FINAL REPORT:

Prochnow Auditorium Stage Rigging
317 W Dupont Ave, Flagstaff, AZ 86011

PREPARED FOR:

Northern Arizona University
Department of Facilities Services
501 E Pine Knoll Dr, Flagstaff, AZ 86011
Attn: Joshua Spear

SUBMITTED BY:

O.A.T Structural Engineering
2112 S Huffer Ln, Flagstaff, AZ 86011
May, 9th 2023

May 9, 2023

Joshua David Spear, Thomas Charles Eberly, David S. Merrell, P.E.
CC: R. Tuchscherer, B. Dymond
Senior Project Manager, Principal of Hubbard Merrell
Facility Services – NAU
501 E Pine Knoll Dr,
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Dear Spear, Eberly, and Merrell,

On behalf of the NAU's Prochnow Auditorium Rigging senior design team, OAT Engineering is pleased to submit our future loading plan design and condition assessment. The purpose of this report is to express the team's findings, process, and justifications.

The future loading plan the team developed consists of eight additional loading locations on the structural rigging located above the stage floor. Half of these locations are three feet from proscenium arch and the other half are 3 feet from the back wall of the stage. Each loading location specified can carry an additional 2 kips of loading.

Using a model of the rigging in Risa-3D, the team ensured all the rigging members' deflection did not exceed the deflection limit of L/240 as per the current 15th edition of the Steel Construction Manel. In addition, as per the 2018 International Existing Building Code, the demand-capacity ratios of the members of the rigging must not increase by 5%. The team successfully meet both of these standards calculating a maximum deflection limit is 0.756 in of the eight loaded W8x15 beams and the most critically stressed members' demand capacity ratio were only increase by 1% to be as conservative.

As OAT Engineering successfully completed the scope of the Prochnow Stage Rigging structural analysis, the developed Risa-3D model and this technical report will be submitted to David Merrell for continuing this project and stamping the results. As this is a design load suggestion, there is no cost of implementation for this project.

If you have any additional questions or concerns, please contact Justin Portillo-Wightman by email (portwight@gmail.com) or by phone (602-497-8104).

Sincerely,

Justin Portillo-Wightman, Jose Espinoza, Amy Ajungo, & Theo Quax

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Acknowledgements

The team would like to acknowledge Dr.Tuschcherer (GI), Dr.Dymond (TA), and Joshua Spears (Client). Their guidance has helped in accomplishing the teams goal of analyzing the Prochnow Auditorium Rigging.

1.0 Project Purpose

The purpose of this project is to conduct a condition assessment on the structural rigging of the Prochnow Auditorium and develop a future loading plan where the optimum placement of additional loads is determined while maintaining code. The condition assessment includes acquiring existing engineering plans and documenting existing conditions and loading through photos and creating a set of rigging as-builts. The analysis will account for the current loads applied on the structural framing as well as future predicted loads applied by future users of the rigging. Once the report is finalized the clients will have documentation indicating the capacity of the rigging. In cases where a future user may modify the current arrangement of the rigging, the client will be able to provide the future user with loading limitations based on capacities found within the analysis of the rigging structure. The clients for this project are Joshua Spears (Facilities Project Manager), Thomas Charles Eberly (Vice President of Campus Operations), and David S. Merrell (Principal of Hubbard Merrell).

1.1 Scope of Work

In order to accomplish this purpose, our team will inspect, create as-built drawings, model, and analyze the existing structure. The first step was to plan and conduct a site visit. This involves taking measurements and photos in order to confirm any information found in these archived plans and correct any faults. This allowed for a creation of an updated set of master plans from these corrections. Once a master set of plans was created, this allowed the team to model and analyze the rigging structure in Risa 3D. The analysis seeks to find the deflection and internal forces are within the allowable limits found in the AISC 360-16 (15^{th} ed.).

1.2 Implications of Work

This project was done to utilize the structural rigging more efficiently. This will give insight to clients as well as benefit stakeholders of Prochnow Auditorium and its success.

2.0 Project Background

Erected in 1951, the Prochnow auditorium is located in the city of Flagstaff, Arizona. More specifically, the auditorium can be located at the north most point of the NAU campus off of 317 W Dupont Ave. Its location within the state of Arizona is shown below in Figure 1. The street level view of the auditorium can be seen in Figure 2, with the auditorium circled in red.

Figure 1: Satellite View [1].

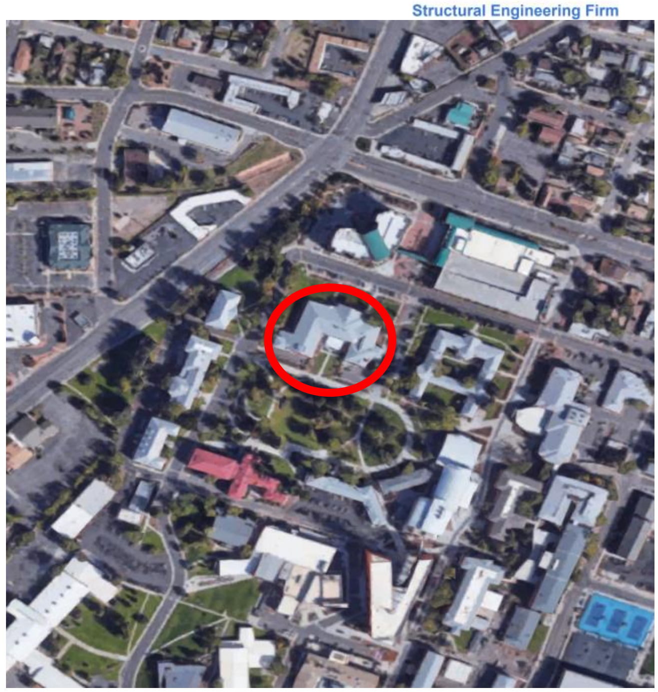

Figure 2: Street View [1]

The Prochnow Auditorium shares its building with the 1899 Bar and Grill, although it should be noted that they are separated into different structures within the overall building structure. Figures 3 and 4 show outside imagery of the joint building structure.

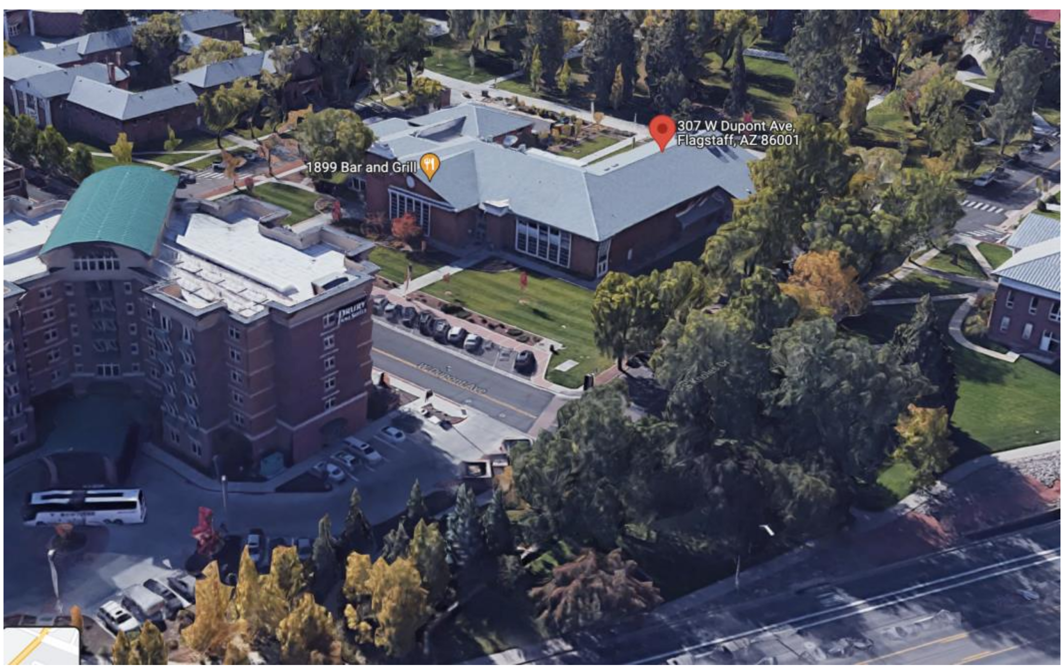

Figure 3: Outside View [1]

Figure 4: Outside View [1]

The rigging system our team will analyze for this project is located directly above the stage depicted in Figure 5. Figure 6 shows a view of the rigging from the stage itself.

Figure 5: View of Stage [2]

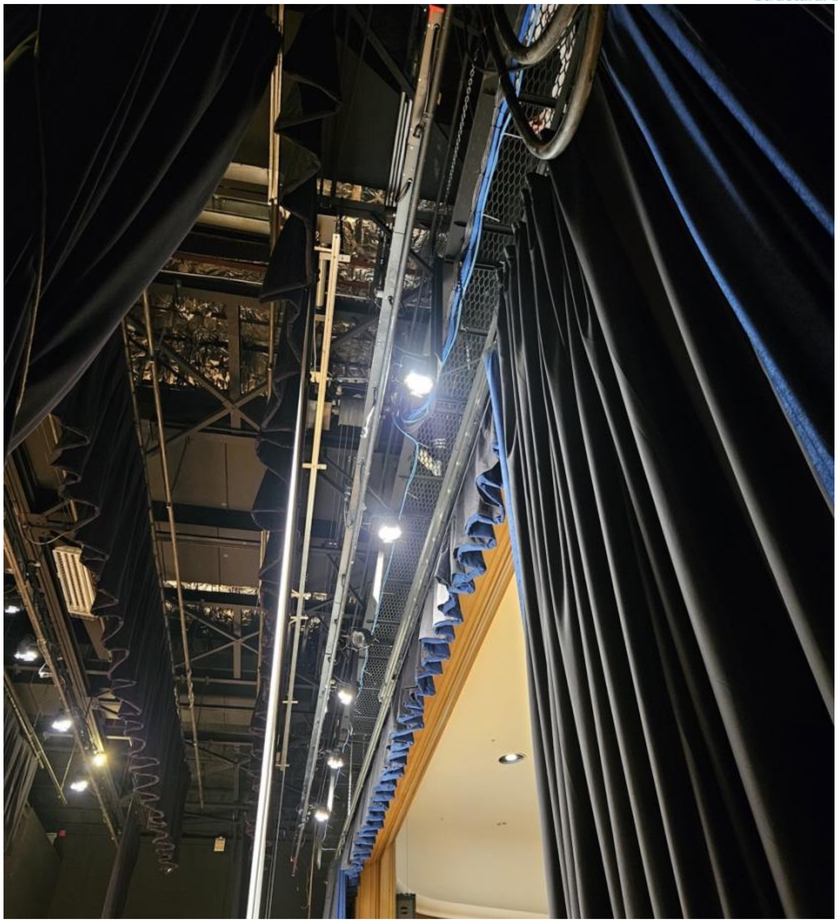

Figure 6: View of Existing Rigging From Below [2]

The rigging structure primarily exists of a grid of W-beams. W8x15-beams are attached to the wall above the opening of the stage perpendicular to the length of the stage. The W8x15-beams are cross membered by W6x9s that fit snuggly and are welded together. This creates a grillage which allows for loads to be hung from the W6x9s to the W8x15s.

As-built drawings do not exist. The rigging was constructed by a subcontractor hence why NAU does not have as-builts. The most relevant plans found the archives of Northern Arizona University's Facility Services building were construction documents from "NAU Project No. 09.030.091" which include a renovation of the stage rigging I-beams where they were replaced for safety upgrades [3]. These documents were used as our reference plans. A site visit to confirm dimensions of the rigging and the current condition of the rigging was conducted.

3.0 Site Visit

The following figures were taken on the February 14th Site visit. The rigging can be seen as the W6x9-beams that crosses over the 2 – L4x4x1/4" beam in Figure 7. Figure 7 also shows the batten locations and chain connections between the battens and the rigging structure. Figure 8 shown below shows the group members simplified plans of the rigging.

Figure 7: Rigging Road Existing [2]

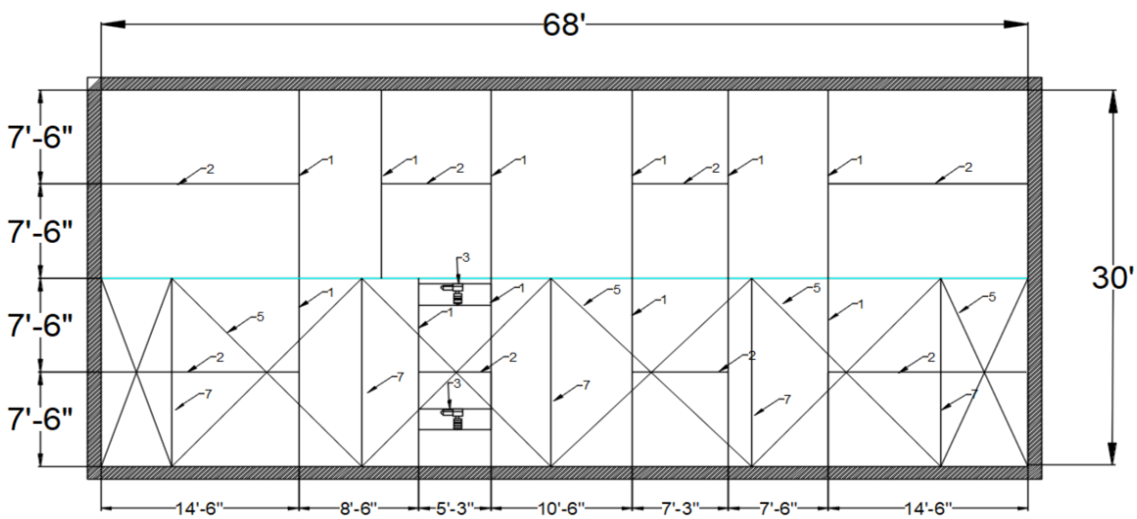

Figure 8: Rigging Rod Plans, Simplified

The cross members that are called out as L2” x 2” x ¼." Figure 9: Cross Member stemming from left of figure was measured as a L3” x 2” x ¼" on site.

