Winter Presentation
Express Team

Nick - SE
Leyla - CM
David - SE
Mikki - MEP
Johanna - CM
Sara - A

A  SE  MEP  CM
Team Process

Kick-off | Online | The Crit | Owner Meeting | Winter Presentation

CM | A | MEP | SE
Location – Ljubljana, Slovenia
Location - Analysis

1. Destinations
2. Roads and paths
3. Agricultural geometries

Locations:
- Rožnik hill
- Zoč
- City center
- Barje

Areas:
- Forest
- Factory
- Residential area
- Faculty buildings
- Public area
- Project site
- Roads
- Paths
- Fields direction
- River

Directions:
- SE
- MEP
- CM

Map:
- Roads
- Paths
- Fields direction
- River
Location – Site Conditions

- **Flood Hazard (WHO): Low**
  - Cause: Heavy downpour

- **Snow Loads**: 2 kN/m²
  - Max Depth: 50 cm

- **Ground Accel.**: 0.225g
  - Max Magnitude: 6.1 (1895)

- **Avg. Wind Speed**: 2 m/s

**Temperature**

Average min and max temperatures in Ljubljana, Slovenia. Copyright © 2015 www.weatherandclimate.com

**Rain/snow**

Average precipitation (in mm/i.e. rain) in Ljubljana, Slovenia. Copyright © 2015 www.weatherandclimate.com
Air Quality

Ljubljana, Limit or target value **exceeded**
“The aim is for Slovenia to improve the **quality of ambient air** in future by seeking more **effective solutions**, especially in the **transport sector**, and by devoting greater **attention to education, notification and awareness-raising**”

- Slovenian environmental agency
Architectural Concepts

The Alder tree

Kozolec
Atrium

Middle of building

Floor plans

Connections

No need for artificial lighting

Sections

Views up and down

Vegetation in the middle of volume

Side of building

Floor plans

Connections

Sides to outward

No need for artificial light in the middle of the volume

Vegetation in the middle of volume

Views inside up and down

Vegetation in the middle

No glass roof = less heatloss
Flexible Spaces

Private

Semipublic

Public

Person

Person's view

Path of a student

Path of a professor

Private

Semipublic

Public
The Alder Tree
Floor Plans – First Floor

- River
- Walking path
- Faculty building

Legend:
- Seminar room
- Interior pond
- Sloped lecture halls
- Small classroom
- Server room
- Offices
- Restrooms
- Cafe
- Green atrium

Dimensions:
- 18 m
- 20.6 m
- 55 m
- 8.2 m
Floor Plans – Second Floor

River

Walking path

- Green atrium
- Interior pond
- Small classroom
- Server room
- Offices
- Restrooms

Seminar room
Sloped lecture halls
Faculty building

15
Floor Plans – Third Floor

- River
- Faculty building
- Walking path
- Seminar room
- Laboratory
- Sloped lecture halls
- Small classroom
- Server room
- Offices
- Restrooms

16
Section north-east/south-west

- Atrium
- Auditorium
- Laboratory
- Core

Dimensions:
- 55 m
- 0 m
- 3 m
- 6 m
- 9 m

Section Atrium

Section north-east/south-west

Plan view
Facades

Northern facade

Eastern facade

Southern facade

Western facade
3D View

View from the north

View of the atrium with the pool in the middle
Kozolec

Fundation
Horizontals
Wooden pillar
Simple roof
Placement on Site

- Forest
- Factory
- Residential area
- Faculty buildings
- Public area
- Our site
- Roads
- Paths
- Fields direction
- River
Floor Plans – First Floor

River

Walking path

18 m

18 m

6 m

6 m

6 m

6 m

18 m

18 m

38 m

3 m

- Seminar room
- Laboratory
- Sloped lecture halls
- Small classroom
- Server room
- Offices
- Restrooms
- Cafe
- Green atrium

