BYENS SKOLE

"A SCHOOL FOR THE FUTURE"

PRESENTATION

Master Thesis 2020
Sustainable Architecture
Aalborg University

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Byens Skole - A School for the Future

Group 15 /

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Report information /

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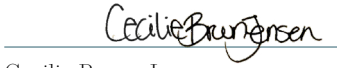

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ABSTRACT

This report presents the Master Thesis of Msc04 Arch/Sus group 15. The thesis presents a design proposal for a new school in Sundby, Lolland, focusing on social and environmental sustainability. As there is an ongoing competition about a new school in Sundby, the specific tender documents has been used as a basis for the project.

As a result of the national state school reform of 2013 implying more individuality and the educational strategy of "problem based learning", the architecture of schools calls for a change. The question remains how to design a place fitting all individual needs regarding personal development and education. Through research, studies and field trips, a program has been made where the most important keypoints of modern knowledge are concluded in a room program and specific design strategies taking all the different users of the building into account.

Sundby is situated in one of the municipalities in Denmark which has the highest amount of socially deprived children, making the implementation of well-being architecture essential. Through the spatial design, the school investigates spaces which acts as safe, restorative spaces.

The architecture is a result of the integrated design process, with a focus on implementing a great indoor climate, natural resources and a low energy consumption. Through implementing strategies to fulfill these technical aspects, the goal is to increase the awareness of sustainability for both pupils, teachers and the town of Sundby, making the building a teacher in itself.

The final outcome is a zero energy building which creates a new gathering point for the town of Sundby, while also considering the functionality of a modern school.

READING GUIDE

This project is divided into two parts with to different formats; a program- and process report, and a presentation report. The two parts are highly connected, and to understand all aspects of the project it is recommended to read both in the aforementioned order. Both parts are using the Harvard-method for referencing, where "(ibid.)" references to the last mentioned source. Each illustration is marked "fig.x", referring to the list of illustrations at the end of each part. If a figure is not in the list of illustrations, it corresponds to an illustration created by the group.

The assignment has been inspired by the tendering documents of a building program (Guldborgsund Kommune 2, 2019), where the group has extracted key information and inspiration for the spaces needed in the building. Though, it is not necessary to read these documents to understand this proposal.

As a result of the Covid-19 crisis, this assignment is exclusively handed in digitally, unfortunately making scales, sizes, colours and line weights highly dependent on the readers screen. Both PDFs are designed as spreads, but exported as pages. Though, it is recommended to read both PDFs, and especially the Program and Process, as spreads. **For the best graphical presentation of the project, the PDF should be read in Adobe Acrobat, and the following settings should be applied:** Open the file in Adobe Acrobat. Click **"View"** (vis) > **"Page display"** (sidevisning) and apply **"Two-Up"** (to-sidevisning). Go to **"Edit"** (rediger) > **"Settings"** (indstillinger) > **"Page Display preferences"** (sidevisning). Here, under **"Resolution"** (Opløsning), check the box for **"Custom Resolution"** (brugerdefineret opløsning) and set the resolution to **300 pixels per inch** (pixels/tomme). Under **"Rendering"** (gengivelse), **UNCHECK** the box for **"Enhance Thin Lines"** (forfin tynde streger). Make sure the box for **"Smooth Line Art"** (udjævn streggrafik) is checked.

This will make the PDF a bit more heavy to scroll, and the pages may need a few seconds to load, but in return the quality of the graphics are more representable. It is still recommended to zoom in the PDF if diagrams, drawings or pictures if they appear unfocused or dissolved. This is especially in regards to the plans, elevations, sections, diagrams and illustration with a high amount of lines. If the reader wants to print out the assignment, both document sizes fits within an A4. Though, there is no guarantee for the quality of drawings, pictures, nor scales if printed.

Every measurable drawing is presented with a suitable measuring bar, as well as a vignette displaying where the illustration has been made from.

The school is a powerful tool for the community and an early intervention in **social distances**, but how is a future school optimally designed to **include all pupils** regardless of background and act as an **unifying organism** in its community?

fig. 1. site photography

How do we create the framework to support different kinds of teaching, with spaces for **calmness and concentration**, while environments for **movement** and **social inclusion** emerges? How can the school through its architecture act as a pedagogue and tool for **education** and **sustainability**?

fig. 2. site photography

BYENS SKOLE

Byens Skole lands elegantly on the open field at the very edge of Sundby Town. With its curved forms, large openings and displaced geometry over two floors, the school acts as a back cloth for the new social gathering space called the Agora, which refer to the proud craftsmanship and commercial function of Sundby and Nykøbing Falster. Here, the school invites the local community to exploit its functions, both inside and outside, attracting all social layers of the little society, hereby creating the foundation for a lively atmosphere. The soft geometry cladded in untreated nordic Douglas spruce provides a gentle expression, securing a welcoming and safe atmosphere for both pupils and visitors.

Large facade openings secures a social connection between inside and outside. The same principle is exploited internally in the building, with windows displaying the specialized classrooms towards the common areas. At the same time, the common areas are designed with large transparent facades towards the different gardens, creating a strong sense of unity, sufficient daylight and calming, natural views. As the building and Agora is designed to be used by more than pupils and teachers, the functionality is solved by socially graduating the functions from public common areas towards the Agora to more private and undisturbed home bases towards north.

The craftsmanship is further tributed with an honest presentation of the materials and construction. Exposed wooden beams and columns support the light facade and roof, while the concrete cores and columns carries the heat accumulating concrete floor. Plywood board are used throughout the building, both with and without acoustic perforation, contributing to a warm, contrasted and tactile atmosphere with playful daylight.

Strategies for both social and environmental sustainability has been implemented as key design parameters in the design. Strategies for restorative and healing architecture has formed the common areas, while sustainable features like the double skin facade, PV-panels and trombe walls are contributing with a distinctive and characteristic look. Together with the exposed technicalities and construction, these features are a part of increasing the awareness towards sustainability and how a building actually works. The building acts as a teacher itself, evoking curiosity around the different solutions.

Furthermore, the school is fronting an architecture designed for problem based learning and more physical activity in line with the reform. The spatiality accommodates the need for each individual, whether it is to find contemplation alone in a window overlooking the garden, or playing together in groups in the group rooms.

Byens Skole is designed to lift Sundby for all its citizens, but most importantly it is the stepping stone into society for children, in an area marked by having above average of socially deprived children. With its many features, it evokes a sense of proudness, unity and desire to explore the world. Byens Skole is accommodating everyone, while seeing the individual.

