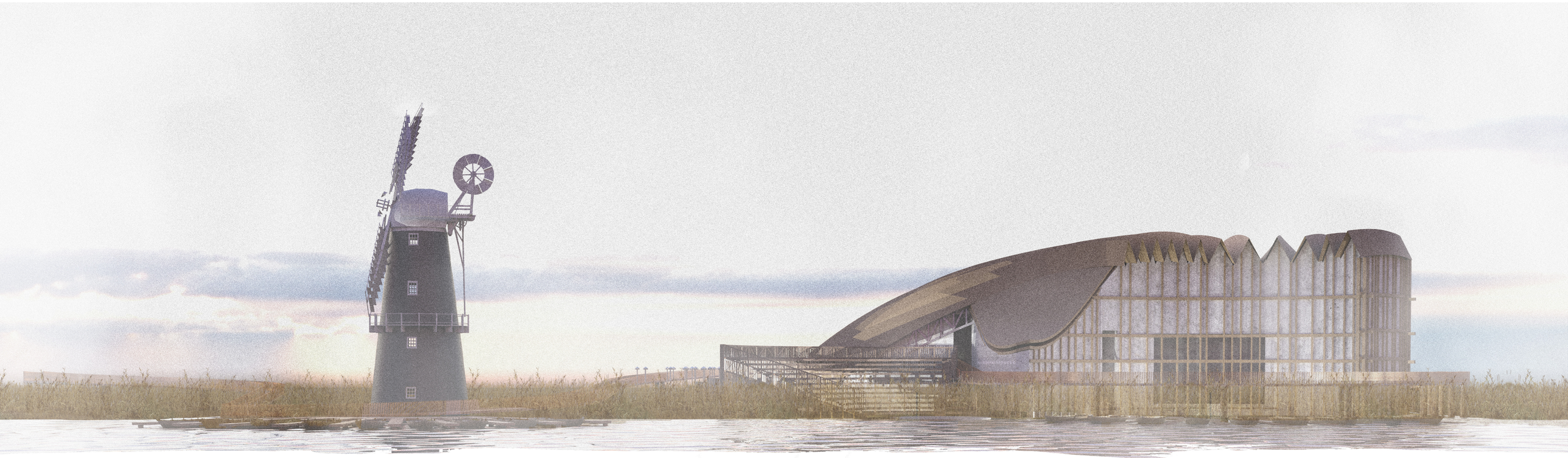
ECHOES OF THE YARE

AN IMMERSIVE THEATRICAL EXPERIENCE

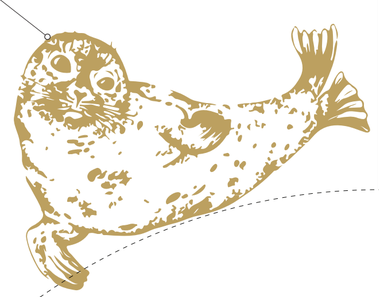




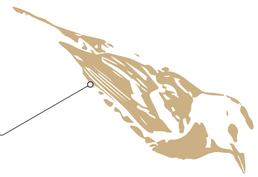

YORK ROAD

STUDYING THE SEASONALITY OF NORFOLKS BIRDS AND VEGETATION

GREY SEALS HAVE THEIR BABIES AND NURSE THEM BY THE SHORE



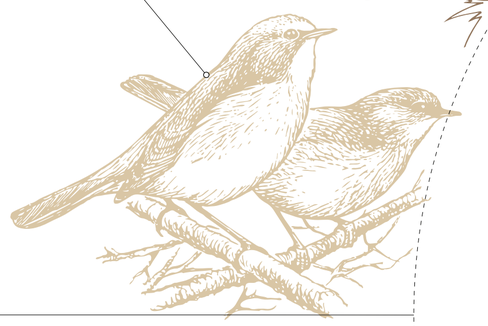
RARE WARBLERS



MUSHROOMS AND TOAD STOOLS



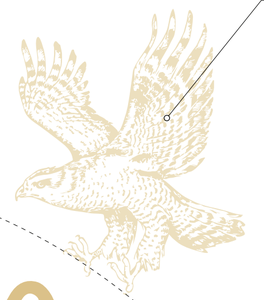
RED FLANKED BLUE TAILS



BRITAIN'S LARGEST BUTTERFLY, SWALLOWTAIL



MARSH HARRIER



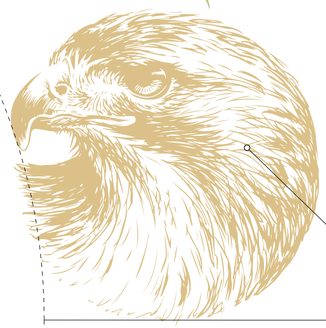
PURPLE SEA LAVENDER

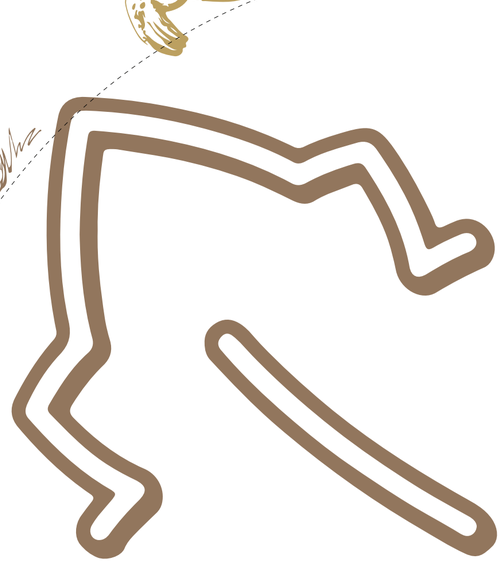


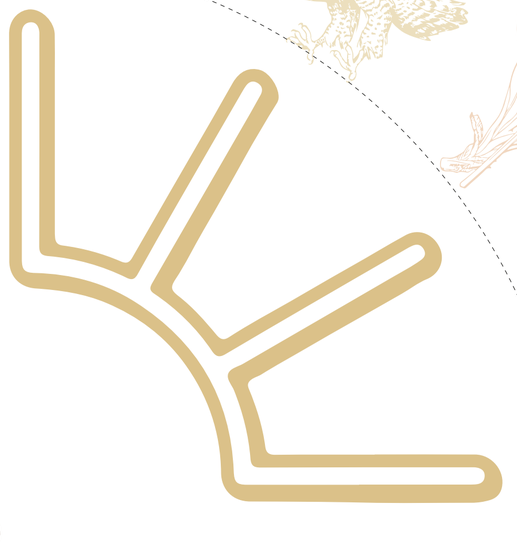
SWALLOWTAIL



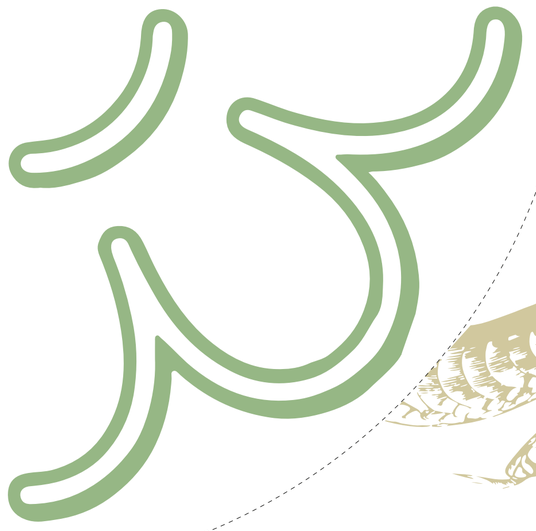
THE WHITE CLAWED, NATIVE CRAYFISH



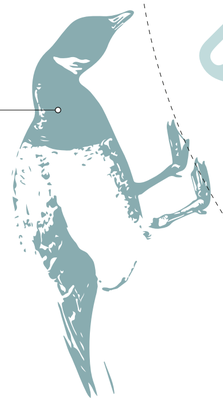








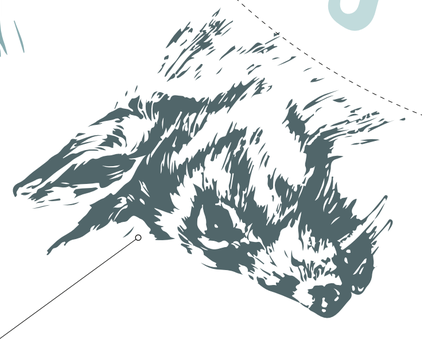
DARK BELLIED BRENT GOOSE



WATERFOWL



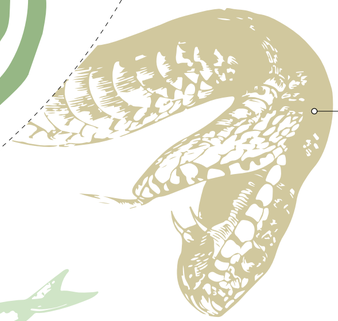
CHINESE WATER DEER



DAMSELFLIES, FLY CLOSE TO THE WATER SURFACE



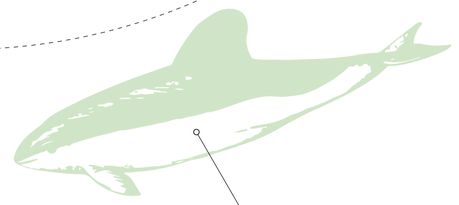
ADDER, BRITAIN'S ONLY VENOMOUS SNAKE



MIGRATING SWALLOWS



ELUSIVE HARBOUR PORPOISE



ECHOES OF THE YARE: AN IMMERSIVE THEATRICAL EXPERIENCE



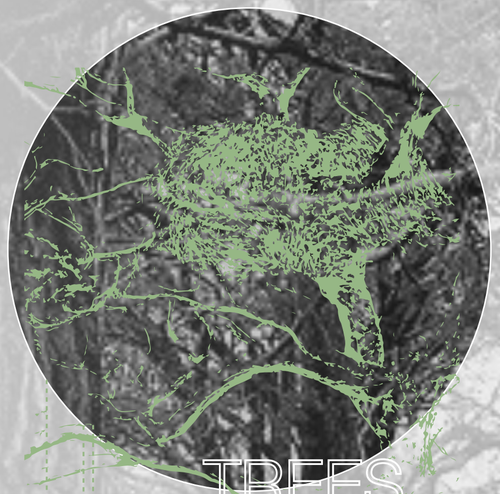








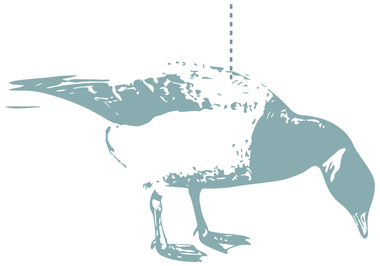




TREES



MARSHES







ROOTS



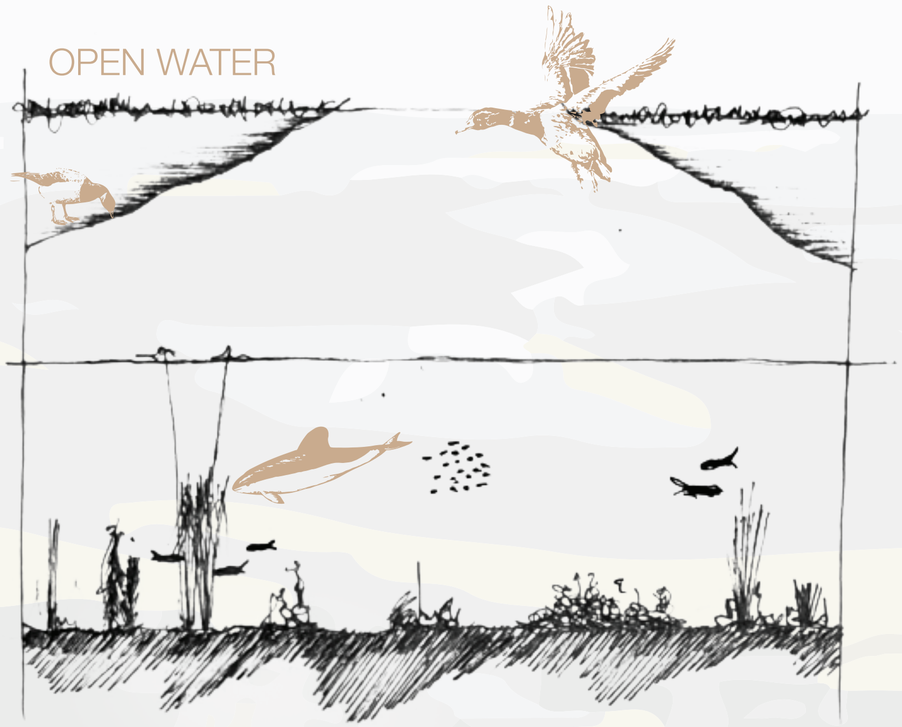






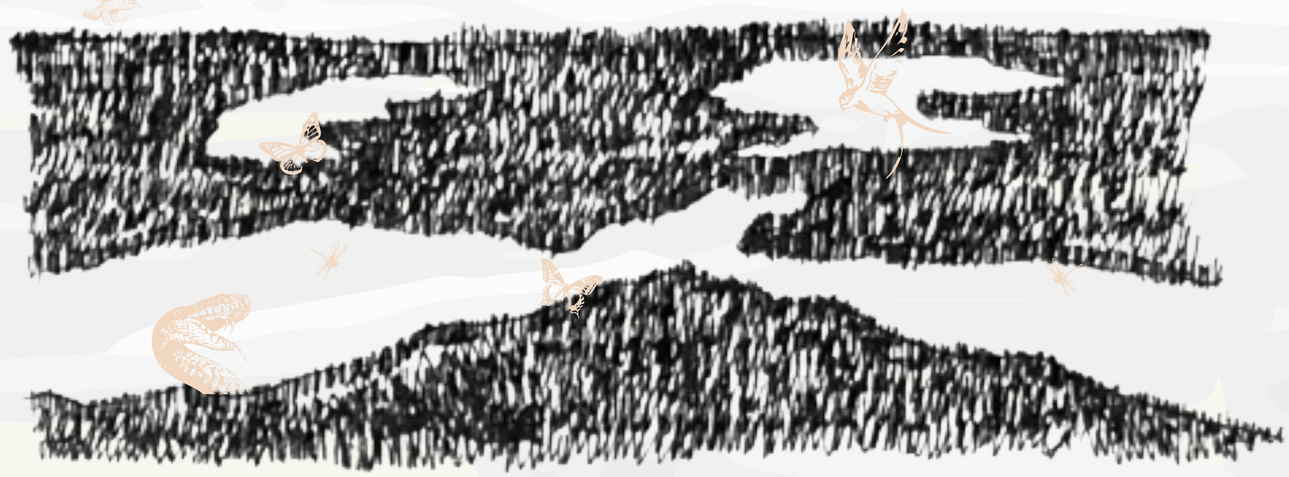
HABITATS

OPEN WATER



OPEN WATER AREAS WITHIN MARSHES ARE DEEPER SECTIONS OF RIVERS, LAKES, OR PONDS. THEY MAY HAVE VARYING DEPTHS AND WATER FLOW RATES. FISH, WATERFOWL, AND AQUATIC INVERTEBRATES ARE COMMONLY FOUND IN OPEN WATER.

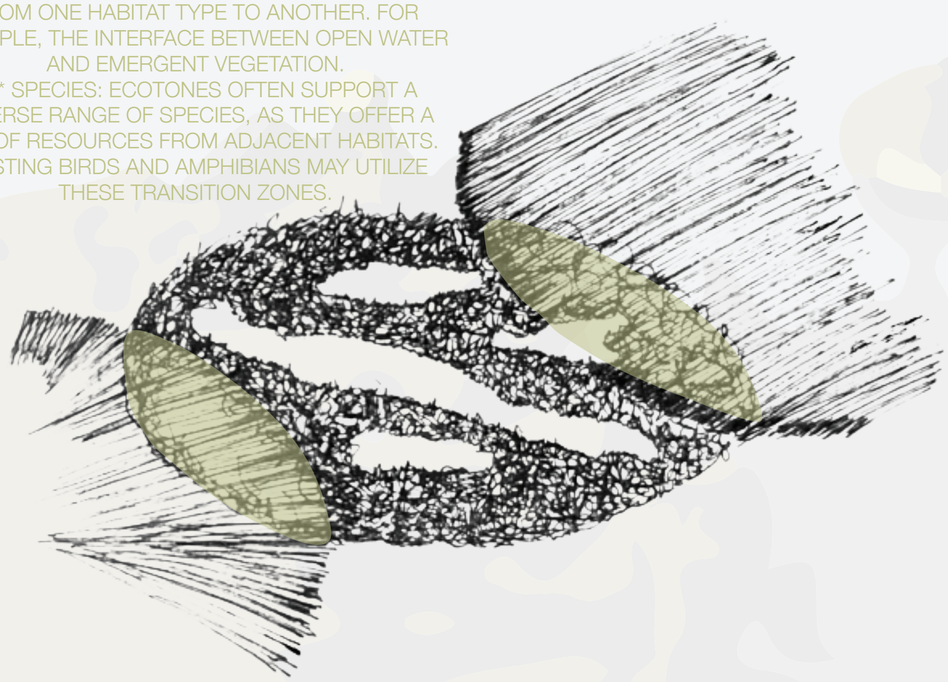
MUDFLATS AND SHALLOW WATER ZONES



AREAS WITH SHALLOW WATER AND EXPOSED MUD DURING LOW WATER LEVELS. MUDFLATS ARE IMPORTANT FORAGING GROUNDS FOR CERTAIN BIRD SPECIES. WADING BIRDS FEED ON SMALL FISH, INVERTEBRATES, AND INSECTS FOUND IN THESE ZONES.

TRANSITION ZONES - ECOTONES

AREAS WHERE DIFFERENT ECOLOGICAL COMMUNITIES MEET, CREATING A TRANSITION FROM ONE HABITAT TYPE TO ANOTHER. FOR EXAMPLE, THE INTERFACE BETWEEN OPEN WATER AND EMERGENT VEGETATION.
* SPECIES: ECOTONES OFTEN SUPPORT A DIVERSE RANGE OF SPECIES, AS THEY OFFER A MIX OF RESOURCES FROM ADJACENT HABITATS. NESTING BIRDS AND AMPHIBIANS MAY UTILIZE THESE TRANSITION ZONES.

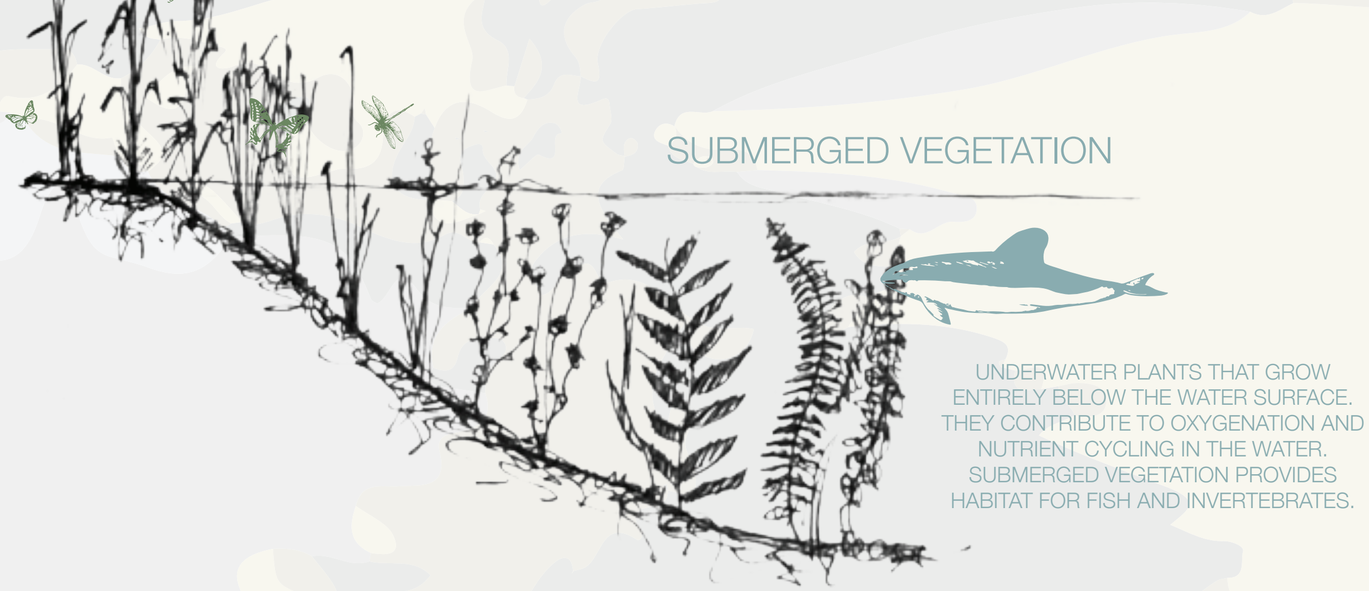


EMERGENT VEGETATION



THESE ARE AREAS WHERE PLANTS HAVE ADAPTED TO GROW PARTIALLY SUBMERGED IN WATER. EMERGENT VEGETATION INCLUDES REEDS, CATTAILS, AND BULRUSHES. BIRDS LIKE MARSH HARRIERS OFTEN NEST IN EMERGENT VEGETATION. INSECTS, AMPHIBIANS, AND SMALL MAMMALS FIND SHELTER AND BREEDING SITES IN THESE AREAS.

SUBMERGED VEGETATION



UNDERWATER PLANTS THAT GROW ENTIRELY BELOW THE WATER SURFACE. THEY CONTRIBUTE TO OXYGENATION AND NUTRIENT CYCLING IN THE WATER. SUBMERGED VEGETATION PROVIDES HABITAT FOR FISH AND INVERTEBRATES.

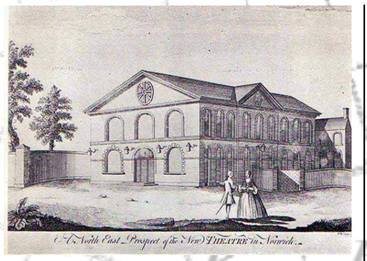
HISTORY OF THE THEATRE IN NORFOLK

EARLY 15TH CENTURY



ST. GEORGE'S GUILDHALL, KING'S LYNN: ORIGINALLY A MEDIEVAL GUILDHALL, IT BECAME A VENUE FOR EARLY THEATRICAL PERFORMANCES.

LATE 15TH CENTURY



THE THEATRE ROYAL, NORWICH: THE ORIGINAL THEATRE ROYAL WAS BUILT, SHOWCASING A MIX OF DRAMA, MUSIC, AND DANCE.

1758

NORWICH GUILDHALL: ANOTHER GUILDHALL THAT LIKELY HOSTED EARLY THEATRICAL EVENTS.



19TH CENTURY



NORWICH CASTLE GARDENS: OPEN-AIR PERFORMANCES AND EVENTS WERE HELD IN THE GARDENS, CONTRIBUTING TO THE DIVERSITY OF THEATRICAL EXPERIENCES.

1903



THE HIPPODROME, GREAT YARMOUTH: ESTABLISHED BY CIRCUS SHOWMAN GEORGE GILBERT, THE HIPPODROME FEATURED A UNIQUE COMBINATION OF CIRCUS AND VARIETY ACTS.





MADDERMARKET THEATRE, NORWICH: ESTABLISHED BY NUGENT MONCK, IT AIMED TO REVIVE ELIZABETHAN-STYLE THEATRE AND PROMOTE LOCAL TALENT.

1921

NORFOLK AND NORWICH FESTIVAL: AN ANNUAL ARTS FESTIVAL FEATURING A WIDE ARRAY OF PERFORMANCES, EXHIBITIONS, AND EVENTS HELD ACROSS NORFOLK.



1957

SHERINGHAM LITTLE THEATRE: A COMMUNITY-FOCUSED THEATRE IN NORTH NORFOLK HOSTING A RANGE OF PRODUCTIONS, INCLUDING PLAYS, MUSICALS, AND FILMS.



1960s

NORWICH PLAYHOUSE: THE VENUE, A FORMER MALTINGS BUILDING, BECAME A VIBRANT SPACE FOR DRAMA, COMEDY, AND MUSIC.



1995

THE FORUM, NORWICH: WHILE NOT ORIGINALLY A THEATRE, THE FORUM BECAME A CULTURAL HUB HOSTING VARIOUS EVENTS, INCLUDING PERFORMANCES AND FESTIVALS.



2001

2007

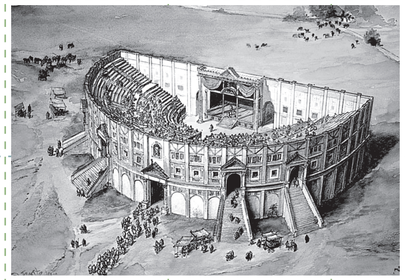
WELLS MALTINGS, WELLS-NEXT-THE-SEA: THE RENOVATED MALTINGS COMPLEX SERVES AS A CULTURAL HUB, HOSTING THEATRICAL PERFORMANCES AND COMMUNITY EVENTS.

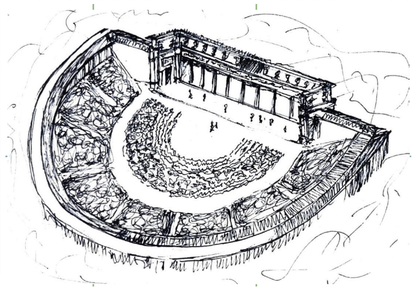


2018

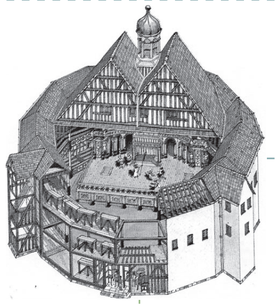
NORWICH THEATRE ROYAL (NEW BUILDING): A NEW BUILDING FOR THE THEATRE ROYAL WAS OPENED, ENHANCING ITS FACILITIES AND CONTINUING THE TRADITION OF HOSTING DIVERSE PERFORMANCES.

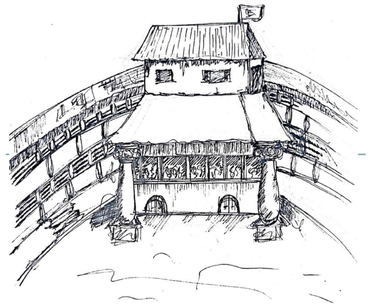






THE FIRST BUILDINGS USED FOR THEATRICAL PERFORMANCES IN BRITAIN WERE AMPHITHEATRES INTRODUCED BY THE ROMANS, WHO COPIED THEATRES FROM ANCIENT GREECE. THESE WERE SEMI-CIRCULAR STRUCTURES, CONSTRUCTED OF WOOD INITIALLY AND LATER STONE. THEY WERE OPEN TO THE AIR WITH BANKED SEATING SURROUNDING A RAISED STAGE.





MEDIEVAL THEATRE WAS PRESENTED ON ELABORATE TEMPORARY STAGES INSIDE GREAT HALLS, BARNS, OR IN THE OPEN COURTYARDS OF GALLERIED INNS. IT WAS FROM THESE THAT ELIZABETHAN TIMBER-FRAMED OPEN-AIR THEATRES TOOK THEIR FORM. THEY WERE OFTEN MULTI-SIDED BUILDINGS, WITH A COVERED PLATFORM STAGE AGAINST ONE SIDE. THE AUDIENCE SAT OR STOOD IN COVERED GALLERIES AROUND THE OTHER SIDES OR IN THE OPEN COURTYARD. ALL THE PERFORMANCES TOOK PLACE IN DAYLIGHT.

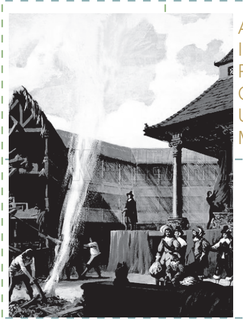


INTEREST IN THEATRE INCREASED DURING THE 17TH CENTURY AND MANY RICH COURTIERS AND ARISTOCRATS HOSTED TOURING THEATRICAL PRODUCTIONS IN THEIR HOMES.