Figure 9: Cross Member [2]

4.0 Analysis Performed

4.1 Load Determination

To start analysis, first dead and live loads need to be documented. Of the loads on the rigging there are five main loads to consider. These are the lights, curtains, screen, two winches, and a hand-crafted box made to fit four lights that we have called a “Light Box.” In addition, smaller loads were considered too such as the weight of batten rods themselves that span the length of the stage.

The team has classified all loads applied to the rigging, outside of the beams self-weight as self-weight is considered dead load, to be live loads. The justification for this is that the placements of the loads can be altered at any time during the lifetime of the structure. The magnitude of these loads was found from either manufacturer tags or relative sources.

Table 1 shows the summary of the loading types as well as the individual weights of each load. It is also important to note that all these weights, except for the two winches as those are attached directly to the rigging members, are hung from 17 batten rods (batten rods depicted in Figure 7) and are distributed to the rigging system via chain connection.

Table 1: Batten Loading

Live Load Cases: Battens & Winch			Number of Loads	# of Loads Weight (lbs)
Batten Loading	1	Valence Curtains	3	169
	2	Main Traveler Curtains	3	276
	3	1st Electric	5	254
	4	Projector Screen	1	1059
	5	1st Border Curtains	3	169
	6	1st Side Leg Curtains	3	162
	7	General Purpose 1	1	138
	8	2nd Border Curtains	3	169
	9	2nd Side Leg Curtains	3	162
	10	2nd Electric	5	254
	11	General Purpose 2	1	138
	12	3nd Border Curtains	3	169
	13	3nd Side Leg Curtains	3	162
	14	3rd Electric & Light Boxes	4	254
	15	Cyclorama Curtain	2	226
	16	Commando Cloth Curtain	2	240
	17	General Purpose	1	138
Winch Loading			2	2720
			Sum of Total Weight:	**6862 lbs**

There is room for fifty-four lights on the rigging, two light boxes, one screen, ten curtains, and two winches when the rigging is fully loaded. Lights have been identified as ETC Source Four PAR EA 575W with Stage-Pin, or '750 Stage Pin' [3] lights and the weight given by the manufacturer is 7.5 pounds. This makes for a total loading of approximately 405 pounds for lights [4].

The light boxes are handmade, out of wood, made to fit four lights. From this we can approximate the weight of these boxes filled with all four lights. From the dimensions of the lights, 15.9" x 10.8" x 8.3", the team estimated the size of the light box as 8" x 25" x 19". This is accurate from our observations of the light box and accommodates all four lights spaced 2 x 2 with space between them. This also accounts for half the depth of the lights to accommodate for wiring to reach into the box to power the lights. Assuming these dimensions are accurate and four pounds per board foot which is estimated as average wood weight, our team has determined that the light boxes approximately weigh thirty pounds without lights. Therefore, with four lights in both of them together they combine for approximately 120 pounds [5].

The curtains have been identified as Velour 58 in IFR from the tags. These curtains have a unit weight of 23 ounces per square yard or 0.160 pounds per square foot. These dimensions are multiplied by the height and width of the curtain to get a total weight of the curtain.

Figure 10: Velour 58 Curtain Tag [2]

The winch has been identified as U.S. MOTORS General Purpose Motor: Totally Enclosed Fan-Cooled, Rigid Base Mount, 3 HP, 182T Frame [4]. This model, along with other components is listed to weigh 61.3 lbs. However, the largest part of the winch had no identifying markers on it. Group members used engineering judgment to estimate a weight of 1360 lbs for the total weight of the winch.

The screen is custom made so there are no manufacturing details, only a manufacturer. Group members reached out to the companies "Experts" who estimated that, for a screen that has a diagonal of 610 in such as the one in the auditorium, it would weight approximately 500 lbs. For this project group members decided to use engineering judgement to over-compensate for an undefined weight so this weight for the screen is listed as just over 1000 lbs as a generous estimation.

The self-weight of the beams is another factor that must be considered when evaluating a structural model. For this stage rigging, W8x15 beams carry a self-weight of 15 pounds per linear foot while W6x9 beams have a self-weight of 9 pounds per linear foot. These weights are considered dead loads.

In addition to these loads, roof loads were considered for the roof truss. For snow load, 58 psf was taken from the Coconino County design criteria for building [9]. For roof dead load, a value of 20 psf was used for the roof trusses [10]. Roof live load also used a value of 20 psf [10]. Rain load was not considered because the slope of the roof does not allow ponding. The total loads applied to the truss for analysis can be seen in Table 2, shown in pounds per linear foot. The area loads are multiplied by the tributary width to get the linear load applied to the truss. The tributary width of the roof truss is 15 feet.

Table 2: Load Applied to Truss

Load Type	Load Applied to Truss	Unit
Snow	870	plf
Dead Roof	300	plf
Live Roof	300	plf

Refer to Appendix A for the complete loading details.

4.2 Load Cases and Combinations

DL is defined as dead load, SL is snow load, and LL is live load. Dead load is the intrinsic weight of the structure that cannot be moved. For this project just the self-weight of the beams is classified as dead load. Snow load is the force of accumulated snow and ice weighing down on a roof. This is considered in this project since the rigging is attached to the roof. Live loads are movable weights attached to the structure. For this project the curtains, lights, light boxes, winches, and screen are all classified as live loads.

Table 3 shows the load combinations that will be used to assess the rigging structure in Risa 3D under the “worst case scenario”. These loading combinations are from the AISC Steel Manual [5].

Table 3: Load Combinations

Type	Load Combination
Serviceability	DL+0.75SL+0.75LL
Ultimate	1.2DL+1.6SL+0.5LL

The serviceability load combination will be used to account for the dead, live, and snow loads expected to be applied under service. This combination will be used to evaluate expected deflections values that will be present when new loads are applied, in the case of this project, when new d-rings are attached to the rigging with their max capacity.

The ultimate load combinations will be used to evaluate the strength of the steel structure under the most extreme loads to ensure that it will not fail over its design lifetime. This is done by applying factors of safety to the dead, live, and snow loads. This rigging structure only requires the use of ultimate load combinations 1&2 from the AISC Steel Manual [5], as the structures only support dead and live loads.

When modeling these load combinations, two load cases are considered. The first load case is an even distribution of load across the rigging. This is when the curtains of the rigging are closed. The second load case is when the weight is distributed in points on either side of the battens. This represents the weight of the curtains when they are fully opened. Figure 11 displays the loading schedule for load case 1.

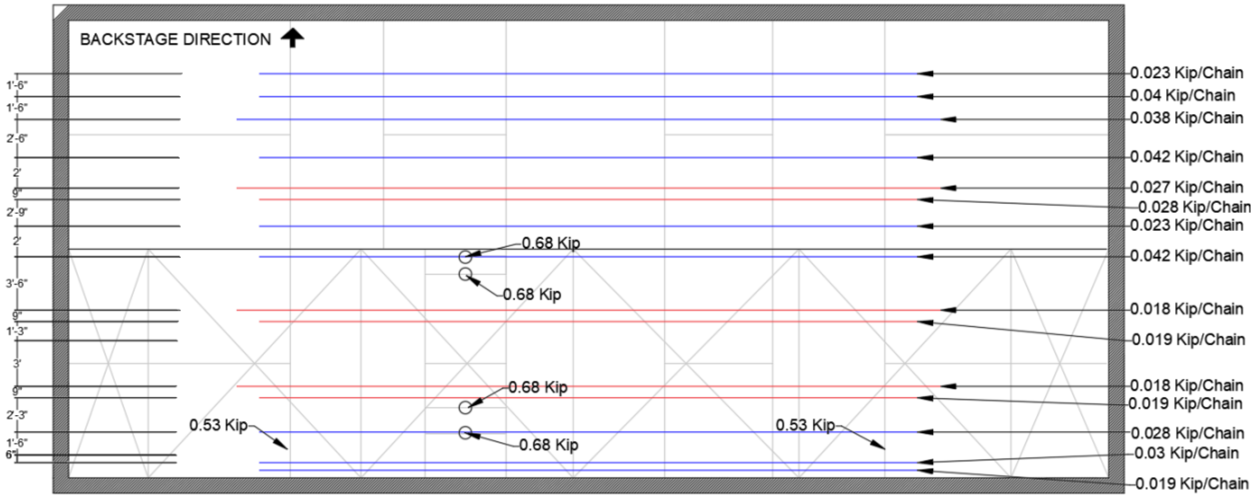

Figure 11: Load Case 1 Batten Schedule

Each red/blue horizontal line represents a batten with their weights per chain connection shown on the right side of the Figure. A chain connection is placed at each perpendicular crossing between the batten and the overlying rigging beams (in grey). The second load case (curtains open) can be created by converting the distributed weights on the red battens to just two-point loads at each end of the batten.

4.3 As Built Drawings

The team collected existing construction documents and used this to create a set of as-built drawings. The team's focus was on the truss above the stage rigging, the stage rigging, and existing connections. There were two sets of plans that were reviewed during the plan review task. The first set of plans were from 1951 and the second set was from 1994. The 2023 plans are the updates plans created by the team.

Figure 12 above shows the plan view of the rigging structure from 1951. These drawings only include the cross-bracing members on the downstage part of the stage. The TA2 is the double channel 7"

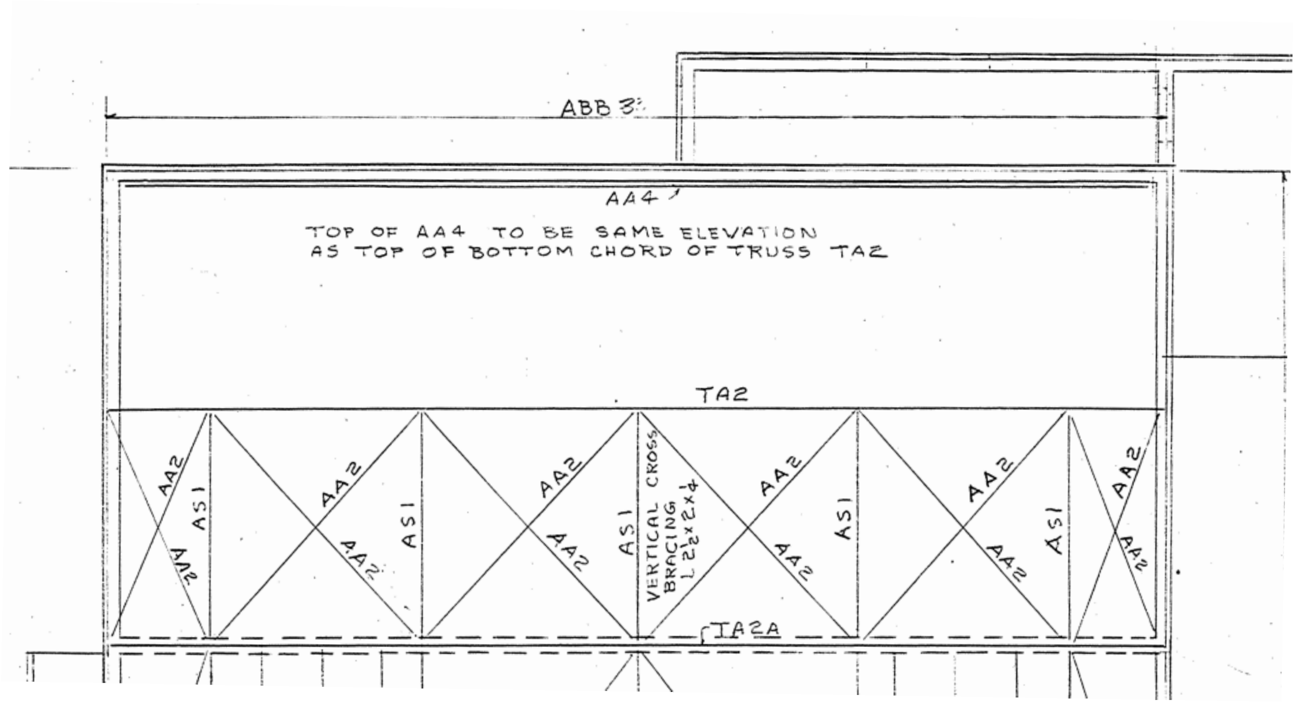

Figure 12: Plan View of Rigging

Figure 13 shows the 1994 Plan View which did not include dimensions and also included dotted lines. These dotted lines represent the previous steel beams that were replaced by the darker lines. As shown, this plan view has more details of the rigging beams than the 1951 plans in Figure 13 below. This plan view also had a set of keynotes that provided detailed information about the beam types, winch locations, and catwalk dimensions.

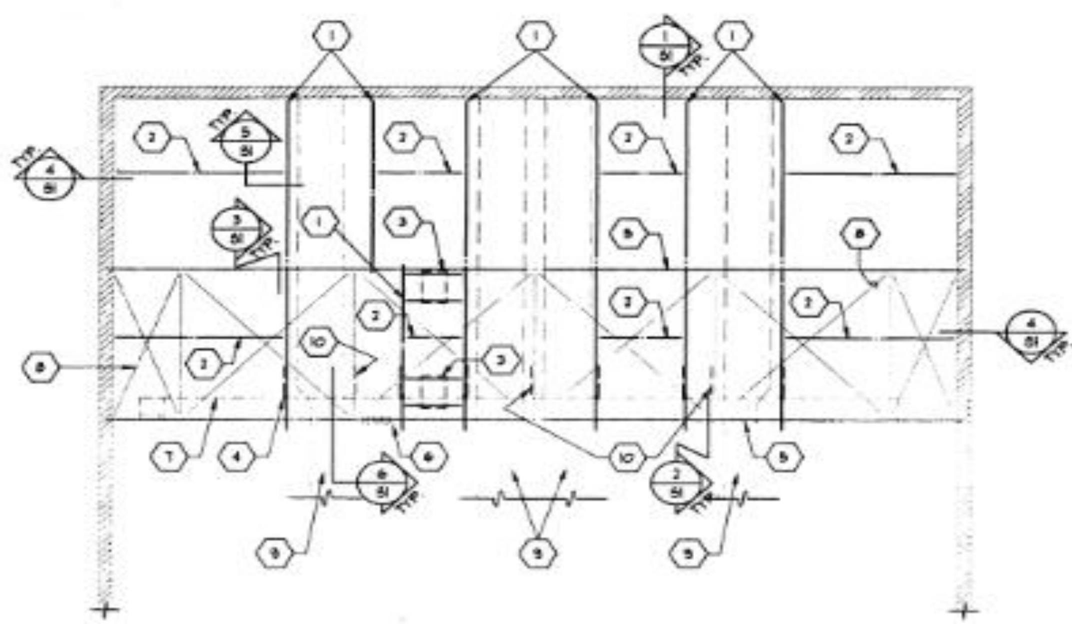

Figure 13: 1994 Plan View [3]

Figure 14 below shows the 2023 Plan View which is the plan view that was generated by the team. The dimensions used are field verified. The plan view also includes the two winches that are located on the W6X9 beams and are called out by the number three keynote. Only the existing conditions of the rigging are being assessed, therefore the dotted beams from 1994 were not included in the updated as built drawings.

