LinStatic	0.660	0.669	-0.056	-0.002	0.002	0.000
102	LF	LinStatic	0.666	0.663	0.011	-0.002	0.002	0.000
103	LF	LinStatic	0.187	0.192	0.008	-0.002	0.002	0.000
108	LF	LinStatic	0.163	0.165	-0.028	0.000	0.000	0.000
113	LF	LinStatic	0.164	0.165	0.023	0.000	0.000	0.000
114	LF	LinStatic	0.160	0.161	0.021	0.000	0.000	0.000
116	LF	LinStatic	0.188	0.191	-0.053	-0.003	0.001	0.000
117	LF	LinStatic	0.666	0.662	-0.058	-0.002	0.002	0.000
118	LF	LinStatic	0.661	0.667	0.008	-0.002	0.002	0.000
119	LF	LinStatic	0.186	0.192	0.006	-0.001	0.003	0.000
124	LF	LinStatic	0.195	0.195	0.154	-0.001	-0.001	0.000

125	LF	LinStatic	0.663	0.663	0.163	-0.002	0.002	0.000
126	LF	LinStatic	0.661	0.661	0.162	-0.002	0.002	0.000
127	LF	LinStatic	0.195	0.195	0.154	0.000	0.001	0.000
132	LF	LinStatic	0.196	0.197	-0.199	0.001	0.001	0.000
133	LF	LinStatic	0.661	0.661	-0.208	-0.002	0.002	0.000
134	LF	LinStatic	0.662	0.661	-0.209	-0.002	0.002	0.000
135	LF	LinStatic	0.197	0.197	-0.198	-0.001	-0.002	0.000
143	LF	LinStatic	0.163	0.154	0.005	0.000	0.000	0.000
144	LF	LinStatic	0.156	0.161	-0.005	-0.001	0.000	0.000
150	LF	LinStatic	0.187	0.191	-0.040	-0.002	0.000	0.000
151	LF	LinStatic	0.188	0.191	-0.059	-0.003	0.002	0.000
152	LF	LinStatic	0.186	0.192	-0.002	-0.001	0.002	0.000
153	LF	LinStatic	0.186	0.192	0.012	-0.002	0.003	0.000
154	LF	LinStatic	0.197	0.196	-0.187	0.004	0.001	0.000
155	LF	LinStatic	0.196	0.197	-0.193	0.000	0.002	0.000
156	LF	LinStatic	0.197	0.196	-0.179	-0.001	-0.005	0.000
157	LF	LinStatic	0.196	0.197	-0.199	-0.001	-0.001	0.000
158	LF	LinStatic	0.187	0.192	0.001	-0.002	0.001	0.000
159	LF	LinStatic	0.187	0.192	0.009	-0.003	0.002	0.000
160	LF	LinStatic	0.185	0.193	-0.034	0.001	0.002	0.000
161	LF	LinStatic	0.185	0.193	-0.062	-0.001	0.003	0.000
175	LF	LinStatic	0.123	0.110	0.011	-0.001	0.001	-0.001
176	LF	LinStatic	0.100	0.087	0.012	-0.001	0.000	0.000
177	LF	LinStatic	0.100	0.097	0.006	-0.001	0.000	0.000
178	LF	LinStatic	0.113	0.110	0.006	0.000	0.001	0.000
179	LF	LinStatic	0.093	0.110	0.023	0.000	0.000	0.000
180	LF	LinStatic	0.111	0.092	-0.013	-0.001	0.000	0.000
181	LF	LinStatic	0.105	0.092	-0.003	0.000	0.000	0.000
182	LF	LinStatic	0.093	0.104	0.003	0.000	0.001	0.000
183	LF	LinStatic	0.124	0.109	-0.014	-0.001	0.001	0.001
184	LF	LinStatic	0.101	0.086	-0.015	-0.001	0.000	0.000
185	LF	LinStatic	0.101	0.096	-0.008	-0.001	0.000	0.000
186	LF	LinStatic	0.114	0.109	-0.008	0.000	0.001	0.000
200	LF	LinStatic	0.186	0.192	0.032	-0.001	0.002	0.000
201	LF	LinStatic	0.661	0.669	0.032	-0.002	0.002	0.000
202	LF	LinStatic	0.668	0.662	-0.083	-0.002	0.003	0.000
203	LF	LinStatic	0.188	0.191	-0.083	-0.003	0.002	0.000
212	LF	LinStatic	0.196	0.197	-0.186	-0.002	-0.001	0.000
213	LF	LinStatic	0.661	0.661	-0.191	-0.002	0.002	0.000
214	LF	LinStatic	0.661	0.661	-0.189	-0.002	0.002	0.000
215	LF	LinStatic	0.194	0.196	-0.187	-0.002	0.002	0.001
224	LF	LinStatic	0.185	0.193	-0.080	-0.001	0.002	0.000
225	LF	LinStatic	0.660	0.670	-0.080	-0.002	0.002	0.000
226	LF	LinStatic	0.669	0.663	0.035	-0.002	0.003	0.000
227	LF	LinStatic	0.187	0.191	0.035	-0.003	0.002	0.000
237	LF	LinStatic	0.547	0.547	-0.081	-0.002	0.002	0.000
238	LF	LinStatic	0.543	0.552	0.035	-0.002	0.002	0.000