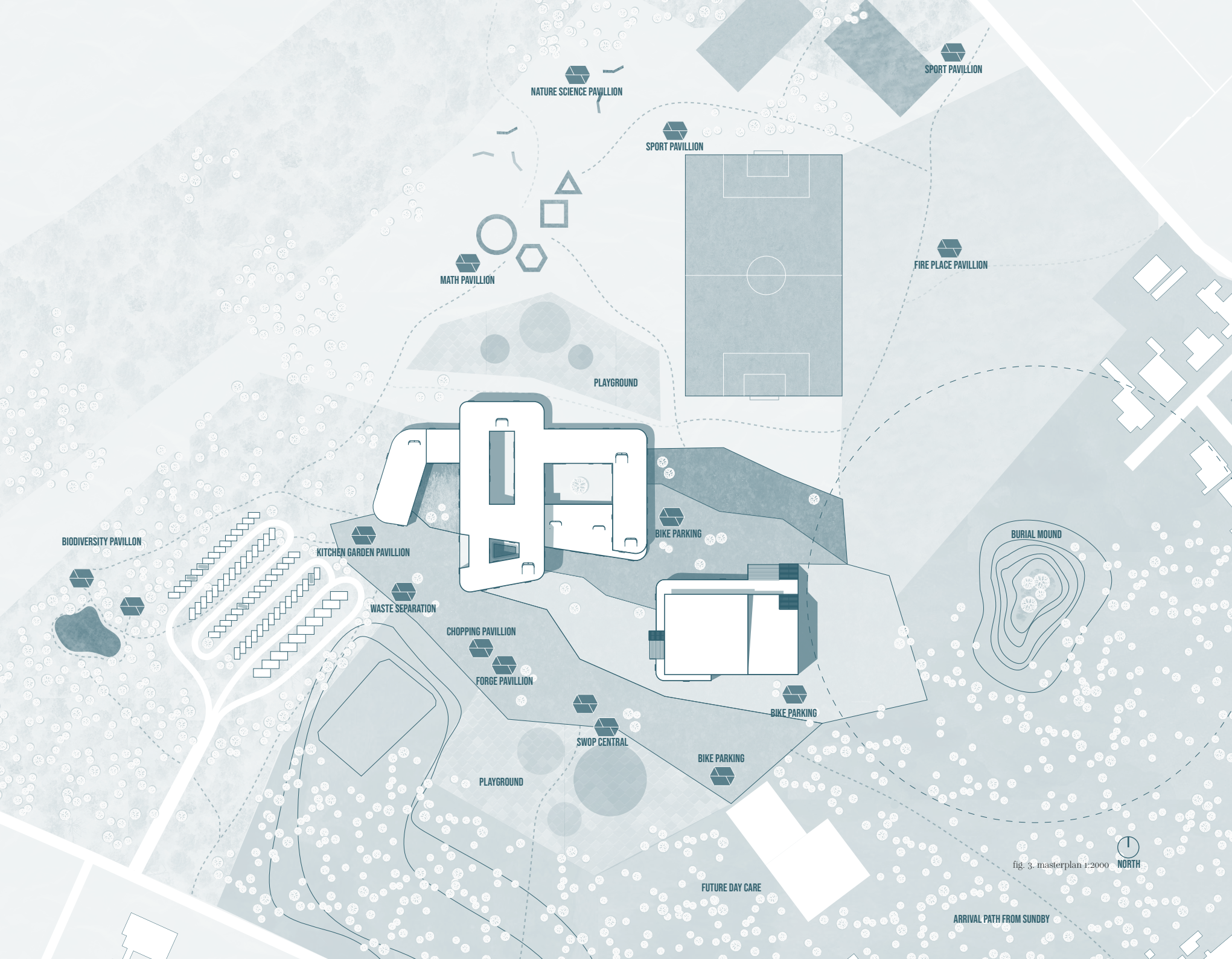
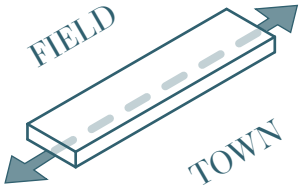
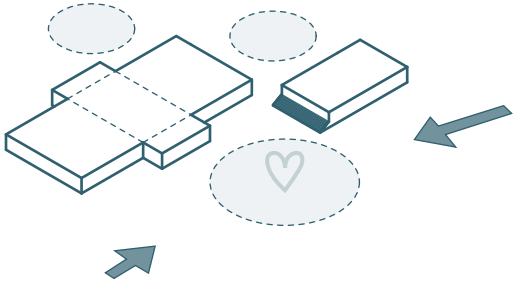


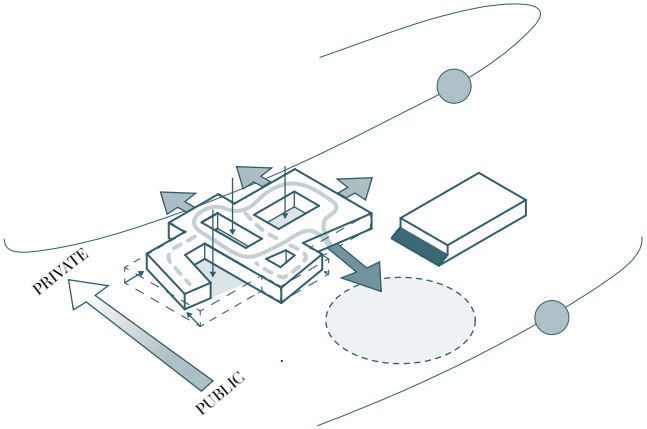
fig. 3. masterplan 1:2000



1. AT THE EDGE OF SUNDBY

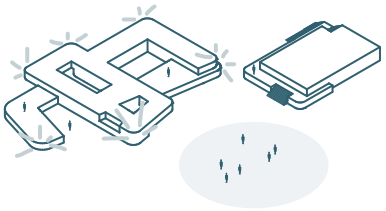


2. BUILDING VOLUME AS BACK CLOTH FOR SOCIAL EXPERIENCES

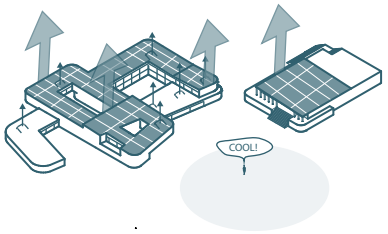


3. VOLUMETRIC ADAPTATION TO FUNCTIONS, LIGHT, SOCIAL GRADUATION AND PRIVATE GARDENS

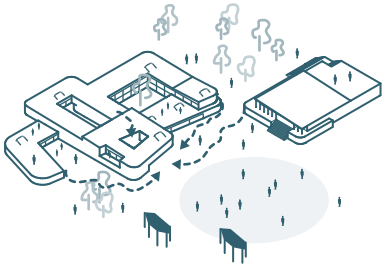
fig. 4. concept diagrams



4. WELCOMING FORM AND
RELATION TO HUMAN SCALE



5. SUSTAINABLE DESIGN



5. VIVID EXTERIOR AREAS

fig. 5. concept diagrams

fig. 6. perspective from the arrival path

fig. 7. framing the future

AGORA

With the school, sportshall and open landscape as a back cloth, the Agora appears as the new public meeting point in Sundby. The large open space will be filled with sunlight and seems protected by the great building volumes and pavillions, allowing multiple social activities like flea markets, festivals and social gatherings to occur.

In the everyday life, there are both spaces for activity and stay offered by the hard pavement, benches and pergolas. The space is designed with Jan Gehl's principles of social distances in mind (Gehl, J., 2010.), securing elective social participation through the creation of both intimate and open zones. Views and insight towards the different activities in the school, sportshall and outside areas are part of creating a vivid atmosphere, offering the desire to find stay and observe.

The vision of exposing the traditions of craftsmanship and sustainability is further underlined by letting the two craft subjects, trombe walls and visible PV-panels be facing the Agora. Together with other public functions, the Agora will attract a diversity of users.

fig. 8. agora plan 1:500

COMPONENTS OF AGORA

Besides the need for heated areas, the school is in need of multiple outside spaces which is sheltered. These pavilions, which are placed tactically around the site, is formed by a simple, modular system based on the form of the concrete tiles at the agora. To further promote reuse and awareness of the material world we live in, the modular construction will be cladded with different recycled materials from the neighbouring city and factories, creating a unique look for each pavillion. Maybe one of the walls has been created through a class during craft? Furthermore the honesty of the design will contribute to the Agora with a more raw atmosphere, while underlining the schools vision of treating the world we live in better.