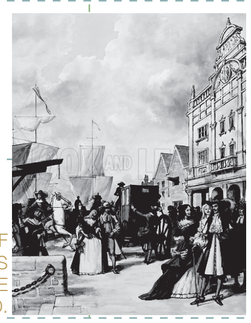
MASQUES BECAME A POPULAR FORM OF RECREATION FOR THE ROYAL COURT AND THE VERY RICH, OFTEN COMMISSIONED FOR CELEBRATIONS. THEY WOULD INVOLVE MUSIC, DANCE AND ELABORATE COSTUMES AND SCENERY.



THE ARCHITECT INIGO JONES DEVISED THE SETS FOR SEVERAL ROYAL MASQUES, AND LATER WENT ON TO DESIGN THEATRE BUILDINGS. HE HAD TOURED ITALY AND FRANCE AND WAS HEAVILY INFLUENCED BY THEIR DESIGNS. HE IS ALSO ATTRIBUTED WITH INTRODUCING THE FIRST PROSCENIUM ARCH – A DECORATIVE ARCHITECTURAL FRAME OVER A THRUST STAGE.



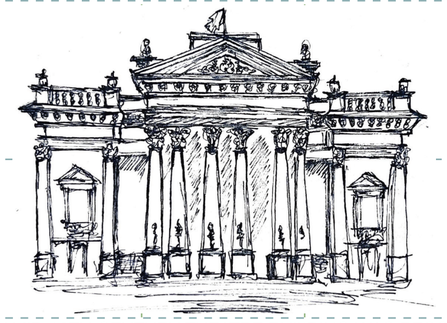
AFTER THE EXECUTION OF CHARLES I IN 1642, THEATRICAL PERFORMANCES WERE OUTLAWED OWING TO THE THREAT OF CIVIL UNREST. THEATRES CLOSED AND MANY WERE DEMOLISHED.



FOLLOWING THE RESTORATION OF THE MONARCHY TWENTY YEARS LATER, INTEREST IN THEATRE RESUMED.



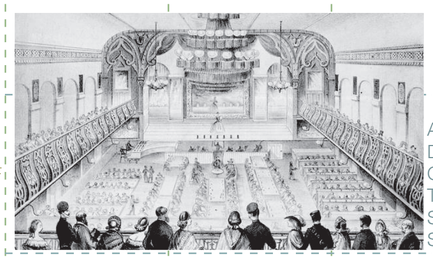
THE KING ISSUED PATENTS TO LONDON THEATRES. THEATRE BUILDINGS BEGAN TO CHANGE, INFLUENCED BY EUROPE. THEY WERE ROOFED, WITH STAGES FOR CHANGEABLE SCENERY THAT WAS SLID INTO POSITION USING GROOVES IN THEIR FLOORS. OTHER SCENERY WAS FLOWN IN FROM ABOVE. TO ACCOMMODATE THESE ELABORATE STAGE SETS MORE SPACE WAS NEEDED BEHIND THE STAGE.



A SERIES OF ROYAL PATENTS WERE GRANTED TO CITIES OUTSIDE LONDON. THESE BECAME KNOWN AS “THEATRES ROYAL” BUILT IN A RESTRAINED NEO-CLASSICAL STYLE.



THEATRES HAD MAINLY WOODEN INTERIORS WHICH CAUSED RISK OF FIRE. THE DRURY LANE THEATRE, LONDON INTRODUCED THE FIRST IRON SAFETY CURTAIN, WHICH WOULD EVENTUALLY BECOME A STATUTORY REQUIREMENT IN ALL LARGE THEATRES. IT ALSO HAD A LARGE WATER TANK ON ITS ROOF – A FEATURE THAT WAS ADOPTED BY OTHER THEATRES – TO EXTINGUISH FIRE IN THE STAGE AREA.



A SPECIFIC TYPE OF THEATRE BUILDING WAS DEVELOPED TO CATER FOR THIS NEW FORM OF ENTERTAINMENT, CALLED A MUSIC HALL. THEY HAD FEWER TABLES IN FRONT OF THE STAGE, USING THE SPACE FOR BENCHED SEATING TO ACCOMMODATE MORE PEOPLE.

BY MID 19TH CENTURY THEATRE BUILDING WAS BECOMING A SPECIALIST ARCHITECTURAL DISCIPLINE, LED BY ARCHITECTS SUCH AS J. T. ROBINSON AND C. J. PHIPPS. THEY WERE TASKED WITH BUILDING EVEN BIGGER THEATRES, WITH GRANDER FRONT OF HOUSE ARRANGEMENTS AND MORE LUXURIOUS SOCIAL AREAS.







THE INTENTION WAS TO BRING RESPECTABILITY TO THEATRE-GOING AND MAKE IT MORE SOCIALLY ACCEPTABLE FOR THE MIDDLE CLASSES. TO ACHIEVE THIS, DIFFERENT CLASSES WERE SEGREGATED: FINANCIALLY BY THE COST OF THE TICKETS; AND PHYSICALLY BY THE REQUIREMENT TO USE SEPARATE ENTRANCES AND EXITS AND CIRCULATION ROUTES.

THE VICTORIAN PERIOD SAW A NUMBER OF INNOVATIONS THAT IMPACTED UPON THEATRE DESIGN. LIGHTING CHANGED FROM CANDLE TO GAS AND THEN LATER TO ELECTRICITY AS A RESULT OF STRINGENT HEALTH AND SAFETY LEGISLATION.

WHAT IS NEXT?

IDENTIFYING THE VARIOUS PERFORMERS IN THE AREA

THE PERFORMERS

Performance Artists and Installations

Community Theatre Groups

Local Theatre Groups

Outdoor Performance Artists

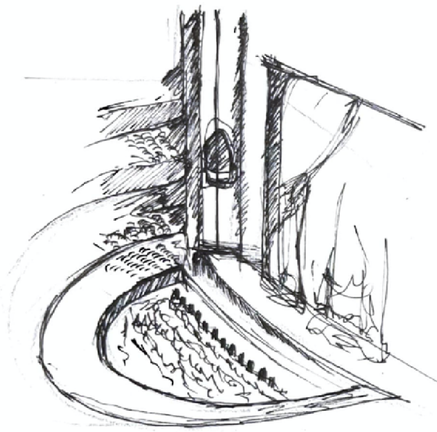
Dance Companies

Cultural and Ethnic Performers

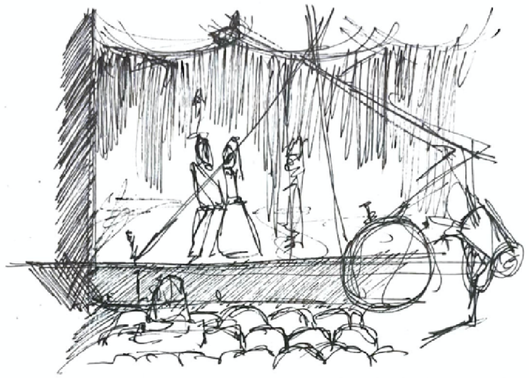
Musical Acts

ECHOES OF THE YARE: AN IMMERSIVE THEATRICAL EXPERIENCE

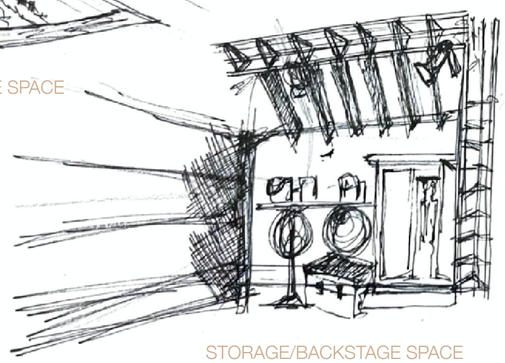
ENCLOSED SPACES



PERFORMATIVE SPACE



WORKSHOP/REHEARSAL SPACE



STORAGE/BACKSTAGE SPACE

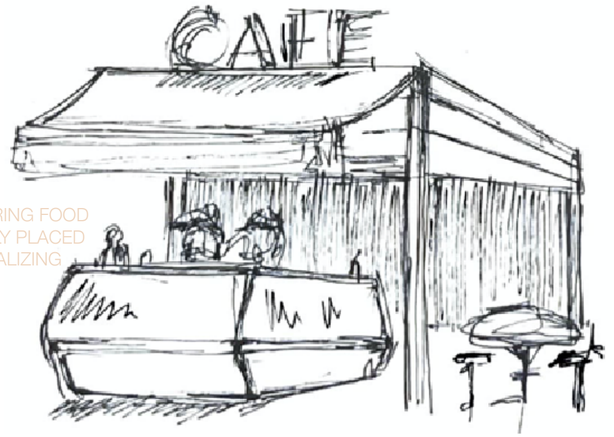
OPEN + SEMI-OPEN SPACES



COVERED PAVILIONS

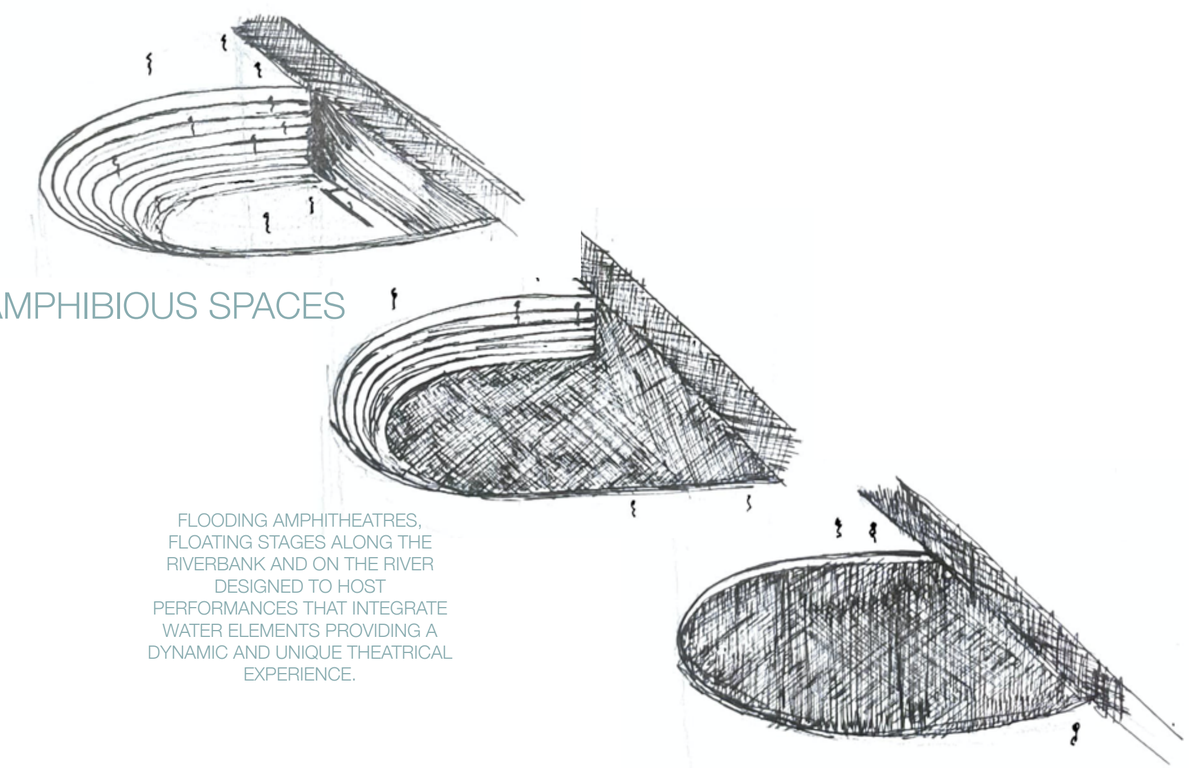
FLOATING STAGES

MISCELLANEOUS SPACES



CAFETERIA-STYLE SPACES OFFERING FOOD AND BEVERAGES, STRATEGICALLY PLACED FOR SCENIC VIEWS AND SOCIALIZING

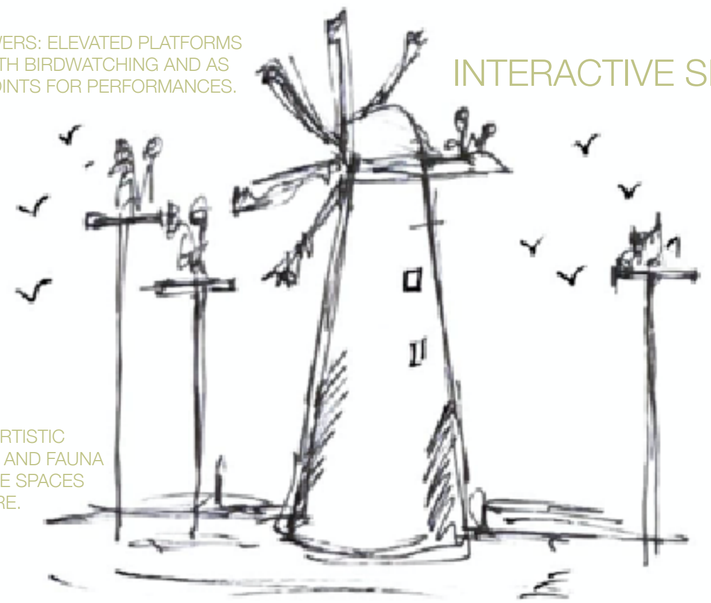
AMPHIBIOUS SPACES



FLOODING AMPHITHEATRES, FLOATING STAGES ALONG THE RIVERBANK AND ON THE RIVER DESIGNED TO HOST PERFORMANCES THAT INTEGRATE WATER ELEMENTS PROVIDING A DYNAMIC AND UNIQUE THEATRICAL EXPERIENCE.

INTERACTIVE SPACES

BIRDWATCHING TOWERS: ELEVATED PLATFORMS DESIGNED FOR BOTH BIRDWATCHING AND AS UNIQUE VIEWING POINTS FOR PERFORMANCES.



INTERACTIVE ART INSTALLATIONS: ARTISTIC INSTALLATIONS INSPIRED BY THE FLORA AND FAUNA OF THE BROADS, CREATING IMMERSIVE SPACES FOR THE AUDIENCE TO EXPLORE.

THE PROGRAM

NESTLED ALONG THE PICTURESQUE RIVER YARE, OUR IMMERSIVE THEATRE SPACE IS A CELEBRATION OF ART SEAMLESSLY ENTWINED WITH THE DELICATE RHYTHMS OF NATURE. DESIGNED AS A LIVING TAPESTRY, EACH SPACE WITHIN THE PROGRAM PAYS HOMAGE TO SPECIFIC MICROHABITATS ALONG THE RIVERBANKS, ENSURING A HARMONIOUS COEXISTENCE BETWEEN THE ARTISTIC AND THE NATURAL.

FROM CLOSED SPACES HOUSED WITHIN THE HISTORIC MILL TO SEMI-OPEN STAGES FLOATING ALONG THE RIVERBANKS, AND OPEN AMPHITHEATERS CARVED INTO THE LANDSCAPE, EACH VENUE MIRRORS THE NUANCES OF THE BROADS' DIVERSE MICROHABITATS. THE WORKSHOP, BOTH WITHIN AND BEYOND THE MILL, BECOMES A HUB OF CREATION, ECHOING THE INDUSTRIOUS SPIRIT OF THE SURROUNDING FLORA AND FAUNA.

FOOD AND DRINK AREAS, FROM CAFÉ VIEWS FRAMED BY THE BROADS' EMERGENT VEGETATION TO FLOATING FOOD STALLS ON THE RIVER YARE, OFFER CULINARY EXPERIENCES THAT MIRROR THE DIVERSITY OF THE NATURAL LANDSCAPE. UNIQUE SPACES, INCLUDING BIRDWATCHING TOWERS AND INTERACTIVE ART INSTALLATIONS INSPIRED BY THE BROADS' ECOLOGY, INVITE AUDIENCES TO ENGAGE WITH NATURE IN UNEXPECTED WAYS.

CRUCIALLY, THE PROGRAM IS WOVEN TOGETHER BY A CONTINUOUS NARRATIVE OF BIRDS. BIRD MOVEMENTS AND SOUNDS, CAREFULLY INTEGRATED INTO THE IMMERSIVE JOURNEY, ENSURE THAT THE NATURAL EXPERIENCE OF THE MICROHABITATS REMAINS UNDISTURBED. AUDIENCES NOT ONLY WITNESS PERFORMANCES BUT ALSO BECOME PART OF THE LIVING NARRATIVE, GUIDED BY THE AMPHIBIUOUS THEMES INSPIRED BY THE UNIQUE ECOLOGY OF THE BROADS.

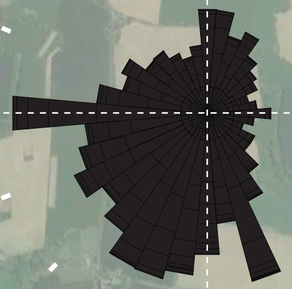
IN ESSENCE, THIS IMMERSIVE THEATRE SPACE TRANSCENDS TRADITIONAL PERFORMANCE SETTINGS. IT BECOMES A CONDUIT FOR STORYTELLING, AN HOMAGE TO THE NATURAL WORLD, AND AN INVITATION FOR AUDIENCES TO IMMERSE THEMSELVES IN THE DELICATE DANCE BETWEEN ART AND NATURE ALONG THE BANKS OF THE RIVER YARE.

WIND AND SOLAR ANALYSIS

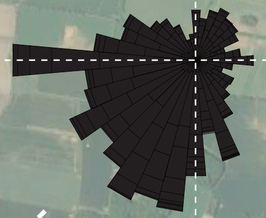
AUTUMN EQUINOX



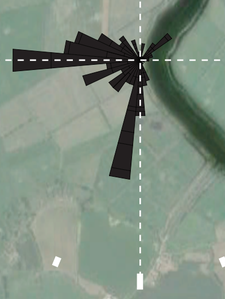
SPRING EQUINOX



SUMMER SOLSTICE



WINTER SOLSTICE



WINDROSE

THE CHOSEN SITE

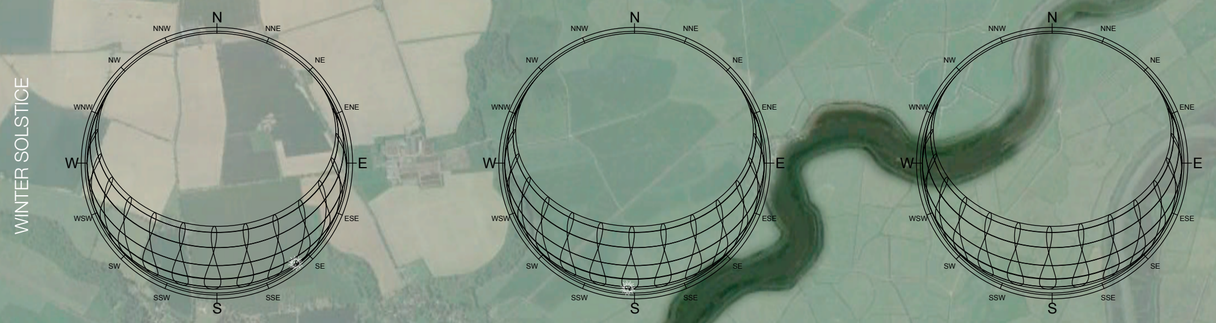


9:00

12:00

17:00

WINTER SOLSTICE



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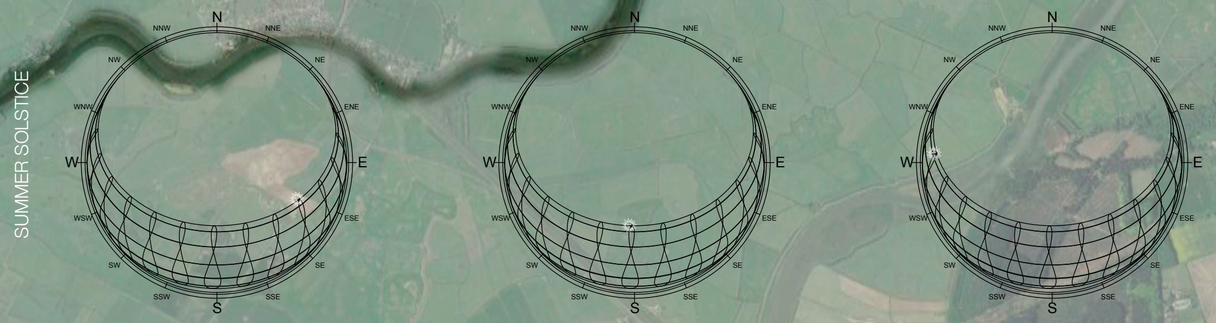
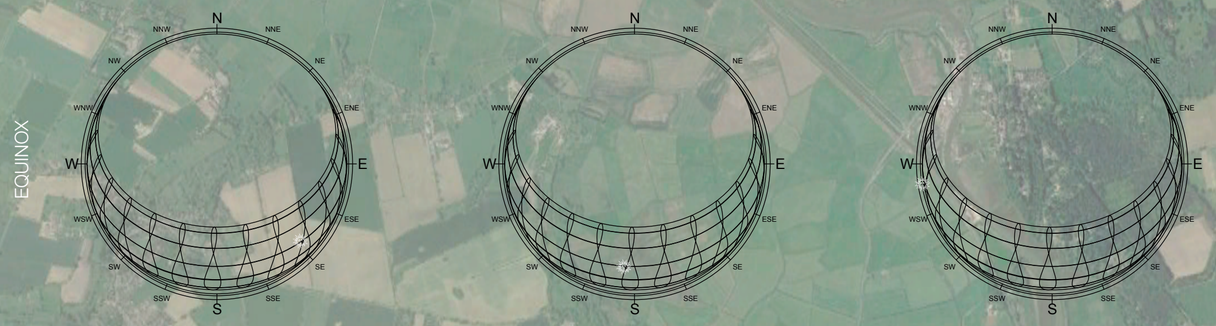


EQUINOX



SUNPATH DIAGRAMS

ADJACENCY DIAGRAM

REHEARSAL SPACE

100-150 SQ M

GREEN ROOM

30-40 SQ M

COSTUME STORE

40-60 SQ M

THEATRE

BOX OFFICE /
ENTRY LOUNGE

40-60 SQ M

SCENE DOCK

50-70 SQ M

DOCK I

ROW-THREW
THEATRE

VIEWING
POINT

OPEN AIR STAGE

BIRD PARK

500 SQ M

VIEWING
POINT

20-30 SQ M

AMPHITHEATRE

80-120 SQ M

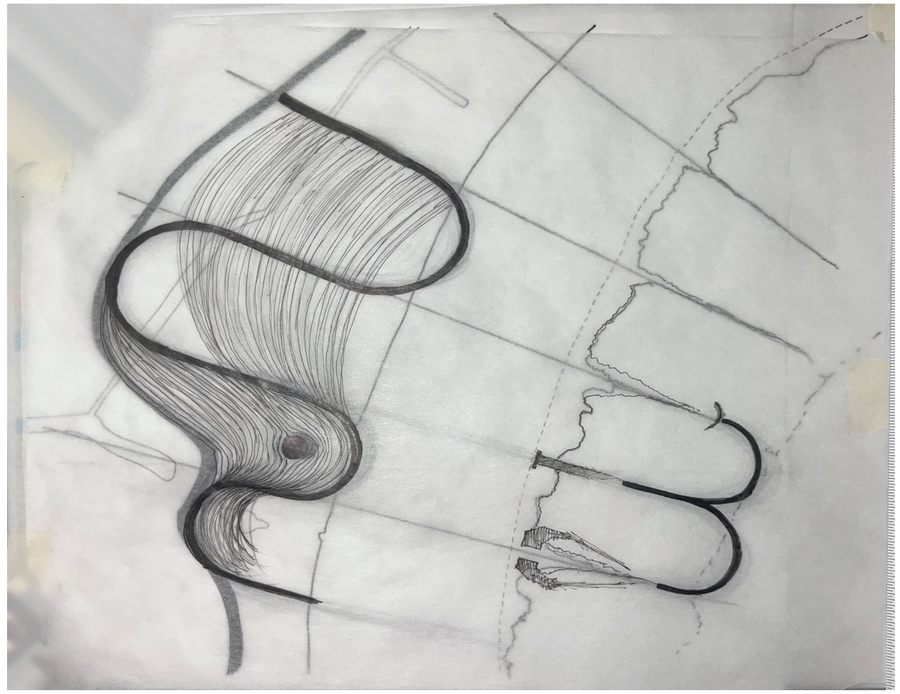
CAFE

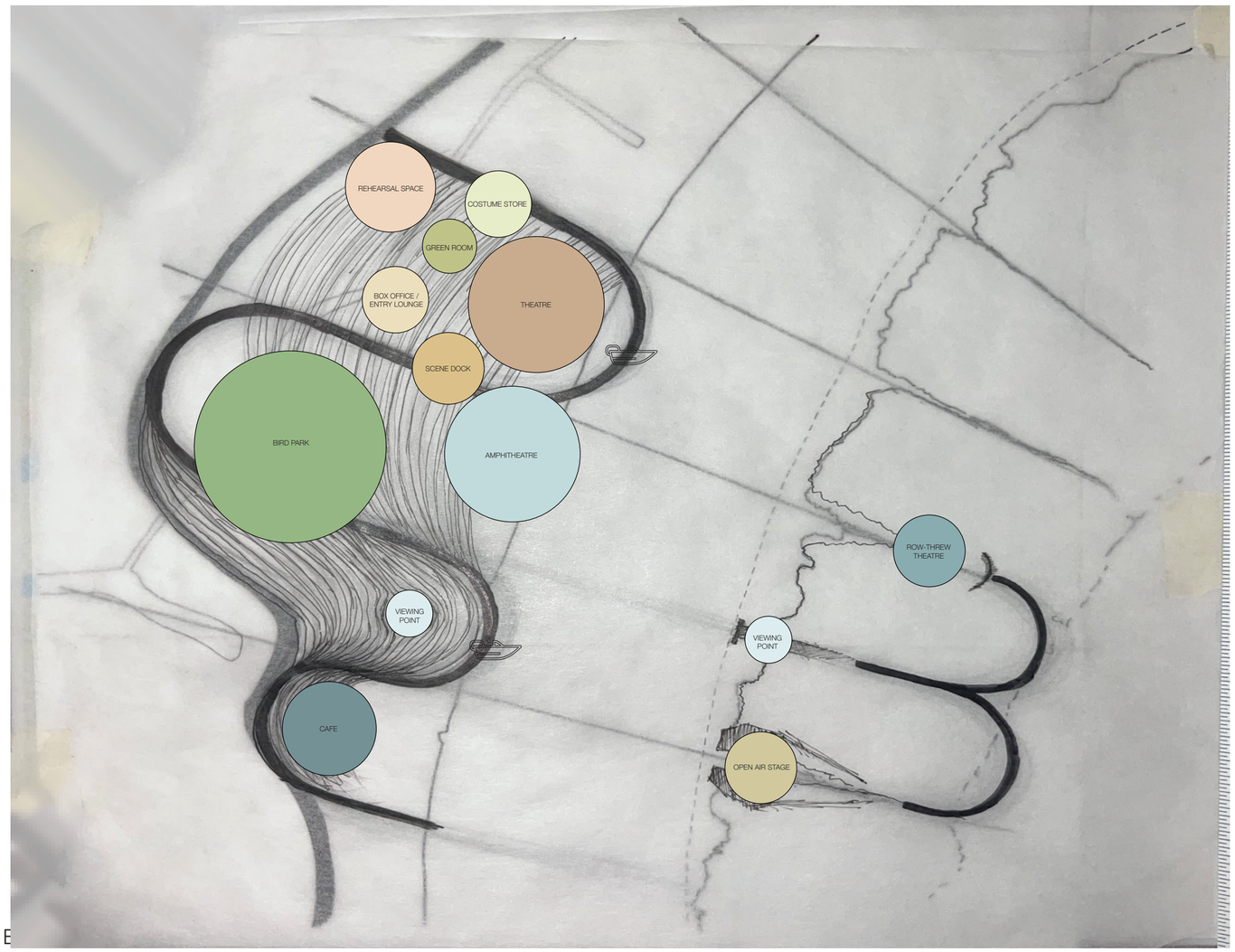
DOCK II

ECHOES OF THE YARE: AN IMMERSIVE THEATRICAL EXPERIENCE








REHEARSAL SPACE
COSTUME STORE
GREEN ROOM
BOX OFFICE / ENTRY LOUNGE
THEATRE
SCENE DOCK
BIRD PARK
AMPHITHEATRE
VIEWING POINT
CAFE
ROW-THREW THEATRE
VIEWING POINT
OPEN AIR STAGE

ILLUSTRATIVE MASTERPLAN

CLOSED THEATRE

DOCK 1

BIRD PARK

AMPHITHEATRE

ROW-THROUGH
THEATRE

ENTERANCE

MILL/TOWER

DOCK 2

VIEWPOINT

VIEWPOINT

CAFE

FLOATING STAGES

INITIAL MASTERPLAN 1:500

LINKING THE MASTERPLAN TO THE IDENTIFIED MICROHABITATS

FLATPLANES

ECOTONE

INTERVENTION

MUDFLATS

EMERGENT VEGETATION

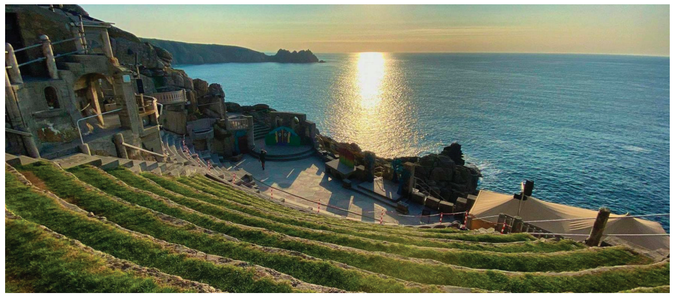
AMPHITHEATRE REFERENCES

MINACK THEATRE

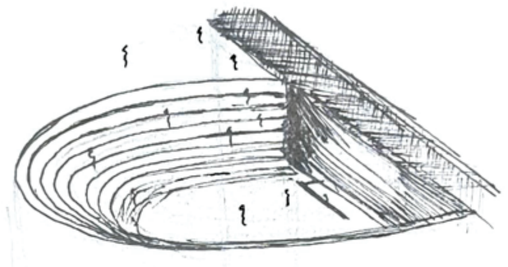
THE MINACK THEATRE IS A UNIQUE OPEN-AIR THEATER LOCATED ON THE CLIFFS OF CORNWALL, ENGLAND. IT IS RENOWNED FOR ITS STUNNING NATURAL SETTING AND DISTINCTIVE ARCHITECTURE. CONCEIVED AND LARGELY CONSTRUCTED BY ROWENA CADE, A LOCAL RESIDENT, THE THEATER WAS BUILT BY HAND INTO THE GRANITE CLIFFS OVERLOOKING THE ATLANTIC OCEAN.