239	LF	LinStatic	0.544	0.552	0.011	-0.002	0.002	0.000
240	LF	LinStatic	0.547	0.549	-0.056	-0.002	0.002	0.000
241	LF	LinStatic	0.548	0.547	0.032	-0.002	0.002	0.000
242	LF	LinStatic	0.542	0.552	-0.084	-0.002	0.002	0.000
243	LF	LinStatic	0.544	0.552	-0.058	-0.002	0.002	0.000
244	LF	LinStatic	0.548	0.548	0.008	-0.002	0.002	0.000
248	LF	LinStatic	0.360	0.376	-0.082	-0.002	0.002	0.000
249	LF	LinStatic	0.360	0.374	-0.055	-0.003	0.003	0.000
250	LF	LinStatic	0.362	0.372	0.010	-0.002	0.002	0.000
251	LF	LinStatic	0.364	0.372	0.035	-0.003	0.002	0.000
252	LF	LinStatic	0.359	0.378	0.034	-0.002	0.002	0.000
253	LF	LinStatic	0.363	0.374	-0.083	-0.003	0.002	0.000
254	LF	LinStatic	0.361	0.374	-0.056	-0.003	0.002	0.000
255	LF	LinStatic	0.359	0.376	0.008	-0.002	0.002	0.000
256	LF	LinStatic	0.550	0.552	0.142	-0.002	0.002	0.000
257	LF	LinStatic	0.550	0.552	0.162	-0.002	0.002	0.000
258	LF	LinStatic	0.548	0.549	0.161	-0.002	0.002	0.000
259	LF	LinStatic	0.548	0.549	0.142	-0.002	0.002	0.000
260	LF	LinStatic	0.370	0.371	0.140	-0.002	0.002	0.000
261	LF	LinStatic	0.368	0.371	0.159	-0.002	0.003	0.000
262	LF	LinStatic	0.365	0.367	0.159	-0.003	0.002	0.000
263	LF	LinStatic	0.365	0.366	0.140	-0.002	0.002	0.000
264	LF	LinStatic	0.364	0.365	-0.187	-0.003	0.002	0.000
265	LF	LinStatic	0.364	0.367	-0.204	-0.003	0.002	0.000
266	LF	LinStatic	0.368	0.371	-0.205	-0.002	0.003	0.000
267	LF	LinStatic	0.370	0.371	-0.188	-0.002	0.002	0.000
268	LF	LinStatic	0.548	0.549	-0.189	-0.002	0.002	0.000
269	LF	LinStatic	0.548	0.550	-0.208	-0.002	0.002	0.000
270	LF	LinStatic	0.550	0.552	-0.208	-0.002	0.002	0.000
271	LF	LinStatic	0.550	0.552	-0.189	-0.002	0.002	0.000