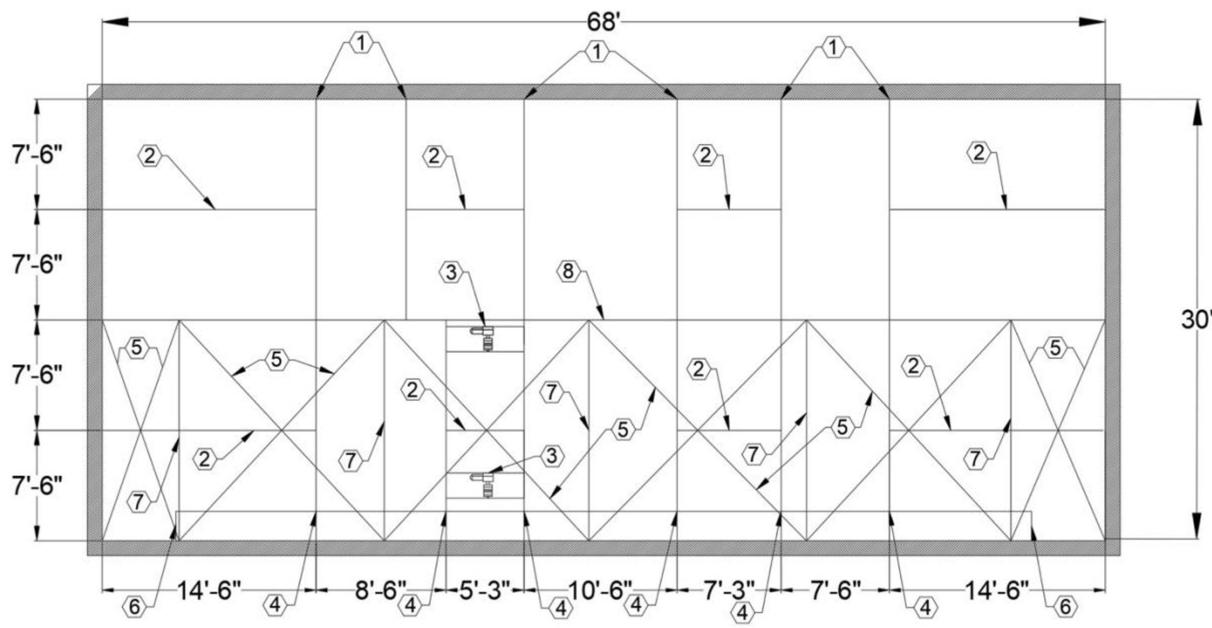

Figure 14: 2023 Plan View [3]

Figure 15 below shows 1994 Truss TA2 View [3] which is the truss from the blueprints in 1951. This is the truss detail for TA2 and TA-2A which are the trusses that are above the bottom chord of the rigging. This was determined by the plan view of the framing plans since these trusses were called out in the stage area where the rigging is located.

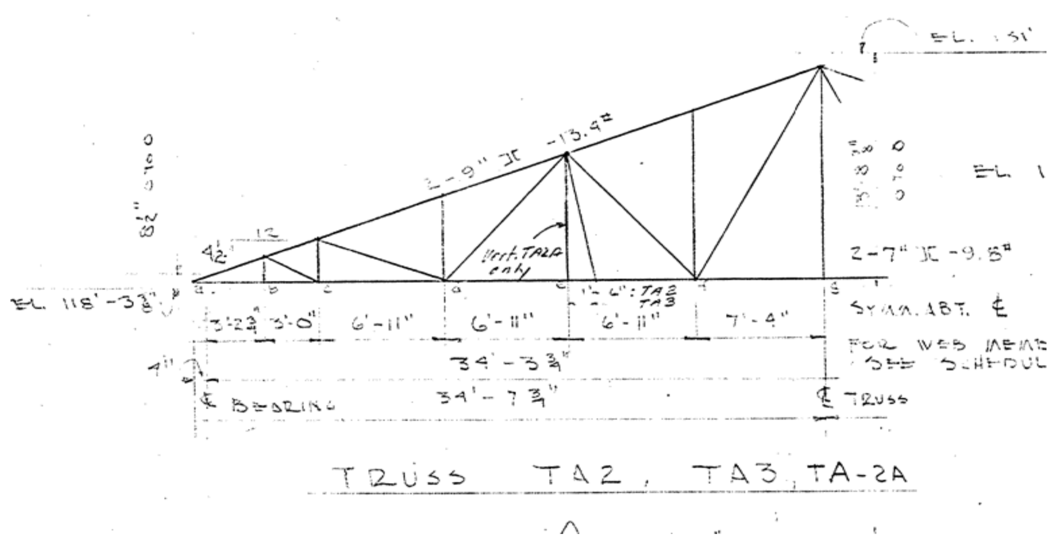

Figure 15: 1994 Truss TA2 View [3]

Figure 16 below 1994 Profile View [3] which is a profile view of the stage rigging from the 1994 plans. The truss is drawn differently in comparison to the 1951 truss. On the site walk the team determined Figure X: 1994 Profile View was drawn incorrectly and the 1951 truss was correct.

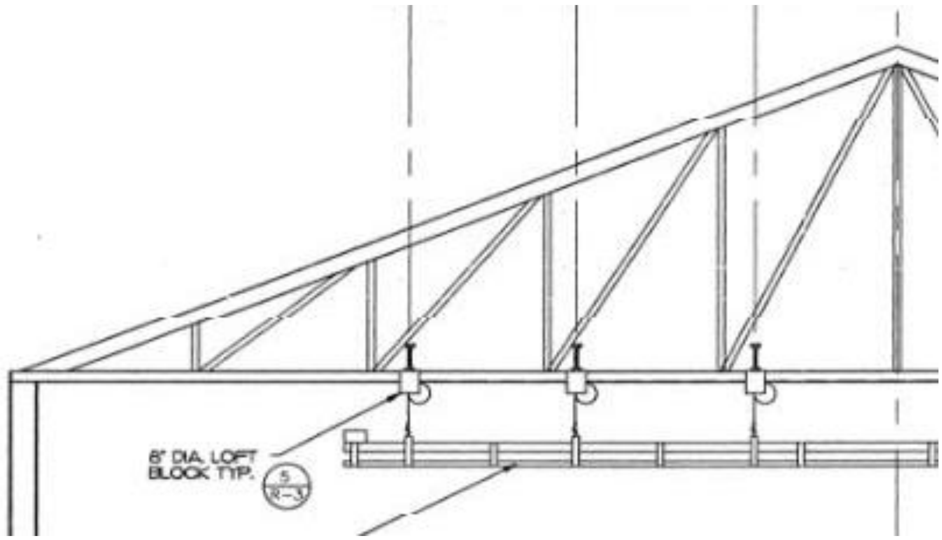

Figure 16: 1994 Profile View [3]

A few adjustments were made to the truss specifications based on measurements taken from the site visits. For one, the vertical truss member at section E was found to have been completely removed sometime after this drawing was created. Another adjustment was the spacing between sections D and F was found to be closer to 12' rather than 13'10". Dimensions for the truss members can be seen in the

Refer to Appendix B for a full set of as-built drawings.

4.4 RISA3D Analysis

4.4.1 Risa 3D Model

Figure 17 displays a top view of the final 3D model developed for the structural analysis of the stage rigging. The rigging structure is comprised of different member types.

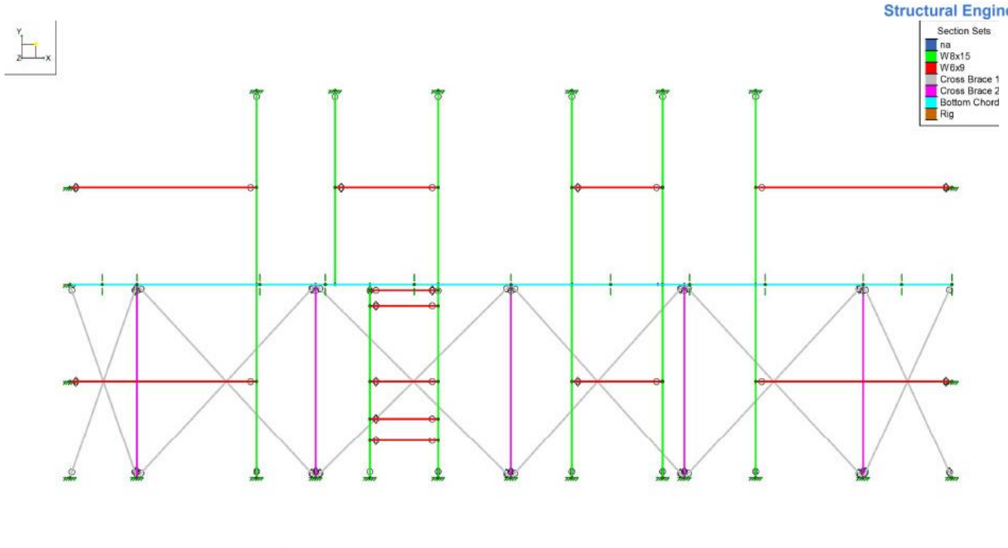

Figure 17: Plan View of Risa-3D Model with Color Code [7]

This Figure shows the model from a plan view (looking down) where the positive y-axis is north and the positive x-axis is east. In other terms, the bottom of this view is the stage opening while the top is the back of the stage.

Referring to the color code, in green are the W8x15 beams and the W6x9 beams are shown in red. These wide flange beams make up the upper layer of the rigging structure. In grey are the L3”x2”x0.25” beams with the pink members being LL3”x2”x0.25” beams. These L-beams are meant to be a horizontal cross brace to the bottom chord shown in blue. This bottom chord acts as a vertical support to the W8x15 beams

The structure’s length from one end of the theatre wall to the other is 67ft 10in from left to right. Individual beam dimensions were taken according to the scale indicated by the plan sheets for the rigging structure. The scale was confirmed in the team's first site visit.

Figure 18 shows a profile view the roof truss structure modeled in Risa 3D.

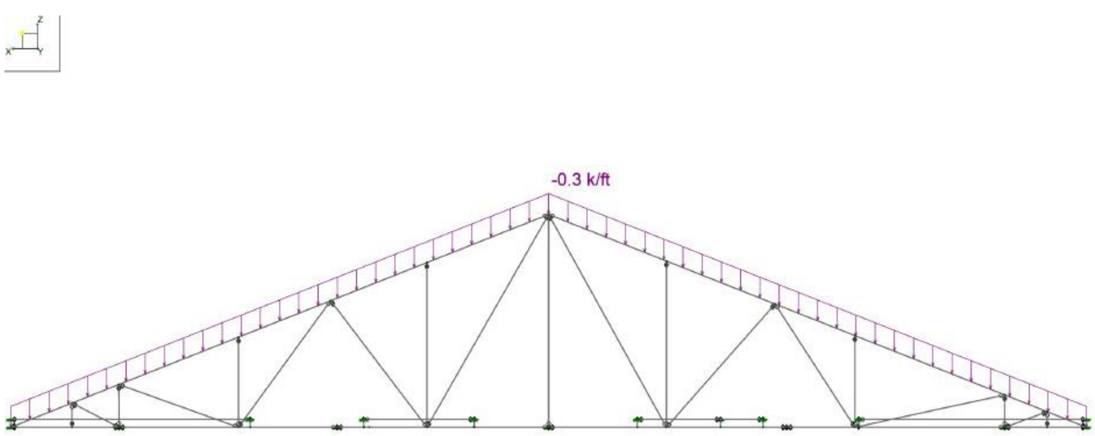

Figure 18: Profile View of Roof Truss With Dead Load Shown [7]

Member types for the truss were inputted based on the specific member details shown in Appendix C. All of the vertical members are connected to the roof structural system via weld, hence why they are shown as a fixed connection. Given the outside building is not covered in the scope of this project, further roof details and loading will not be modeled for this structure.

Rigid links were added to transfer the forces from the upper rigging structure onto the truss. This rigid link has a very large moment of inertia but a density of zero as to not add to the dead load. These can be seen in Figure 18 in the gap between bottom chord and the horizontal W6x9 beams.

The plans provided by Joshua Spear did not provide any detail on the steel grade of the beams so the team had to assume the grade of steel used for the structure. A36 steel was assumed for the wide flanged beams because those were built in 1994 and this steel grade was the most commonly used grade. Since the truss and it cross braces were built in 1951, A7 steel was assumed for these members.

Another assumption the team made is with the boundary conditions. All the L-beams were shown to be pinned to the truss bottom chord (see Figure 19). This is represented in the model as a pin node connection.