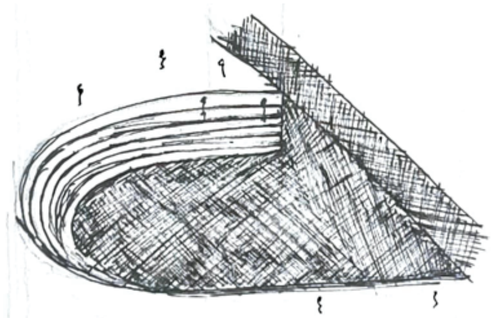
THE ARCHITECTURE OF THE MINACK THEATRE BLENDS HARMONIOUSLY WITH ITS RUGGED SURROUNDINGS. THE STAGE IS FRAMED BY THE DRAMATIC BACKDROP OF THE SEA, CREATING A BREATHTAKING BACKDROP FOR PERFORMANCES. THE SEATING TERRACES ARE CARVED INTO THE CLIFFSIDE, PROVIDING SPECTATORS WITH PANORAMIC VIEWS OF THE COASTLINE.

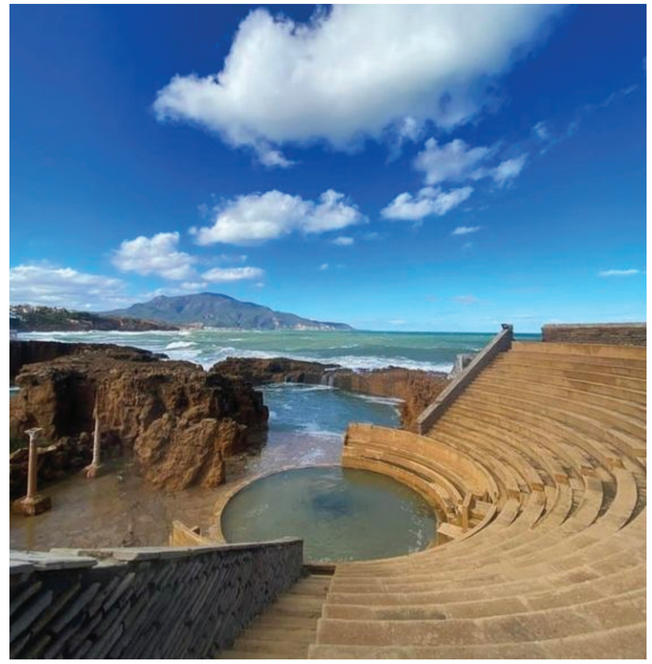
THE DESIGN INCORPORATES ELEMENTS OF BOTH ANCIENT AMPHITHEATERS AND CELTIC RUINS, GIVING THE THEATER AN AURA OF TIMELESSNESS AND MYSTIQUE. STONE WALLS, ARCHES, AND TERRACES ARE INTERSPERSED WITH LUSH VEGETATION, ADDING TO THE THEATER'S ENCHANTING ATMOSPHERE.

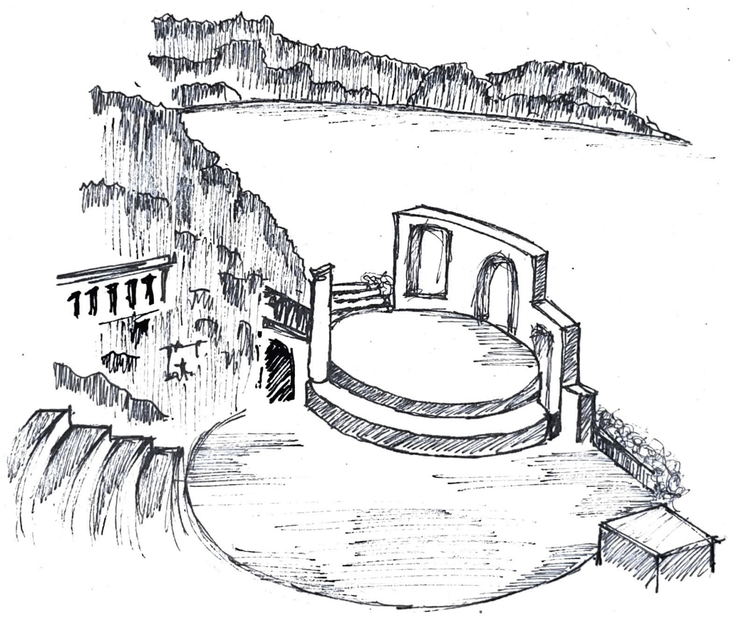




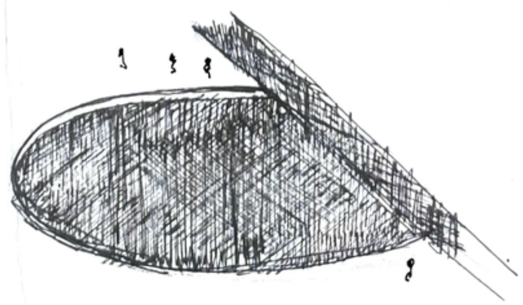








ECHOES OF THE YARE: AN IMMERSIVE THEATRICAL EXPERIENCE





AMPHITHEATRE IN TIPAZA ALGERIA - THE STAGE GETS FLOODED DURING A HIGH TIDE

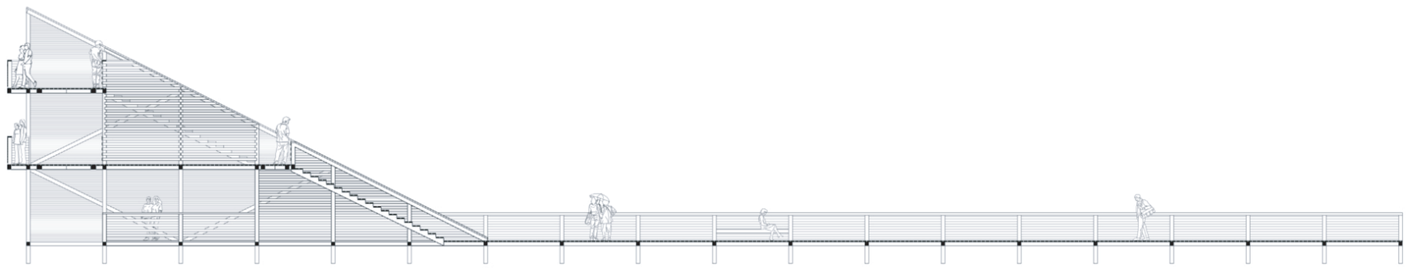
AT HIGH TIDE, THE STAGE OF THE AMPHITHEATRE IS SUBMERGED BENEATH THE OCEAN'S WATERS, AS IF NATURE ITSELF IS CLAIMING THE SPOTLIGHT. WAVES CRASH AGAINST THE ANCIENT STONE, CASTING A MESMERIZING DISPLAY OF POWER AND RHYTHM. IT'S A REMINDER THAT THE FORCES OF NATURE ARE THE ULTIMATE PERFORMERS, CAPTIVATING AUDIENCES WITH THEIR TIMELESS PERFORMANCE.

YET, AS THE TIDE RECEDES, THE STAGE EMERGES ONCE MORE, AWAITING THE HUMAN ACTORS WHO WILL GRACE IT WITH THEIR PRESENCE. AGAINST THE BACKDROP OF THE SEA AND SKY, THE AMPHITHEATRE BECOMES A STAGE FOR HUMAN DRAMA, WHERE STORIES OF THE PAST ECHO THROUGH THE CENTURIES.

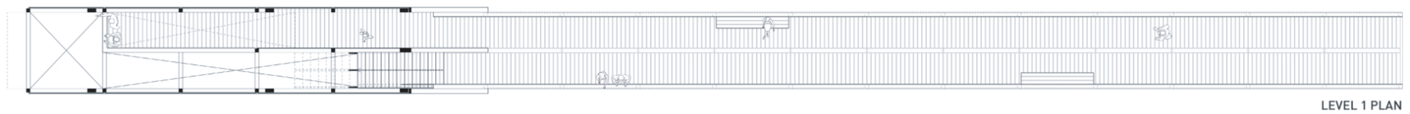
VIEWPOINT REFERENCES

OBSERVATION DECKS + BIRD WATCHING TOWERS





LONGITUDINAL SECTION



LEVEL 1 PLAN

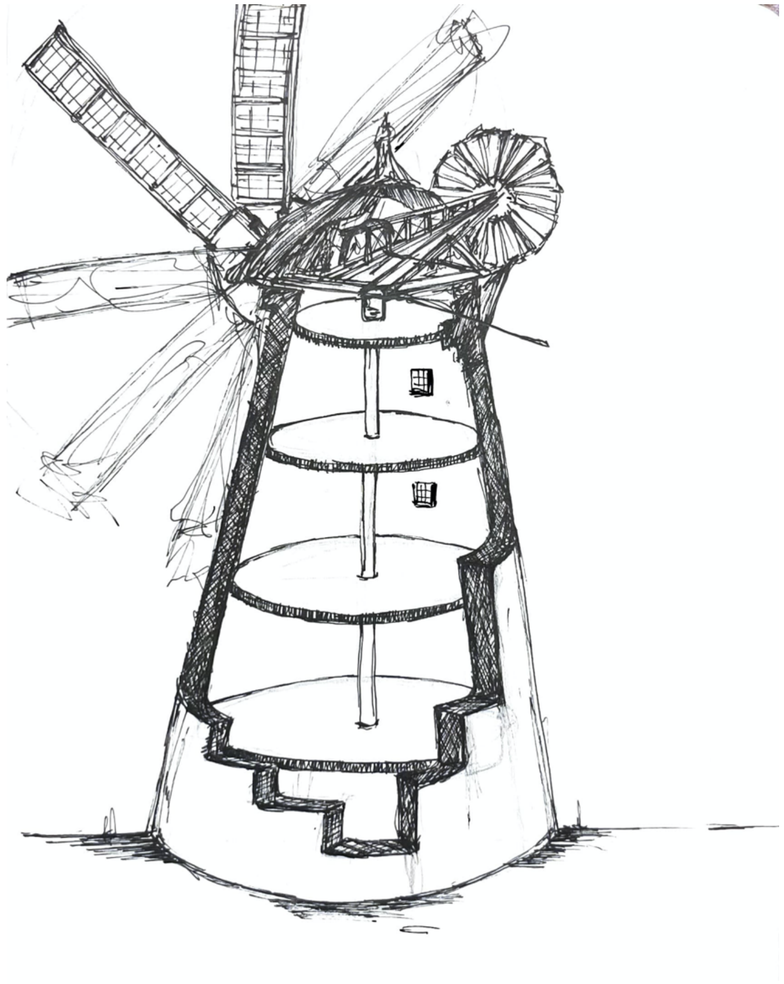


LEVEL 2 PLAN



LEVEL 3 PLAN

ADAPTIVE REUSE OF THE BERNEY ARMS MILL INTO A BIRD WATCHING TOWER

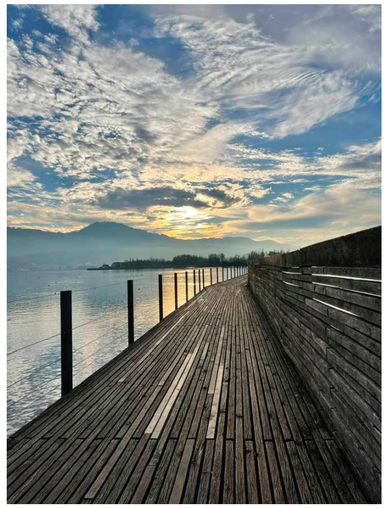




ECHOES OF THE YANE: AN IMMERSIVE THEATRICAL EXPERIENCE

WALKWAY REFERENCES

PEDESTRIAN WALK WAY
DEVELOPMENT - REFERENCES



THE WOODEN BRIDGE FROM RAPPERSWIL TO HURDE

THE BRIDGE ACTS LIKE A HIDE, AND GIVES US ACCESS THAT WE WOULD NOT OTHERWISE HAVE TO THE WETLANDS.





ECHOES OF THE YARE: AN IMMERSIVE THEATRICAL EXPERIENCE

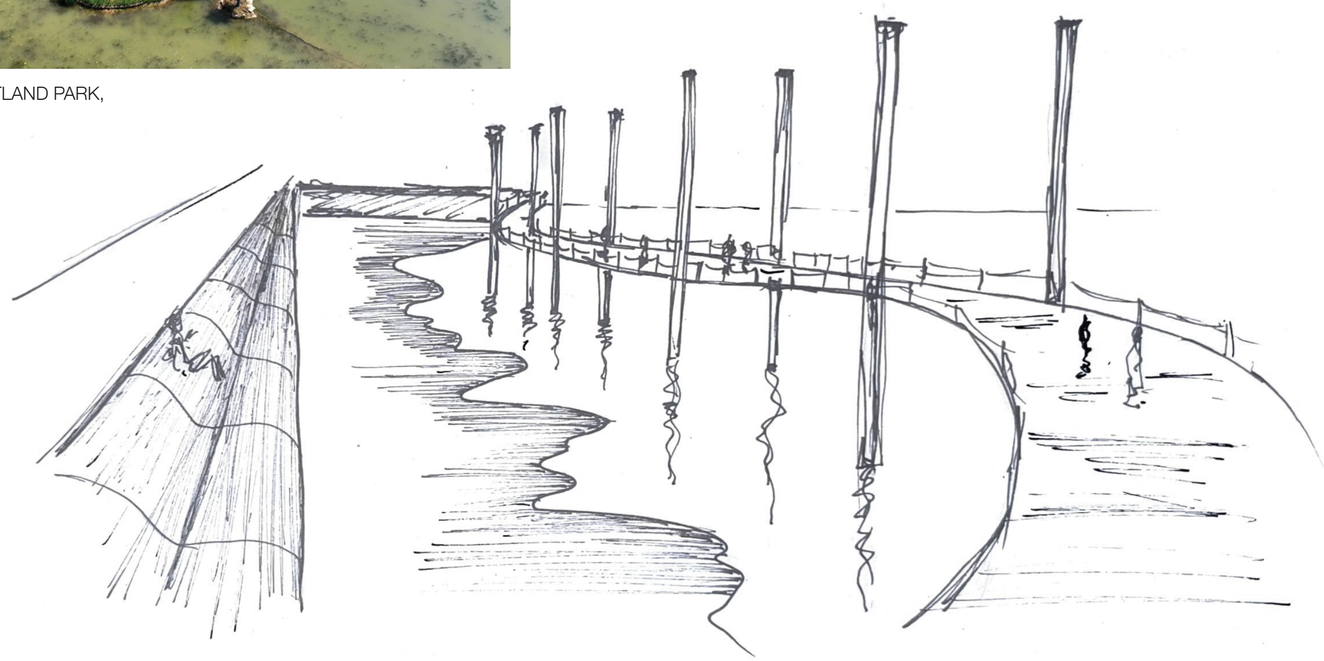


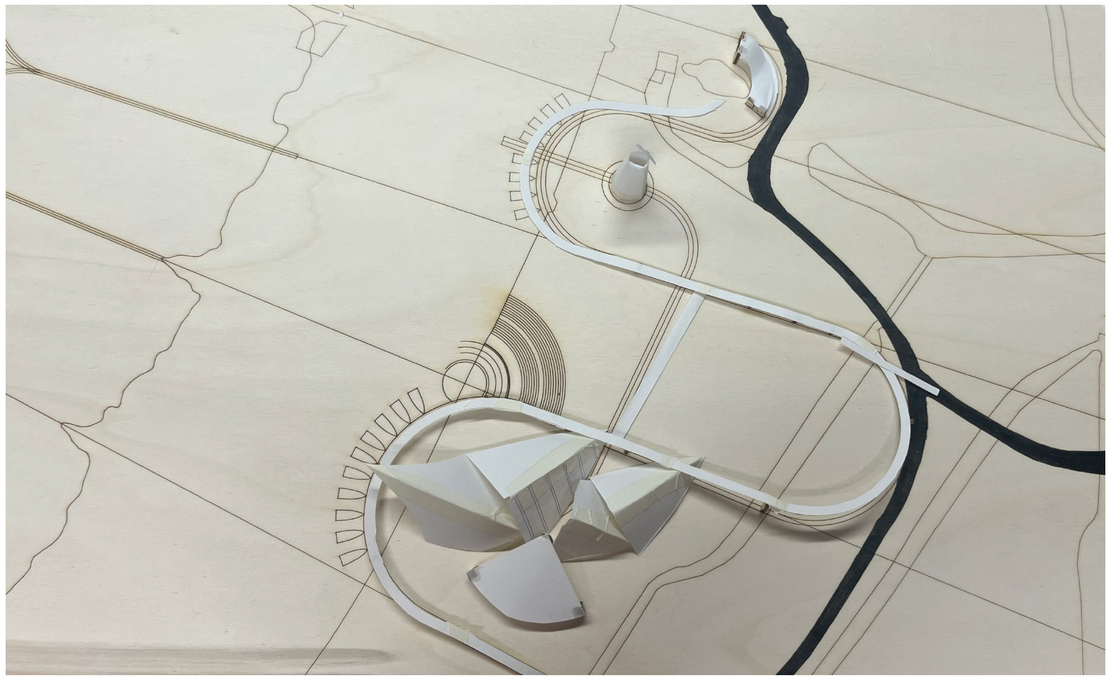


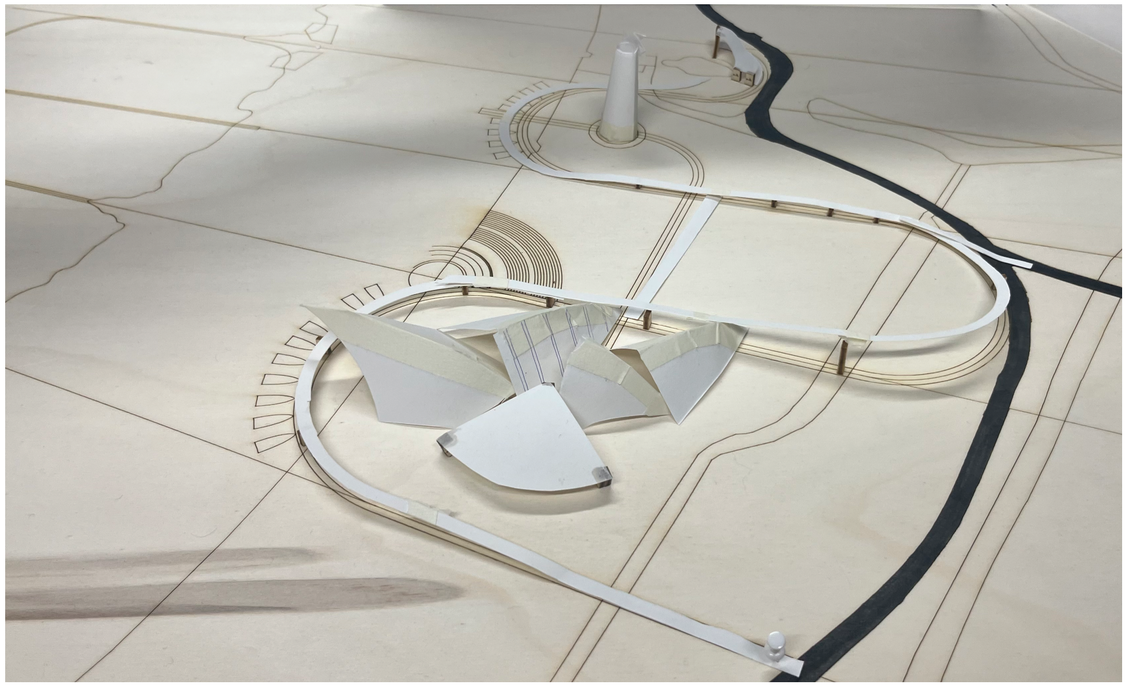
QUNLI STORMWATER WETLAND PARK,
CHINA

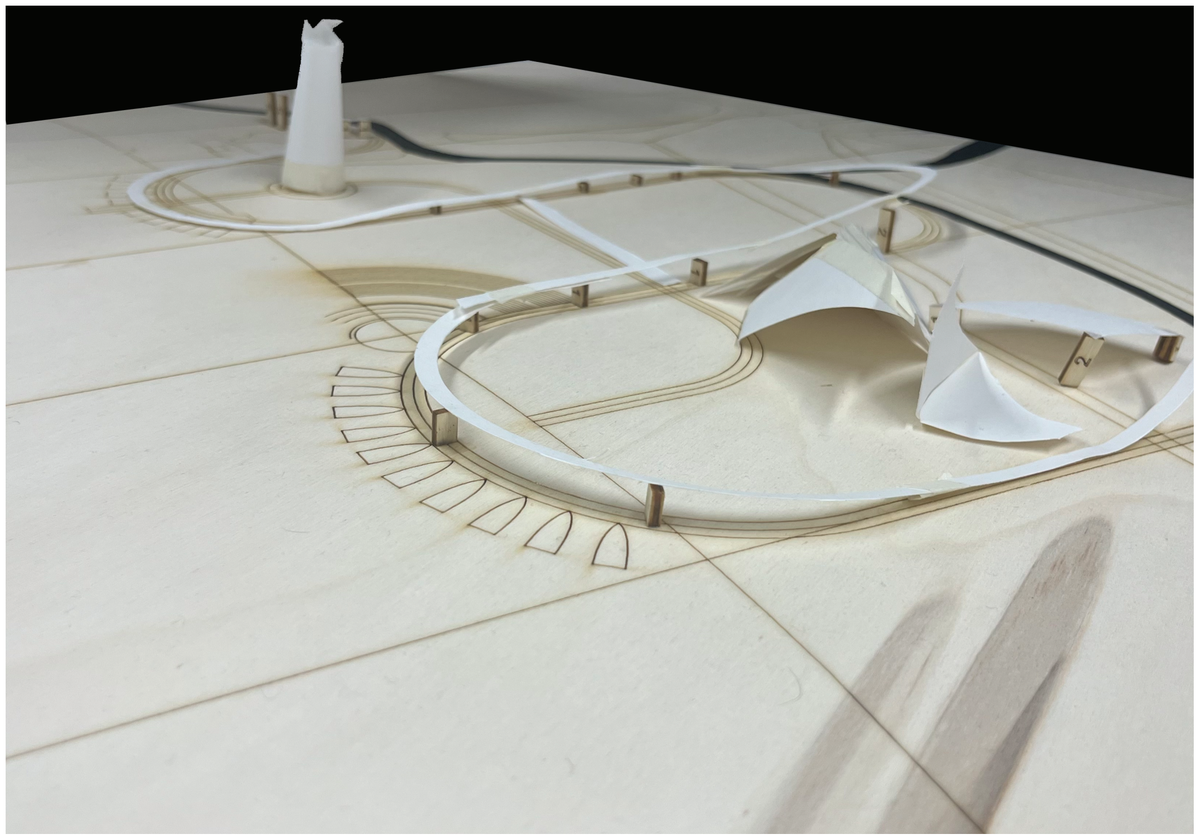






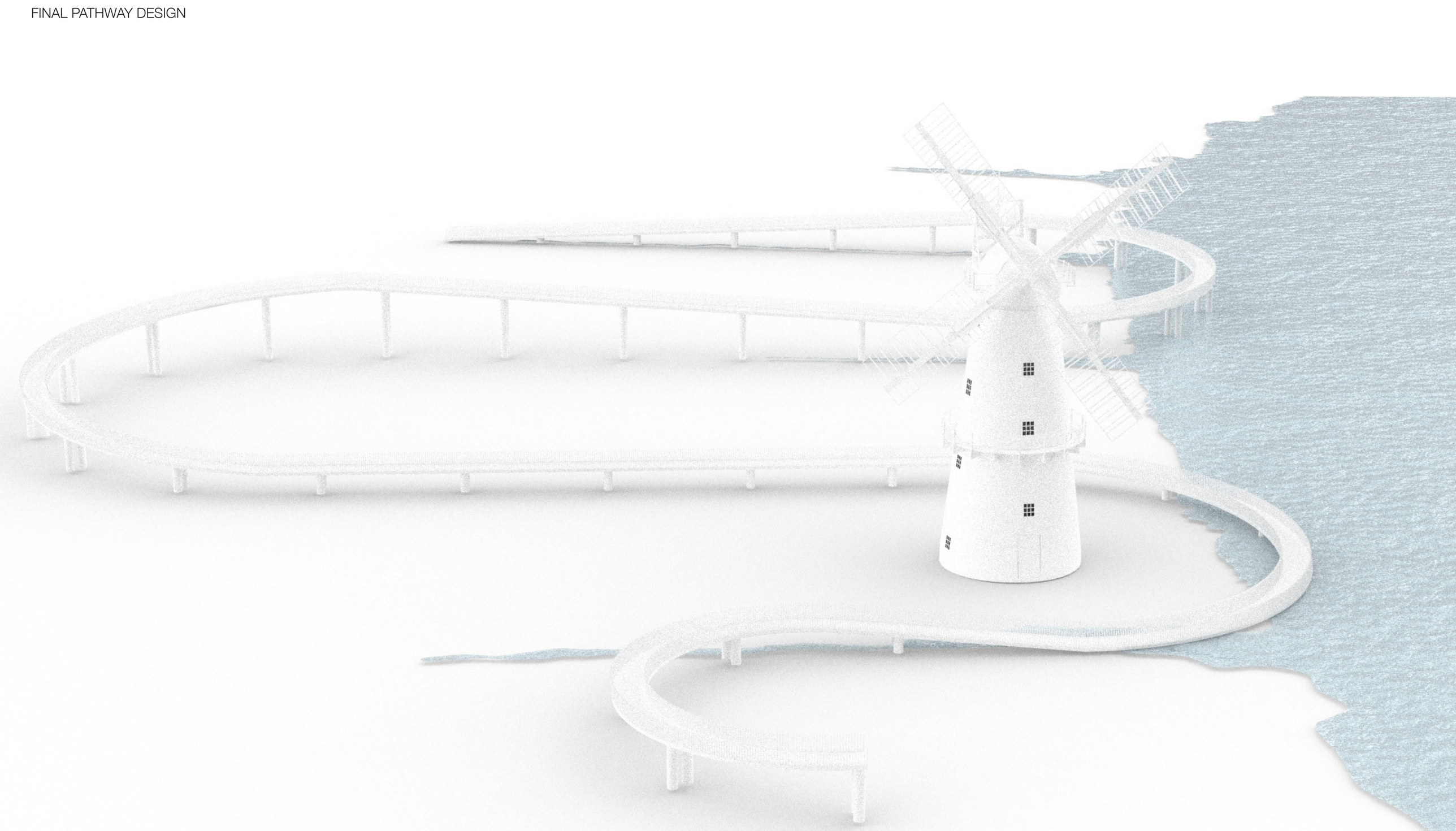






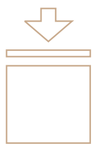


FINAL PATHWAY DESIGN



1. Determine Loads

Dead Load (D)
The dead load includes the weight of the deck boards, beams, and other permanent elements.