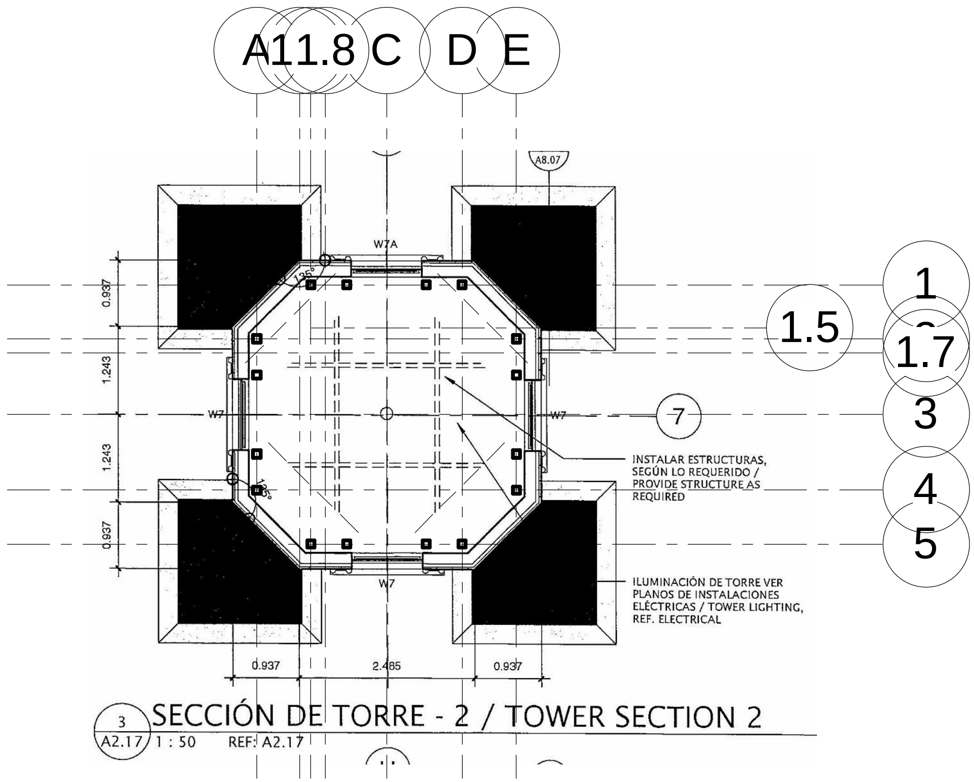

1.7
1.5
4
2
5
3
1
Base of Window10
64' - 0"
Level 2
42' - 0"
T.O. Window 2
38' - 0"
Mid-Window 2
32' - 0"
Level 1
26' - 0"
T.O. Window 1
20' - 0"
Mid-Window1
10' - 8 1/4"
Base of Window1
Base of St1' - 6"
0' - 0"