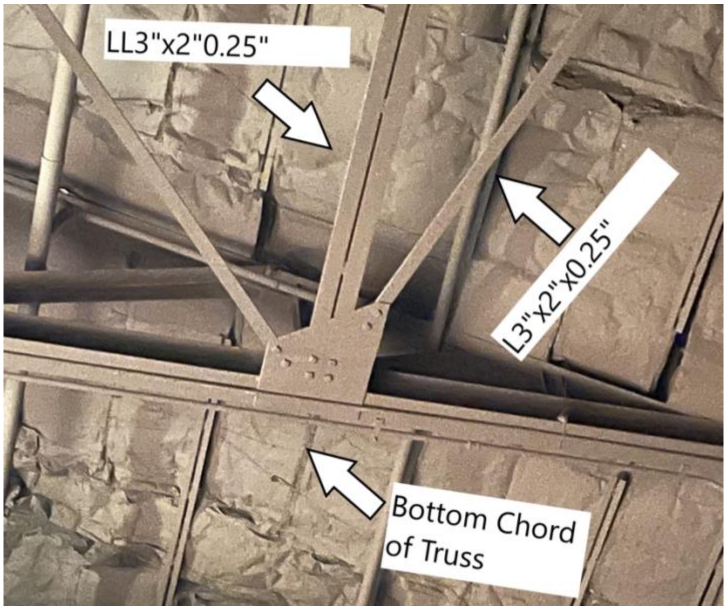

Figure 19: L-Beam Connection to Bottom Chord

Figure 20 shows the welded connection between the wide flange beams and the Prochnow wall. This is represented in the model as a fixed boundary condition.

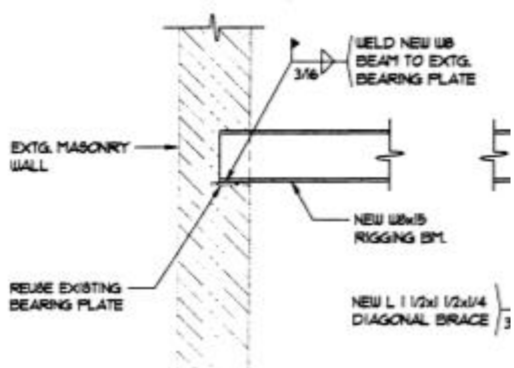

Figure 20: Wide Flange Beam Wall Connection

The steel W-beams are connected to each other via bolted connection. This is shown in the plan sheets in Figure 21 and verified from the site visit with the photo shown in Figure 22.

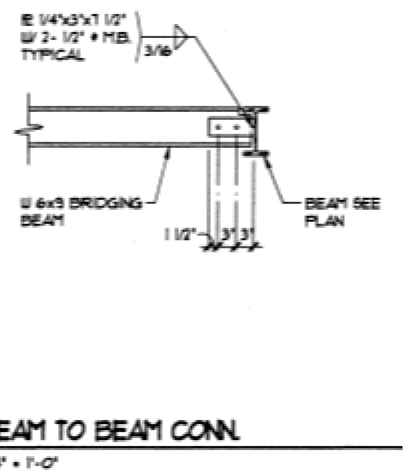

Figure 21: Beam to Beam Pin Connection

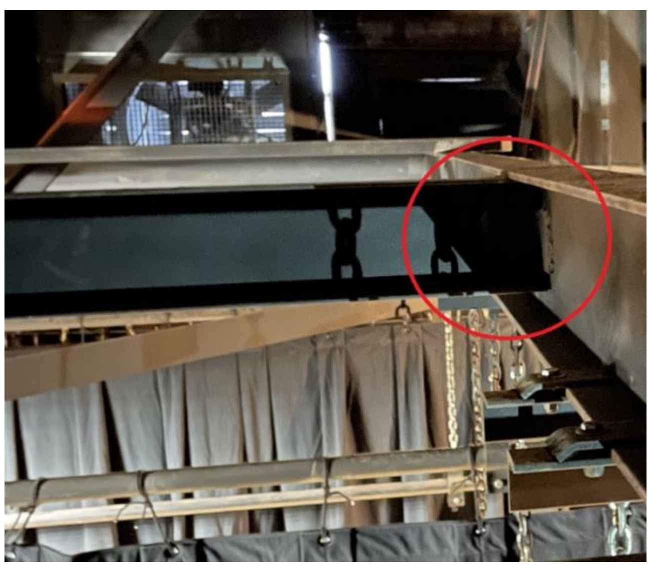

Figure 22: Photo Verification of Beam to Beam Connection

Figure 23 shows an isometric view of the entire rigging structure with all the boundary conditions displayed.

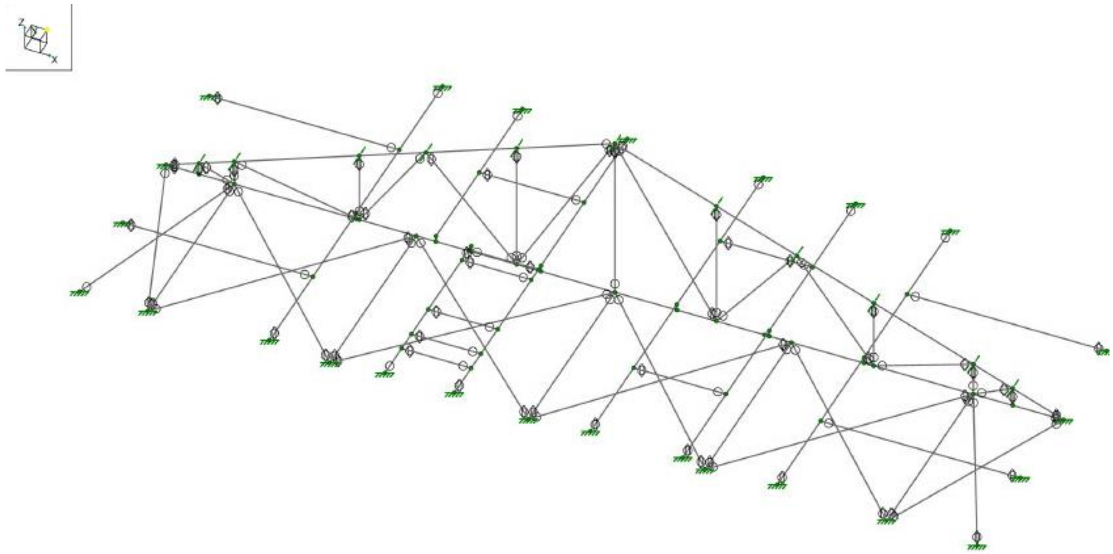

Figure 23: Isometric View With Boundary Conditions Shown

4.4.2 Model Analysis

Before starting the analysis, it is important to understand the existing criteria for strength and serviceability. Table 4 shows the criteria taken from the AISC Steel Construction Manual.

Table 4: Criteria for Strength and Serviceability

	Member Type	Criteria
Strength	Overall	The demand to capacity ratio should not exceed 1.0 to satisfy current building code
Serviceability	Roof Truss	Under total load, roof truss deflection should not exceed L/180
	W-beams	Deflections should not exceed L/240

Coconino County's building design criteria adopted the "2018 International Existing Building Code" in their county code ordinance [8]. Within the 2018 International Existing Building Code (IEBC), chapter 12 covers historic buildings and provides some exceptions from the current International Building Code (IBC) requirements when the structure in question have historic value. In the case of the Prochnow Auditorium, this structure would be considered a historic building as it was built in 1951 and, due to several renovations, not all the structural changes have been documented [9].

Chapter 12 of the IEBC continues with section “1204 Structural” covering when a change in occupancy occurs. A change in occupancy is any change in the purpose or a change in the level of activity within a building or structure. In the case of this project, the level of loading activity will be increased on the structural rigging due to the addition of future loads. Section 1204.1 states, “historic buildings undergoing a change of occupancy shall comply with the applicable provisions of chapter 10.” Within Chapter 10 section “1006 structural,” 1006.1 Live Loads details states, “Structural elements carrying tributary live loads from an area with a change of occupation shall satisfy the requirements of ‘section 1607’ of International Building Code. Design live loads for areas of new occupation shall be based on ‘section 1607’ of the International Building Code. Design loads for other areas shall be permitted to use previously approved design live loads. <u>Exception: Structural elements whose demand-capacity ratio considering the change of occupation is not more than **5 percent** greater than the demand-capacity ratio based on previously approved live loads</u>” [9]. This section instructs when structural elements carrying tributary live loads are involved in a change of occupancy then requirements of the International Building Code must be upheld. However, the IBC’s requirements can be disregarded when a change in occupancy does not cause the demand-capacity ratio to be more than 5% of the previous approved live loads.

The exception stated in section “1006.1 Live Loads” of the IEBC is the design constraint the team will be used to add additional future live loading while still staying in code.

Assessing the model for load case 1, we get the following unity check in Figure 24.

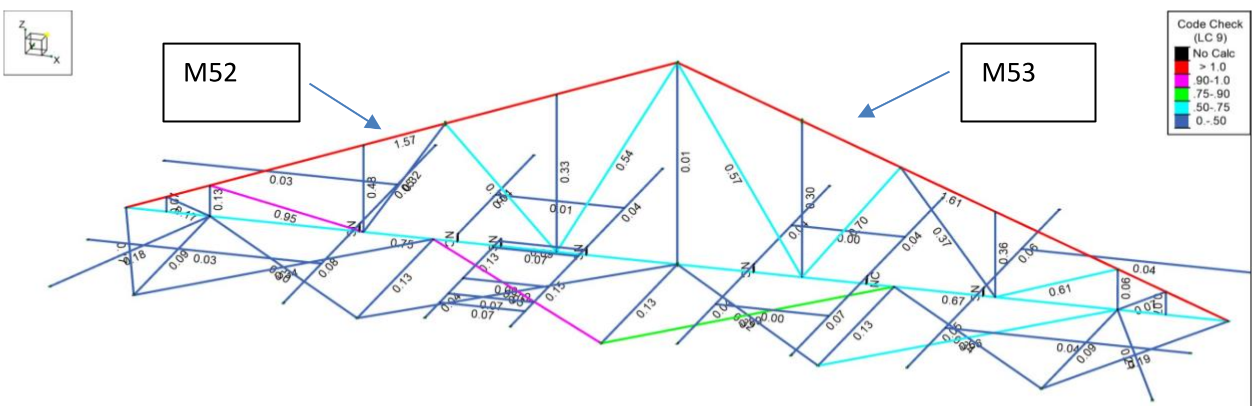

Figure 24: Unity Check for Load Case 1 [7]

A unity check tells us the ratio of applied stresses to the capacity of each member (also called the demand/capacity ratio). Any member with a value below 1.0 is considered safe and stable. The existing structure has two critical member (M52 & M53). These members have a unity factor exceeding 1.0, meaning that these members will need close attention when additional loads are being applied. They must not exceed 5% in additional stress.

LC2 produces similar results with more stresses applied to the outside W8x15 beams and less stress applied to the bottom chord. This gives us a good starting point how much more loads can be applied.

5.0 Results of Analysis

The team created a loading plan that meets building code requirements for deflection and applied stresses. The rigging does not undergo any significant shear or tension, so those will not be necessary to analyze. Because of the critical members

When determining optimal load placements, the team and client came up with a few constraints. The constraints go as follows:

1. The loading plan needs a minimum of 6 locations
2. Potential loads should only be applied to W8x15 beams because they have the lowest demand/capacity ratio (thus are the most structurally sound)
3. Deflection must not exceed L/240 for W-beams and L/180 for roof truss. Considering all lengths of the W8x15 beams are 15 ft, the max deflection at these members should not exceed 0.075 in [5]
4. Critical stressed members must not exceed additional 5% their demand/capacity ratio per International Existing Building Code [8]

Following these constraints, the optimal load placement plan was created. This loading plan is displayed in Figure 25.

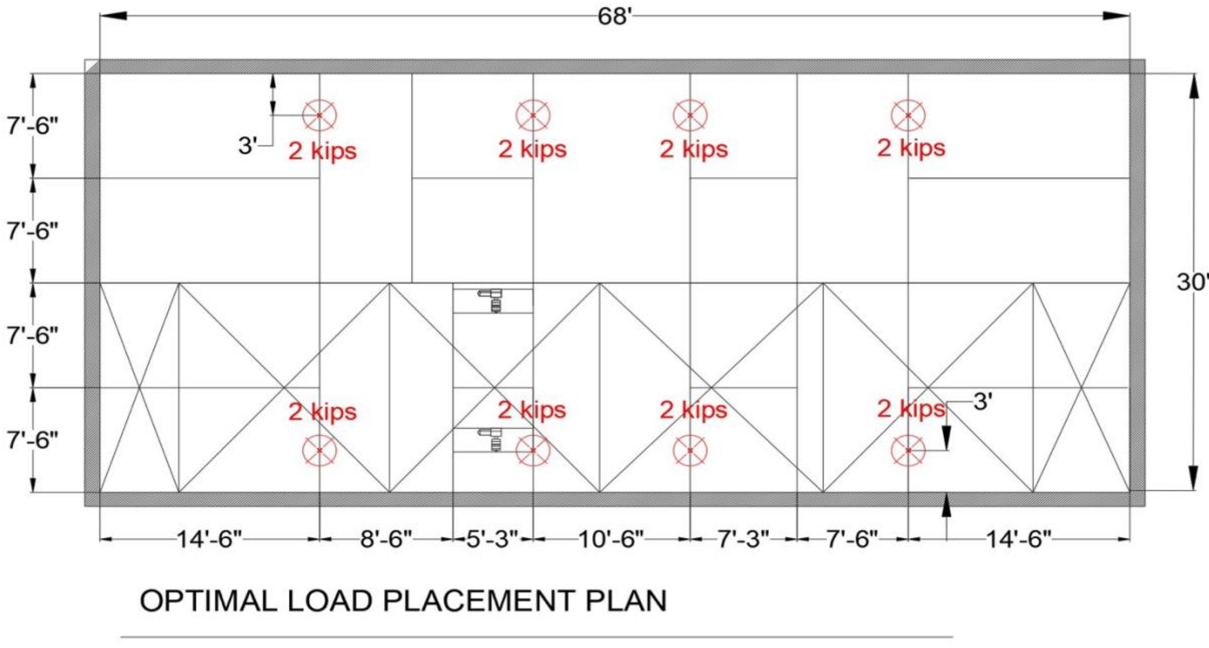

Figure 25: Optimal Load Placement Plan [7]

The design decisions for this plan were controlled by the demand/capacity ratio under the ultimate strength rather any deflections under serviceability. This load case has 2000 lb loads at 8 different points on the rigging, totaling 16,000 lbs of loading. These load placements are located at exactly 3 feet away from the masonry wall at both sides. This decision was made to mitigate the stresses being added onto the truss, to keep additional stresses within 5%. Figure 26 shows the unity check for this loading plan under load case 1.