Decking: Assume timber decking weighs approximately 0.6 kN/m².
Beams and Joists: Estimated weight is around 0.4 kN/m².
Total Dead Load = 0.6 + 0.4 = 1.0 kN/m²

Live Load (L)
For pedestrian walkways, the live load is typically 5.0 kN/m² as per BS EN 1991-1-1.

Snow Load (S)
The UK snow load map indicates a ground snow load (s_g) for Norfolk of approximately 0.6 kN/m². For elevated structures, a shape coefficient (μ) of 0.8 is applied.

Snow Load = $s_g \times \mu = 0.6 \times 0.8 = 0.48 kN/m^2$



Wind Load (W)
The wind load depends on the height, location, and exposure. Norfolk is in a wind zone with a basic wind speed (V_b) of about 22 m/s.

Wind Pressure (q) is calculated using:
$q = 0.613 \times V_b \times C_e \times C_d$

where C_e and C_d are exposure and direction coefficients (typically 1.0 for simplicity).

Wind Load (approx.) = $0.613 \times (22)^2 \times 1.0 \times 1.0 = 295.7 N/m^2 = 0.296 kN/m^2$

2. Structural Elements Sizing

Decking
Timber deck boards of 2m width and 25mm thickness.



Beams and Joists
Assuming timber beams, selecting a common size : 150mm x 50mm C24 timber).

Stilts/Columns
Using timber columns, we can start with an assumed size and verify through calculations.
Assuming size 200mm x 200mm for stability.

3. Spacing and Number of Stilts

Span-to-Depth Ratio
Using a conservative span-to-depth ratio for timber beams of around 20:

Beam span = 2m / 20 = 0.1m = 100mm (suitable for 150mm x 50mm beams).
For a length of 400m, support stilts every 2m for stability.
Number of stilts = 400m / 2m = 200 stilts

4. Foundation Design
Foundation Size
Clayey soil usually requires deeper foundations due to lower bearing capacity.



Assuming a bearing capacity of 75 kN/m².
Each stilt foundation must support combined loads (D + L + S + W).
Load per stilt (approx.) = (2m x 2m) x (1.0 + 5.0 + 0.48 + 0.296) = 2m x 2m x 6.776 kN/m² = 27.104 kN

Required area = Load / Bearing Capacity = 27.104 kN / 75 kN/m² = 0.361 m²

Assuming square footing: side length = $\sqrt{0.361 m^2} \approx 0.6$ m.

Foundation Depth
For clayey soil and frost protection, assume a depth of 1.0m to 1.5m.

The beam span is 2 meters and assuming a uniform distribution of load:

$q_{beam} = q_{total} \times$ width of the pathway = $6.776 kN/m^2 \times 2 m = 13.552 kN/m$

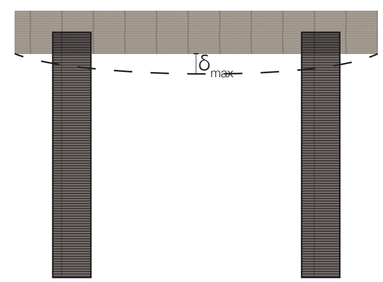
Deflection Calculation for Simply Supported Beam
For a simply supported beam with a uniformly distributed load, the maximum deflection (δ_{max}) is given by:

$\delta_{max} = 5 q L^4 / 384 E I$

Where:
q = load per unit length (13.552 kN/m)
L = span length (2 m)
E = modulus of elasticity of timber (assume 10,000 N/mm² = 10,000 kN/m² for C24 timber)
I = moment of inertia of the beam cross-section

For a beam of cross-section 150 mm x 50 mm (0.15 m x 0.05 m):
$I = bh^3/12 = (0.05) \times (0.15)^3 / 12 = 1.40625 \times 10^{-5} m^4$

Substitute the values into the deflection formula:



$\delta_{max} = 5 \times 13.552 \times (2)^4 / 384 \times 10{,}000 \times 1.40625 \times 10^{-5}$

$\delta_{max} = 1084.16 / 53.76$

$\delta_{max} = 20.16$ mm

Allowable Deflection
The maximum allowable deflection for pedestrian walkways is typically:

$\delta_{allowable} = L / 300$

$\delta_{allowable} = 2000 / 300$

$\delta_{allowable} = 6.67$mm

Conclusion
The calculated maximum deflection (δ_{max}) of 20.16 mm exceeds the allowable deflection ($\delta_{allowable}$) of 6.67 mm. Therefore, the current design does not satisfy the deflection criteria.

To reduce deflection, consider the following:

-Increase the beam size.
-Reduce the span length between supports.
-Use a higher modulus of elasticity material.

Trying a larger beam size : 200 mm x 75 mm (0.2 m x 0.075 m):

$I = 0.075 \times (0.2)^3 / 12 = 5 \times 10^{-5} m^4$

Recalculate deflection with the new I:

$\delta_{max} = 5 \times 13.552 \times (2)^4 / 384 \times 10{,}000 \times 5 \times 10^{-5}$

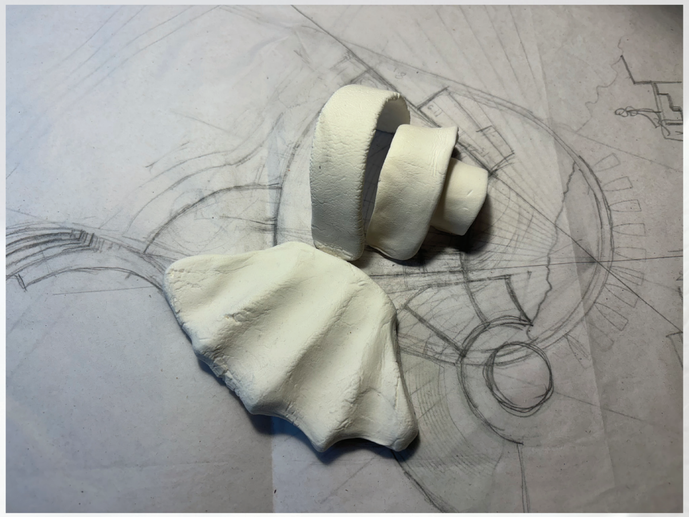
$\delta_{max} = 1084.16 / 192$

$\delta_{max} = 5.65$ mm

Now, the deflection of 5.65 mm is within the allowable limit of 6.67 mm. Therefore, a 200 mm x 75 mm beam size is suitable for this design.

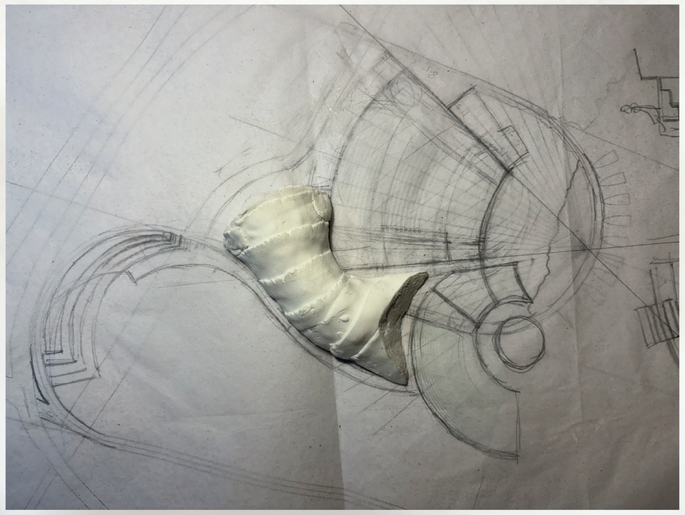
DEAD LOAD	*LIVE LOAD*	*SNOW LOAD*	*WIND LOAD*	*TOTAL LOAD*	*COLUMNS*	*FOUNDATIONS*
1.0 kN/m²	5.0 kN/m²	0.48 kN/m²	0.296 kN/m²	6.776 kN/m²	200mm x 200mm timber	0.6m x 0.6m pad with 1.0m - 1.5m depth

FORM FINDING THROUGH CLAY MODELS





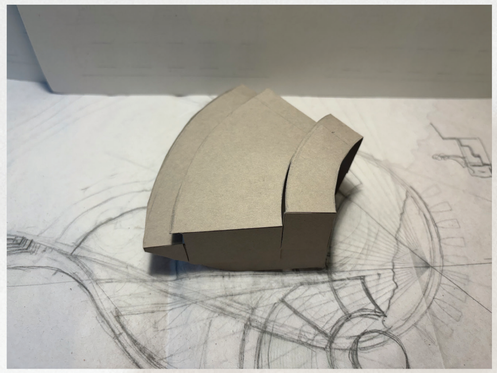


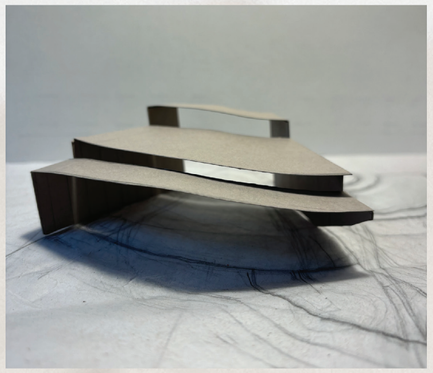


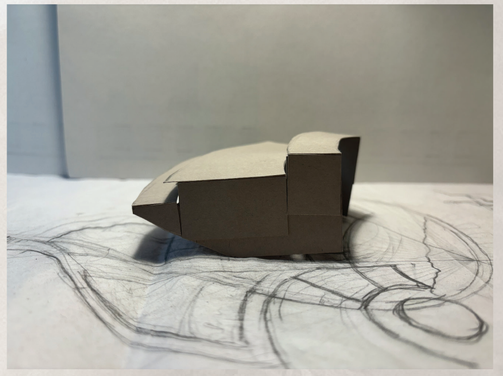


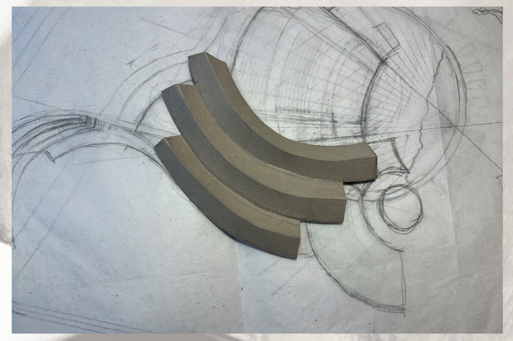


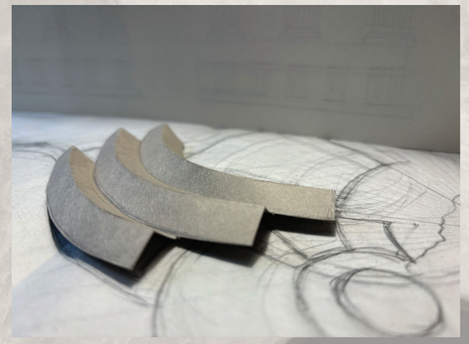
ROOF DESIGN FORM FINDING THROUGH PAPER MODELS