The pavillions will act as pergolas, bike parking, swop central and educational environments around the site. Additionally, the simple constructions will be creating shelter and wind barriers to improve the microclimate of the Agora. The positioning of them will be crucial to complete the form of the Agora as a "trading post", with references to the old traditions of Sundby and Nykøbing Falster as a commercial town.

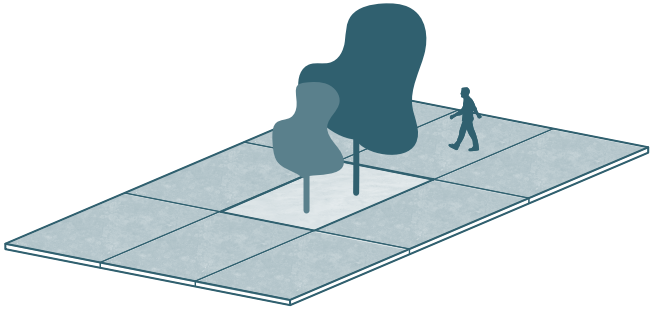


fig. 9. green dissolvers

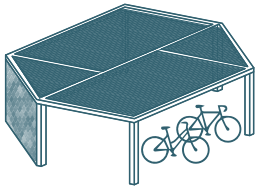


fig. 10. bike parking pavilions

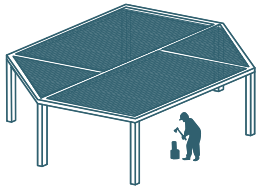


fig. 11. educational pavilions

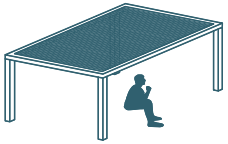


fig. 12. pergolas

fig. 13. concrete pathwork

fig. 14. bench

SOCIAL VALUES

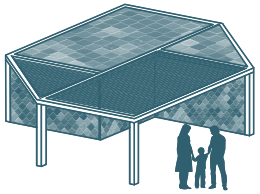


fig. 15. semi-closed pavilions

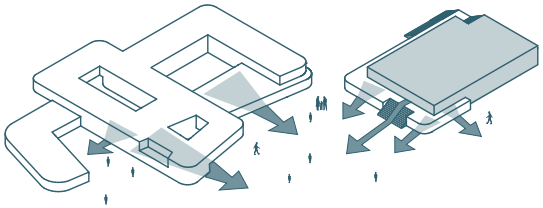


fig. 16. public functions

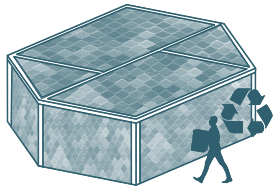


fig. 17. fully closed pavilions

Pavilions. Constructed for and by the residents of Sundby through volunteering and school. The pavilions will increase the local sense of unity and proudness of the place, while simultaneously making a statement of the importance of reusing materials.

Alluring functions. The functions facing the Agora will be available for public utilisation after school hours and during weekends, making the school the new meeting point of town by attracting the local residents. This includes the library, workshops, kitchen, sportshall and music facilities. Also, there has been made space for a little coffee shop, selling local temptations based on food harvested by the school children in the kitchen garden and energy from the science garden and PV-panels. This will emphasize how things are connected, as well as a sense of pride for the children.

Swop central. Where can a child learn the value of a material good, if there is no tradition for it in the family? The swop central is designed as one of the pavillions and will act as a place where the local community can trade and exchange items they no longer need, as well as items created in the schools workshops.

Rainwater collection. As part of the school acting as a pedagogue in itself, the rainwater will be visibly collected in multiple spots. The paths will be a part of the Agora between the concrete tiles, creating a visible border to step over, ending in a rainwater basin next to the main entrance. During rainy times, this basin will stepwise display the amount of rain by numbers on the pavement (fig. 18), while acting as a intimate space for stay during times with less water (fig. 19). Furthermore, the water from this bassin will supplement the water for toilet flush in the building.

fig. 18. filled basin

fig. 19. gathering basin

fig. 20. the Agora

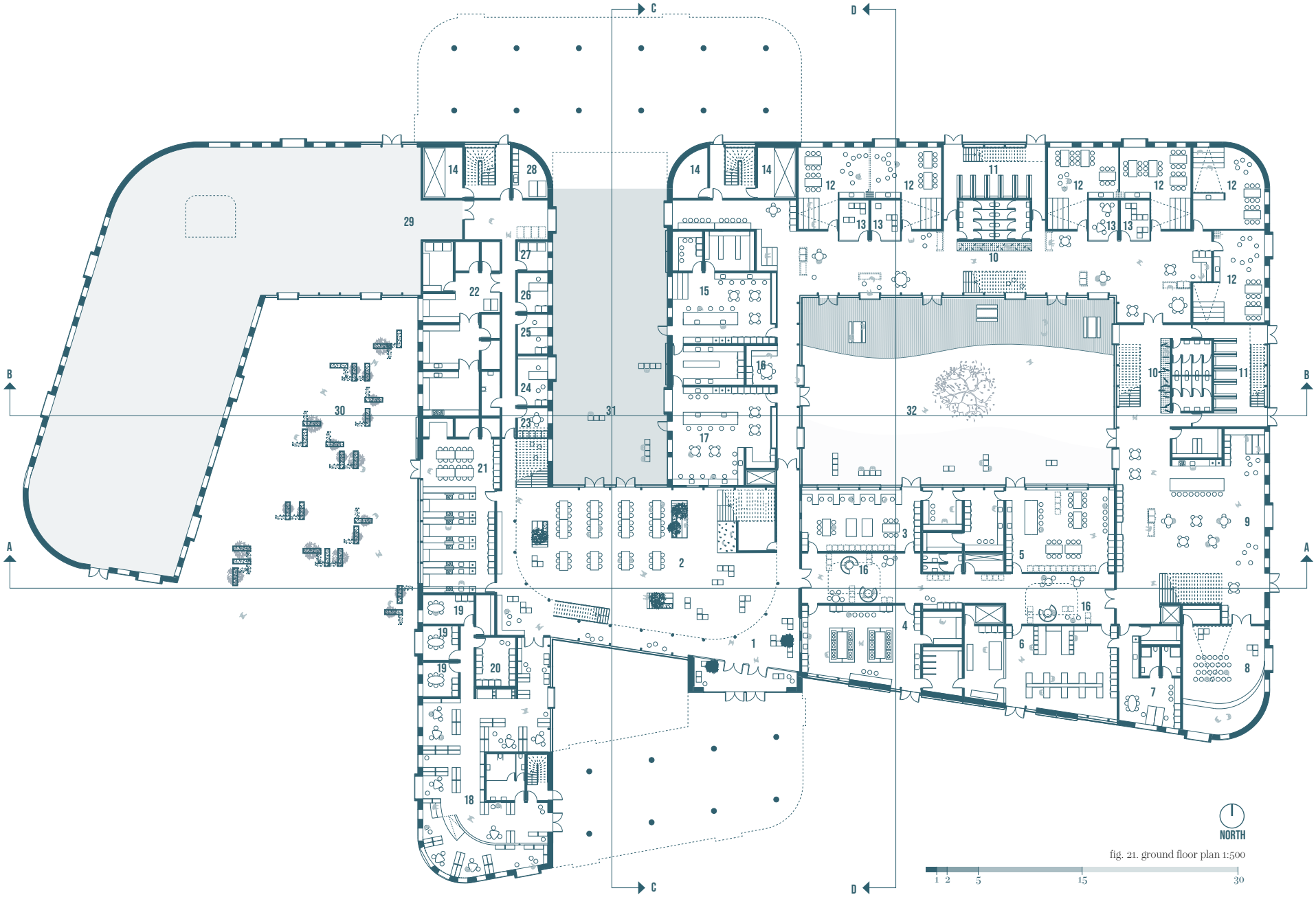


fig. 21. ground floor plan 1:500

Common zone: 450 m²
1. Entrance
2. Common area

Craft zone: 580 m²
3. Design
4. Craft / metal workshop
5. Visual art
6. Craft / wood workshop
7. Technical support department