Faculty building
Floor Plans – Second Floor

- River
- Walking path
- 18 m x 18 m
- 6 m x 6 m
- 3 m x 3 m

Areas:
- Seminar room
- Laboratory
- Sloped lecture halls
- Small classroom
- Server room
- Offices
- Restrooms
- Cafe
- Collaboration space with private cubes

Legend:
- A
- SE
- MEP
- CM
Floor Plans – Third Floor

- River
- Walking path
- Faculty building

Legend:
- Seminar room
- Laboratory
- Sloped lecture halls
- Small classroom
- Server room
- Offices
- Restrooms
- Cafe
- Collaboration space with private cubes
Facades

Northern facade

Eastern facade

Southern facade

Western facade
3D Views

View from the north

View of the atrium
Site Conditions

- **Flood Hazard (WHO):** Low
  - Cause: Heavy downpour

- **Snow Loads:** 2 kN/m²
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- **Avg. Wind Speed:** 2 m/s

*Soil profile was adopted from Express Team 2015*
# Load Summary

<table>
<thead>
<tr>
<th>Load Type</th>
<th>Gravity</th>
<th>Lateral</th>
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<tbody>
<tr>
<td></td>
<td>Live (psf)</td>
<td>Dead (psf)</td>
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<tr>
<td>Roof</td>
<td>20</td>
<td>82</td>
</tr>
<tr>
<td>Level 3</td>
<td>100</td>
<td>90</td>
</tr>
<tr>
<td>Level 2</td>
<td>100</td>
<td>90</td>
</tr>
<tr>
<td>Level 1</td>
<td>100</td>
<td>90</td>
</tr>
<tr>
<td>Total Base Shear</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Governing Load Case: \(1.2(D + F) + 1.0E + f1L + 1.6H + f2S\)

Source(s): IBC 2012, ASCE 7-10
Foundations

Axial Demand per column
= 533 kN (120 kips)

Excavate 0.5m from Surface

Soil Bearing Capacity = 290 kPa (6000 psf)

Footing Dimension = 2m x 2m, 50 cm Thick

Base Shear = 1600 kN (347 kips)

Soil Profile with footing adopted from Express Team 2015
Alder Tree – Steel Option

Structural plan - Level 1

Concrete Core: 10" Thick (25 cm)
- Column: W14x132
- Beam: W12x136
- Cantilever Beam: W30x191
- Metal Stud Wall: 2x8 @ 16" O.C.
- Braced Frame Locations
- Frame Brace: HSS7.5x0.500
  - Frame Beam: W12x96
  - Frame Column: W14x193

*Steel Composite Deck:
  - 3VL 5.25" Lightweight Concrete (130mm)
Alder Tree – Steel Option

Concrete Core: 10" Thick (25 cm)

Column: W14x132

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Braced Frame Locations

Frame Brace: HSS7.5x0.500
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Frame Column: W14x193

Auditorium Truss: 40" Steel OWJ

Steel Cable: 0.7 in^2

*Steel Composite Deck: 3VL 5.25" Lightweight Concrete (130mm)
Alder Tree – Steel Option

Auditorium Cantilever: 7.5m extreme case

Structural section - North west
Alder Tree – Wood Option

Structural plan - Level 1

Concrete Core: 10" Thick (25 cm)
Column: 10"x10"
Beam: 6 ¾" x 12"
Cantilever Beam: W30x191
Metal Stud Wall: 2x8 @ 16" O.C.
Shear Walls: 2x8 @ 16" O.C.
Gable Frame Beam: 6 ¾" x 36"
Gable Frame Column: 24" x 24"

*2x10 Wood Joist @ 12" O.C., Sheathing top and bottom
Alder Tree – Wood Option

Structural plan - Level 2 & 3

Concrete Core: 10" Thick (25 cm)

Column: 10"x10"

Beam: 6 ¾" x 12"

Metal Stud Wall: 2x8 @ 16" O.C.