-

North

-

West



3 A2.17 SECCIÓN DE TORRE - 2 / TOWER SECTION 2

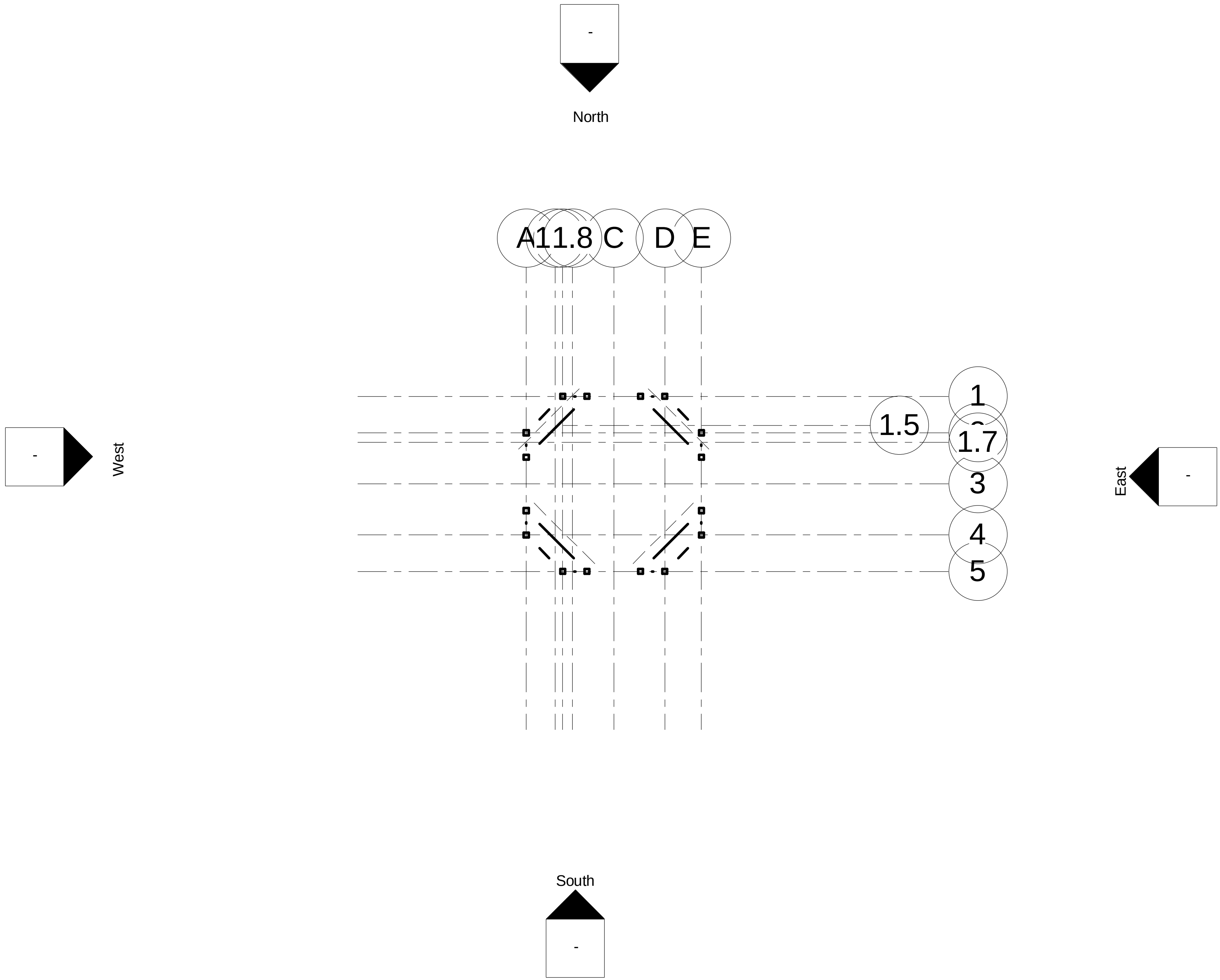
1 : 50 REF: A2.17

East

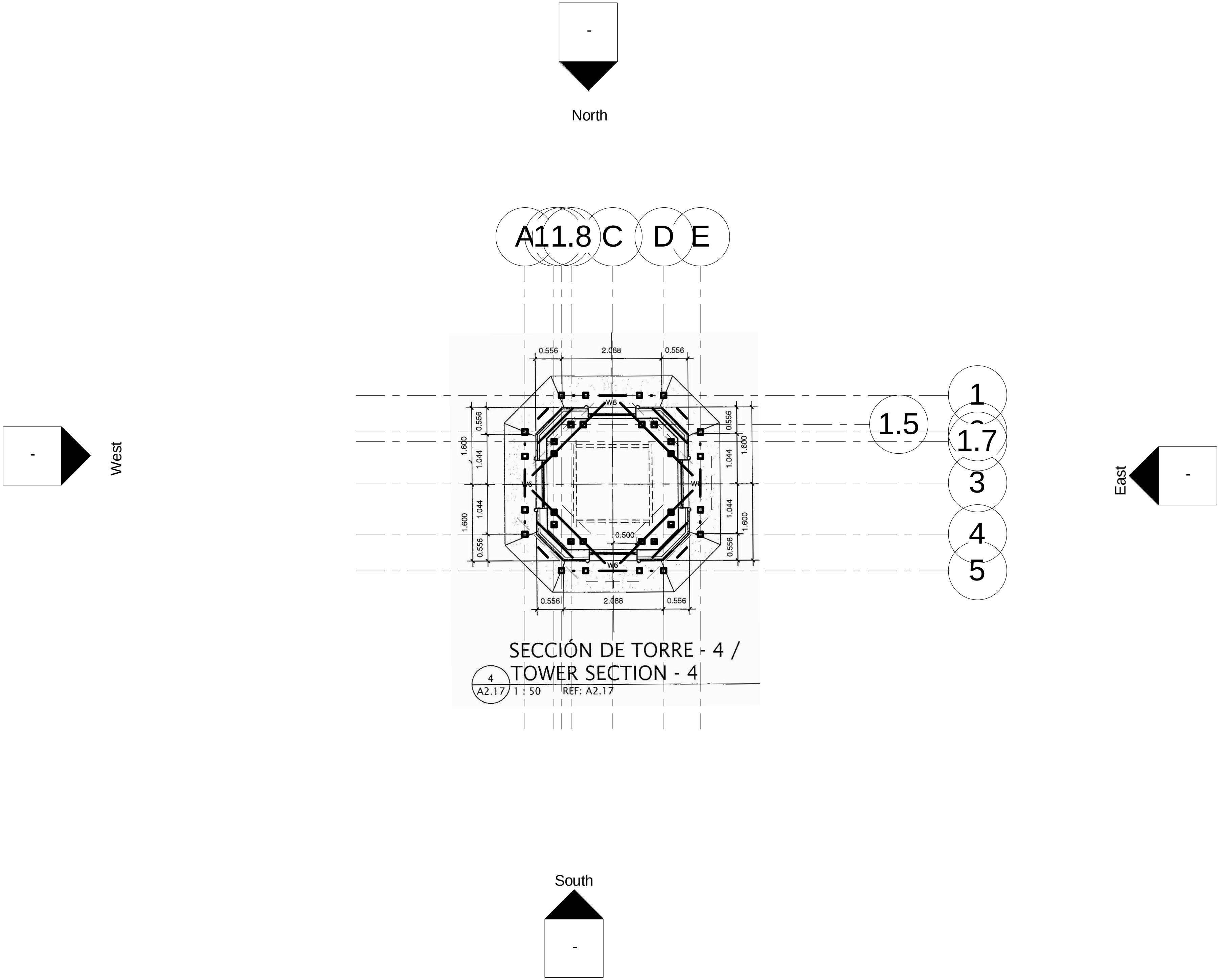
-

South

-



North
A
1.8
C
D
E
1
1.5
1.7
3
4
5
West
East
South