ASC zone: 300 m²
8. After school care / the stage
9. After school care / kitchen

Pre-preparatory zone: 850 m²
10. Activity path
11. Wardrobe for ASC 0. - 2. class
12. 0.-2. home base
13. 0.-2. group room

Nature science zone: 280 m²
14. Technical room
15. Nature science
16. Research zone
17. Nature science / biology

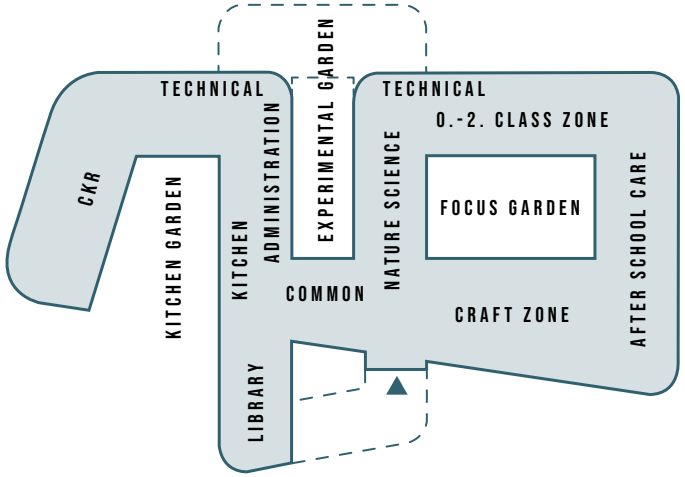
Library zone: 230 m²
18. Library
19. Pedagogical learningcenter
20. Pedagogical workshop

Kitchen / food zone: 250 m²
21. Food knowledge
22. Production kitchen

Administration / staff zone: 120 m²
23. IT department
24. School nurse
25. School psychologist
26. Education supervisor
27. Laundry room / storage
28. Cleaning room

CKR zone: 870 m²
29. CKR (children with physical and psychical handicap)

Outdoor areas
30. Kitchen garden
31. Experimental garden
32. Focus garden



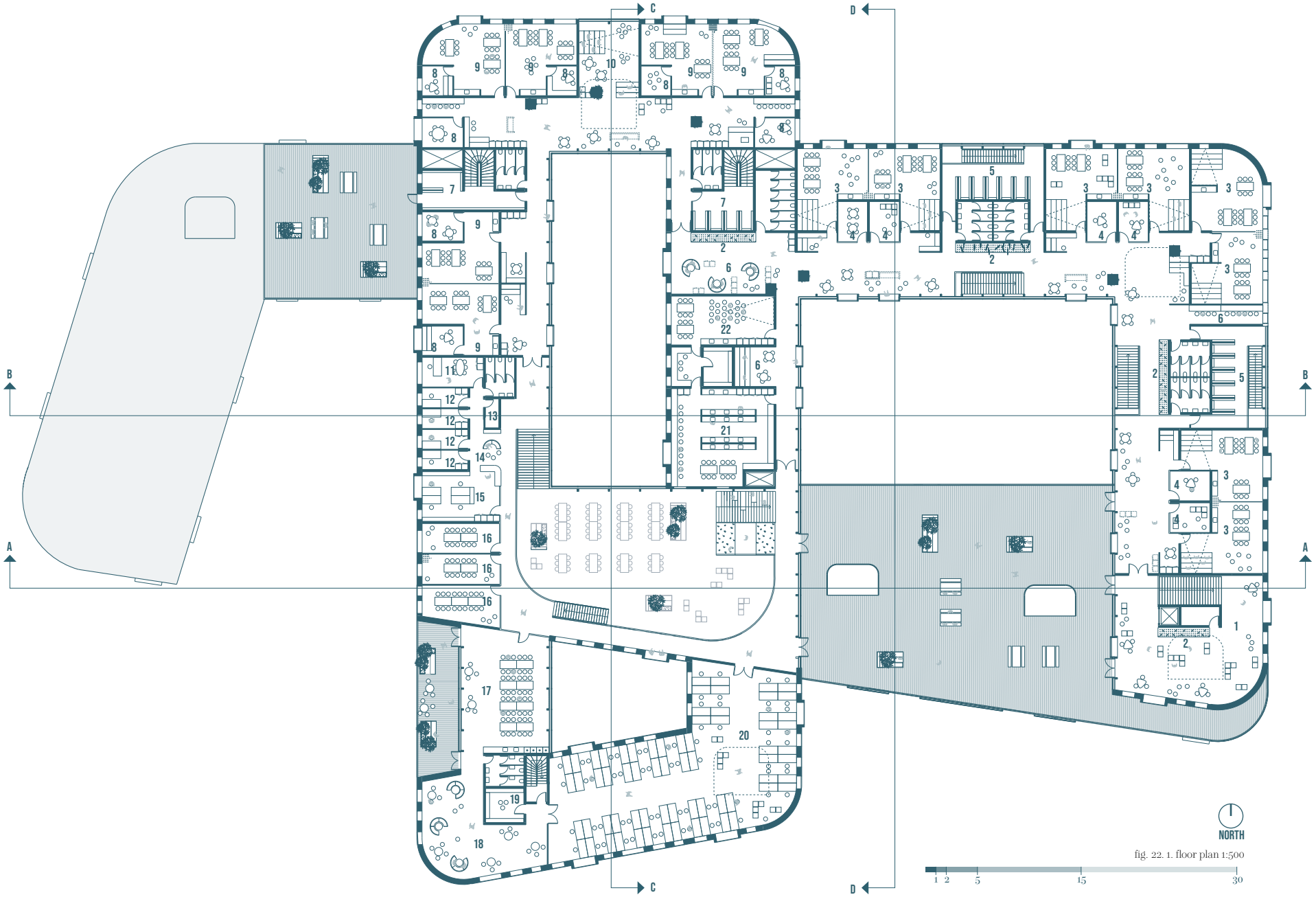


fig. 22. 1. floor plan 1:500

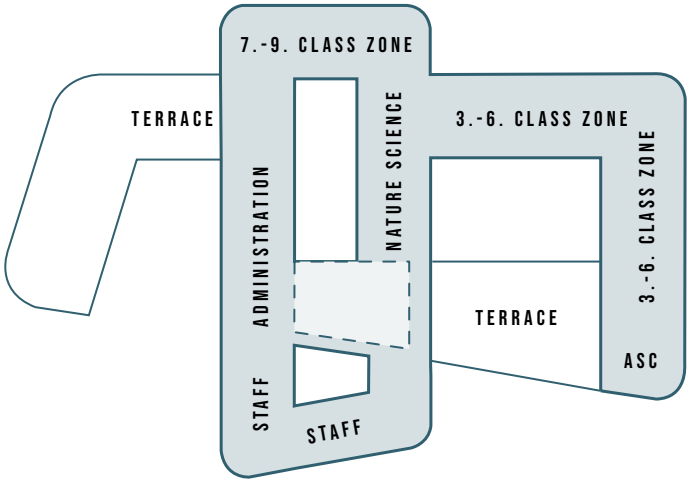
ASC zone: 150 m²
1. After school care
2. Activity path