Shear Walls: 2x8 @ 16" O.C.

Gable Frame Beam: 6 ¾" x 36"
Gable Frame Column: 24" x 24"

Auditorium Truss: 40" Steel OWJ

Steel Cable: 0.7 in^2

*2x10 Wood Joist @ 12" O.C., Sheathing top and bottom
Alder Tree – Wood Option

Auditorium Cantilever: 7.5m extreme case

Structural section - North west
Alder Tree – 3D View

Steel Option

Wood Option
Atrium Frame Alternatives

**Gable Frame**

- Max P on beam: 1092 kips
- Max M: 576 k-ft

**Multi-post Truss**

- (Axial Forces Only)

- Max P on truss member: 140 kips

**Braced Frame**

- Max P on brace: 415 kips
- Max M: 571 k-ft

**Moment Frame**

- Max P on beam: N/A
- Max M: 1922 k-ft
Auditorium Cantilever Support

STEEL CABLE

170 k (T)

ROOF TERRACE

52 k (C)

174 k (C)

AUDITORIUM

0 k

93 k (C)

41k (C)

CONCRETE CORE

7.5m  6m  6m

5970 k-ft
Kozolec – Steel Option

Structural plan - Level 1

Concrete Core: 10" Thick
- Column: W14x82
- Beam: W12x96
- Cantilever Beam: W24x94
- Metal Stud Wall: 2x8 @ 16" O.C.
- Concentric Braces: HSS6x5x1/8
- Diagonal Braces: HSS3x3x1/8
- Seismic Separation

*Steel Composite Deck: 3VL 5.25" Lightweight Concrete (130mm)
Kozolec – Steel Option

Structural plan - Level 2 & 3

Concrete Core: 10" Thick
Column: W14x82
Beam: W12x96
Cantilever Beam: W24x94
Metal Stud Wall: 2x8 @ 16" O.C.
Concentric Braces: HSS6x5x1/8
Truss: 40" Steel OWJ
Diagonal Braces: HSS3x3x1/8
Seismic Separation

*Steel Composite Deck:
3VL 5.25" Lightweight
Concrete (130mm)
Kozolec – Steel Option

Structural section – North

Structural section – West

Seismic Separation
Kozolec – Wood + Steel Option

Structural plan - Level 1

Concrete Core: 10" Thick
Steel Perimeter Column: W14x82
Glulam column: 10"x10"
Glulam Beam: 6 3/4" x 10 1/2"
Steel Cantilever Beam: W24x94
Wood Stud Wall: 2x8 @ 16" O.C.
SIPS: 6" thick
Diagonal Braces: HSS3x3x1/8
Seismic Separation

*Prefabricated 2x10 Wood Joist @ 12" O.C. Sandwich Panel
Kozolec – Wood + Steel Option

Structural plan - Level 2 & 3

- Concrete Core: 10" Thick
- Steel Perimeter Column: W14x82
- Glulam column: 10”x10”
- Glulam Beam: 6 ¾” x 10 ½”
- Steel Cantilever Beam: W24x94
- Wood Stud Wall: 2x8 @ 16” O.C.
- SIPS: 6" thick
- Truss: 40" Steel OWJ
- Diagonal Braces: HSS3x3x1/8
- Seismic Separation

*Prefabricated 2x10 Wood Joist @ 12" O.C. Sandwich Panel
Kozolec – Wood + Steel Option

Structural section – North

Seismic Separation

Structural section – West
Seismic Expansion Joints

Considerations:
1. Relative Displacements/rotations between buildings
2. Joint width
3. Vertical vs. Horizontal joints
4. ~$70/ft including installation

Source: http://emseal.com/Products/Architectural/Colorseal_SeismicColorseal.htm
Double Cantilever Analysis