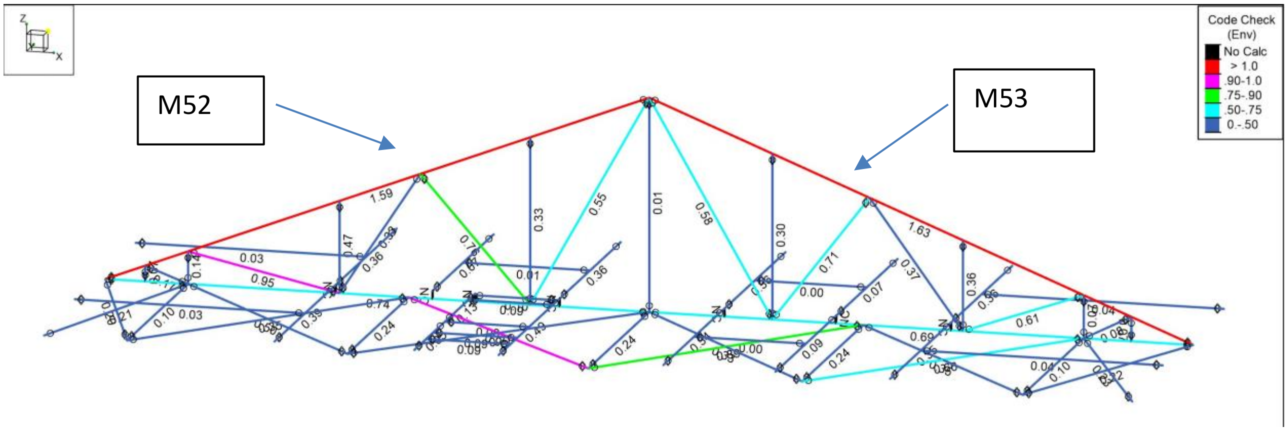

Figure 26: Optimal Load Placement Unity Check Load Case 1 [7]

The additional loads are being analyzed under load case 1 (curtains closed) because this load case produces the "worst case scenario". As you can see, the unity check for M52 jumped by 0.02 points while the unity check for M53 also jumped by only 0.02 points. Table 5 shows the results when comparing the proposed loading plan to the criteria established for strength.

Table 5: Strength Criteria

Load Case	Member	Criteria	Existing	Proposed	% Change	Criteria Met?
Load Case 1	M52	<5%	1.57	1.59	1.3%	yes
	M53	<5%	1.61	1.63	1.2%	yes
Load Case 2	M52	<5%	1.57	1.59	1.3%	yes
	M53	<5%	1.61	1.63	1.2%	yes

The stresses being applied with the optimal load plan are within the 5% criteria discussed earlier. The team opted to keep the loading at 2 kips each because that seemed like a reasonable loading capacity for a stage theater rigging structure. Table 6 shows the fulfillment of the structure under serviceability.

Table 6: Serviceability Criteria

Load Case	Member Type	Criteria	Length (in)	Max Allowable (in)	Max Present (in)	Criteria Met?
Load Case 1	Roof	<L/180	144	0.8	0.423	yes
	W-beam	<L/240	450	1.875	0.236	yes
Load Case 2	Roof	<L/180	144	0.8	0.431	yes
	W-beam	<L/240	450	1.875	0.276	yes

Figure 27 displays the location of the wide flange member (M27) that has the most deflection after having the proposed loads added. This deflection is also amplified by load case 2, where the opened curtain acts as a single point load on the member.

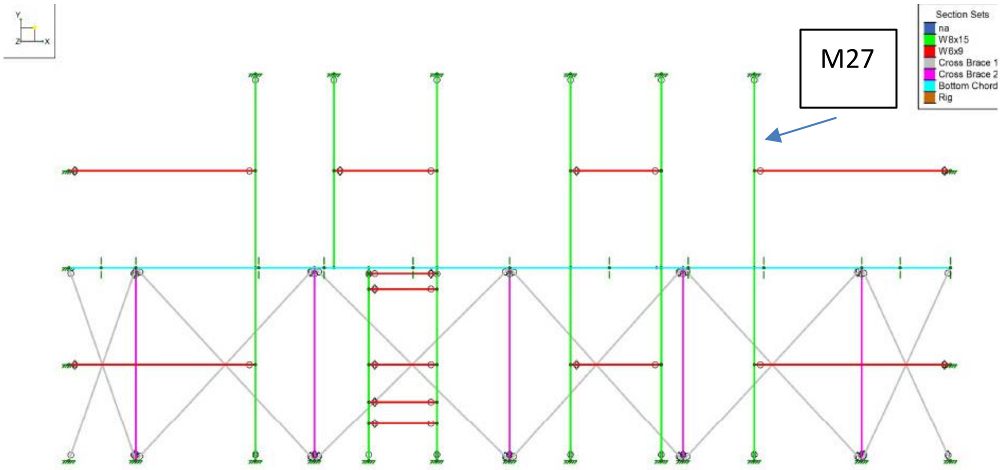

Figure 27: Member With Most Deflection [7]

6.0 Summary of Engineering Work

Table 7 displays the hours that each individual team role has put into the project. The hour log is compared to the proposed hours in the final proposal.

Table 7: Hour Log Comparison

Scheduled						**Actual**					
Task	**DFT**	**INT**	**SRE**	**ENG**	**SUR**	**Task**	**DFT**	**INT**	**SRE**	**ENG**	**SUR**
Task 1.0 Plan Review	**0**	**20**	**5**	**48**	**30**	**Task 1.0 Plan Review**	**0**	**26**	**4**	**27**	**0**
Task 1.1 Analyze Existing Rigging Plans and Specifications	**0**	**10**	**0**	**10**	**20**	**Task 1.1 Analyze Existing Rigging Plans and Specifications**	**0**	**7**	**4**	**13**	**0**
Task 1.2 Code Review	**0**	**5**	**0**	**20**	**0**	**Task 1.2 Code Review**	**0**	**2**	**0**	**1**	**0**
Task 1.3 Create Master Set of Plans	**0**	**0**	**0**	**5**	**0**	**Task 1.3 Create Master Set of Plans**	**0**	**6**	**0**	**7**	**0**
Task 1.4 Plan For Site Visit	**0**	**0**	**0**	**3**	**0**	**Task 1.4 Plan For Site Visit**	**0**	**11**	**0**	**6**	**0**
Taks 1.4.1 Create Safety Plan	**0**	**0**	**0**	**1**	**0**	**Taks 1.4.1 Create Safety Plan**	**0**	**3**	**0**	**2**	**0**
Task 1.4.2 Access to Site	**0**	**0**	**0**	**1**	**0**	**Task 1.4.2 Access to Site**	**0**	**5**	**0**	**3**	**0**
Task 1.4.3 Rent Equipment	**0**	**3**	**0**	**1**	**0**	**Task 1.4.3 Rent Equipment**	**0**	**3**	**0**	**1**	**0**
Task 2.0 Site Visit	**0**	**15**	**0**	**35**	**65**	**Task 2.0 Site Visit**	**0**	**3**	**0**	**27**	**12**

Scheduled						Actual					
DFT	**INT**	**SRE**	**ENG**	**SUR**	**Task**	**DFT**	**INT**	**SRE**	**ENG**	**SUR**	
Task 2.1 Take Photographs	0	5	0	5	5	**Task 2.1 Take Photographs**	0	3	0	3	3
Task 2.2 Measurement Procedure	0	5	0	10	30	**Task 2.2 Measurement Procedure**	0	0	0	12	3
Task 2.3 Identify Existing Loads on Rigging	0	5	0	20	30	**Task 2.3 Identify Existing Loads on Rigging**	0	0	0	12	6
Task 3.0 Structural Analysis	120	25	40	170	0	**Task 3.0 Structural Analysis**	106	13	24	85	8
Task 3.1 Classify and Document Potential Dead & Live Loads	20	5	5	35	0	**Task 3.1 Classify and Document Potential Dead & Live Loads**	4	0	0	3	0
Task 3.2 Create a 3D Model & Analyze	60	5	5	10	0	**Task 3.2 Create a 3D Model & Analyze**	50	2	0	2	0
Task 3.3 As-built Built Drawings and Load Map	40	5	10	15	0	**Task 3.3 As-built Built Drawings and Load Map**	30	5	0	60	0
Task 3.4 Assess Results of Analysis	0	5	10	45	0	**Task 3.4 Assess Results of Analysis**	20	0	4	20	0
Task 3.5 Identify Optimal Load Placements	0	5	10	65	0	**Task 3.5 Identify Optimal Load Placements**	2	6	20	0	8
Task 4.0 Project Impacts	0	0	5	5	0	Task 4.0 Project Impacts	0	0	5	5	0
Task 5.0 Project Deliverables	0	65	0	65	0	Task 5.0 Project Deliverables	0	65	0	65	0
Task 5.1 30% Deliverable	0	15	0	15	0	Task 5.1 30% Deliverable	0	15	0	15	0
Task 5.2 60% Deliverable	0	20	0	20	0	Task 5.2 60% Deliverable	0	20	0	20	0
Task 5.3 90% Deliverable	0	25	0	25	0	Task 5.3 90% Deliverable	0	25	0	25	0
Task 5.4 Final Deliverable	0	5	0	5	0	Task 5.4 Final Deliverable	0	5	0	5	0
Task 6.0 Project Management	0	4	0	36	0	**Task 6.0 Project Management**	0	4	0	36	0
Task 6.1 Meetings	0	0	0	32	0	Task 6.1 Meetings	0	0	0	32	0
Task 6.2 Schedule	0	4	0	0	0	Task 6.2 Schedule	0	4	0	0	0
Task 6.3 Resource Management	0	0	0	4	0	Task 6.3 Resource Management	0	0	0	4	0
Total	120	129	50	359	95	Total	106	111	33	245	20

Table 8 below displays the percent difference in total hours of the proposal and the actual hours completed.

Table 8: Hour Log Difference

Proposed (Hours)	Actual (Hours)	% Difference
753	515	37.5%

The hours scheduled in the proposal are much larger than hours completed. This is largely due to less work than initially anticipated. Most significantly, engineer and senior engineer hours are reduced. The percent difference for the total hours calculated is 37.5%.

For the 30% deliverable Task 1.0 Preparation For Site Visit, with the exception of Task 1.2 Code Review, should be completed and Task 2.0 Site Visit should be underway. As of February 14th Prochnow team members are on schedule with the proposed plan.

Task 1.0 has been completed, with the exception of Task 1.2 Code Review which is still ongoing. Existing rigging plans have been looked over and understood and from those a master set of plans have been created. Sub-tasks under Task 1.4 Plan For Site Visit were also completed. A safety plan with both variations of using a ladder for measurements as well as a scissor lift was created and given to team members. Access of site was granted on February 2nd by Joshua Spears, equipment was rented on the same day as the first official site visit was conducted on February 14th.

The actual site visit that took place on February 14th involved taking photos of structurally significant points such a connections, boundary conditions, and any points of deflection. The site visit also included measurements of beams to confirm specifications from plans. Lastly, photos were taken of existing loads on the rigging and weights, manufacturers, and any other specifics can be confirmed from these photos.

For the 60% deliverable Task 3.0, Structural Analysis, has been started and Tasks 1.0 and 2.0 have been completed. As of March 21st Prochnow team members are on schedule with the proposed plan.

Task 3.1, Classify and Document Potential Dead & Live Loads, has been started. Loads have been classified as dead or live and calculations and estimations have been made to determine the weight of these loads. This task is still in progress as weights for the screen, the winches, as well as the self-weight of the beams have not yet been determined. Therefore, load combinations are not able to be calculated.

Task 3.2, Create a 3D Model & Analyze, has been started. A model of the rigging with accurate dimensions has been created. This model also classifies member types as well boundary conditions. This task is still in progress as group members have not yet been able to create a load map.

Task 3.3, As-built Built Drawings and Load Map, has been started. As-built drawings were not found so a set of as-builts have been created. This task is still in progress as the set of as-builts is being finalized and a load map has not yet been created.

Task 3.4, Assess Results of Analysis, and Task 3.5, Identify Optimal Load Placements, have not yet been started since a load map first needs to be created.

For the 90% deliverable and the final deliverable all tasks have been completed and analysis has taken place.

Task 3.1, Classify and Document Potential Dead & Live Loads, was finished. The weight of the screen, winches, lights, light-boxes, curtains, and self-weight of the beams have all been determined through manufacturers and steel types. Live and dead loads were also classified and documented for modeling.

Task 3.2, Create a 3D Model & Analyze, was finished. A model of the rigging with accurate dimensions has been created using Risa3D. This model also classifies member types as well boundary conditions.

Task 3.3, As-built Drawings and Load Map, was finished. A load map has been created as well as as-builts. This load map is a plan view of the rigging and helped group members analyze the Risa3D model.

Task 3.4, Assess Results of Analysis, was finished. Once the load map and model was put together and run through Risa3D, group members were able to identify points on the rigging that were more heavily loaded than others. All of the rigging was under capacity of loading by a substantial amount which makes for a flexible loading placement.

Task 3.5, Identify Optimal Load Placements, was finished. Group members identified eight places where deflection was smallest and where the overall structure of the rigging would not faulter. These points were then loaded with D-rings to show the client where different loads could be hung. These loads magnitudes were based on what would potentially be hung and what load the rigging could take.