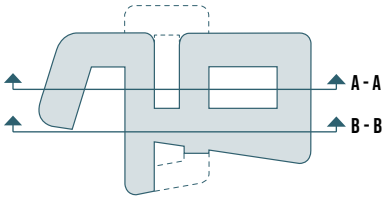
Pre-preparatory zone: 850 m²
3. 3.-6. class home base
4. 3.-6. class group room
5. 3.-6. class wardrobe
6. Research zone

Lower secondary zone: 740 m²
7. 7.-9. class wardrobe
8. 7.-9. class group room
9. 7.-9. class home base
10. Common area

Administraion / staff zone: 780 m²
11. Headmaster office
12. Management office
13. Copy room / storage
14. Welcoming center
15. Administration office
16. Meeting room
17. Staff break room
18. Staff lounge / meeting zone
19. Staff wardrobe
20. Staff preparation office

Nature science zone: 280 m²
21. Nature science base room
22. Nature science theory room





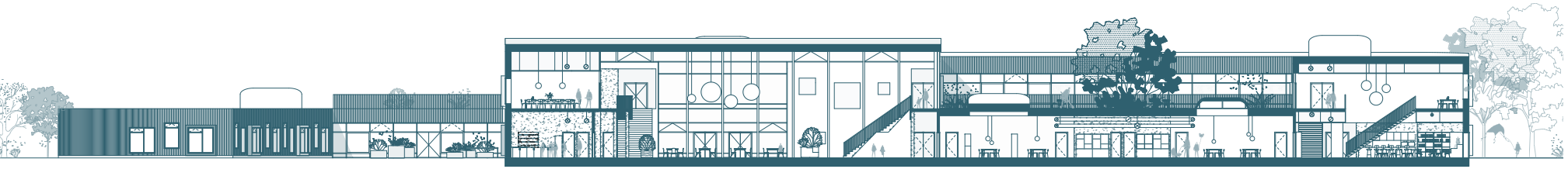
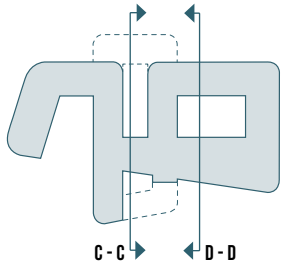


fig. 23. section A-A 1:500

1 2 5 15 30

fig. 24. section B-B 1:500

1 2 5 15 30



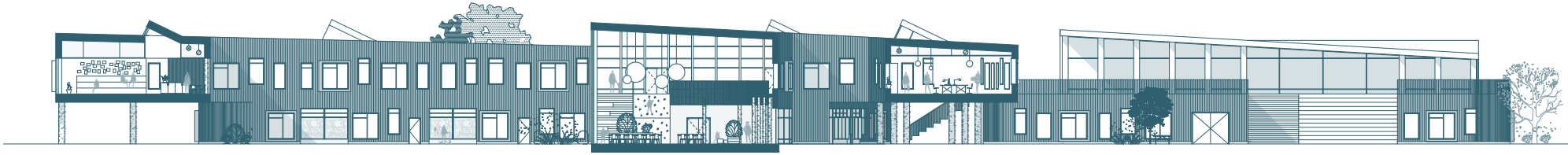


fig. 25. section C-C 1:500

1 2 5 15 30

fig. 26. section D-D 1:500

1 2 5 15 30

fig. 27. north facade 1:500

1 2 5 15 30

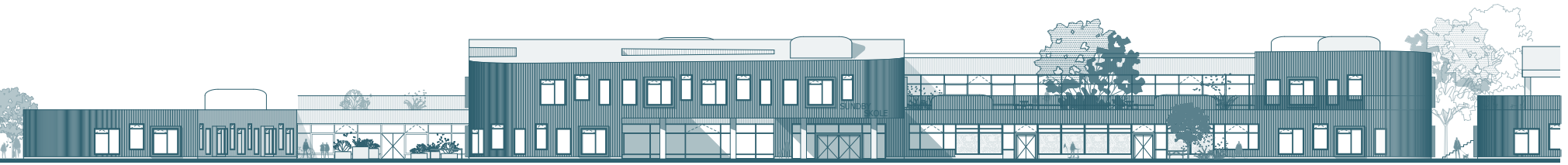


fig. 28. south facade 1:500

1 2 5 15 30

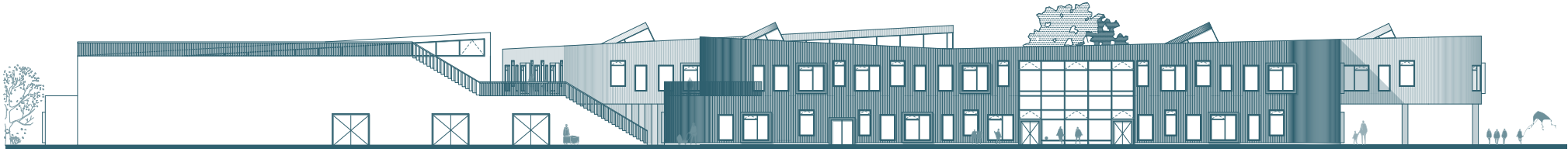


fig. 29. east facade 1:500

1 2 5 15 30

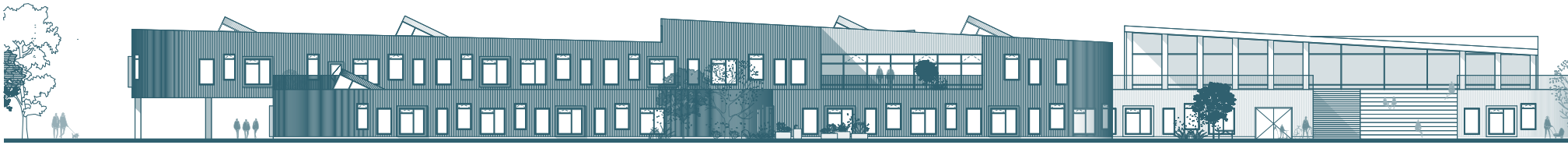


fig. 30. west facade 1:500

1 2 5 15 30

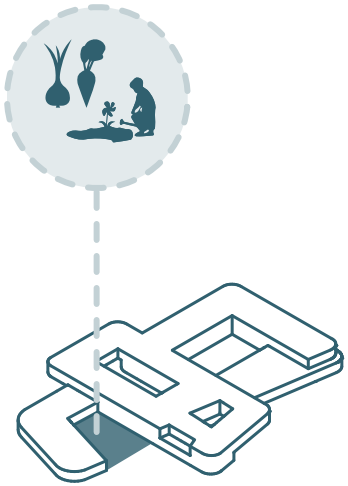


fig. 31. kitchen garden

Kitchen garden. The kitchen garden is placed with a direct connection to the two kitchens. The area will be supplied with outside kitchen facilities and places to grow food and herbs. By providing the opportunity to grow plants, it will both have an educational and well-being impact for the children.