<table>
<thead>
<tr>
<th>Member</th>
<th>Length (ft)</th>
<th>Weight (lb/ft)</th>
<th>Weight (lb)</th>
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<tbody>
<tr>
<td>Struts + Cantilever</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>A</td>
<td>W12x45</td>
<td>11</td>
<td>45</td>
</tr>
<tr>
<td>B</td>
<td>W10x33</td>
<td>22.5</td>
<td>33</td>
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<tr>
<td>C</td>
<td>W8x18</td>
<td>9</td>
<td>18</td>
</tr>
<tr>
<td>D</td>
<td>W24x94</td>
<td>24</td>
<td>94</td>
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<tr>
<td></td>
<td>Total</td>
<td></td>
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<tr>
<td>Cantilever only</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>E</td>
<td>W40x183</td>
<td>24</td>
<td>183</td>
</tr>
</tbody>
</table>

20% Material savings!
Climate – Temperature & Dewpoint

Seasonal temperature variation

Seasonal dewpoint temperature

Source: www.weatherspark.com
HVAC – Hot Water Supply

Alternative 1 – Geothermal HVAC

- Renewable energy
- Material consumption
- Constructability

Alternative 2 – Cogeneration Plant

- Non-renewable energy
- Material consumption
+ Constructability
HVAC – Air Handling Units

Alternative 1 – one AHU
- Energy efficiency
+ Material consumption
- Flexibility

Alternative 2 – two AHUs
+ Flexibility
- Material consumption
+ Energy efficiency
HVAC – Air Circulation

Alternative 1 – Recirculation of air

- Energy efficiency
- Indoor air quality
- Constructability

Alternative 2 – 100 % OA

- Energy efficiency
- Indoor air quality
+ Constructability
HVAC – Offices Air Supply

Alternative 1 – Textile ventilation
- Thermal environment
+ Material consumption
  + Flexibility
  +- Aesthetics

Alternative 2 – Diffuse ceiling plenum
- Flexibility
  - Material consumption
  - Energy efficiency
  + Thermal environment
## HVAC Options – Primary Systems

<table>
<thead>
<tr>
<th></th>
<th>Alternative 1</th>
<th>Alternative 2</th>
<th>Weight 0-1</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Recirculate server room air</td>
<td>Geothermal heat pump</td>
<td>100% fresh air</td>
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<tr>
<td>Air quality</td>
<td>4</td>
<td>5</td>
<td>10</td>
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<tr>
<td>Energy efficiency</td>
<td>10</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>Constructability</td>
<td>4</td>
<td>1</td>
<td>5</td>
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<tr>
<td>Maintenance</td>
<td>5</td>
<td>7</td>
<td>10</td>
</tr>
<tr>
<td>Material usage</td>
<td>5</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td><strong>Total score</strong></td>
<td><strong>37.1</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## HVAC Options – Secondary Systems

<table>
<thead>
<tr>
<th></th>
<th>Alternative 1</th>
<th>Alternative 2</th>
<th>Weight 0-1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overhead supply, diffuse ventilation</td>
<td>Exhaust grills in rooms</td>
<td>Overhead supply, textile terminal ventilation</td>
<td>Decentral axial fans, exhausts in atrium</td>
</tr>
<tr>
<td>Air quality</td>
<td>4</td>
<td>7</td>
<td>10</td>
</tr>
<tr>
<td>Energy efficiency</td>
<td>4</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>Constructability</td>
<td>4</td>
<td>7</td>
<td>10</td>
</tr>
<tr>
<td>Thermal comfort</td>
<td>8</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Material usage</td>
<td>5</td>
<td>5</td>
<td>10</td>
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<tr>
<td><strong>Total score</strong></td>
<td><strong>45.5</strong></td>
<td><strong>59</strong></td>
<td></td>
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</tbody>
</table>
HVAC Section

Auditorium + Classrooms:
Underfloor supply
Overhead exhaust

Offices + Seminar Rooms:
Overhead supply
Decentral exhaust
Radiant flooring

Exposed

Auditorium
CORE 2
ATRIUM
CORE 1
MEP 2
MEP 1
Supply
Exhaust
HVAC Floor Sandwich

Offices + Seminar rooms:

Overhead supply

Radiant flooring

Decentral fan
HVAC Distribution

Supply

Exhaust
HVAC Section

Offices + Seminar rooms:

- MEP 2
- Boiler
- ATRIUM
- MEP 1
- Classrooms
- Auditorium
HVAC Floor Sandwich

- Radiant flooring
- Overhead textile ventilation
- Decentral fan

Dimensions:
- 3.30
- 2.98
- 0.31
- 2.58

A - SE - MEP - CM
Orientation Study

- Green atrium
- Auditorium
- Laboratory
- Small classroom
- Server room
- Seminar room
- Offices
Orientation Study

Green atrium
Sloped classroom
Laboratory
Small classroom
Server room
Seminar room
Offices
Energy Performance Strategy

Nearly net zero energy buildings:

- Annual consumption of less than 55 kWh/m²
- The building should have 50% Renewable energy sources
Envelope Transmission Area

= 2070 m²

= 1520 m²
Site Logistics – The Alder Tree

- Fence
- Access road
- Traffic flow
- Unload area
- Trailers
- Material storage
- Recycling area
- Mobile crane

Dimensions:
- 20 m
- 20 m
- 10 m
Site Logistics – Kozolec

- Fence
- Access road
- Traffic flow
- Unload area
- Trailers
- Material storage
- Recycling area
- Mobile crane
Equipment Plan

Mobile Crane
Requirements:
• Minimum range - 60-80 meters
• Minimum height - 15 meters
• Minimum weight - 9 ton (Air handling unit)

Forklifts

Atrium Lifts
Safety and Disturbance

Clear rules & responsibilities

- Contraction sound barrier
- Silt Fence
- Gate
- Pedestrian protection
## Flooding

**Berm**

**Pros**
- Low maintenance
- Increases floor to floor height

**Cons**
- Supplementation in extreme weather
- Disturbs site

**Cost**
$84,000

**Portable Fence**

**Pros**
- Prevents higher flood
- Manufacturer reliability

**Cons**
- Installation time
- Requires storing on site

**Cost**
$193,200
Local Vendors

- **Riko**
  - Wood structures
  - 50 km

- **Jelovica**
  - Steel structures
  - 10 km

- **REM**
  - Modules
  - 30 km

- **CBD**
  - Timber structures
  - 50 km

Note: The map shows the locations and distances of various vendors within a certain radius from their respective cities.
Kozolec - Schedules

Wood+Steel

Steel
Target Value Design

**Steel**
- $11,134,000

**Timber**
- $12,128,000

**Steel**
- $12,477,000

**Timber**
- $12,562,000

### Categories
- A Substructure
- B Shell
- C Interiors
- D Services
- E Equipment and Furnishing
- F Specialty Construction
- G Building Sitework
- H General Conditions
Decision Matrix

Alder Tree - Timber
Alder Tree - Steel
Kozolec - Wood + Steel
Kozolec - Steel

TVD

STV

Structural cost

May deadline
## Decision Matrix

<table>
<thead>
<tr>
<th></th>
<th>Alder Tree</th>
<th></th>
<th>Kozolec</th>
<th></th>
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<tbody>
<tr>
<td></td>
<td>Team</td>
<td>Owner</td>
<td>Team</td>
<td>Owner</td>
</tr>
<tr>
<td>Interdisciplinary</td>
<td>52</td>
<td>36</td>
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<td>Aesthetics</td>
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<td>Design Potential</td>
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<td>KPI</td>
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<td>54</td>
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<td>Total</td>
<td>181</td>
<td>140</td>
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<td>156.4</td>
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<td>177.2</td>
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</table>

Weighted Average

Team 40%
Owner 60%

Rate from 1-10
The Winner

?