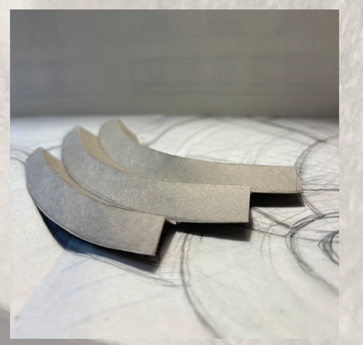


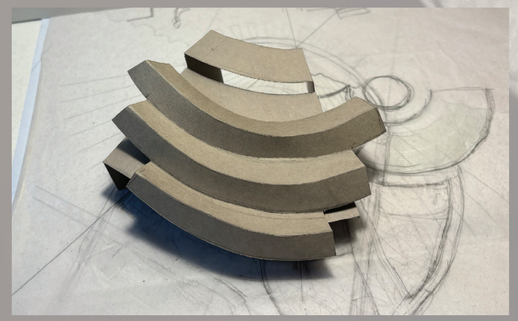


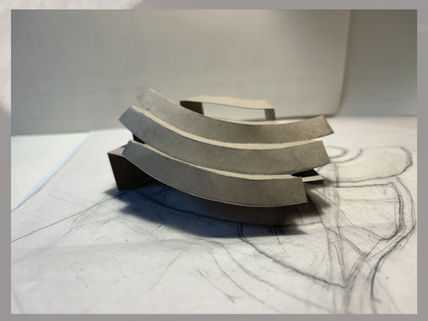


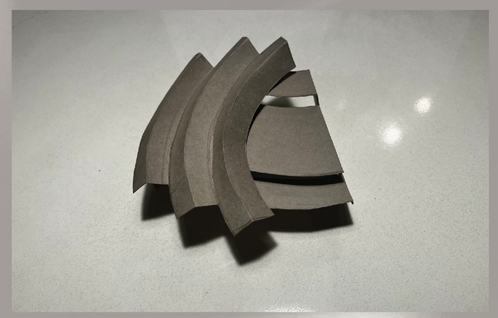


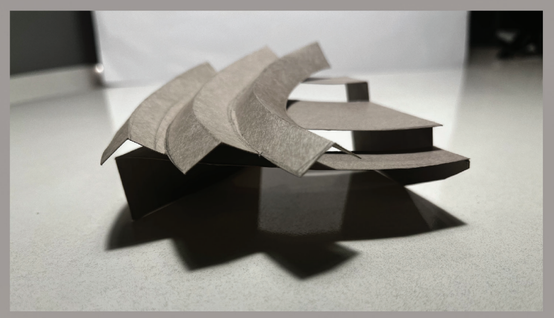


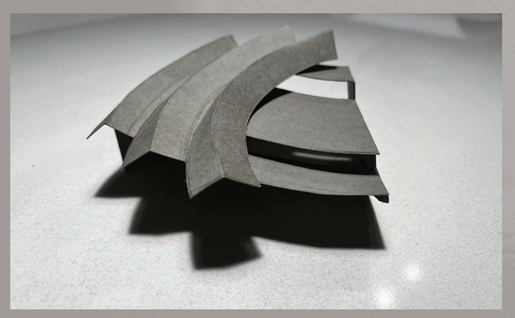


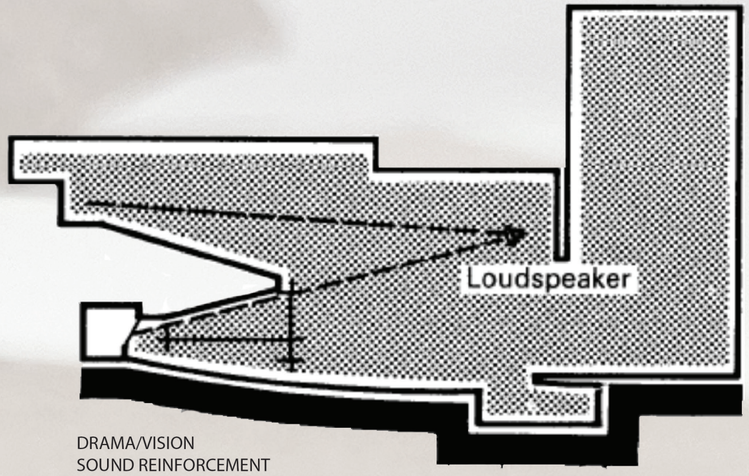






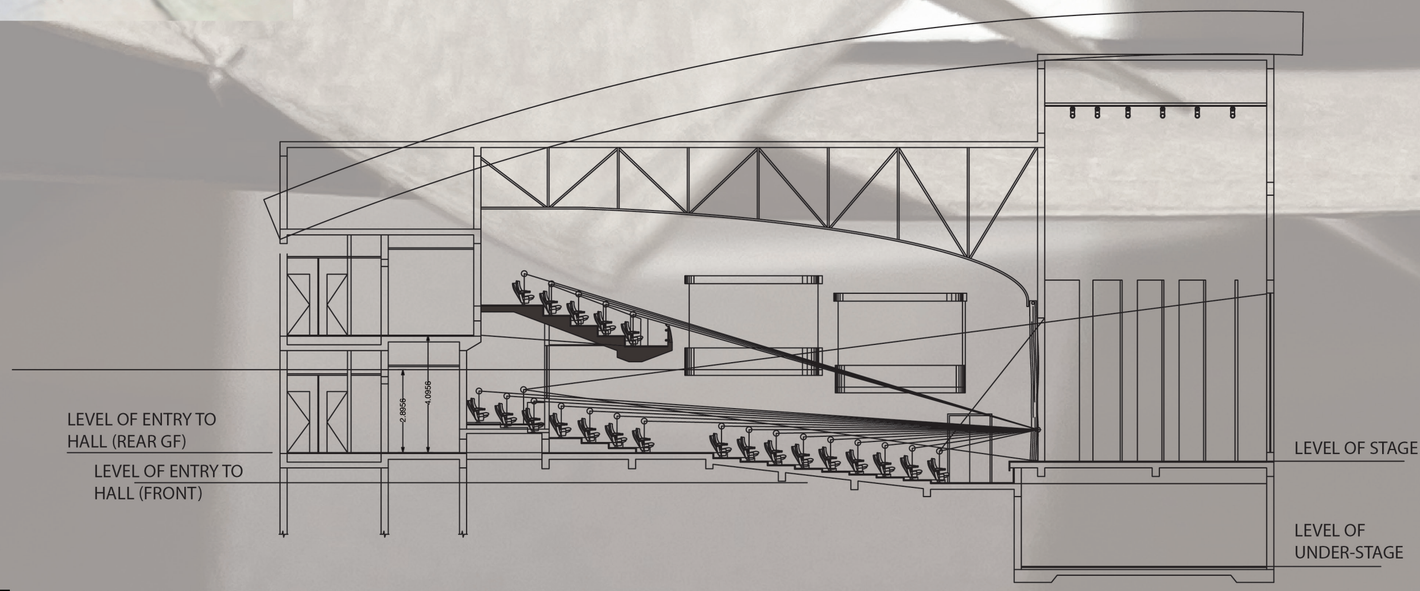




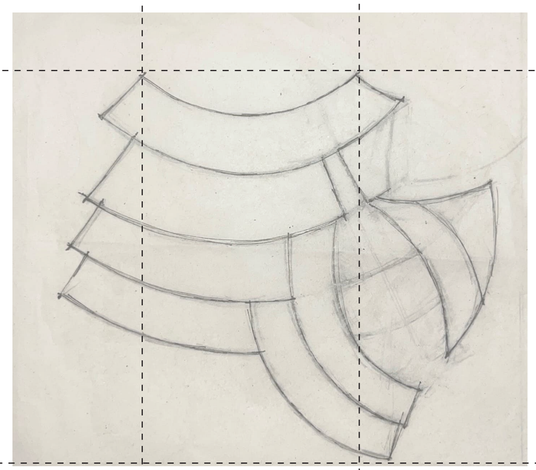


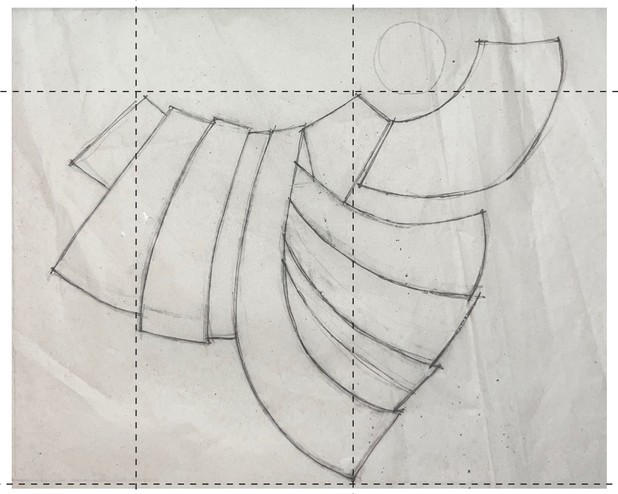
DRAMA/VISION
SOUND REINFORCEMENT

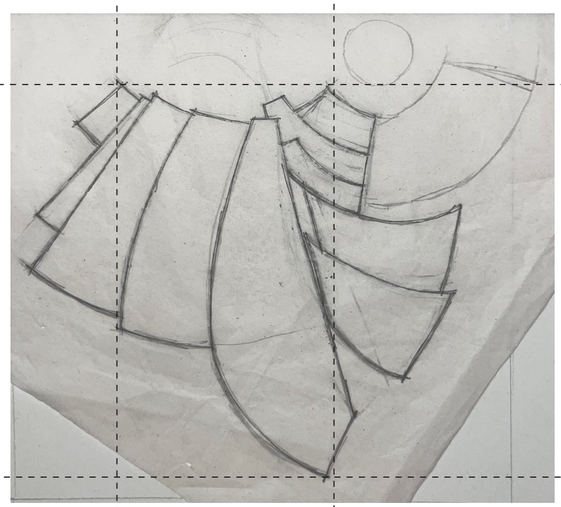
DIMENSIONS SET BY VIEW OF ACTING
SPACE AND VIEW OF SOUND CLUSTERS

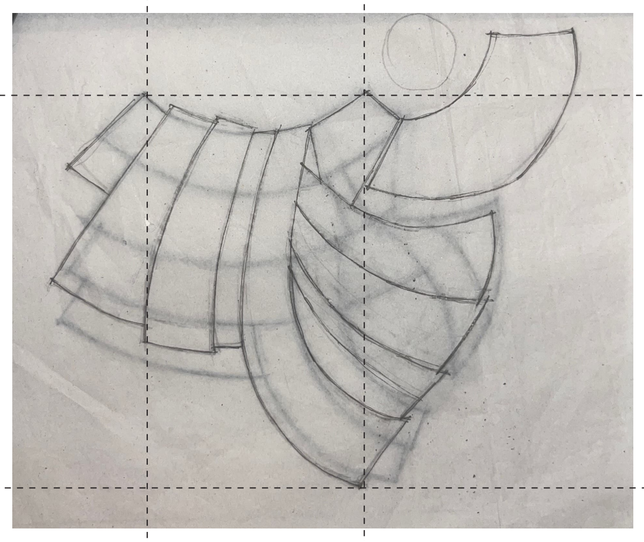


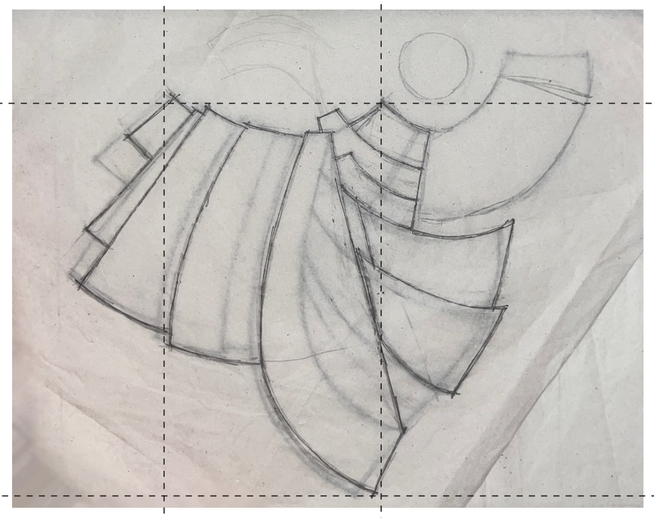
ROOF DESIGN DEVELOPMENTAL SKETCHES

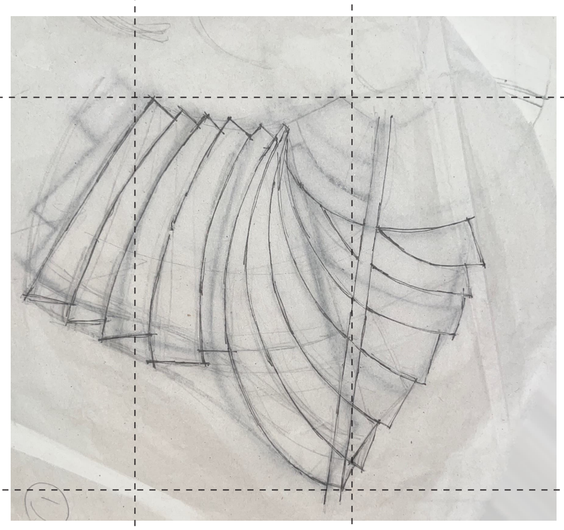


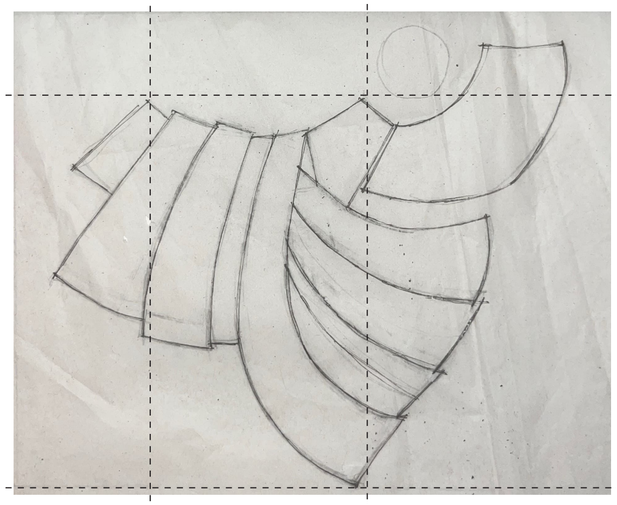


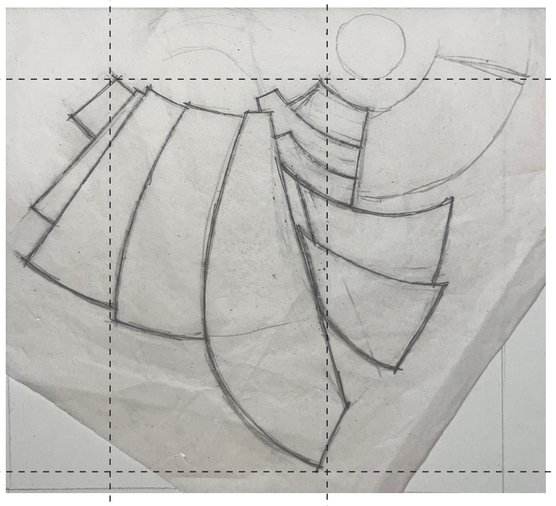


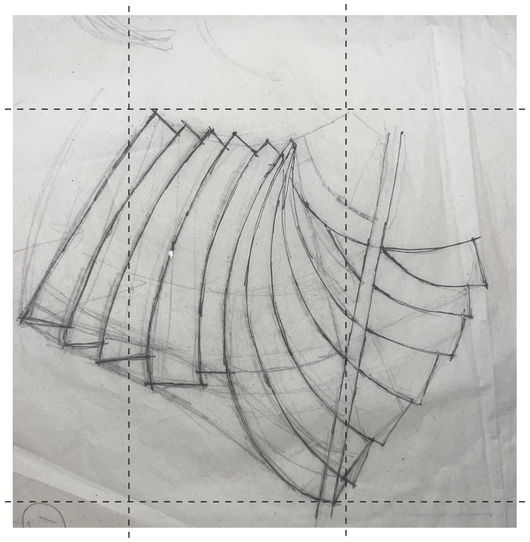






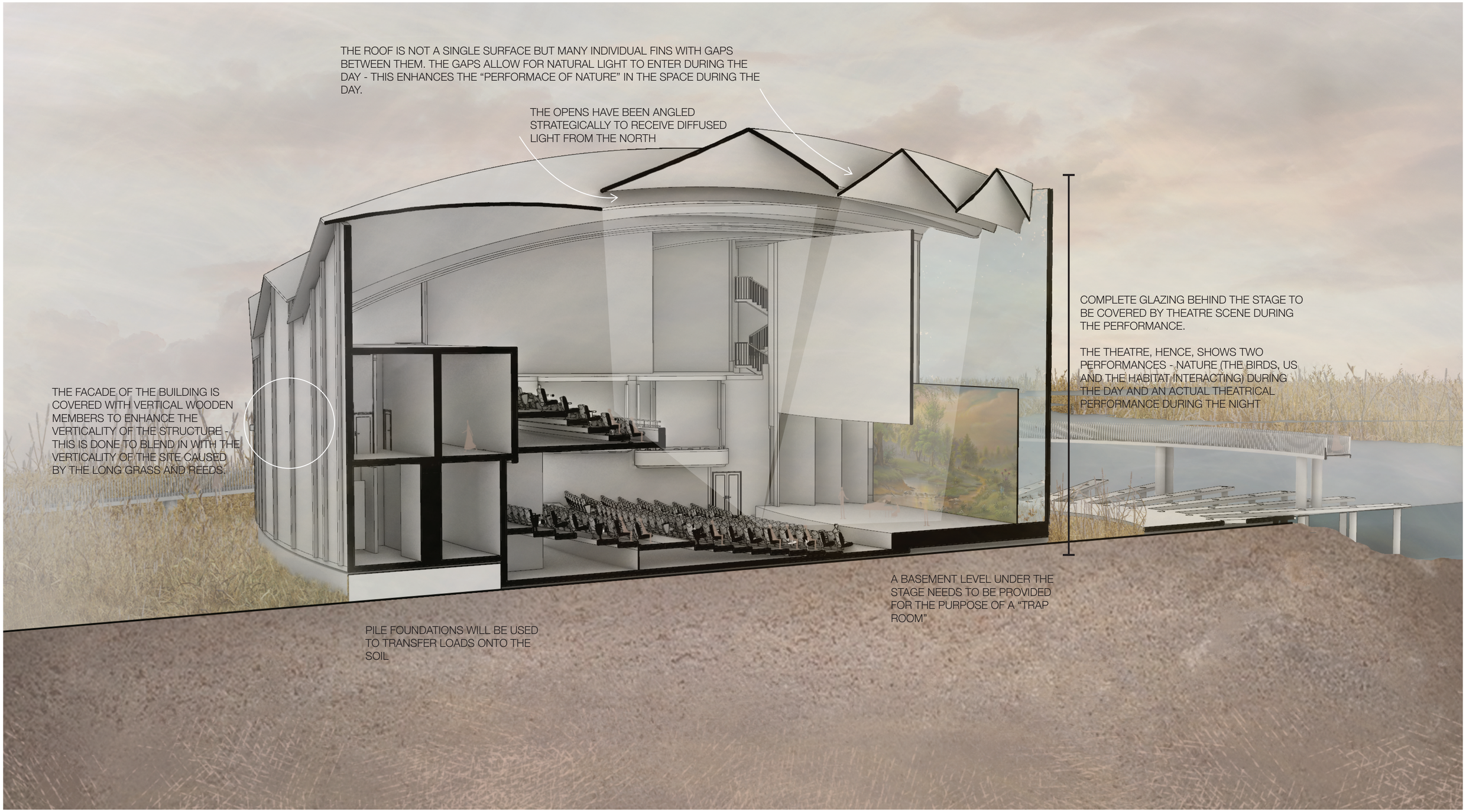




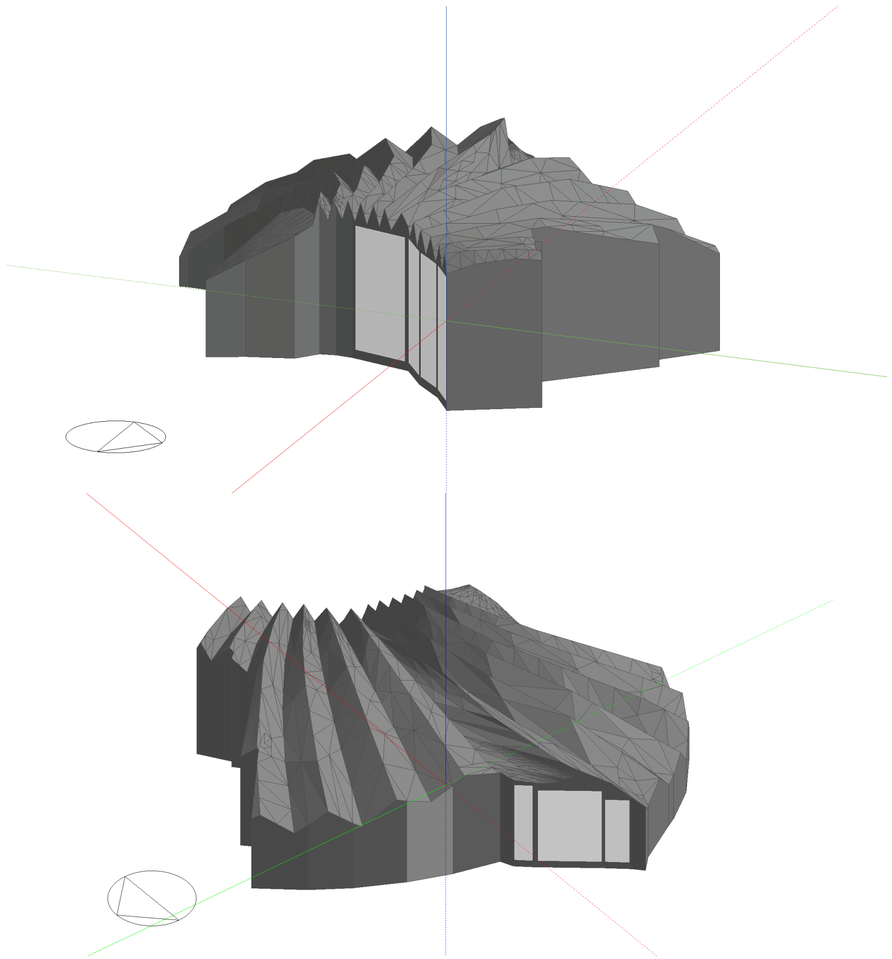


DESIGN ETHOS REPRESENTED THROUGH SECTION

INITIAL REPRESENTATIVE SECTION



BASELINE SIMULATION



MODEL SET UP

A SIMPLIFICATION OF THE CORRUGATED ROOF WAS MODELLED AND THE SKY LIGHT GAPS WERE OMMITED.

THE MODEL WAS SPLIT INTO 7 ZONES - THEATRE, STORAGE, REHEARSAL 1, REHEARSAL 2, CORRIDOR, BAR AND ADMIN/BOX OFFICE

SETTING UP THE BASELINE SIMULATION

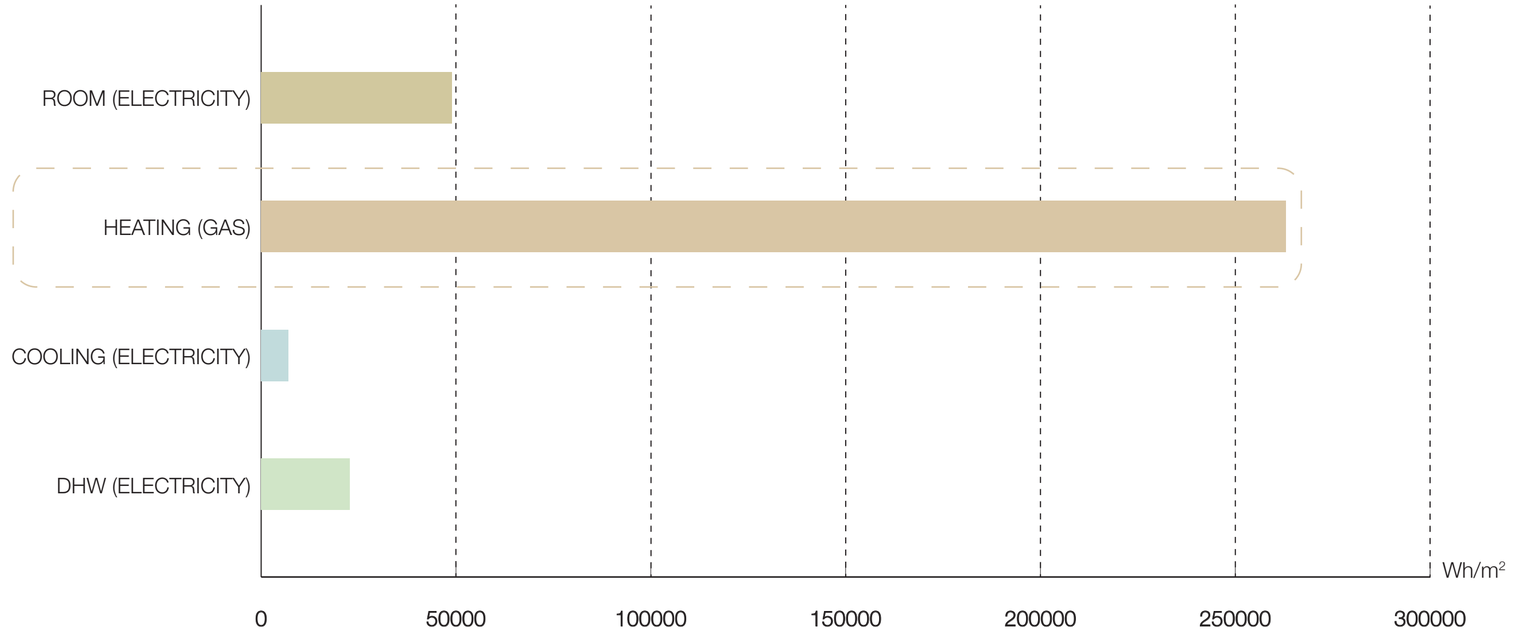
DEFAULT TIMBER LIGHTWEIGHT CONSTRUCTION TEMPLATE

BASIC OCCUPANCY SCHEDULES SET UP ACCORDING TO ZONE ACTIVITY

DEFAULT LIGHTING SET UP

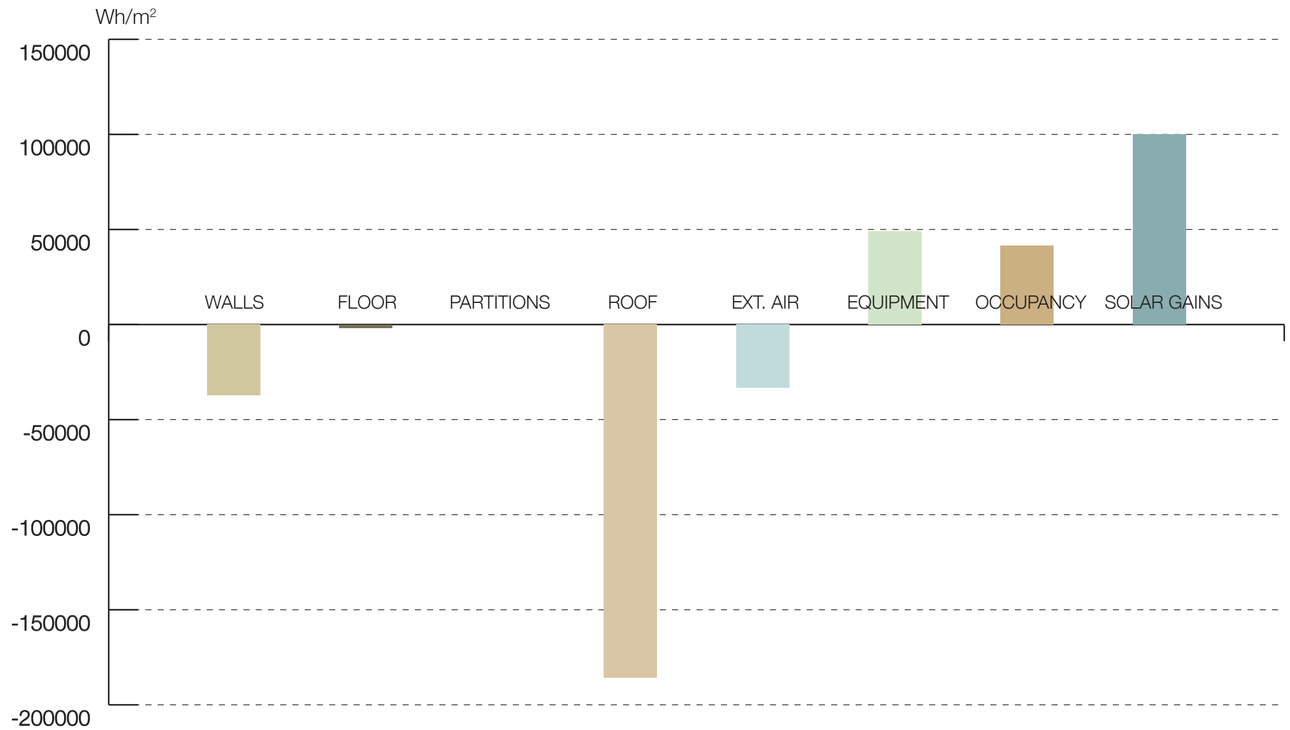
MECHANICAL VENTILATION TURNED ON - BASIC FAN COIL UNIT

ANALYSING THE ANNUAL ENERGY LOADS OF THE BASELINE



HEATING LOADS CONTRIBUTE TO A VAST MAJORITY OF THE BUILDINGS ENERGY CONSUMPTION. THIS IS CONSISTENT WITH THE COLD CLIMATE OF THE SITE IN NORFOLK.

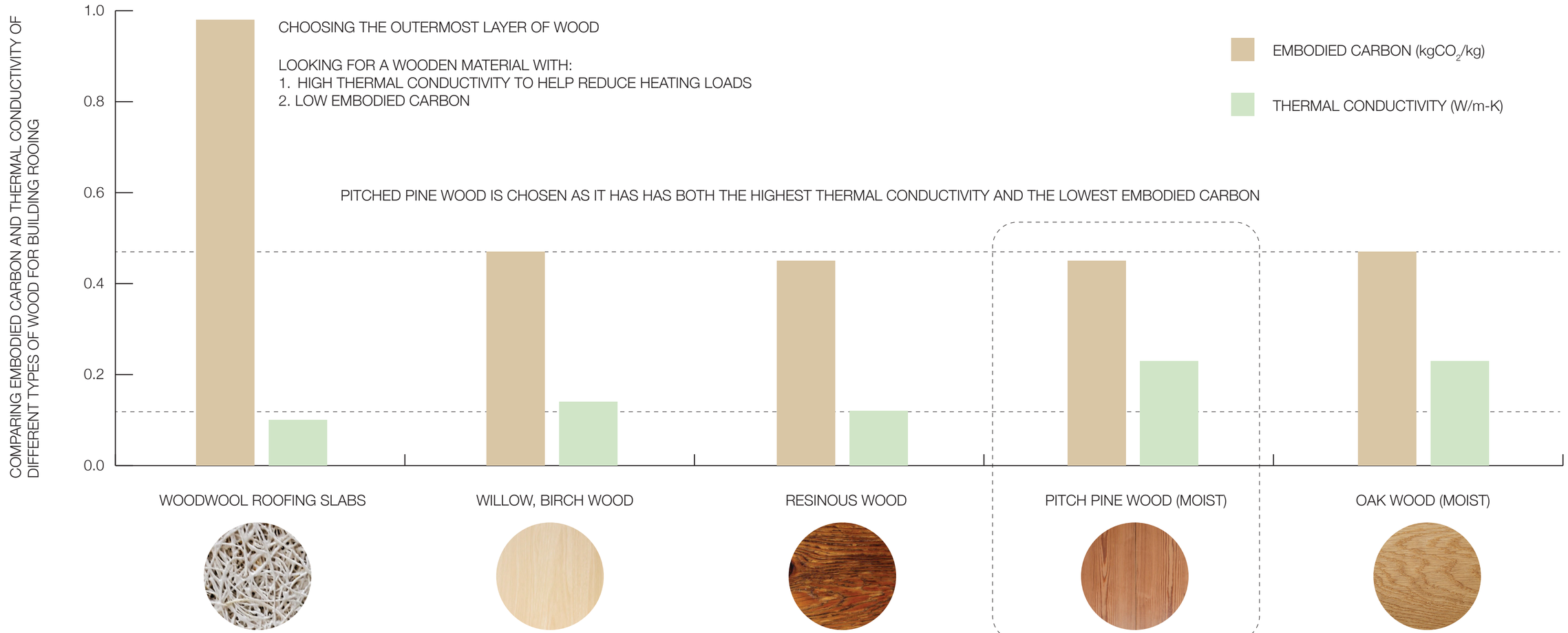
ANALYSING THE MAJOR CAUSES OF HEAT LOSS/GAIN IN THE BULDING ANNUALLY



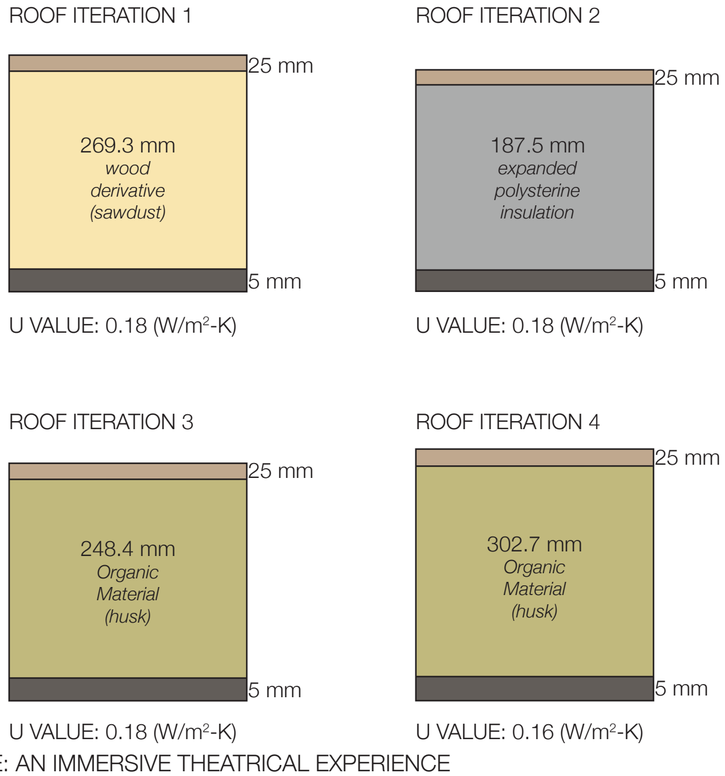
IT CAN BE OBSERVED THAT THE MAJOR CAUSE OF THE HEAT LOSS IS HAPPENING THROUGH THE FABRIC OF THE ROOF AND WALLS. THIS INDICATES THAT AN INSULATED BUILDING FABRIC WITH RESONABLY LOW U-VALUES NEED TO BE CHOSEN.

MOST OF THE HEAT GAIN IS THROUGH SOLAR GAINS AND SLIGHTLY THROUGH EQUIPMENT AND OCCUPANCY.

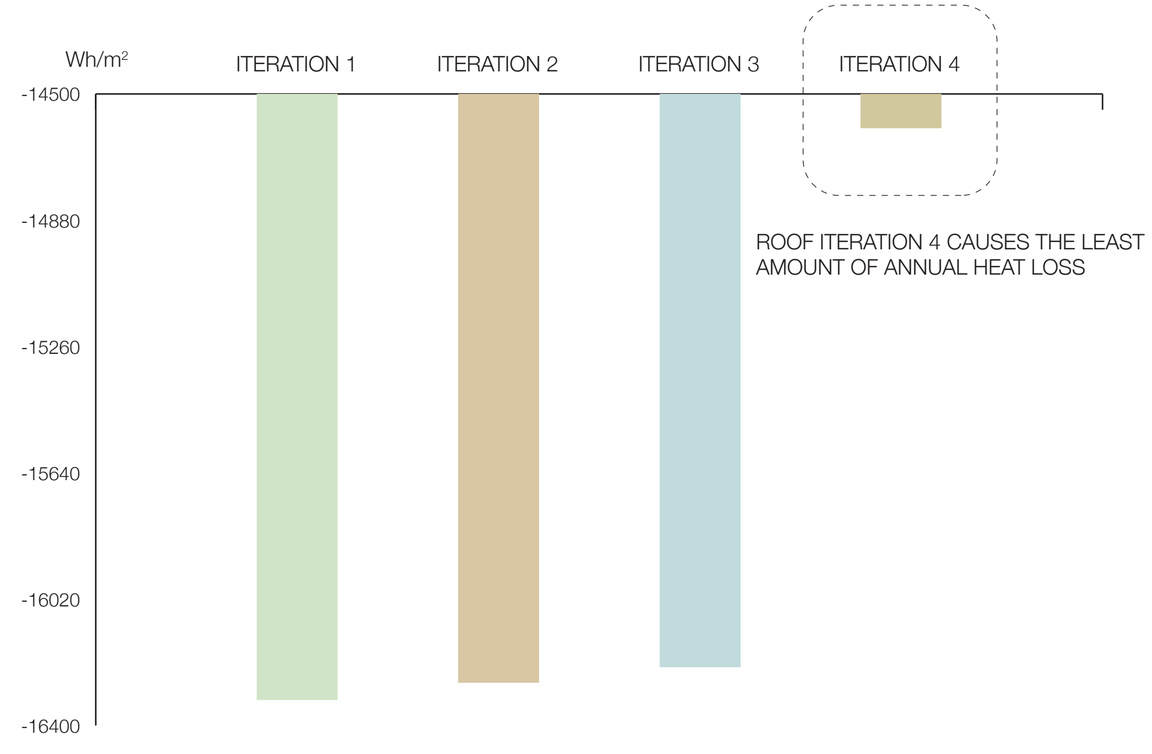
COMPARING EMBODIED CARBON AND THERMAL CONDUCTIVITY OF DIFFERENT TYPES OF WOOD FOR BUILDING ROOING



STUDYING VARIOUS ROOF COMPOSITIONS KEEPING 25 MM OF PITCH PINE WOOD (MOIST) AS THE OUTERMOST LAYER AND 5 MM OF ROOFING FELT AS THE INNERMOST LAYER AND VARYING INSULATION



COMPARING ANNUAL HEAT LOSS THROUGH THE ROOF BETWEEN DIFFERENT ROOF BUILDUP COMPOSITIONS



Lighting

1. Reference Standards

Using typical values from ASHRAE 90.1 and IESNA recommendations as guidelines for the LPD for different space types.

Box Office/Admin: 8-10 W/m²
Bar: 10-15 W/m²
Corridor: 3-5 W/m²
Rehearsal Space: 10-12 W/m²
Storage: 3-5 W/m²
Performing Arts Theatre: 10-15 W/m² (higher end for performance areas due to stage lighting needs)

Using average values within these ranges for the calculations.

2. Calculations

Box Office + Admin (194 sq m)
LPD: 9 W/m² (average value within the range)
Absolute Zone Power: 194 sq m * 9 W/m² = 1,746 W

Bar (203 sq m)
LPD: 12.5 W/m² (average value within the range)
Absolute Zone Power: 203 sq m * 12.5 W/m² = 2,537.5 W

Corridor (190 sq m)
LPD: 4 W/m² (average value within the range)
Absolute Zone Power: 190 sq m * 4 W/m² = 760 W

Rehearsal Space 1 (54 sq m)
LPD: 11 W/m² (average value within the range)
Absolute Zone Power: 54 sq m * 11 W/m² = 594 W

Rehearsal Space 2 (104 sq m)
LPD: 11 W/m² (same as Rehearsal Space 1 for consistency)
Absolute Zone Power: 104 sq m * 11 W/m² = 1,144 W

Storage (121 sq m)
LPD: 4 W/m² (average value within the range)
Absolute Zone Power: 121 sq m * 4 W/m² = 484 W

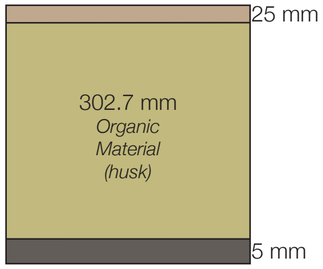
Performing Arts Theatre (707 sq m)
LPD: 12.5 W/m² (higher end of the range for stage lighting needs)
Absolute Zone Power: 707 sq m * 12.5 W/m² = 8,837.5 W

Summary of Absolute Zone Powers

Box Office + Admin: 1,746 W
Bar: 2,537.5 W
Corridor: 760 W
Rehearsal Space 1: 594 W
Rehearsal Space 2: 1,144 W
Storage: 484 W
Performing Arts Theatre: 8,837.5 W

Construction

ROOF CONSTRUCTION



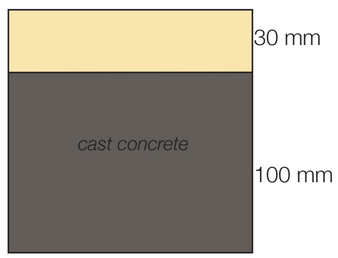
U-VALUE : 0.16 (W/m²-K)

WALL CONSTRUCTION



U-VALUE : 0.18 (W/m²-K)

FLOOR CONSTRUCTION



U-VALUE : 0.13 (W/m²-K)

Occupancy

1. Template Set-up

SETTING UP OCCUPANCY TEMPLATES ACCORDING TO ZONE ACTIVITY.

2. Setting Up Occupancy Density per Zone

Box Office + Admin (194 sq m)
Total Occupancy Limit: 20 people
Occupancy Density: 0.1 people/m²

Bar (203 sq m)
Total Occupancy Limit: 100 people
Occupancy Density: 0.5 people/m²

Corridor (190 sq m)
Total Occupancy Limit: 20 people
Occupancy Density: 0.1 people/m²

Rehearsal Space 1 (54 sq m)
Total Occupancy Limit: 30 people
Occupancy Density: 0.5 people/m²

Rehearsal Space 2 (104 sq m)
Total Occupancy Limit: 50 people
Occupancy Density: 0.5 people/m²

Storage (121 sq m)
Total Occupancy Limit: 6 people
Occupancy Density: 0.05 people/m²

Performing Arts Theatre (707 sq m)
Total Occupancy Limit: 500 people
Occupancy Density: 0.7 people/m²

Summary of Occupancy Density

Box Office + Admin: 0.1 people/m²
Bar: 0.5 people/m²
Corridor: 0.1 people/m²
Rehearsal Space 1: 0.5 people/m²
Rehearsal Space 2: 0.5 people/m²
Storage: 0.05 people/m²
Performing Arts Theatre: 0.7 people/m²

THE ABOVE RESULTS ARE A STARTING POINT FOR MAXIMISING ENVIRONMENTAL OPTIMIZATION FROM THE BUILDING. THESE FORM A BASIC STARTING POINT TO DEVELOP A SUCCESSFUL PASSIVE DESIGN STRATEGY FOR THE BUILDING.