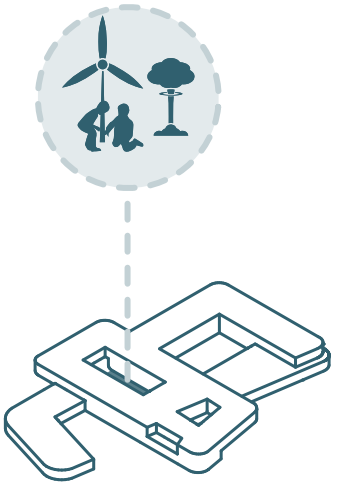


fig. 32. experimental garden

Experimental garden. Outside the educational spaces for biology and nature science, it will be a space for learning and experiments, including water collection and trombe walls. The concrete pavement will be able to stand the experiments, and over time wear the scars of them. This garden will most likely experience high wind speeds, which also can be used for experiments, but compromise the use for stay. Therefore, the space will be kept with a minimum of furniture, providing the beautiful view from figure 7, also from the common room.

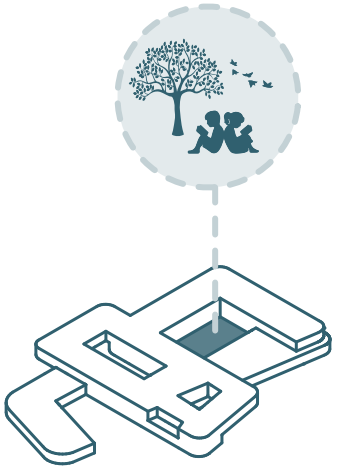


fig. 33. focus garden

Focus garden. Through the highly transparent facades, the focus garden blurs the border between inside and outside in the common areas of the preprepartory classes and nature science. This internal garden will be a place for contemplation in a protected natural environment with different pavements, tactilities, plants and sounds. Besides having a gathering effect of the common areas, the view to the natural garden will have a calming effect, as seen in figure 34.

fig. 34. the focus garden

SPORTS HALL

Walking through from the town, the first volume leading visitors and residents to the Agora is the large sports hall cladded in concrete and wood. To break down the scale, there is a distinct indication of the internal heights in the exterior expression, while it is designed to reflect upon the architecture of the school.

The sports hall is separated from the school volume to emphasize its more public availability and to improve the spatial quality of the Agora. The sports hall is facing several exterior activities with stairs to activate the surfaces of the roof and in front of it.

The volume has two main entrances; one for the public and one for the pupils. Furthermore, the building contains the spaces for music, which provides the opportunity to arrange for concerts inside the hall, and outside towards the Agora. As a part of the public entrance, a small cafe is placed selling local food and drinks.

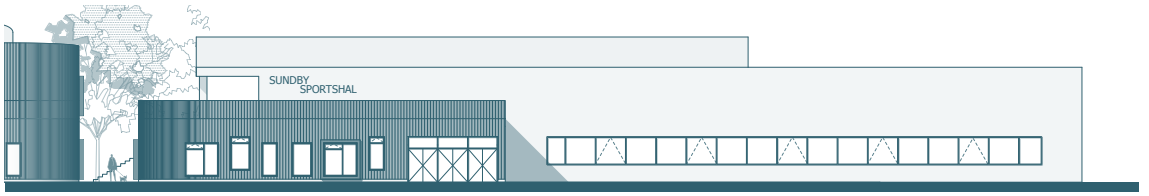


fig. 35. south facade 1:500

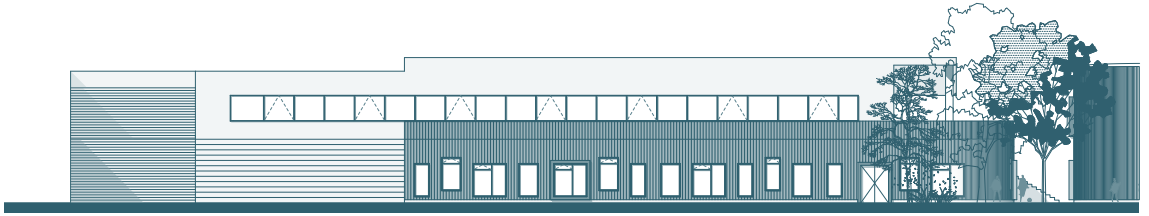
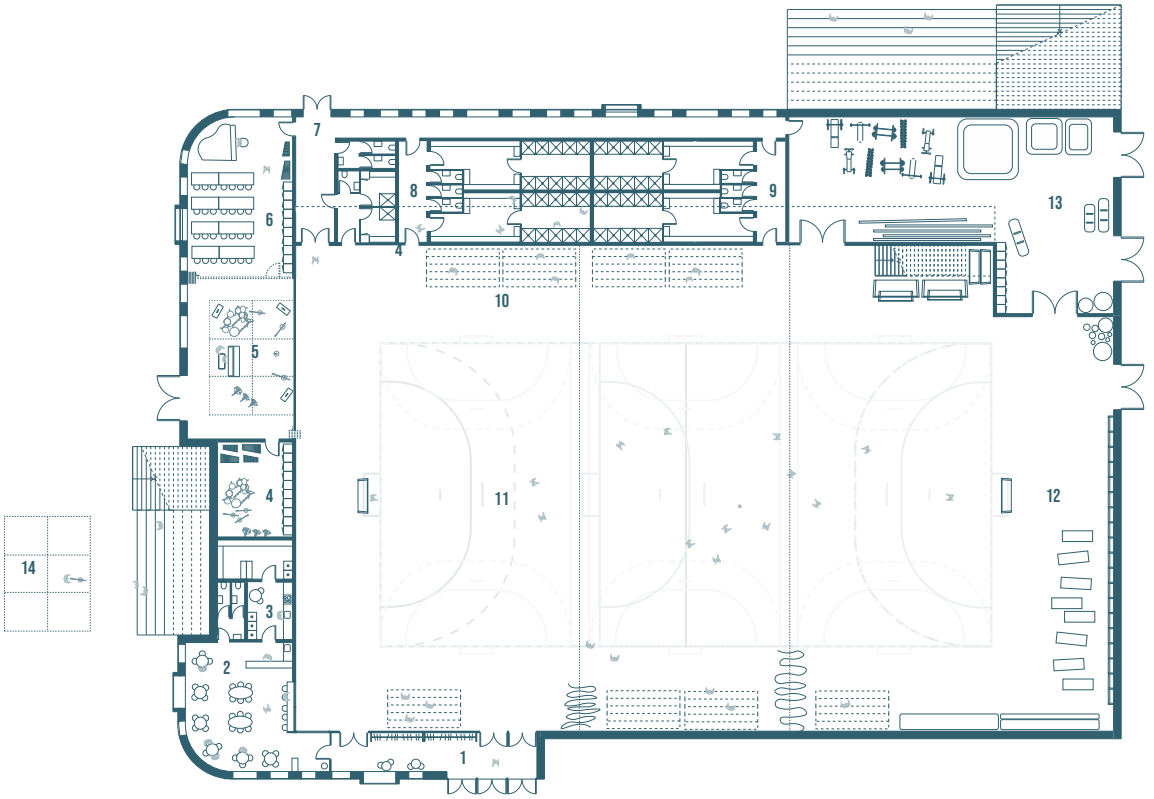


fig. 36. north facade 1:500

1. Main entrance
2. Coffee shop
3. Kitchen
4. Music storage
5. Music room
6. Music room / practice room
7. Entrance
8. Woman change
9. Man change
10. Movable tribune / music tribune
11. Field area
12. Stretching zone
13. Storage
14. Movable scene



NORTH

fig. 37. sports hall plan 1:500

1 2 5 15 30

ZERO ENERGY BUILDING

The building is designed as a Net Zero Site Energy Building (nZEB), which is described as a building that "produces at least as much energy as it uses in a year, when accounted for at the site." (Larsen, O. K., 2018. p16). This corresponds to a building which has a greatly reduced energy demand. This energy demand is covered by energy production from renewable sources at the site. As the energy production may vary, the building should supply the same amount of energy which it has received from the net when accounted for over a year (Larsen, O. K., 2018). The school is designed to cover both building energy, but also the use of equipment, etc. As the building is dependent on the sun for both heat and electricity, an additional technical supply room is placed besides the eastern entrance for the 7.-9. grade.