SECCIÓN DE TORRE - 4 /
TOWER SECTION - 4

4
A2.17 1 : 50 REF: A2.17

-

North

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West

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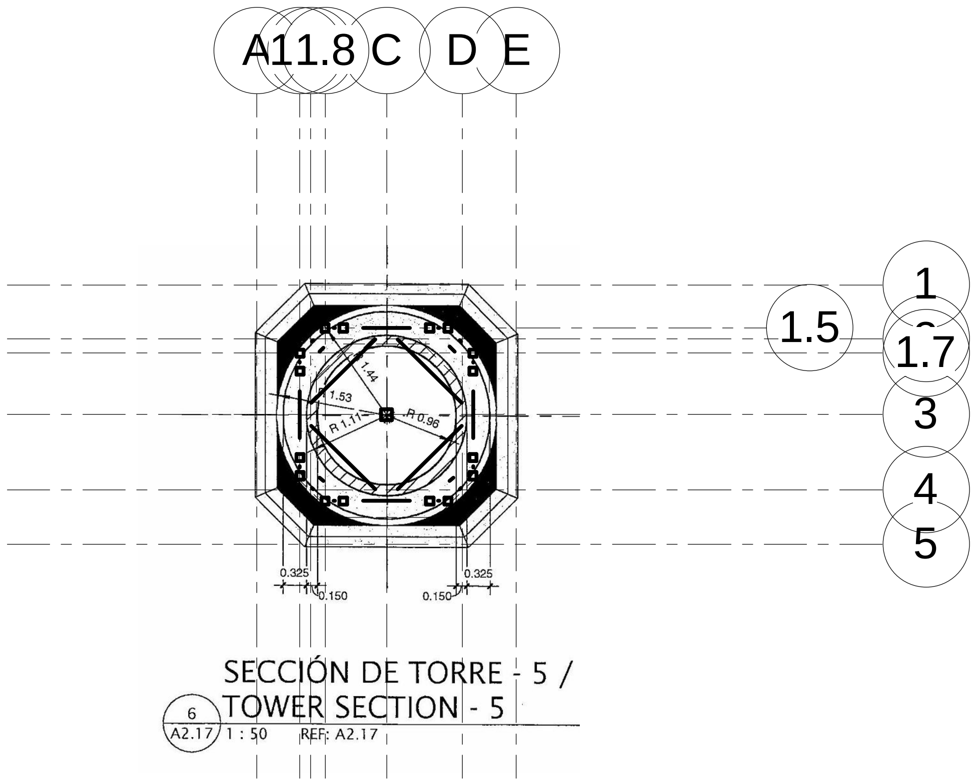
East