ITERATION 1

SIMULATIONS SET-UP WITH MENTIONED CONSTRUCTION BUILDUP, LIGHTING AND OCCUPANCY. THE BUILDING RUNS HEATING AND COOLING COMPLETELY USING MECHANICAL VENTILATION

ITERATION 2

NATURAL VENTILATION TURNED ON TO REDUCE COOLING LOADS

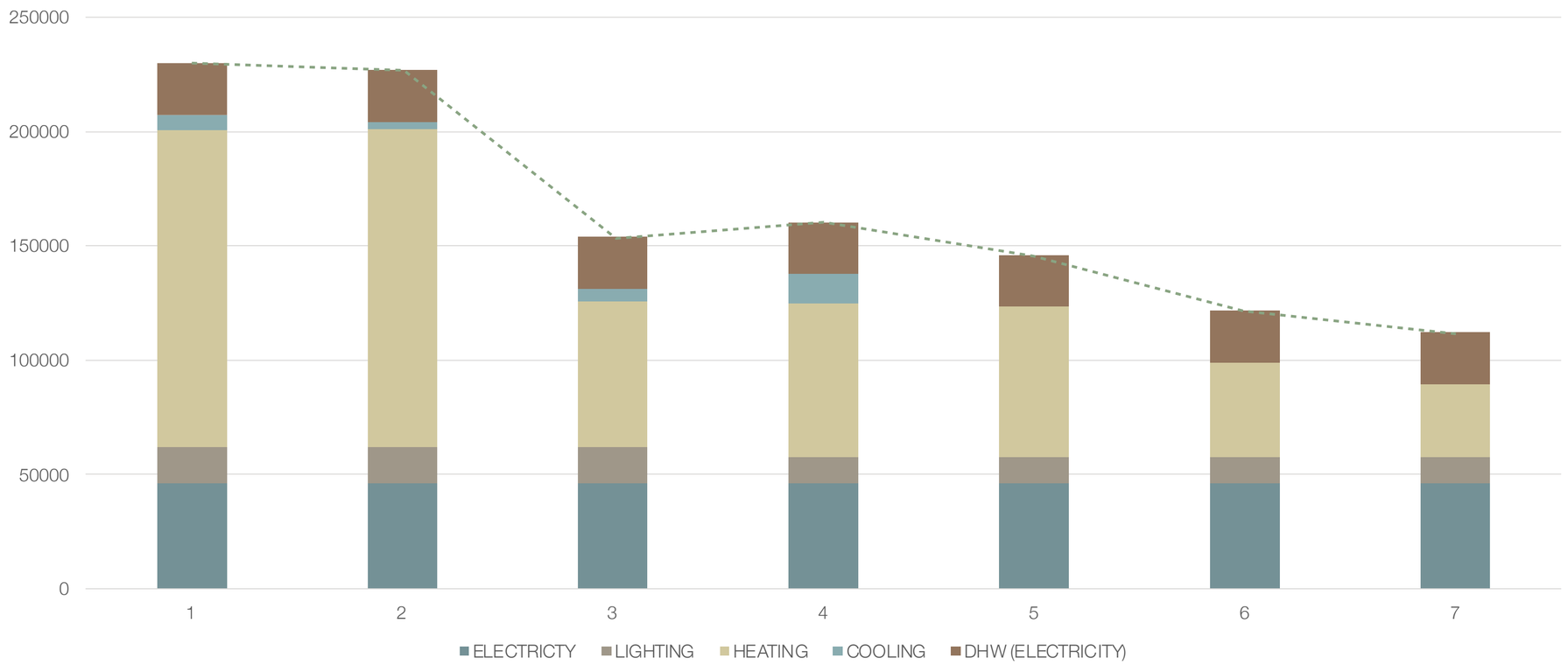
ITERATION 3

NATURAL VENTILATION TEMPERATURE CONTROL SET-POINTS ARE SET UP. THE OUTDOOR MINIMUM TEMPERATURE CONTROL BEING 14C AND THE OUTDOOR MAXIMUM TEMPERATURE CONTROL BEING 28C

ITERATION 4

THE OVERALL GLAZING ACROSS THE BUILDING INCREASED FROM AN ARCHITECTURAL STAND-POINT AND SO THE GLAZING ON THE MODEL WAS ALSO INCREASED. THIS WAS ALSO DONE WITH THE EXPECTATION TO INCREASE SOLAR GAINS, REDUCING HEATING AND INCREASE NATURAL LIGHT, REDUCE LIGHTING LOADS

PASSIVE DESIGN ITERATIONS



ITERATION 5

CONSIDERING THE CLIMATE OF THE SITE AND THE GENERAL LOW TEMPERATURE, COOLING IS TURNED OFF AND NATURAL VENTILATION IS EXPECTED TO COOL SPACES

ITERATION 6

THE HEATING AND COOLING SET POINTS ARE READJUSTED.

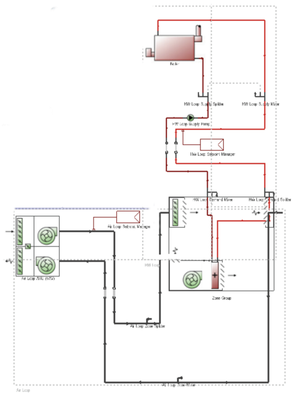
HEATING SET POINT: 20C
HEATING SET BACK: 13C
COOLING SET POINT: 25C
COOLING SET BACK: 28C

ITERATION 7

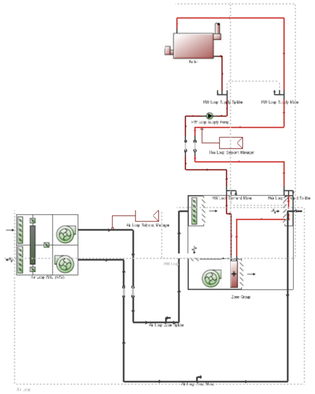
READJUSTING THE NATURAL VENTILATION SCHEDULE BY SEASON. THE AIR CHANGE RATE IS SET TO 2 ACH TO LOWER THE NATURAL VENTILATION IN THE WINTER AND IS SET TO 5 ACH FOR COOLING IN THE SUMMER

DETAILED HVAC ITERATIONS

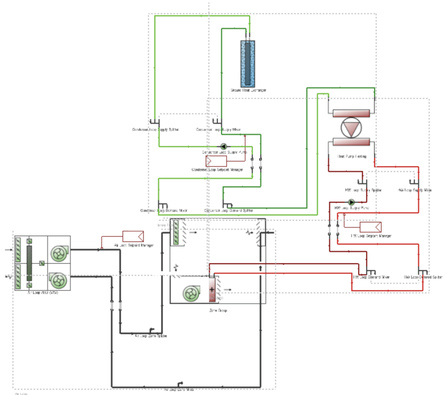
OPTION 1: VAV + FCU + BOILER



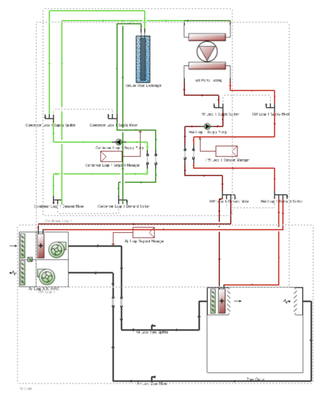
OPTION 2: VAV + FCU + BOILER + HEAT RECOVERY



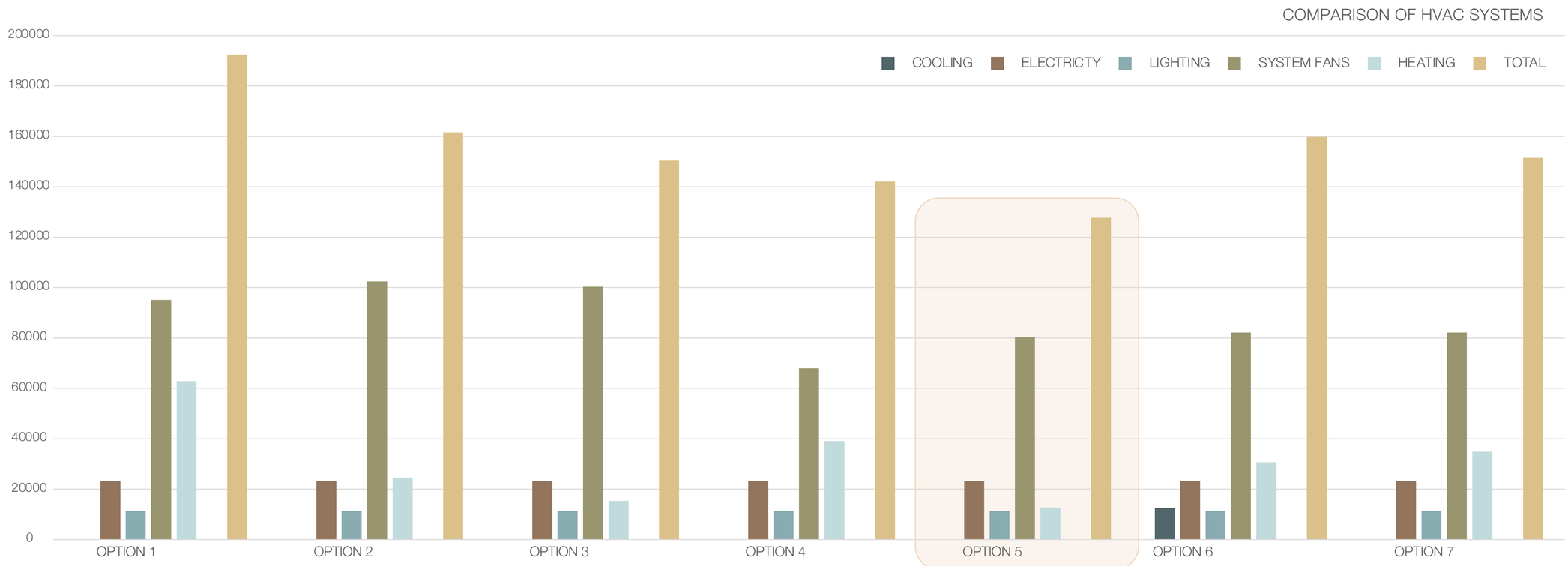
OPTION 3: VAV + FCU + GSHP + HEAT RECOVERY



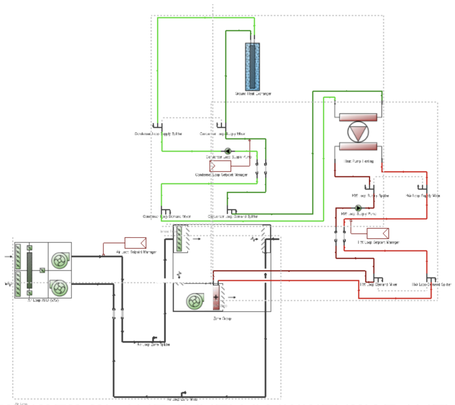
OPTION 4: VAV + GSHP



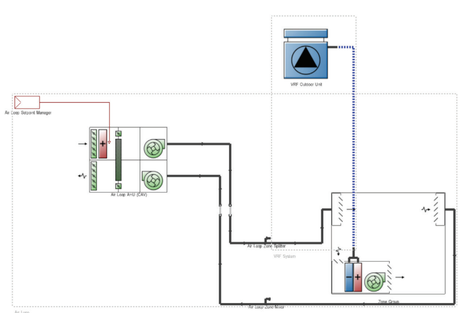
COMPARISON OF HVAC SYSTEMS



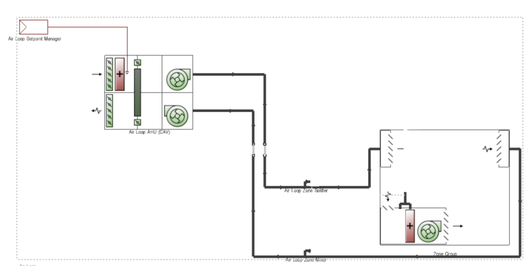
OPTION 5: VAV + GSHP + HEAT RECOVERY



OPTION 6: VRF + HEAT RECOVERY + DOAS



OPTION 7: VRF + HEAT RECOVERY + DOAS + NO COOLING

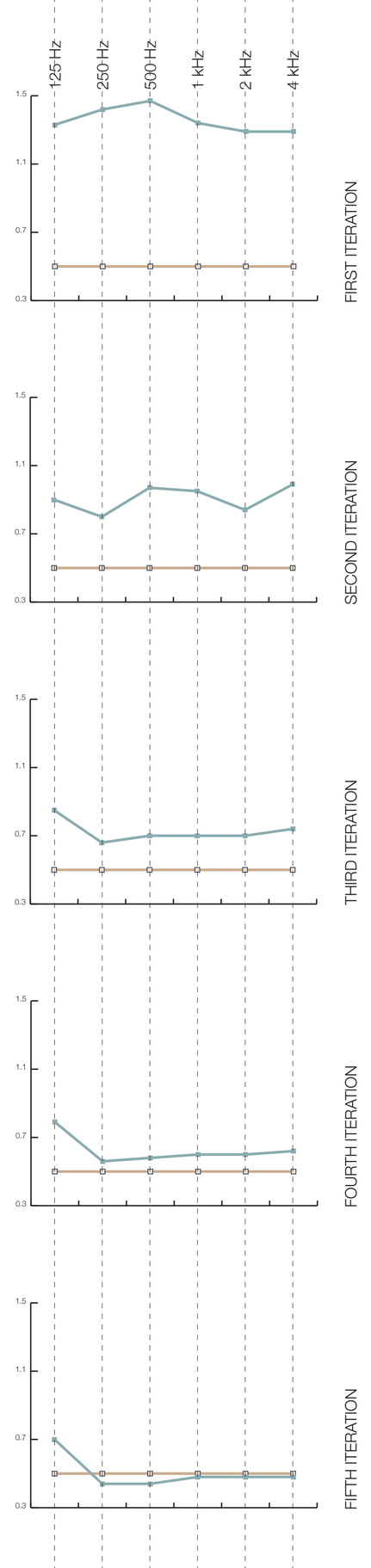


RICAL EXPERIENCE

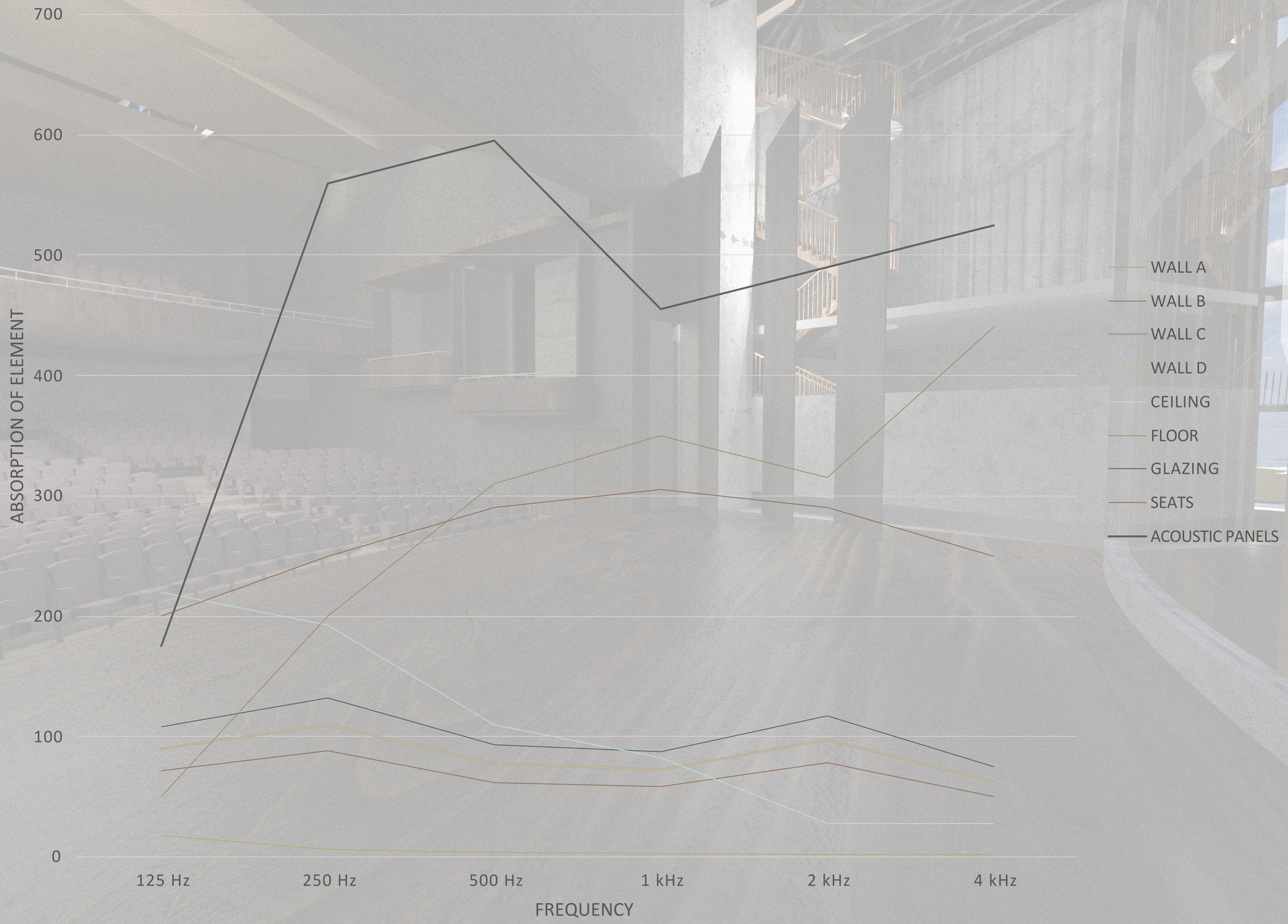
REVERBERATION TIME CALCULATIONS

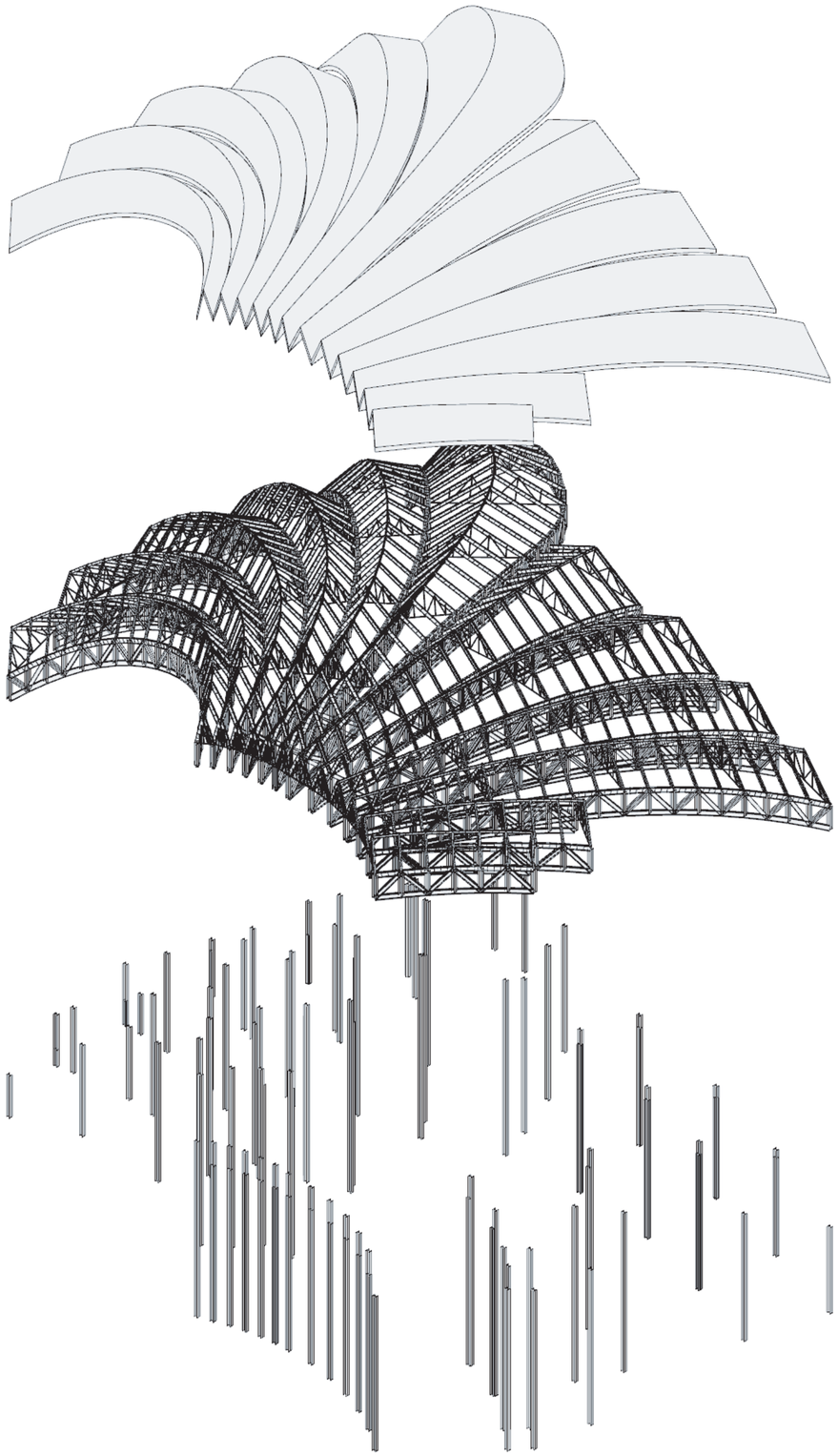
MATERIALISING THE THEATRE FOR OPTIMUM ACOUSTIC PERFORMANCE

		FIRST ITERATION	SECOND ITERATION	THIRD ITERATION	FOURTH ITERATION	FIFTH ITERATION
WALL A	300 m²	CONCRETE BLOCK (PAINTED)	CONCRETE BLOCK (COARSE)	CONCRETE BLOCK (COARSE)	CONCRETE BLOCK (COARSE)	CONCRETE BLOCK (COARSE)
WALL B	200 m²	CONCRETE BLOCK (PAINTED)	CONCRETE BLOCK (COARSE)	CONCRETE BLOCK (COARSE)	CONCRETE BLOCK (COARSE)	CONCRETE BLOCK (COARSE)
WALL C +WALL D	250 m²	CONCRETE BLOCK (PAINTED)	CONCRETE BLOCK (COARSE)	CONCRETE BLOCK (COARSE)	CONCRETE BLOCK (COARSE)	CONCRETE BLOCK (COARSE)
ROOF	550 m²	WOOD ROOF DECKING	WOOD ROOF DECKING	WOOD ROOF DECKING	WOOD ROOF DECKING	WOOD ROOF DECKING
FLOOR	500 m²	CARPET	CARPET	CARPET (LOOP-PILE) TUFTED	CARPET (LOOP-PILE) TUFTED	CARPET (LOOP-PILE) TUFTED
GLAZING	100 m²	GLASS (LARGE PANE)	GLASS (LARGE PANE)	GLASS (LARGE PANE)	GLASS (LARGE PANE)	GLASS (LARGE PANE)
SEATING	500 m²	SEATS (FABRIC-UPHOLSTERD, FULLY OCCUPIED)	SEATS (FABRIC-UPHOLSTERD, FULLY OCCUPIED)	SEATS (FABRIC-UPHOLSTERD, FULLY OCCUPIED)	SEATS (FABRIC-UPHOLSTERD, FULLY OCCUPIED)	SEATS (FABRIC-UPHOLSTERD, FULLY OCCUPIED)
ACOUSTIC PANELS		NO PANELS	NO PANELS	NO PANELS	HARDSIDE BAFFLES 250 m²	HARDSIDE BAFFLES 550 m²
AVERAGE RT60 (TARGET 0.5 m²sabins)		1.36	0.9	0.73	0.63	0.5

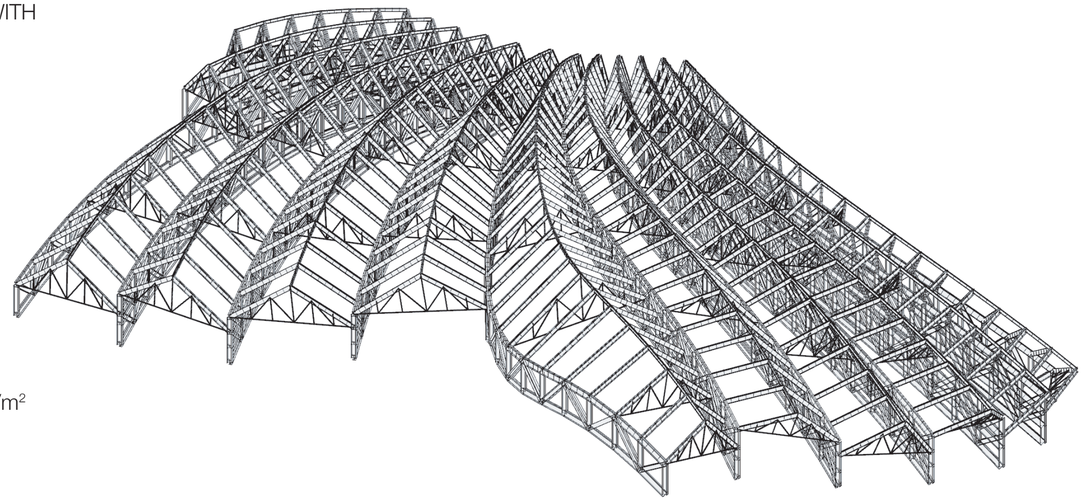


ABSORPTION OF EACH SURFACE WITHIN THE THEATRE





THE ROOFING MATERIAL USED IS MOIST PITCH PINE WOULD, LAYERED WITH INSULATION AND ROOF FELT.