Fig. 38 displays the final result from the Be18 calculation, and how adding the PV-panels influences the energy demand. The Be18 calculation includes general data about the building envelope, as well as other technical and microclimatic factors. The formula used to calculate the ventilation rate can be seen in appendix 1, while the ventilation rate per zone can be seen in appendix 2.

To calculate the amount of PV-panels needed to cover the electricity for building operations, lighting, heating and daily usage of equipment, estimated numbers from the Be18 calculation has been used in an external calculation, also considering the shadowing skylights (appendix 3). The chosen type is the thin film-panel because of its matte black appearance and high efficiency in changing weather. The roof will, apart from the ASC roof and technical paths, be completely covered in the black panels, creating a large homogenous surface matching the black aluminum used for windows.

Because the school has implemented several visible passive strategies in its design, the building meets the Low-energy requirement before applying PV-panels and solar catchers. In other words is the matter of being a nZEB a more economical question. The active strategies will be more expensive seen in the light of operating economy, but as the building is predicted to stand for 50+ years, it makes good sense in an overall economy perspective.

LOW ENERGY-BUILDING (<33KWH/M²)

Energy performance (Be18)	25 kWh/m²
Contributions to energy requirement	
Room heating	4.0 kWh/m²
DHW heating	6.0 kWh/m²
El. for operation	7.6 kWh/m²
Excessive in room	0.0 kWh/m²

NET ZERO SITE ENERGY BUILDING

Energy performance	0 kWh/m²
Energy requirement from Be18	169.090 kWh
El. for equipment, etc.	138.342 kWh
PV-panels area (flat thinfilm)	2900 m²

fig. 38. zeb table

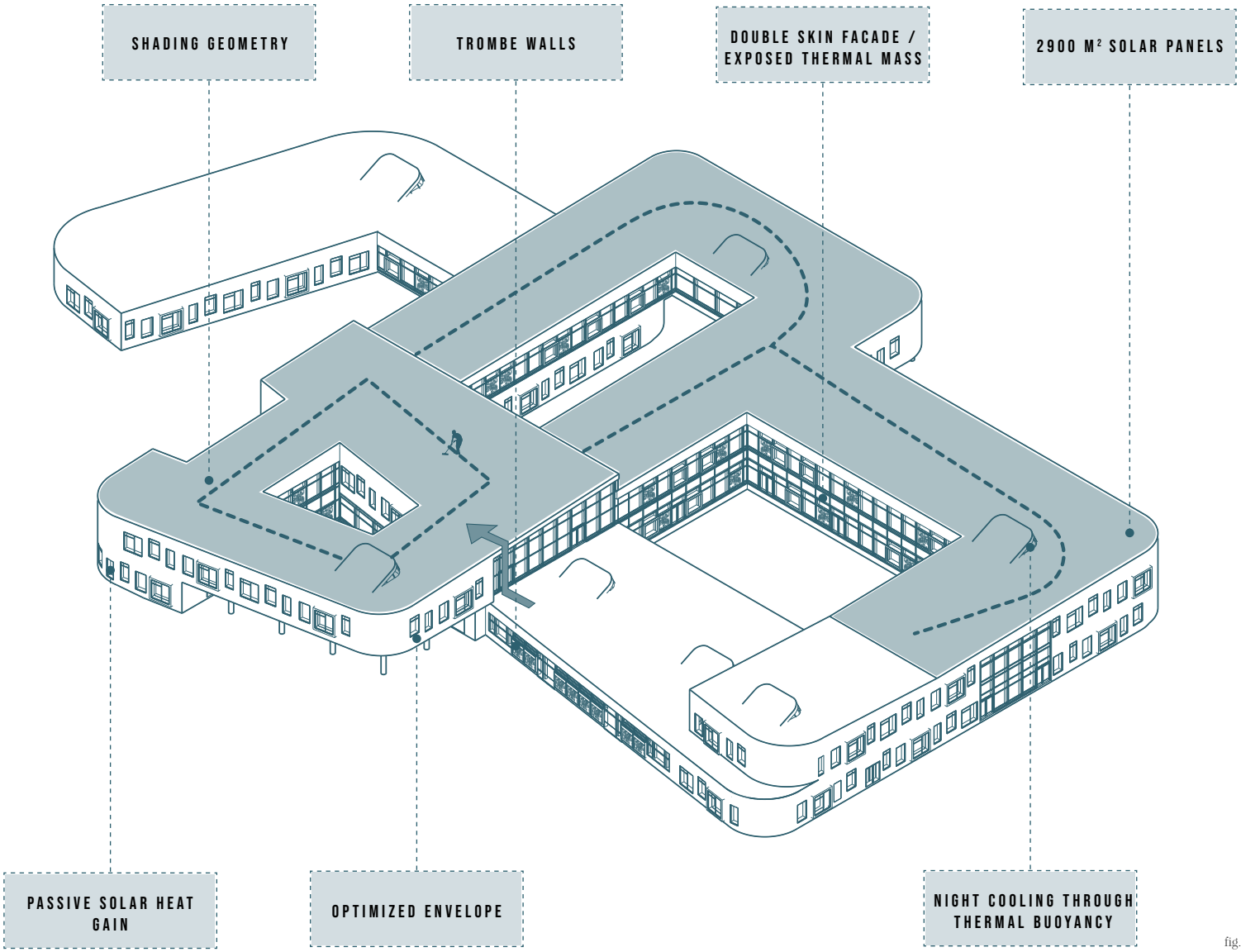


fig. 39. zeb diagram

MATERIALS AND CONSTRUCTION

Material choices. In the composition of the envelope, several choices of materials are based on its CO2-footprint. Seaweed insulation batts has a thermal conductivity as low as the well known Rockwool. Though, opposite of Rockwool, it has a negative CO2-footprint and absorbs more CO2 than it is emits during its lifetime. Crushed seashells is another exploited natural material which in reality is considered a waste product. The exterior cladding is untreated Douglas Spruce, and the interior cladding mainly consist of plywood in birch. By only using screws and glue while keeping most materials raw and nontreated, the envelope is designed with strategies for disassembly and reuse in mind.

Supporting construction. The supporting construction is based on a principal of honesty. The floors are in concrete, and are therefore supported by exposed cores, walls and column in concrete where it is needed. The exterior walls and the roof are light wooden constructions and are supported by columns and beams in glue-laminated wood. The honest construction together with the choice of untreated materials creates an atmosphere with an exciting tactility and awareness of materials.

Envelope. The envelope is designed with low U-values to reach a low energy demand. Roof and foundation has a U-value of 0,08 W/m2K (fig. 40 and 42), and the wall construction 0,09 W/m2K (fig. 41)(appendix 4). To reach this a high amount of insulation material is used, which is why the CO2-friendly material seaweed is chosen. The wall and roof constructions mainly consists of wood and insulation, but also a transparent double facade is used as exterior wall.