South

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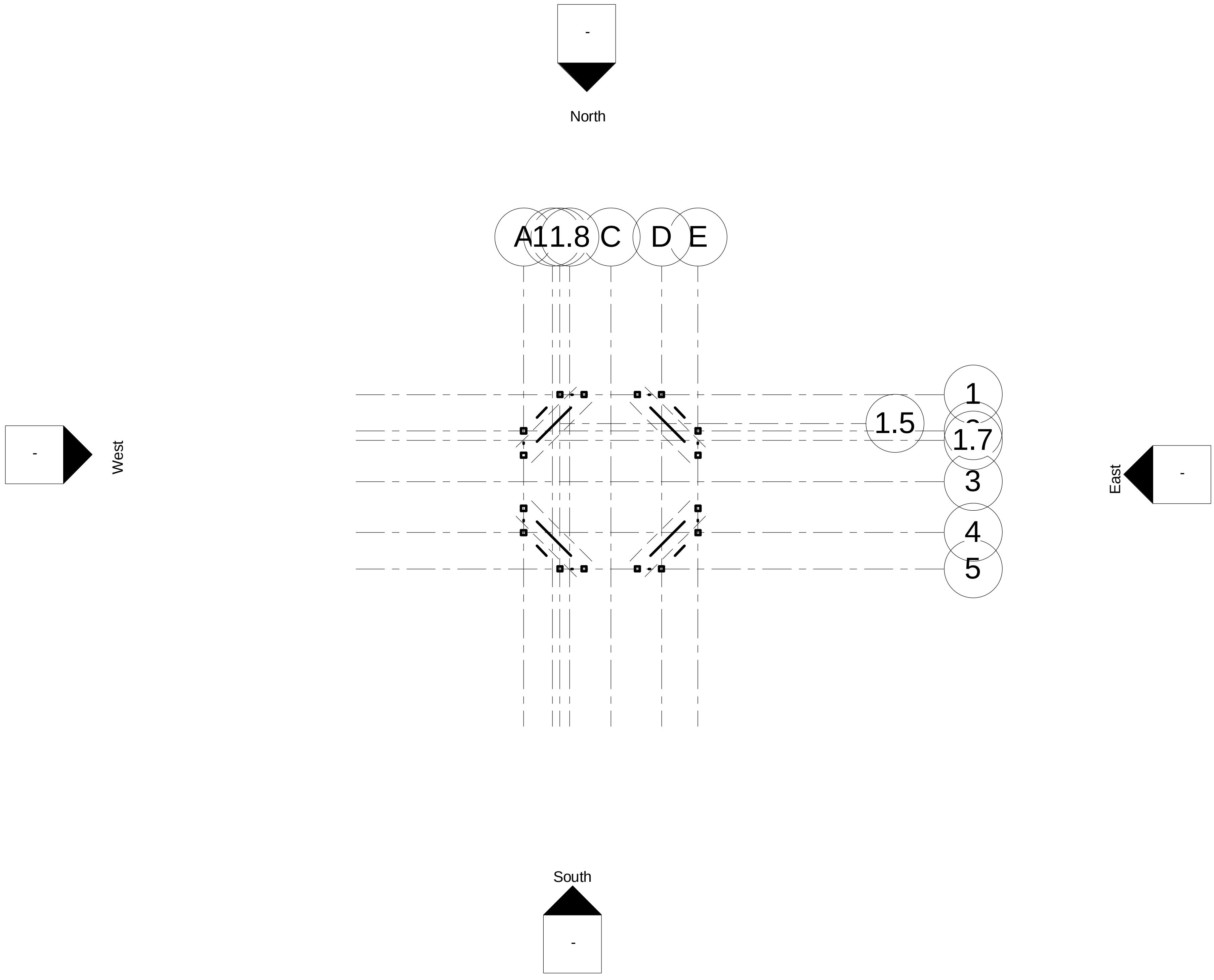
-
North
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West
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East