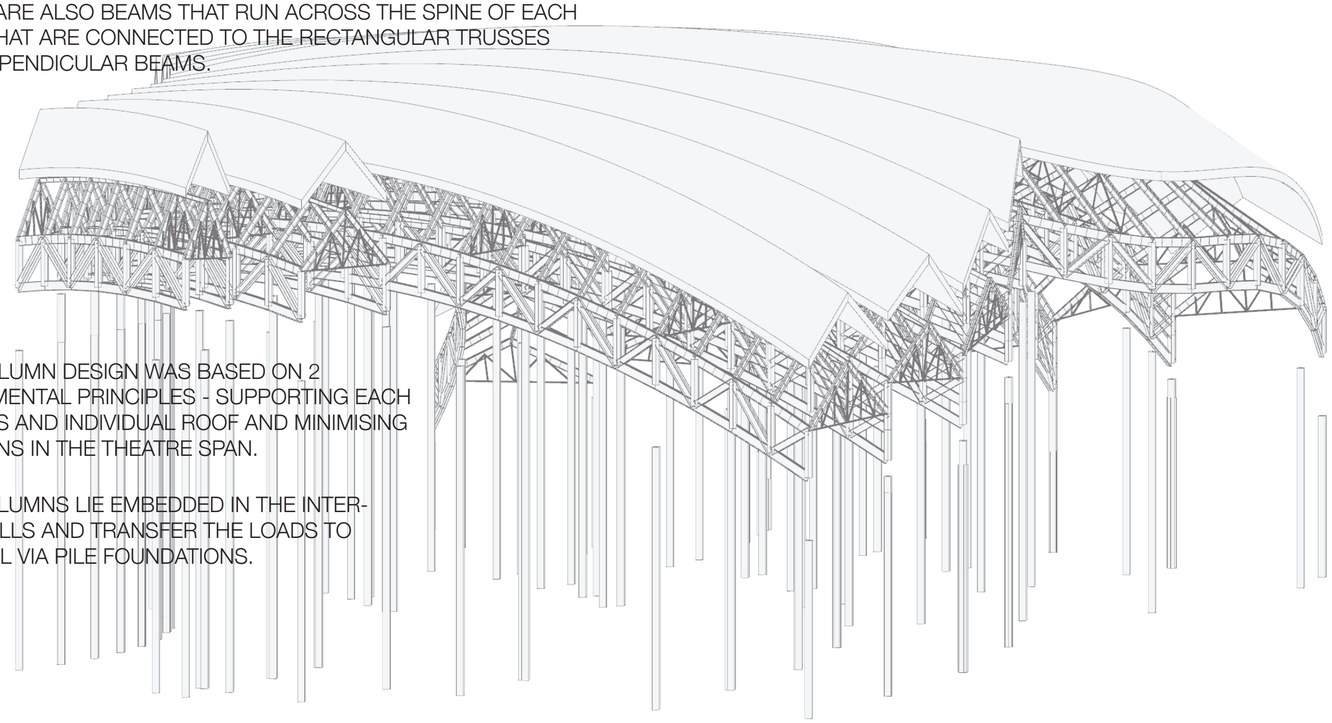
CALCULATING ROOF LOADS

LIVE LOADS = 1 x 1.5 kN/m^2
DEAD LOADS = 1.5 x 1.35 kN/m^2

TOTAL ROOF LOADS = 3.525 kN/m^2

THE BASIC BUILDUP OF THE ROOF STRUCTURAL SYSTEM CONSISTS OF EACH ROOF WING SUPPORTED BY RECTANGULAR WARREN TRUSSES ON EITHER EDGE OF THE WING AND TRIANGULAR DOUBLE HOWE TRUSSES RUNNING THROUGH WITH A SPAN OF 6 m BETWEEN THEM.

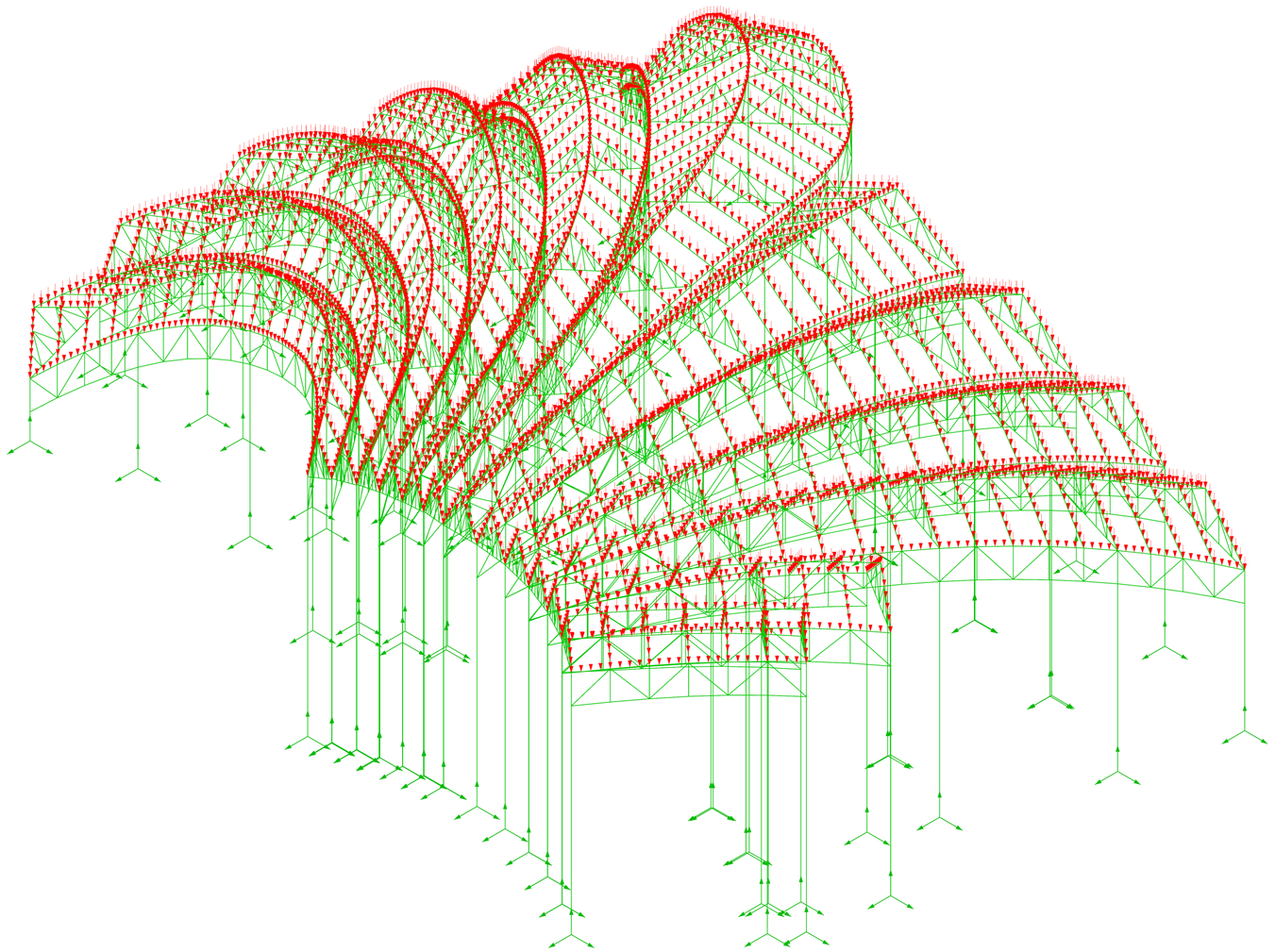
THERE ARE ALSO BEAMS THAT RUN ACROSS THE SPINE OF EACH WING THAT ARE CONNECTED TO THE RECTANGULAR TRUSSES VIA PERPENDICULAR BEAMS.



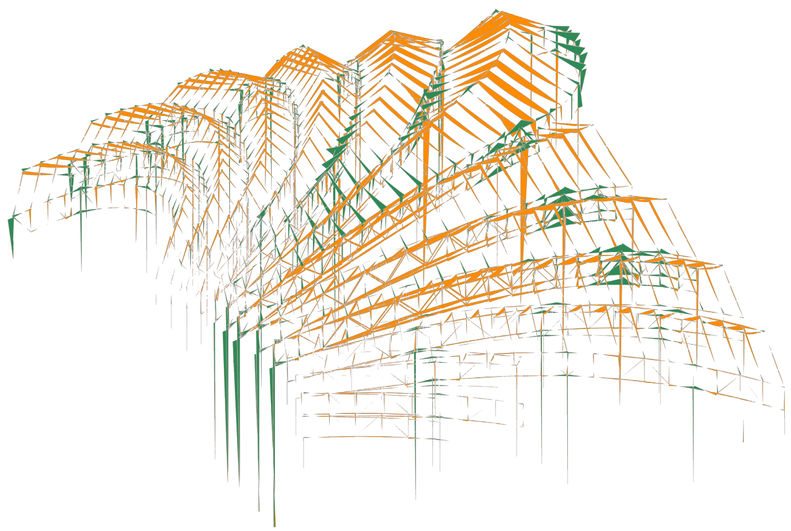
THE COLUMN DESIGN WAS BASED ON 2 FUNDAMENTAL PRINCIPLES - SUPPORTING EACH WING AS AND INDIVIDUAL ROOF AND MINIMISING COLUMNS IN THE THEATRE SPAN.

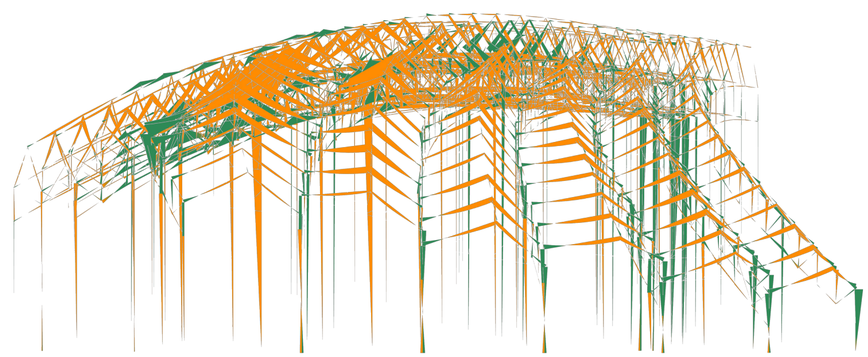
THE COLUMNS LIE EMBEDDED IN THE INTERNAL WALLS AND TRANSFER THE LOADS TO THE SOIL VIA PILE FOUNDATIONS.

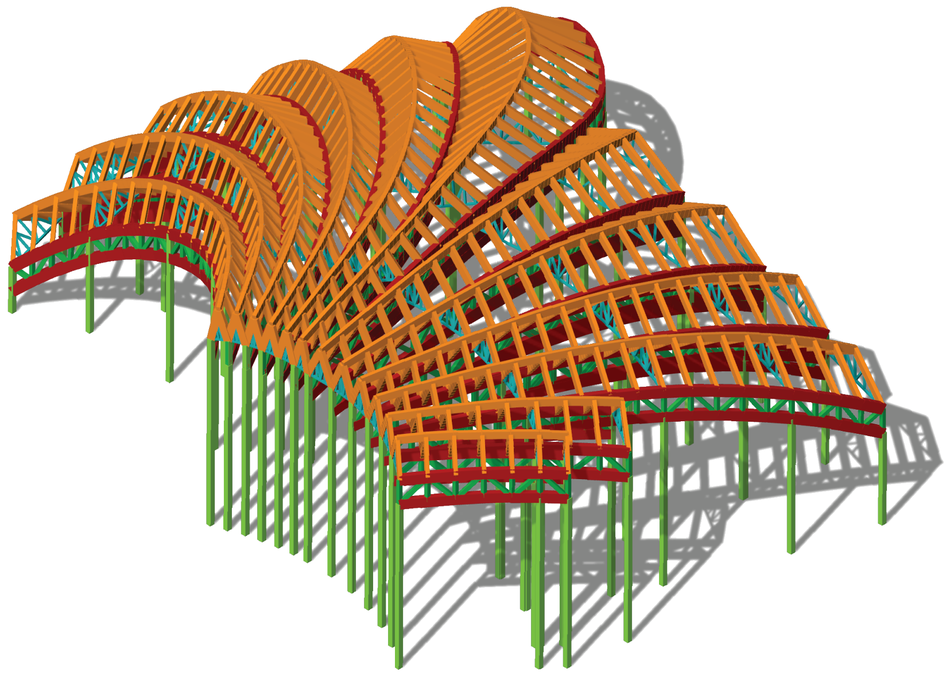
DIAGRAMMATIC REPRESENTATION OF LOADS AND SUPPORTS ON THE STRUCTURAL SYSTEM



BENDING MOMENT DIAGRAMS OF THE STRUCTURAL SYSTEM







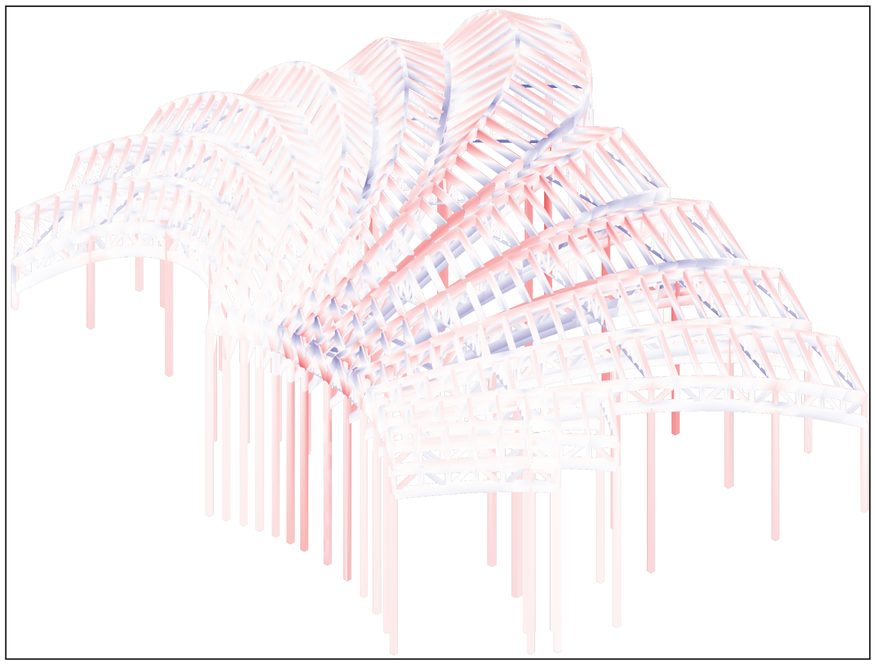
STRUCTURAL SYSTEM OPTIMISATION: TIMBER STRUCTURAL SYSTEM

IN COHESION WITH THE BUILDINGS AESTHETIC MATERIALITY AS WELL AS THE PROJECTS SUSTAINABILITY ETHOS, THE INITIAL IDEA WAS TO DESIGN A TIMBER FRAME STRUCTURAL SYSTEM.

THE TOTAL AMOUNT OF TIMBER USED IN THE OPTIMISED AND SIZED TIMBER STRUCTURE IS 8857.8 TONNES OF TIMBER.

MEMBER SIZING

STRUCTURE UTILIZATION

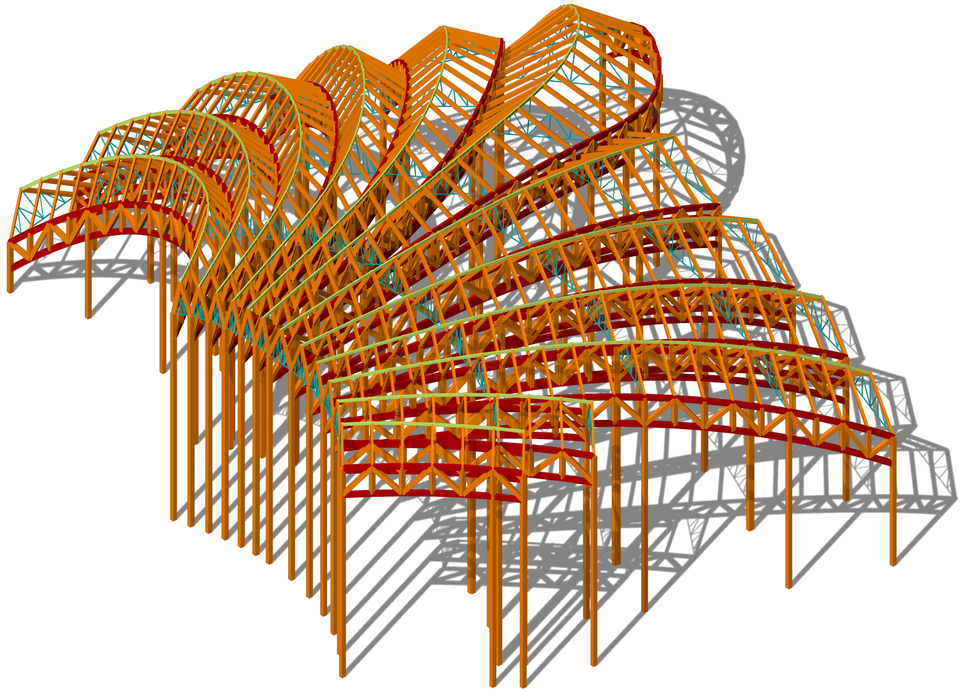


-98.4% 0% 103.5%

STRUCTURAL DISPLACEMENT VISUALISATION



0 cm 10.2 cm



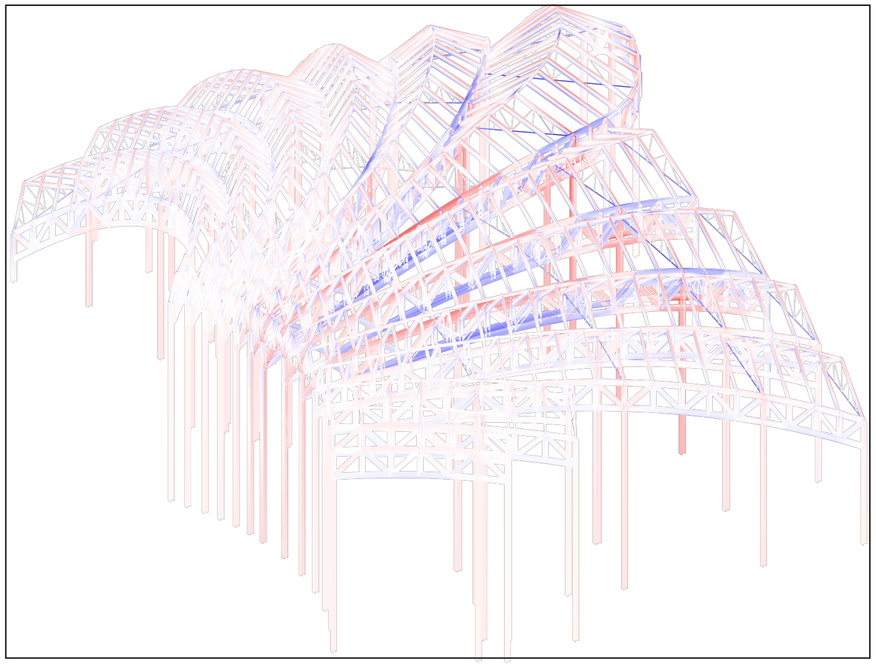
STRUCTURAL SYSTEM OPTIMISATION: STEEL STRUCTURAL SYSTEM

IN ORDER TO IMPROVE THE STRUCTRAL SYSTEM, REDUCE SIZING OF THE MEMBERS IN ORDER TO OBTAIN A LESS IMPOSING STRUCTURAL SYSTEM, TIMBER WAS REPLACED WITH STEEL I-BEAMS

THE TOTAL AMOUNT OF STEEL USED IN THE OPTIMISED AND SIZED STEEL STRUCTURE IS 8155.7 TONNES OF STEEL.

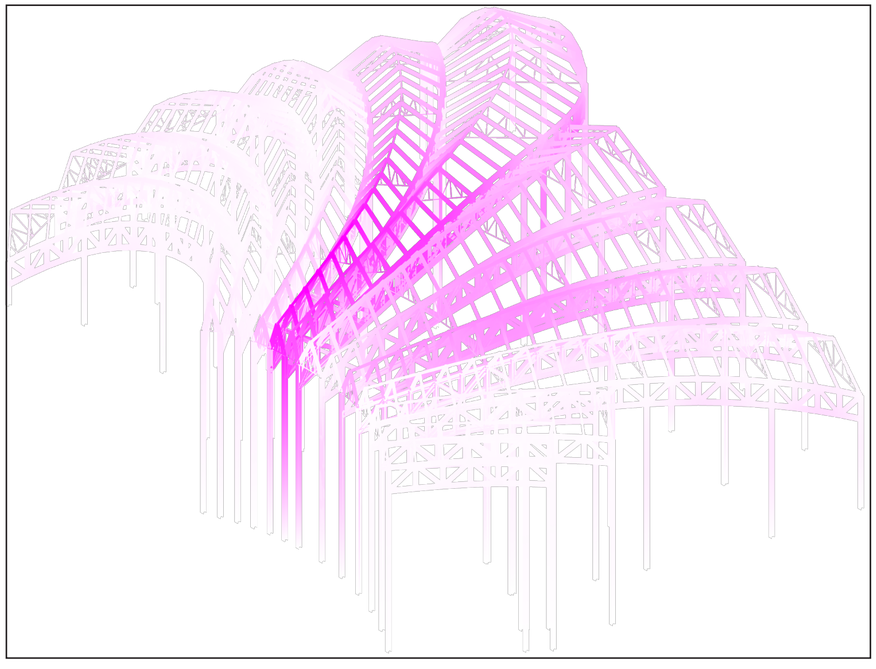
MEMBER SIZING

STRUCTURE UTILIZATION



-79.3% 0% 73%

STRUCTURAL DISPLACEMENT VISUALISATION



0 cm 8.23 cm

COMPARING TIMBER AND STEEL STRUCTURES -

THE STEEL STRUCTURE IS FINALLY SELECTED FOR THE BUILDING DUE TO THE LESS IMPOSING APPEARANCE, LESS USE OF MATERIAL, LOWER DISPLACEMENT AND HIGHER STRUCTURAL OPTIMIZATION

Embodied carbon coefficient for steel: approximately 1.9 tonnes CO_2 per tonne of steel.
Embodied carbon coefficient for timber: approximately 0.2 tonnes CO_2 per tonne of timber.

Embodied carbon for steel:

8155.7 × 1.9 = 15495.83 tonnes CO_2

Embodied carbon for timber:

8857.8 × 0.2 = 1771.56 tonnes CO_2

Difference in embodied carbon:

15495.83 – 1771.56 = 13724.27 tonnes CO_2

Material Transport Assumptions

STEEL from Scunthorpe Steelworks, Scunthorpe, North Lincolnshire (273 km approx.)

TIMBER from Thetford Forest, Norfolk (72 km approx.)

Emissions for Steel:

Mass of Steel=8155.7 tonnes

Distance=273 km

Emission factor=0.132 kg CO_2/tkm

Emissions=8155.7 tonnes×273 km×0.132 kg CO_2/tkm
=293,642.22 kg CO_2
Emissions for Timber:

Mass of Timber=8857.8 tonnes

Distance=72 km

Emission factor=0.132 kg CO_2/tkm

Emissions=8857.8 tonnes×72 km×0.132 kg CO_2/tkm=84,399.40 kg CO_2

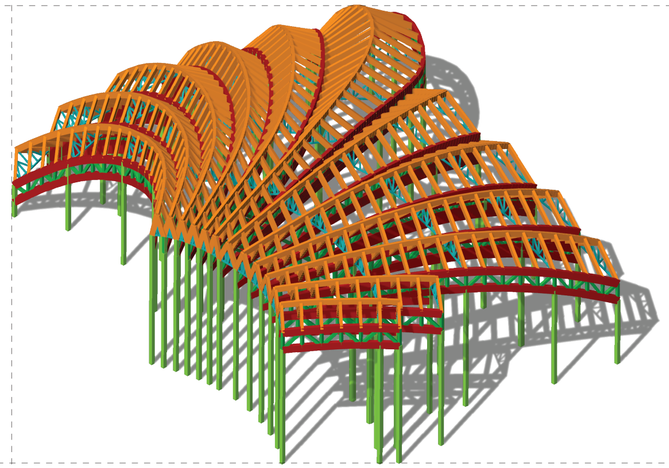
Summary of Transport Emissions
Emissions for transporting steel: 293,642.22 kg CO_2 (or approximately 293.64 tonnes CO_2).
Emissions for transporting timber: 84,399.40 kg CO_2 (or approximately 84.40 tonnes CO_2).

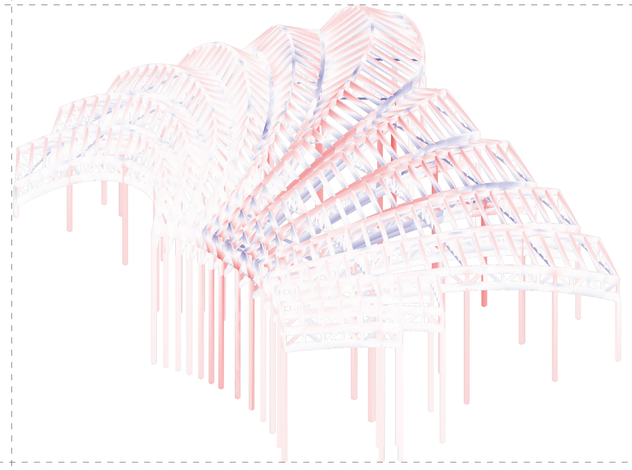
MEMBER SIZING

OPTIMIZATION

DISPLACEMENT

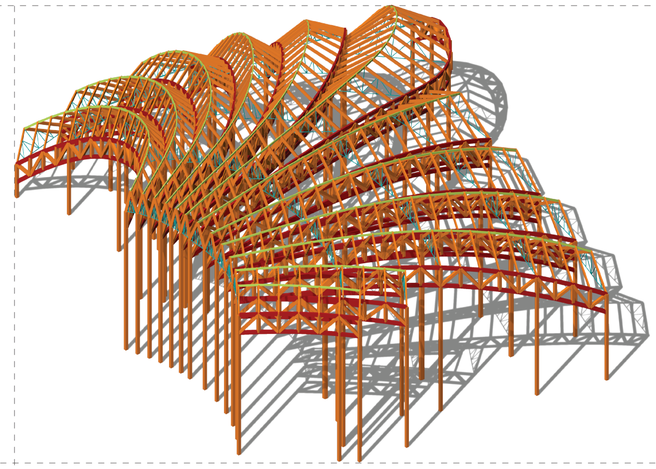
TIMBER STRUCTURE

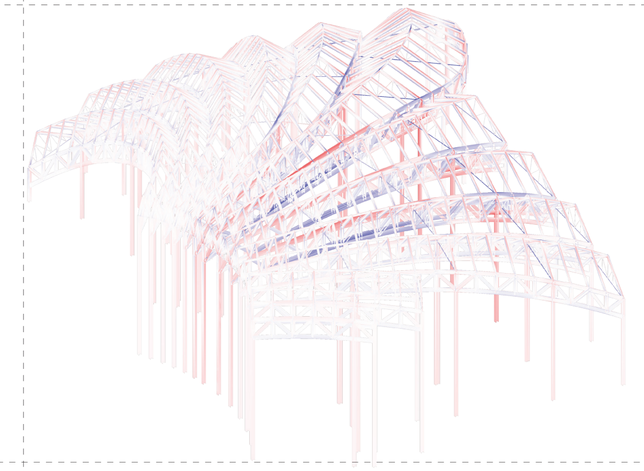






STEEL STRUCTURE







FINAL MASTERPLAN
1:500

INDEX

1. CAFE BY THE POND
2. WINDMILL
3. DOCK A
4. SEATING BY THE BIRD PARK
5. BIRD PARK
6. AMPHIBIOUS AMPHITHEATRE
7. MAIN INDOOR THEATRE
8. DOCK B
9. FLOATING STAGES
10. ROW-THROUGH THEATRE
11. VIEW-POINT

GROUND LEVEL FLOORPLAN
1:200

INDEX OF SPACES

1. THEATRE ENTRANCE
2. BAR + CAFE
3. BAR LOUNGE
4. FOYER SPACE
5. CATERING STORE / PANTRY
6. CORRIDOR BENCH A
7. MALE VISITOR TOILETS
8. FEMALE VISITOR TOILETS
9. CORRIDOR BENCH B
10. REFRESHMENTS
11. THEATRE CONTROL ROOM
12. REHEARSAL HALL 1
13. STAGE MANAGER + FIRST AID ROOM
14. SCENE / PROPERTY ENTRANCE
15. SCENE DOCK + PROPERTY STORE
16. MAIN STAGE
17. CLOAK ROOM
18. REHEARSAL HALL 2
19. AUDITORIUM STORE
20. BOX OFFICE ENTRANCE
21. LOUNGE + SHOW MERCHANDISING AND EXHIBITION
22. BOX OFFICE
23. RECEPTION + SECURITY
24. MANAGER + CASH OFFICE
25. MALE STAFF TOILETS
26. FEMAILE STAFF TOILETS
27. GREEN ROOM
28. COSTUME STORE
29. VIP GREEN ROOM
30. PERFORMERS STAGE ENTRY
31. GROUND LEVEL THEATRE SEATING