Task 4.0 Project Impacts, was finished.

Appendix D shows a comparison of the actual hour log shown above to the hour log that was scheduled in our proposal. All-in-all, the hours are about where we expected them to be outside of the surveying position. This did not meet our scheduled hours due to heavy weather delaying some of our site visits.

6.1 Project Impacts

6.1.1 Environmental Impacts

For positive impacts, group members determined that with accurate data analysis of how much the rigging can hold, NAU Campus Operations would not likely purchase materials such as that would be in excess of the riggings capacity, such as too many or too heavy lights. Therefore, there would be a positive environmental impact through resource and material conservation. There would also be a positive environmental impact if the rigging is loaded correctly. If the rigging is loaded correctly the lifespan of the rigging is fully utilized and extended, therefore, less repairs would need to be made, further increasing resource and material conservation. A negative environmental impact from this project would be to carry these loads suspension hangers would have to be used. The creation of this suspension hangers would require the production of steel which would negatively impact the environment.

Negative environmental impacts of this project is the vehicle emissions created to travel to the auditorium for multiple site visits. Additionally, if our client does decide to utilize this information and load these points, the creation of these loads will most likely consume an amount of fuel and create an amount of emissions that would contribute to environmental pollution.

6.1.2 Societal Impacts

Positive societal impacts would be that with the rigging being fully utilized, NAU Campus Operations would be able to maximize visual effects and performance by better making use of current equipment. With greater performances this would, theoretically, draw in my consumers and help create a larger theatre community and further culture the community on NAU's campus as well as the rest of Flagstaff. Another societal impact would be improving the safety of the rigging by knowing how much loading is safe and where the loading would cause the least amount of deformation. Knowing how much the rigging can load would reduce the likelihood of accidents or the rigging potentially breaking and hurting people. Another positive societal impact of optimizing loading would be the increase of labor required to manage these loads and set up. The creation of these jobs would help benefit the community as well as help more students or hired labor gain experience in this area of expertise.

A negative societal impact from this project would be the potential injury of employees hanging new loads, if NAU was to hang these additional proposed loads.

6.1.3 Economic Impacts

Positive economic benefits, drawing in more customers would drive up the profit margin for Prochnow Auditorium performances. Additionally, resource and material conservation would also mean less money spent on excessive materials would help save unnecessary costs. Knowing how the rigging should be loaded in order to reduce deflection and deformation would also reduce costs in rigging repairs for the future. Loading the rigging correctly will help utilize and expand the riggings serviceable life span.

A negative economic impact of optimizing loading would be the increase of labor required to manage these loads additional and set up. Creation of these jobs require more financial cost. Additionally, purchasing these future loads to be hung would be a negative economic impact

7.0 Summary of Engineering Costs

Table 9 displays the scheduled costs for the engineering services as well as the percent differences for the total cost and each roles cost. The costs are compared side by side with the scheduled costs initially list in the final proposal. The total costs proposed was $63,652, and the project went under budget coming in at $47,956.

Table 9: Summary of Engineering Costs

Scheduled					**Actual**	
1.0 Personnel	**Classification**	**Hours**	**Billing Rate $/hr**	**Cost**	**Cost**	**% Difference**
	SRE	90	$273	$24,570	$9,009	92.7%
	ENG	245	$120	$29,400	$29,400	0.0%
	DFT	120	$52	$6,240	$5,512	12.4%
	INT	60	$28	$1,680	$3,108	59.6%
	SUR	45	$33	$1,485	$660	76.9%
			Total	$63,652	$47,689	28.6%
2.0 Supplies	**Classification**	**Quantity**	**Cost per Quantity**	**Cost**	**Cost**	
	Hard Hats	4	$11 Each	$44	$44	
	Gloves	4	$12 Each	$48	$48	
	Software Use	1	$100	$100	$100	
	Measuring Tape	3	$25 Each	$75	$75	
3.0 Equipment	**Classification**	**Days**	**Billing Rate $/Day**			
	Scissor Lift (Rental)	0	$80	$0	$80	
4.0 Total				$63,652	$48,036	28.0%

The percent difference calculated for the total cost is 28% less than proposed. This is largely due to the shorter total hours. There were 515 completed hours of work for this project and 753 hours proposed. Additionally, the highest billing rate job, senior engineer, had a cut in hours that saw the largest individual role percent difference, 92.7%. Lower hours were worked as the structural analysis section and site visit section took significantly less time than predicted. Additionally, a scissor lift was not required by the project team. This in turn lowers the costs of engineering services.

8.0 Conclusion

Group members were asked to conduct a condition assessment of the rigging structure under current loads to analyze it's condition, current loads, and capacity. Group members were also requested to create as-built drawings for the structure. From this assessment group members were asked to model the structure in order to create a future loading plan to best load additional weight to the rigging. The client requested six places to load the structure.

The purpose of this project was met. A set of as-built drawings were created with accurate dimensions and specs of the rigging taken from measurements done by group members on site. The as-built drawings also listed load placements and member types. A model was created on Risa3D where loads and beam types were input. This model considered two load types, as well as a serviceability and ultimate load combination. From this information Risa3D was able to conduct a unity check to identify critical members and show theoretical deflections. From the information provided by this model group members were able to identify eight additional load placements where deflection and shear stress was minimized but where a sufficient amount of weight could be added. Since the auditorium is considered an historical building, the amount of weight loaded and its position on the structure would be determined through the criteria of critical members stresses not exceeding weight by an additional 5% per International Existing Building Code.

Group members found eight places where the rigging could bear a load of 2000 lbs each that did not affect the structural integrity of the structure and adhered to the International Existing Building Code's 5% weight rule. These loads added 1% to the unity check. In conclusion, the objectives of the project were met, adhered to the code, and satisfied the client's request. As-built drawings were created and are now accurate for any future project concerning Prochnow Auditorium rigging.

9.0 References

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[3] GLHN, "1994 Stage Rigging Renovation." Flagstaff, 26-May-1994.

[4] "ETC source Four par EA 575W with stage-pin (black, 115-240 VAC)," *B&H Photo Video Pro Audio*. [Online]. Available: https://www.bhphotovideo.com/c/product/435235-REG/ETC_7061A1006_0XB_Source_4_750W_EA.html. [Accessed: 01-Apr-2023].

[5] "Totally enclosed fan-cooled, rigid base mount, general purpose motor," *Grainger*. [Online]. Available: https://www.grainger.com/product/U-S-MOTORS-U-S-MOTORS-General-Purpose-23J864?gucid=N%3AN%3APS%3APaid%3AGGL%3ACSM-2295%3A4P7A1P%3A20501231&gclid=CjwKCAjw586hBhBrEiwAQYEnHcGDD-KUQLh_gnc9AxdnJcKVTY85FILlUI3RcPGCkAxGyN9-_rElIhoCx3IQAvD_BwE&gclsrc=aw.ds. [Accessed: 01-Apr-2023].

[6] AISC, *Steel construction manual*. Chicago, IL: American Institute of Steel Construction 2017.

[7] J. Espinoza, "Risa-3D 20.0 Model Outputs." Northern Arizona University, Flagstaff, 25-Apr-2023.

[8] I. C. Council, "Chapter 12: Historic Buildings," in *2018 International Existing Building Code*, International Code Council, 2017

[9] J. R. Portillo-Wightman and D. S. Merrell, "Meeting with David S. Merrell," Flagstaff, Apr. 26, 2023

[10] "Design Criteria Building Division - Coconino County, Arizona," Coconino County Arizona Community Development, https://coconino.az.gov/DocumentCenter/View/8134/Design-Criteria-?bidId= (accessed Apr. 23, 2023).

Appendix A: Loading Schedule:

LOADING SCHEDULE (ALL LIVE LOADs)							
Loading Cases		Number of Loads	Loading Case Specifics: Self Weight (lbs)	Loading Case Specifics: Capacity (lbs)	Total Weight (lbs)	No. of Chains	Total Weight @ Chains (kips)
Winch Loading		2	60	1300	2720	2	0.680
Batten Loading			Unit Weight (oz/yd)	Area (sqft)			
1	Valence Curtain	2	21	215	169.4	9	0.0188
2	Main Traveler Curtain	2	23	864.5	276.1	9	0.0307
3	1st Electric	4			254.0	9	0.0282
4	Projector Screen	1		1227	1059.0	2	0.5295
5	1st Border	2	21	215	169.4	9	0.0188
6	1st Side Leg	2	23	151.4	162.2	9	0.0180
7	General Purpose 1	0			138.0	9	0.0153
8	2nd Border	2	21	215	169.4	9	0.0188
9	2nd Side Leg	2	23	151.4	162.2	9	0.0180
10	2nd Electic	4			254.0	6	0.0423
11	General Purpose 2	0			138.0	6	0.0230
12	3nd Border	2	21	215	169.4	6	0.0282
13	3nd Side Leg	2	23	151.4	162.2	6	0.0270
14	3rd Electic w Light Boxes	3			254.0	6	0.0423
15	Cyclorama	1	23	554	226.5	6	0.0377
16	Commando Cloth Curtains	1	12	1227	240.2	6	0.0400
17	General Purpose	0			138.0	6	0.0230
					6862	**Total Weight**	**1.640**

Appendix A-2: Maintenance Instruction

PROCHNOW AUDITORIUM
FLAGSTAFF, AZ

JOB No. AZ 9424

MAINTENANCE INSTRUCTIONS
RIGGING HARDWARE

ITEM No.	IDENTIFICATION NAME	MANUFACTURER No.	DWG	MAINTENANCE INSTRUCTIONS
1	MOTOR WINCH BASE ASSEMBLIES	PROTECH	1	ANNUAL INSPECTION TO TIGHTEN NUTS PLUS VISUAL INSPECTION
2	8" DIA. DRUM	PROTECH	2	NONE REQUIRED
3	8" ø UNDERHUNG LOFT BLOCK	CLANCY No. 859	3	ANNUAL INSPECTION TO TIGHTEN NUTS PLUS VISUAL INSPECTION
4	BATTEN CLAMP	PROTECH	4	NONE REQUIRED
5	5/16" QUICK LINK	INDUSCO	5	--- *** ---
6	1/4" PROOF COIL CHAIN	INDUSCO	5	--- *** ---
7	MOTOR CONTROL STATION	CLANCY	6	--- *** ---
8	UNISTRUT	UNISTRUT	CAT 1 & 8	ANNUAL INSPECTION FOR SIGN OF DEFLECTION
9	LIFT LINE 3/16" CABLE	FEHR BROTHERS	CAT 2	ANNUAL INSPECTION FOR SIGN OF WEAR
10	3/8 x 6" TURNBUCKLE	FEHR BROTHERS	CAT 3	ANNUAL INSPECTION TO TIGHTEN NUTS PLUS VISUAL INSPECTION
11	3/16" OVAL SLEEVE	FEHR BROTHERS	CAT 4	NONE REQUIRED
12	HEAVY DUTY TRACK	H&H # 400	CAT 9 & 10	ANNUAL INSPECTION OF HAND LINE FOR SIGN OF WEAR
13				
14				

Appendix A-3: Batten Product Data

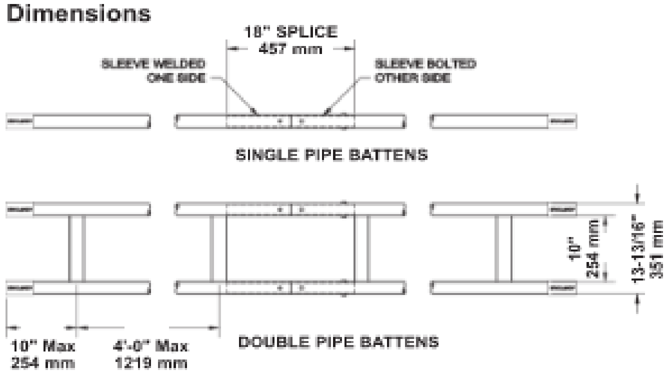
TECHNICAL SHEET

Battens

- Battens are made from seamless pipe and are supplied with a matte black finish.
- Battens up to 21' (6.4 m) long are supplied as a single piece; longer battens are provided with 18" (457 mm) long internal splice sleeves.
- Standard 1-1/2" (38 mm) battens are provided with safety yellow vinyl end caps, making the batten ends easier to see.
- Two pipe ladder trusses are constructed from two 1-1/2" (38 mm) sch 40 pipes with flat bar spacers on 4' (1.219 m) centers. Other special constructions are available, consult factory.