South
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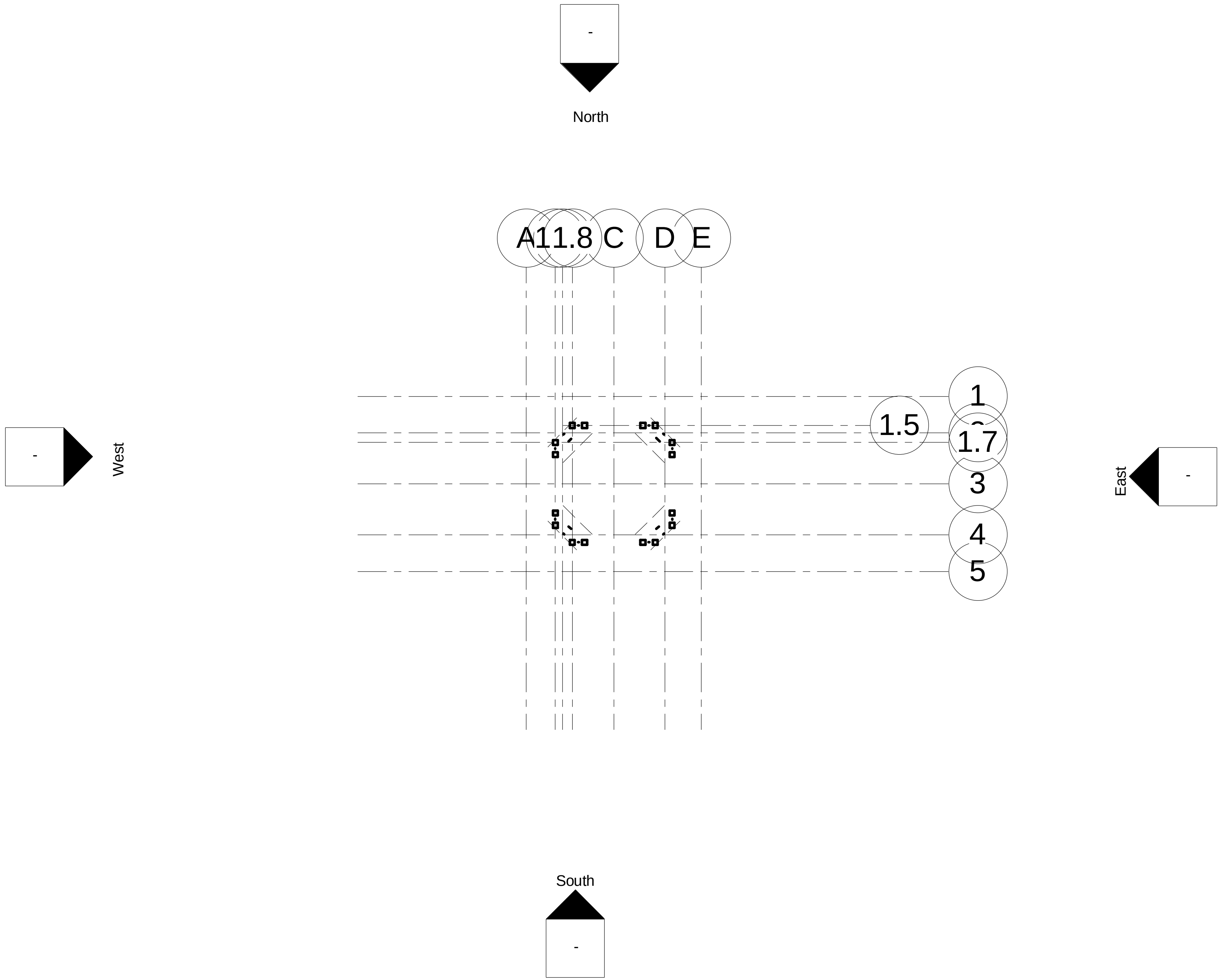
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North
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