BOX SEATING LEVEL FLOORPLAN
1:200

A

B

INDEX OF SPACES

1. BOX TOILET A
2. BOX LOUNGE A
3. BOX A1
4. BOX A2
5. BAR A
6. BOX TOILET B
7. BOX LOUNGE B
8. BOX B1
9. BOX B2
10. BAR B
11. AIR HANDLING UNIT (AHU)

BALCONY LEVEL FLOORPLAN
1:200

A

B

1

2

3

4

5

6

7

8

9

INDEX OF SPACES

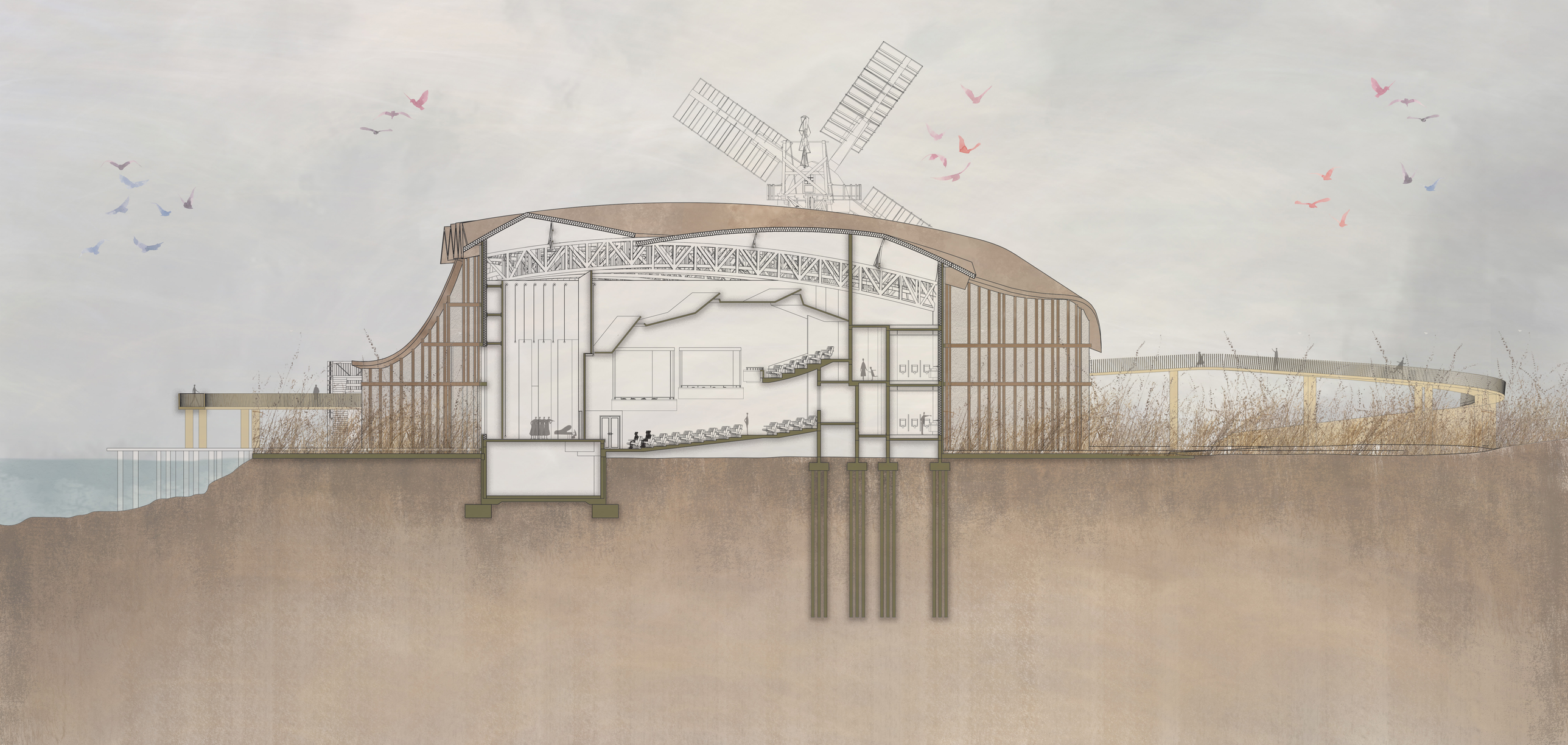
1. BALCONY SEATING
2. MALE TOILETS
3. FEMALE TOILETS
4. FOYER SPACE
5. REHEARSAL ROOM 1
6. STORAGE SPACE
7. REHEARSAL ROOM 2
8. SCENE STORE

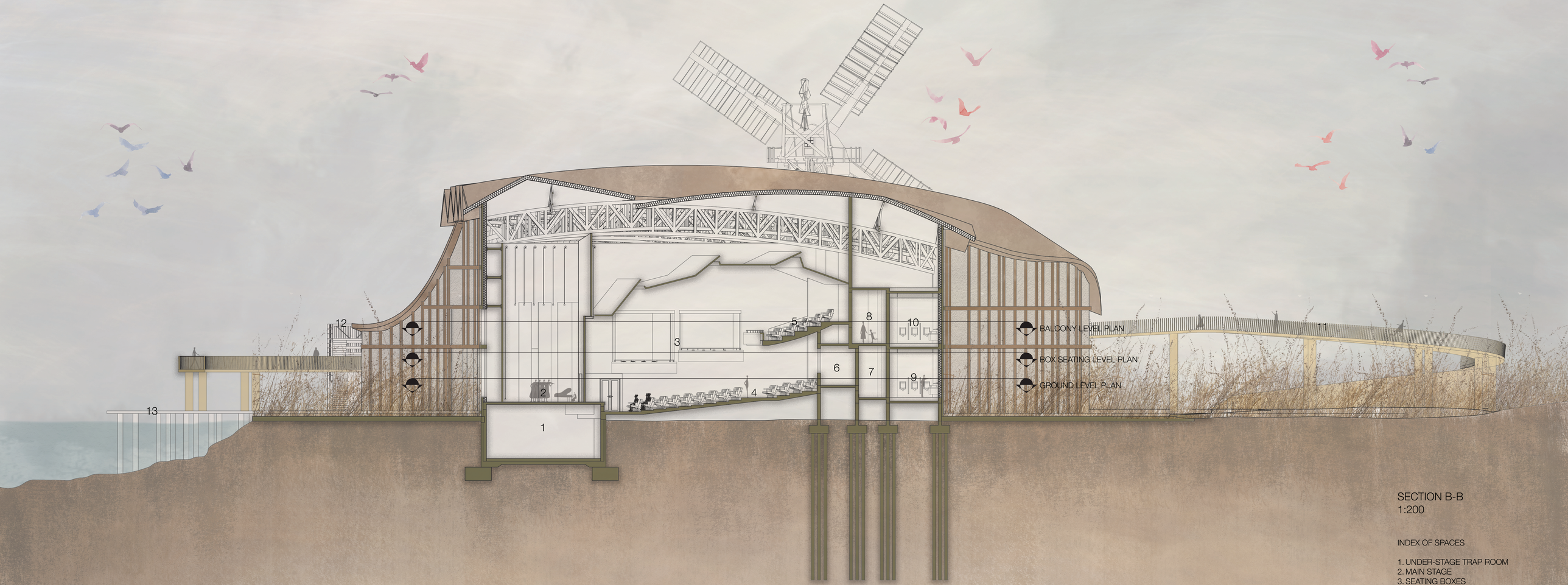
N

W

E

S

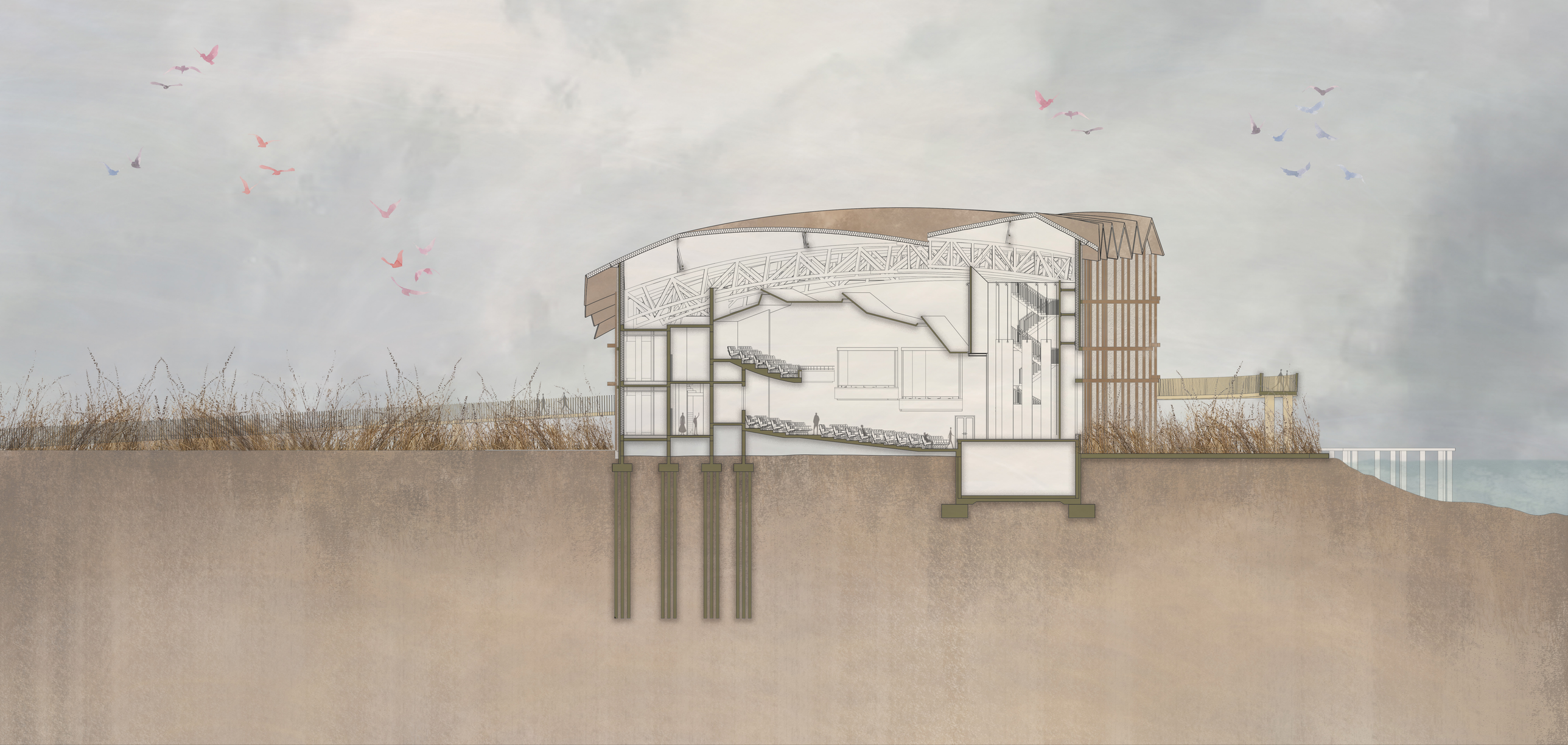




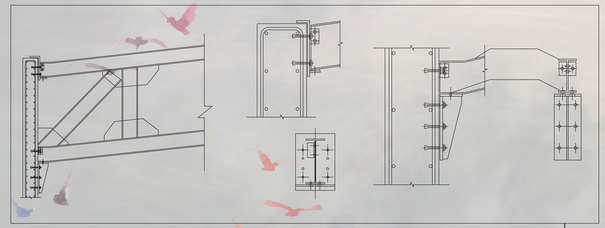
SECTION B-B
1:200

INDEX OF SPACES

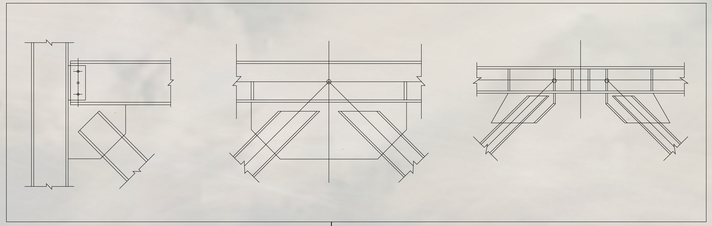
1. UNDER-STAGE TRAP ROOM
2. MAIN STAGE
3. SEATING BOXES
4. GROUND FLOOR SEATING
5. BALCONY SEATING
6. THEATRE CONTROL ROOM
7. GROUND FLOOR CORRIDOR
8. BALCONY LEVEL CORRIDOR
9. GROUND FLOOR TOILETS
10. BALCONY LEVEL TOILETS
11. PATHWAY
12. AMPHITHEATRE
13. DOCK

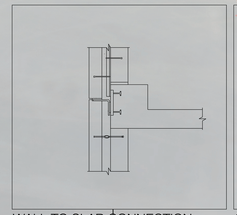


ROOF TRUSS TO WALL CONNECTION

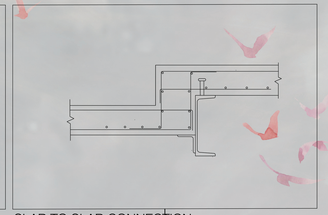


TRUSS CONNECTIONS

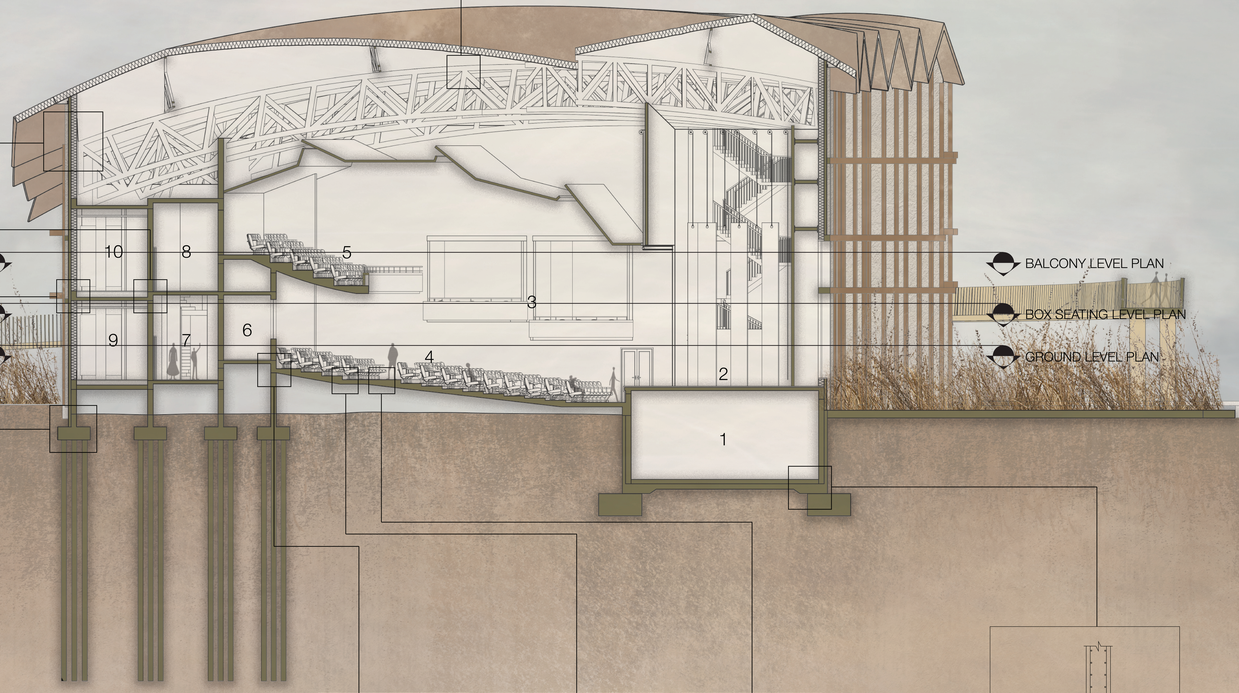


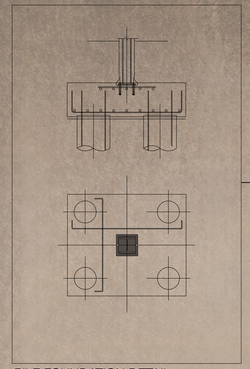


WALL TO SLAB CONNECTION



SLAB TO SLAB CONNECTION

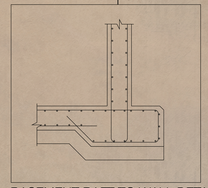




PILE FOUNDATION DETAIL



GROUND SLAB DETAILS



BASEMENT RAFT TO WALL DETAIL

SECTION A-A
1:200

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1. UNDER-STAGE TRAP ROOM
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8. BALCONY LEVEL CORRIDOR
9. GROUND FLOOR TOILETS
10. BALCONY LEVEL TOILETS
11. PATHWAY
12. DOCK

EXTERNAL RENDER OF THE PROJECT FROM THE NORTH-WEST DURING THE DAY



ECHOES OF THE YARE: AN IMMERSIVE THEATRICAL EXPERIENCE

INTERNAL RENDER SHOWING THE THEATRE AND BACKSTAGE DURING THE DAY



ECHOES OF THE YARE: AN IMMERSIVE THEATRICAL EXPERIENCE

INTERNAL RENDER SHOWING THE THEATRE DURING THE DAY



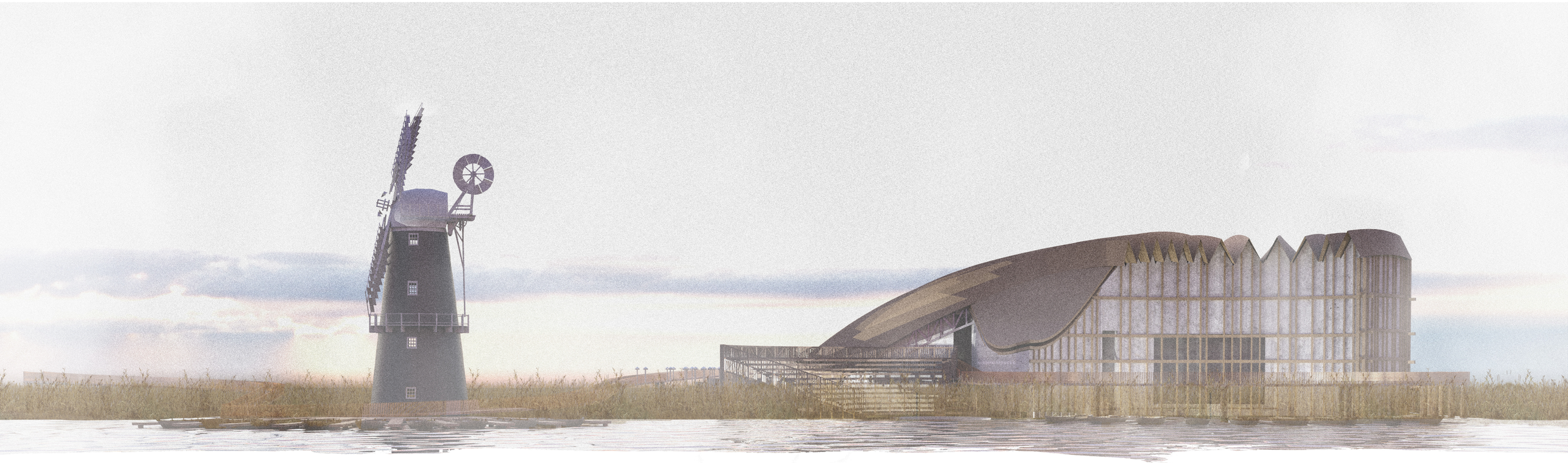
ECHOES OF THE YARE: AN IMMERSIVE THEATRICAL EXPERIENCE

INTERNAL RENDER SHOWING THE THEATRE DURING THE NIGHT

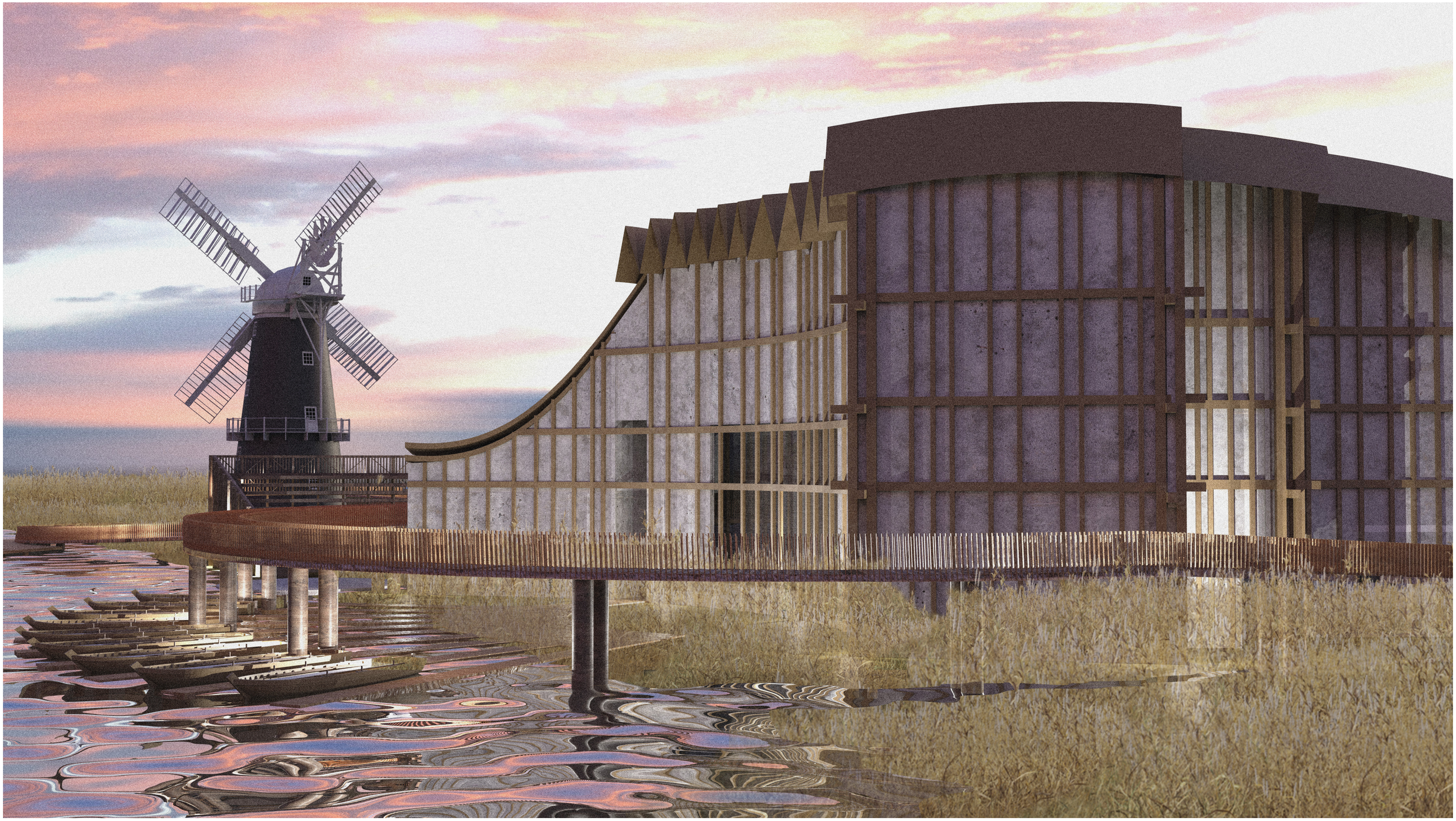


ECHOES OF THE YARE: AN IMMERSIVE THEATRICAL EXPERIENCE

PROJECT ELEVATION FROM THE RIVERSIDE

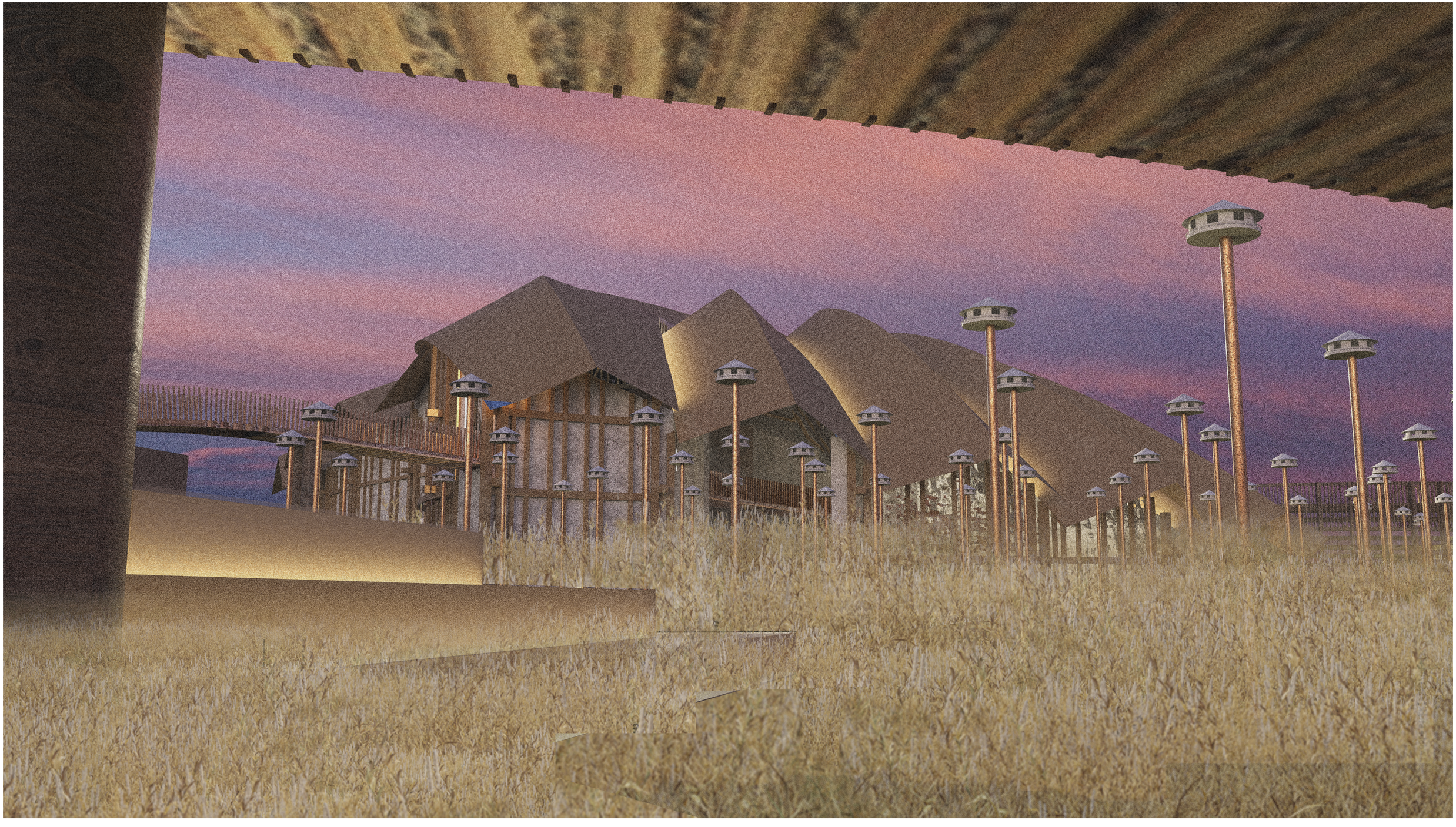


EXTERNAL RENDER OF THE PROJECT FROM THE NORTH-EAST DURING THE SUNSET



ECHOES OF THE YARE: AN IMMERSIVE THEATRICAL EXPERIENCE

EXTERNAL RENDER SHOWING THE BIRD PARK AND ITS VARIOUS BIRD HOUSES



ECHOES OF THE YARE: AN IMMERSIVE THEATRICAL EXPERIENCE

EXTERNAL RENDER SHOWING THE PATHWAY ENTERNING THE BUILDING



EXTERNAL RENDER SHOWING THE BOATS DOCKED AT DAWN