Batten
015-67R

Dimensions



Order Information

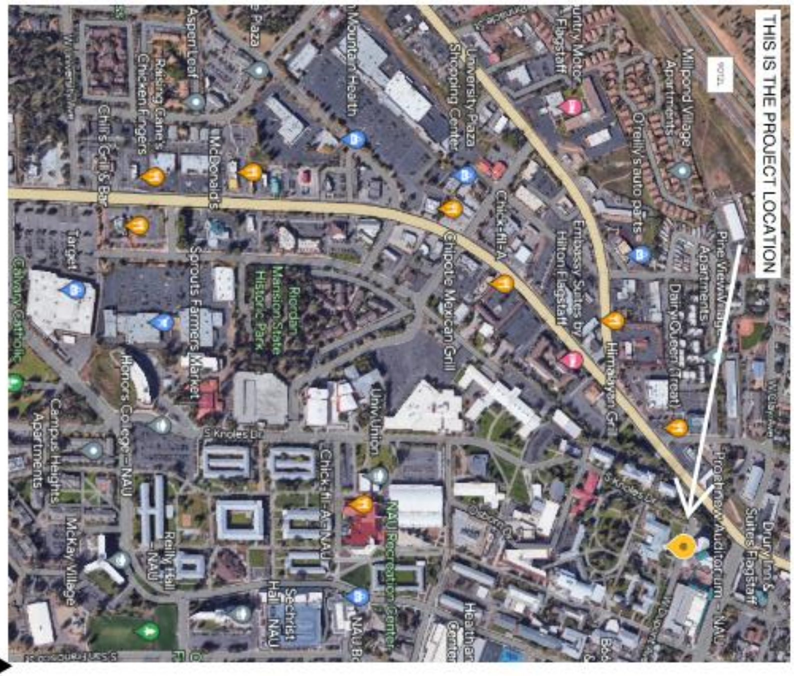
Number	Description	I.D.	O.D.	Weight
015-67R	1-1/2" (38 mm) Sch 40 batten	1.610" (40.9 mm)	1.900" (48.26 mm)	3 lbs./ft. (4.45 kg/m)
015-67H	1-1/2" (38 mm) Sch 80 batten	1.500" (38 mm)	1.900" (48.26 mm)	4 lbs./ft. (5.9 kg/m)
015-68R	2" (51 mm) Sch 40 batten	2.067" (52.5 mm)	2.375" (60.325 mm)	4 lbs./ft. (5.9 kg/m)
015-69R	2-1/2" (64 mm) Sch 40 batten	2.469" (62.7 mm)	2.875" (73.025 mm)	6 lbs./ft. (8.9 kg/m)
015-67T	Two pipe truss batten	1.610" (40.9 mm)	1.900" (48.26 mm)	7 lbs./ft. (10.4 kg/m)
015-67S	1-1/2" (38 mm) Batten sleeve, no holes, 18" long (457 mm)	–	–	3 lbs. (1.3 kg)
015-68S	2" (51 mm) Batten sleeve, no holes, 18" long (457 mm)	–	–	4 lbs. (1.8 kg)
015-69S	2-1/2" (64 mm) Batten sleeve, no holes, 18" long (457 mm)	–	–	9 lbs. (4 kg)
099-BATCAP	Yellow batten end caps, 4" (102 mm) long	–	–	0.1 lb. (0.04 kg)

WENGER CORPORATION Phone 800.4WENGER (493-6437) Worldwide +1.507.455.4100 | Fax 507.455.4258 Worldwide +1.507.774.8576
Parts & Service 800.887.7145 | Canada Office 800.268.0148 | Web wengercorp.com | 555 Park Drive, PO Box 448 | Owatonna | MN 55060-0448

JR CLANCY Phone 800.836.1885 Worldwide +1.315.451.3440 | Fax 877.836.1885 Worldwide +1.315.451.1766 | Web jrclancy.com
7041 Interstate Island Road | Syracuse | NY 13209-9713

GEARBOSS Phone 800.493.6437 | email gearboss@wengercorp.com | Web gearboss.com | 555 Park Drive, PO Box 448 | Owatonna | MN 55060-0448

Appendix B: Cover Sheet



PROCHNOW AUDITORIUM - PROJECT SITE PLAN

NOT TO SCALE

N

PROCHNOW AUDITORIUM
STAGE RIGGING
AS BUILT DRAWINGS

CONSULTANT:

O A T ENGINEERING
STRUCTURAL ENGINEERING FIRM
2112 S Huffer Ln, Flagstaff, AZ 86011

PROJECT SCOPE OF WORK:

The purpose of this project is to analyze the existing rigging above the stage at the Prochnow Auditorium. Our team will inspect, model, and analyze the existing rigging to determine the loading limits so the client knows where and how much load they can apply for future use.

SHEET INDEX:

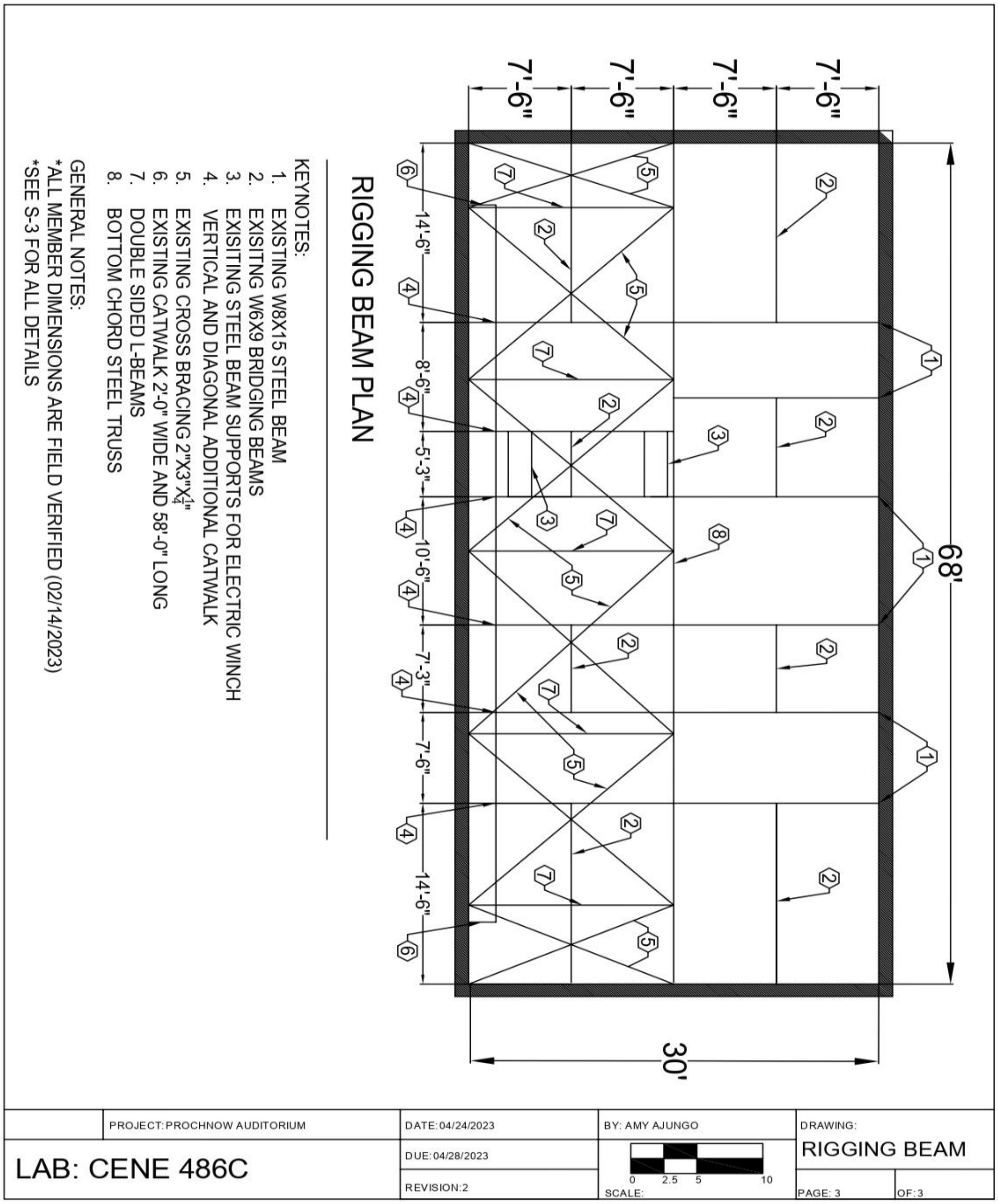
G-1 COVER SHEET
S-1 I BEAM STAGE RIGGING PLAN VIEW
S-2 SECONDARY STAGE ROD RIGGING PLAN VIEW
S-3 CONNECTION DETAILS

CENE 486C
DRAWN BY: AMY AJUNGO
DATE 03/20/2023
CHECKED BY: JOSE ESPINOZA, JUSTIN PORTILLO-WHITEMAN, THEO QUAX

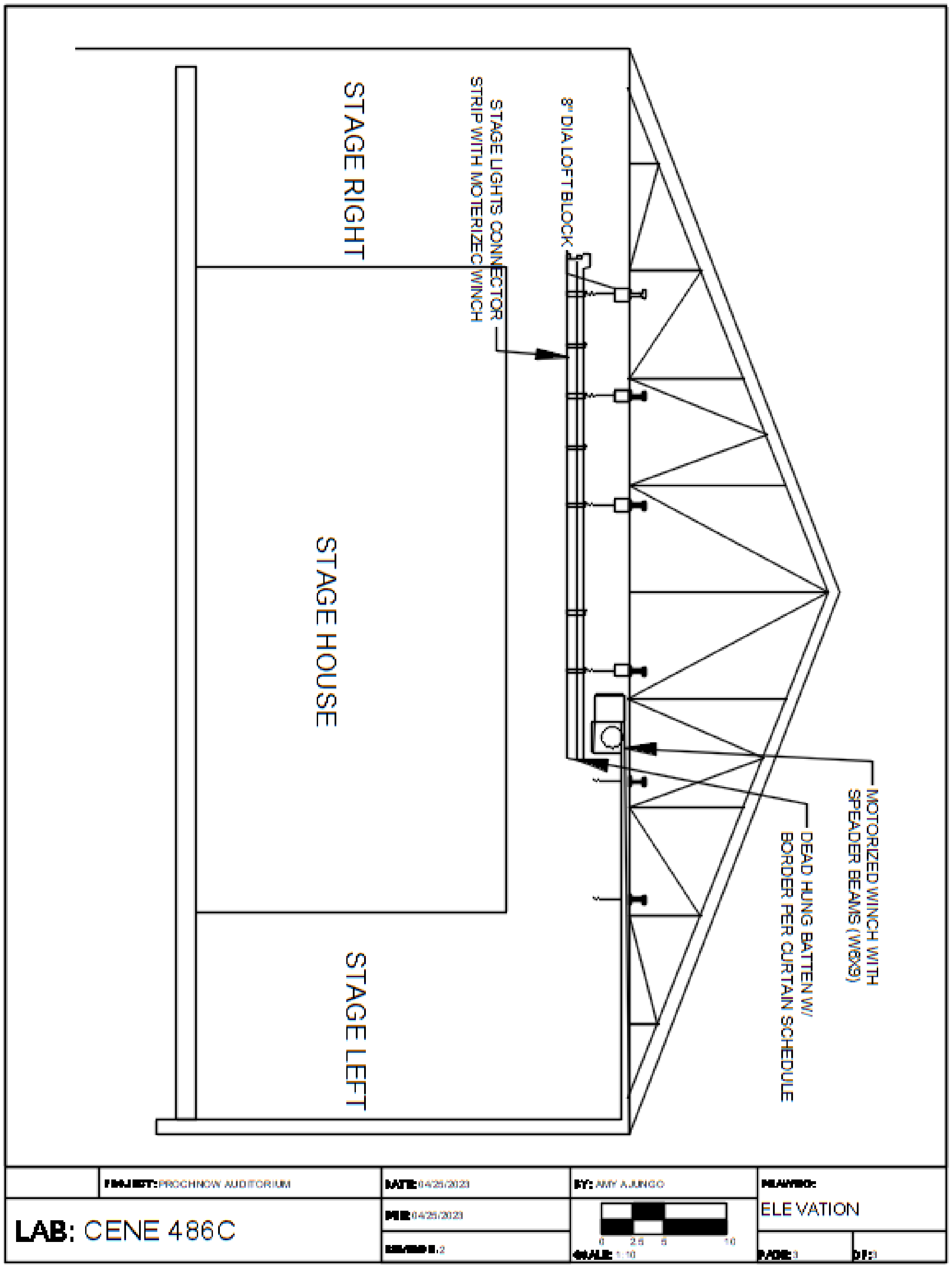
PROCHNOW AUDITORIUM
STAGE RIGGING AS BUILT DRAWINGS