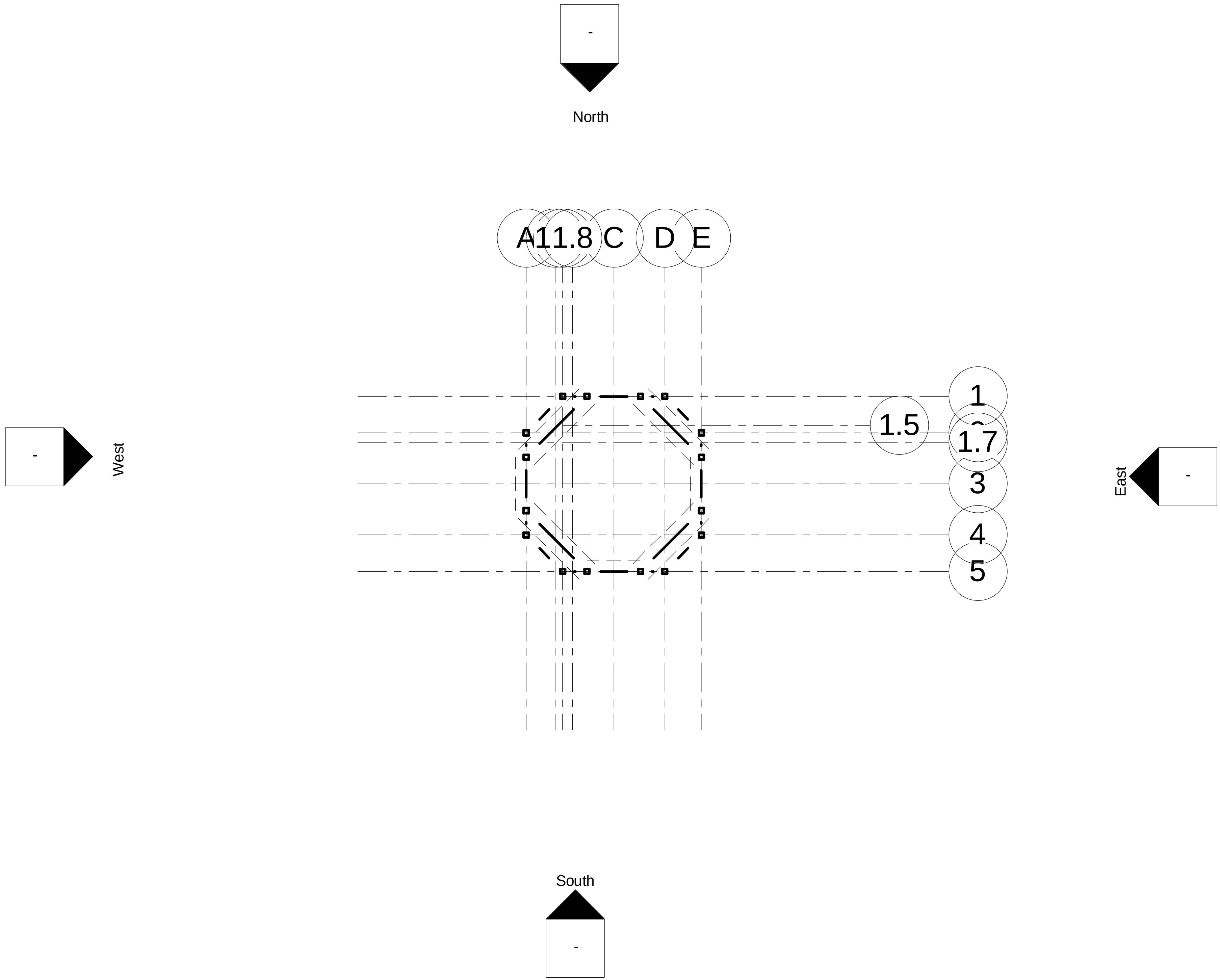
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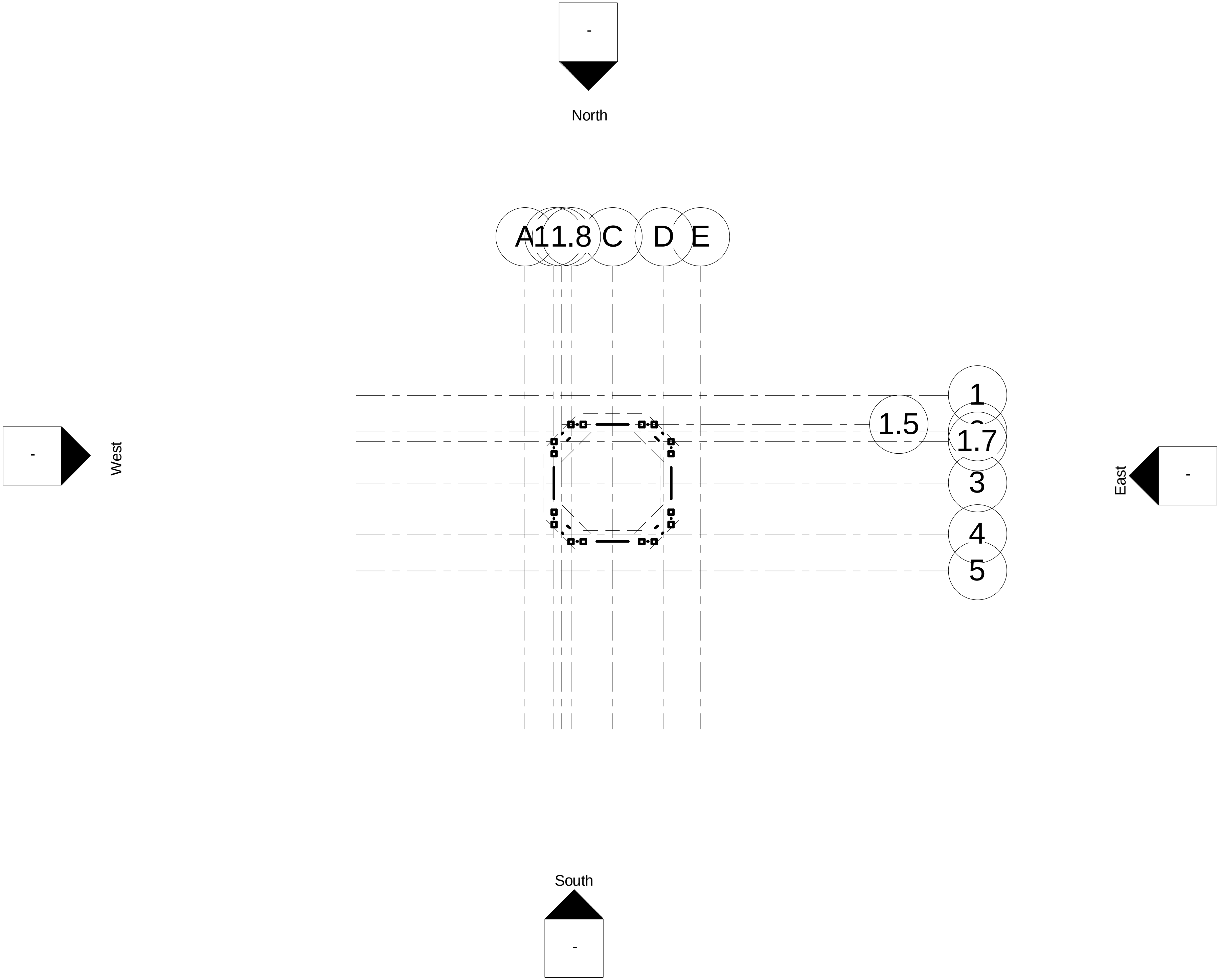
North
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