G-1
COVER SHEET

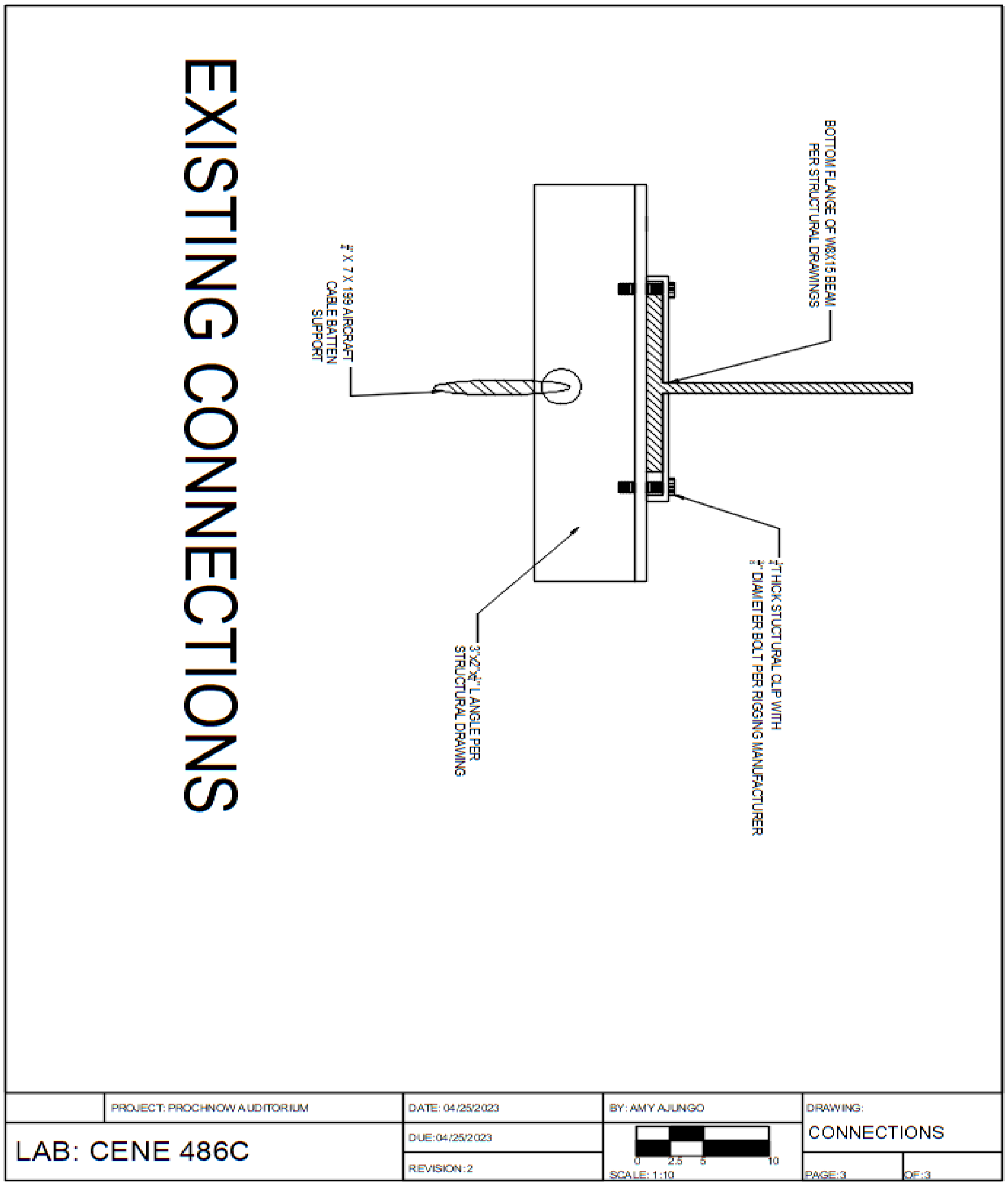
Appendix B-2: Plan View of Rigging



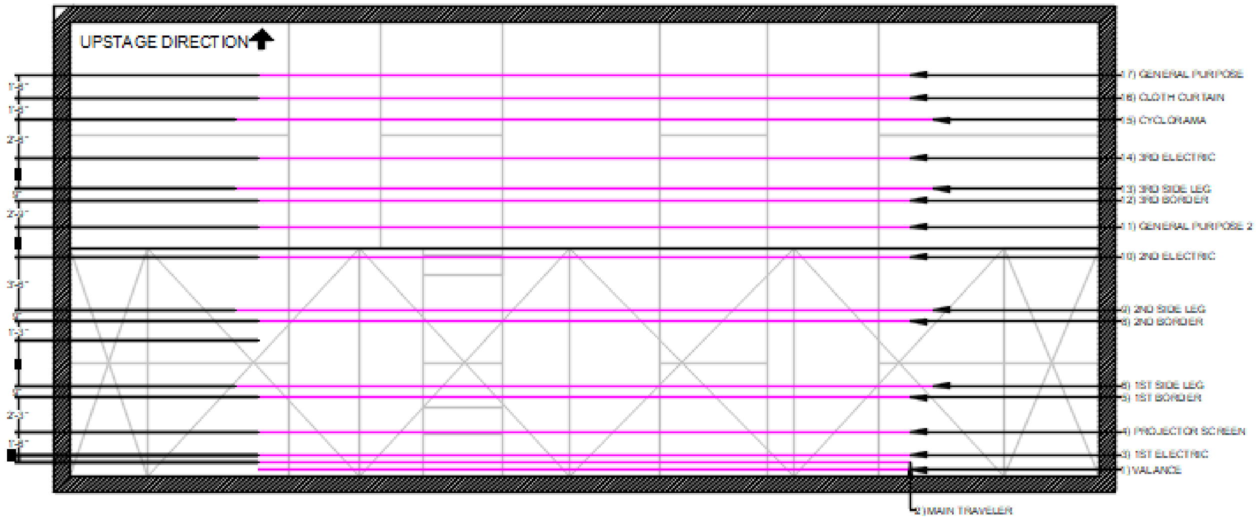
Appendix B-3: Elevation View



Appendix B-4: Existing Conditions for Battens



JAT
Structural Engineering Firm



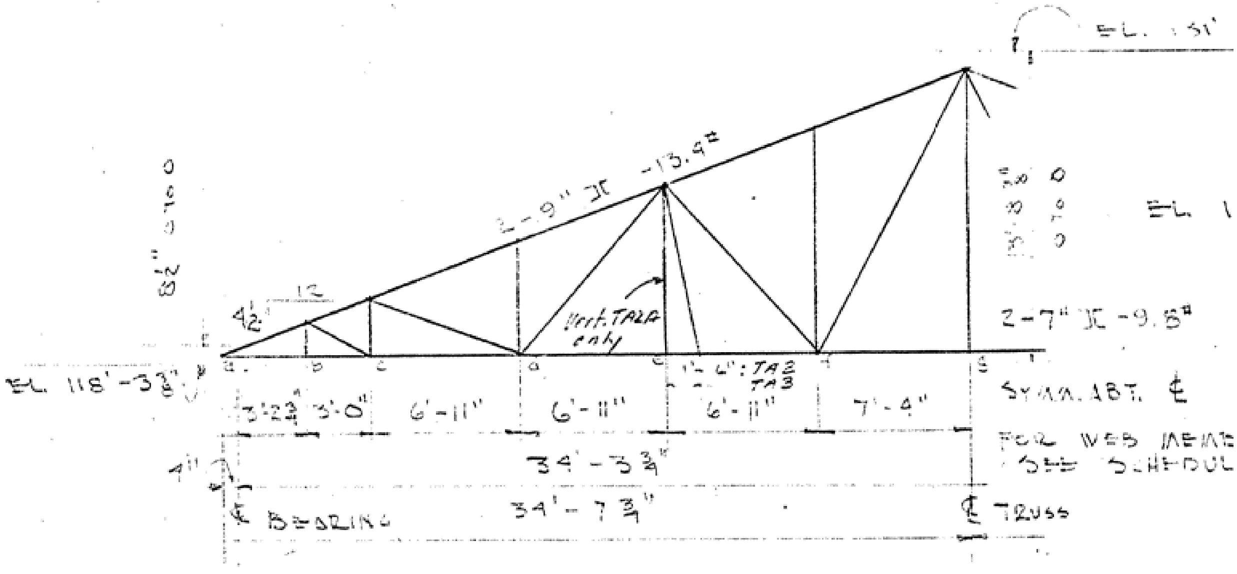
BATTEN LINE SET PLAN

CURTIN SCHEDULE				
CURTAIN LABEL	DESCRIPTION	LINESET	HEIGHT	WIDTH
A	VALANCE	1	5'-0"	43'-0"
B	MAIN TRAVELER	2	22'-2" (2)	6'-10" (2)
C	1st BORDER	4	5'-0"	43'-0"
D	1ST SIDE LEG	5	22'-2" (2)	6'-10" (2)
E	2ND BORDER	8	5'-0"	43'-0"
F	2ND SIDE LEG	9	22'-2" (2)	6'-10" (2)
G	3RD BORDER	12	5'-0"	43'-0"
H	3RD SIDE LEG	13	22'-2" (2)	6'-10" (2)
J	CYCLORAMA	15	22'-2"	43'-0"
K	CLOTH CURTAIN	16	22'-2"	43'-0"

RIGGING SCHEDULE				
LINESET	DESCRIPTION	BATTEN LENGTH	DISTANCE FROM PROSCENIUM	CURTAIN LABEL
1	VALANCE	43'-0"	6"	A
2	MAIN TRAVELER	43'-0"	1'-0"	B
3	1ST ELECTRIC	43'-0"	1'-6"	
4	PROJECTOR SCREEN	43'-0"	3'-0"	C
5	1st BORDER	43'-0"	5'-3"	D
6	1ST SIDE LEG	46'-0"	6'-0"	
7	GENERAL PURPOSE 1	43'-0"	9'-0"	E
8	2ND BORDER	43'-0"	10'-3"	F
9	2ND SIDE LEG	46'-0"	11'-0"	
10	2ND ELECTRIC	43'-0"	14'-6"	
11	GENERAL PURPOSE 2	43'-0"	16'-6"	
12	3RD BORDER	43'-0"	18'-3"	G
13	3RD SIDE LEG	46'-0"	19'-0"	H
14	3RD ELECTRIC	43'-0"	21'-0"	
15	CYCLORAMA	46'-0"	23'-6"	J
16	CLOTH CURTAIN	43'-0"	25'-0"	K
17	GENERAL PURPOSE 3	43'-0"	26'-6"	

PROJECT: PROCHNOW AUDITORIUM	DATE: 04/25/2023	BY: AMY AJUNGO	DRAWING NO:
LAB: CENE 486C	DUE: 04/25/2023	0 2.5 5 10	BATTEN LINESET
	REVISION: 2	SCALE: 1:10	PAGE: 3 OF: 3

Appendix C: Truss TA2 Member Schedule



TRUSS TA2, TA3, TA-2A

		TRUSS TA1					TRUSS TA2, TA-2A				
	MEMBER	SIZE	WELD	e	h	t	SIZE	WELD	e	h	t
DIAGONALS	c - d	2 TT 2½ x 2 x ¼	3/16	2	2	1	2 TT 2½ x 2 x ¼	3/16	2	2	1
	d - e	2 TT 2 x 1½ x ¼	3/16	—	3½	1¾	2 TT 2 x 1½ x ¼	3/16		3½	1¾
	e - f	2 TT 3½ x 2½ x ¼	3/16	3	2½	1¼	2 TT 3½ x 2½ x ¼	3/16	3	2	1
	f - g	2 TT 2½ x 2 x ¼	3/16	—	6½	3	2 TT 2½ x 2 x ¼	3/16		5¼	2½
VERTICALS	b	2-3"][- 4.1#	3/16	SEE DETAIL			2-3"]s - 4.1#	SEE DETAIL			
	c	do	3/16	SEE DETAIL			2-3"]s - 4.1#	SEE DETAIL TA1			
	d	2 TT 2½ x 1½ x ¼	3/16	2	2	1	2 TT 2½ x 1½ x ¼	3/16	2	2	1
	e	2 Ls 1¼ x 1¼ x 3/16	1/8	—	2	1	2 Ls 1¼ x 1¼ x 3/16	1/8		2	1
	f	2 TT 3½ x 2½ x ¼	3/16	3	2	1	2 TT 3½ x 2½ x ¼	3/16	3	2	1
	g	2 Ls 1¾ x 1¾ x 3/16	1/8	—	3	1½	2 Ls 1¾ x 1¾ x 3/16	1/8		2	1

Appendix D: Scheduled Hour Log vs Actual Hour Log

Scheduled						Actual					
Task	DFT	INT	SRE	ENG	SUR	Task	DFT	INT	SRE	ENG	SUR
Task 1.0 Plan Review	0	20	5	48	30	Task 1.0 Plan Review	0	26	4	27	0
Task 1.1 Analyze Existing Rigging Plans and Specifications	0	10	0	10	20	Task 1.1 Analyze Existing Rigging Plans and Specifications	0	7	4	13	0
Task 1.2 Code Review	0	5	0	20	0	Task 1.2 Code Review	0	2	0	1	0
Task 1.3 Create Master Set of Plans	0	0	0	5	0	Task 1.3 Create Master Set of Plans	0	6	0	7	0
Task 1.4 Plan For Site Visit	0	0	0	3	0	Task 1.4 Plan For Site Visit	0	11	0	6	0
Taks 1.4.1 Create Safety Plan	0	0	0	1	0	Taks 1.4.1 Create Safety Plan	0	3	0	2	0
Task 1.4.2 Access to Site	0	0	0	1	0	Task 1.4.2 Access to Site	0	5	0	3	0
Task 1.4.3 Rent Equipment	0	3	0	1	0	Task 1.4.3 Rent Equipment	0	3	0	1	0
Task 2.0 Site Visit	0	15	0	35	65	Task 2.0 Site Visit	0	3	0	27	12
Task 2.1 Take Photographs	0	5	0	5	5	Task 2.1 Take Photographs	0	3	0	3	3
Task 2.2 Measurement Procedure	0	5	0	10	30	Task 2.2 Measurement Procedure	0	0	0	12	3
Task 2.3 Identify Existing Loads on Rigging	0	5	0	20	30	Task 2.3 Identify Existing Loads on Rigging	0	0	0	12	6
Task 3.0 Structural Analysis	120	25	40	170	0	Task 3.0 Structural Analysis	106	13	24	85	8
Task 3.1 Classify and Document Potential Dead & Live Loads	20	5	5	35	0	Task 3.1 Classify and Document Potential Dead & Live Loads	4	0	0	3	0
Task 3.2 Create a 3D Model & Analyze	60	5	5	10	0	Task 3.2 Create a 3D Model & Analyze	50	2	0	2	0
Task 3.3 As-built Built Drawings and Load Map	40	5	10	15	0	Task 3.3 As-built Built Drawings and Load Map	30	5	0	60	0
Task 3.4 Assess Results of Analysis	0	5	10	45	0	Task 3.4 Assess Results of Analysis	20	0	4	20	0
Task 3.5 Identify Optimal Load Placements	0	5	10	65	0	Task 3.5 Identify Optimal Load Placements	2	6	20	0	8
Task 4.0 Project Impacts	0	0	5	5	0	Task 4.0 Project Impacts	0	0	5	5	0
Task 5.0 Project Deliverables	0	65	0	65	0	Task 5.0 Project Deliverables	0	65	0	65	0
Task 5.1 30% Deliverable	0	15	0	15	0	Task 5.1 30% Deliverable	0	15	0	15	0
Task 5.2 60% Deliverable	0	20	0	20	0	Task 5.2 60% Deliverable	0	20	0	20	0
Task 5.3 90% Deliverable	0	25	0	25	0	Task 5.3 90% Deliverable	0	25	0	25	0

Scheduled						Actual					
Task	**DFT**	**INT**	**SRE**	**ENG**	**SUR**	**Task**	**DFT**	**INT**	**SRE**	**ENG**	**SUR**
Task 5.4 Final Deliverable	0	5	0	5	0	Task 5.4 Final Deliverable	0	5	0	5	0
Task 6.0 Project Management	0	4	0	36	0	**Task 6.0 Project Management**	0	4	0	36	0
Task 6.1 Meetings	0	0	0	32	0	Task 6.1 Meetings	0	0	0	32	0
Task 6.2 Schedule	0	4	0	0	0	Task 6.2 Schedule	0	4	0	0	0
Task 6.3 Resource Management	0	0	0	4	0	Task 6.3 Resource Management	0	0	0	4	0
Total	120	129	50	359	95	Total	106	111	33	245	20