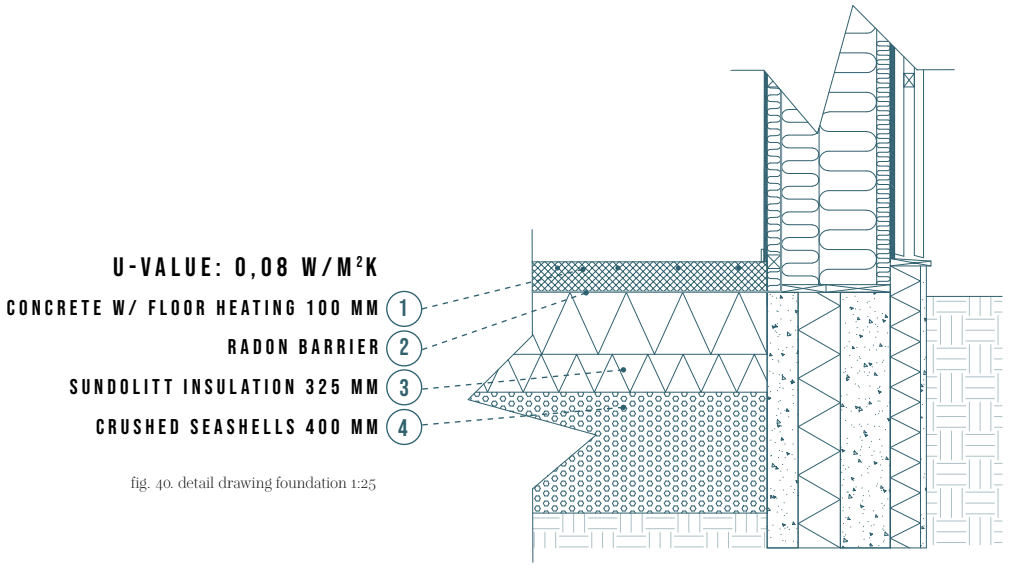
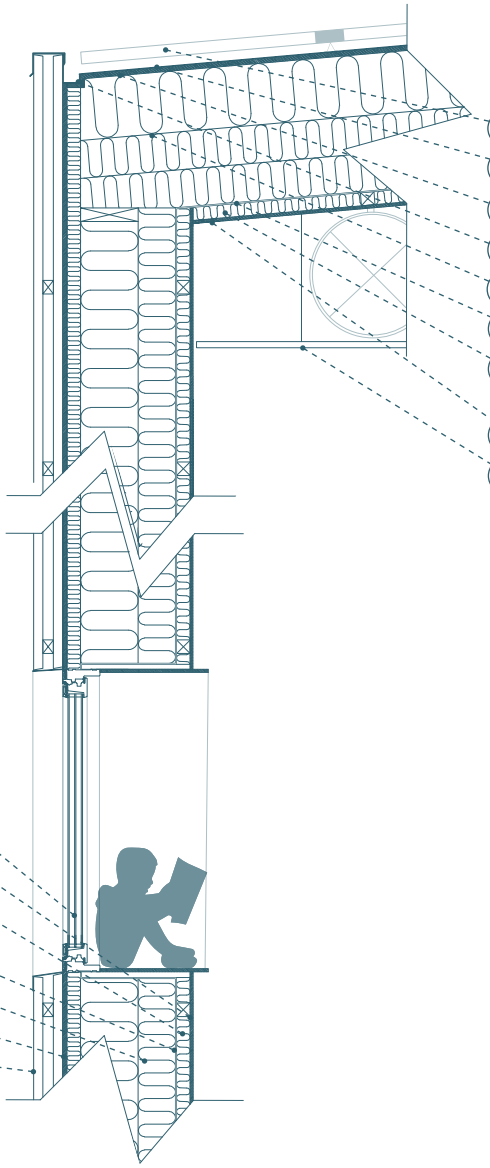


fig. 40. detail drawing foundation 1:25



U-VALUE: 0,08 W/M²K

1. THIN FILM SOLAR CELLS SLOPING SOUTHWARDS
2. ROOFING FELT
3. PLYWOOD WINDBARRIER 16 MM
4. HIDDEN GUTTERS AT END OF SLOPE
5. SEAWEED INSULATION AND I-PROFILES 420 MM
6. DIFFUSION OPEN VAPOUR BARRIER
7. INSTALLATION LAYER: SEAWEED INSULATION AND BATTERNS 45X45 MM
8. PLYWOOD 10 MM
9. LOWERED CEILING W/ SPACE FOR VENTILATION

fig. 42. detail drawing wall / roof 1:25

U-VALUE: 0,09 W/M²K

1. VELFAC THREE LAYER WINDOW
2. PLYWOOD 10 MM
3. INSTALLATION LAYER: SEAWEED INSULATION AND BATTERNS 45X45 MM
4. DIFFUSION OPEN VAPOUR BARRIER
5. SEAWEED INSULATION 365 MM
6. PLYWOOD WINDBARRIER 16 MM
7. VERTICAL WOODEN CLADDING

fig. 41. detail drawing wall / window 1:25

EXTERIOR CLADDING


fig. 43.

Douglas spruce lists, untreated in full height of the facade. Has naturally a long lifetime, and patinates to a light gray.

ROOF


fig. 44.

Thin film solar panels cover southward slopes on the roof and are matte black.

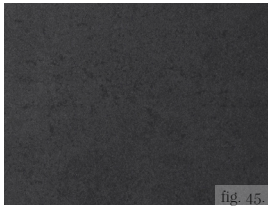


fig. 45.

Black aluminium to cover the rest of the roof, with the same matte black finish.

WINDOWS

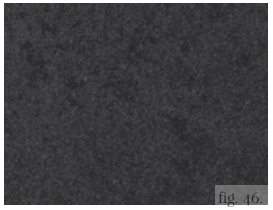


fig. 46.

Black aluminium is the finish on window bars and outside of the projected boxes.


fig. 47.

Plywood (birch) is used for deep window niches and interior framing.

INTERIOR WALLS


fig. 48.

Plywood (birch) with a natural finish as main cladding material on non-supporting walls.

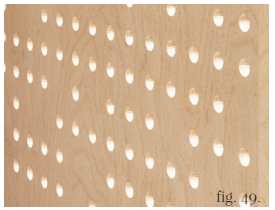


fig. 49.

Perforated plywood in birch is used as acoustic panels and add a playful look.

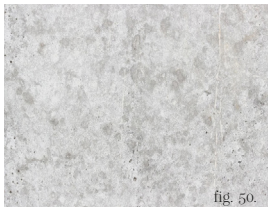


fig. 50.

Concrete with a raw finish is used to support the deck and act as several cores.

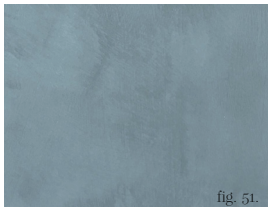


fig. 51.

Limepaint is used to add colors to some of the walls and defines homebases, depth and niches.


fig. 52.

Birch lists with/without glass as semitransparent walls for group rooms.

FLOOR


fig. 53.

Epoxy coated concrete above gives a smooth concrete surface that is easily cleanable.

CEILINGS

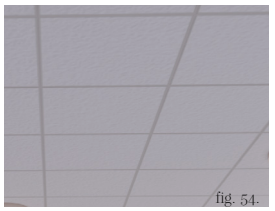


fig. 54.

Rockfon Blanka in offices and classrooms as acoustic ceiling and diffuse ventilation.

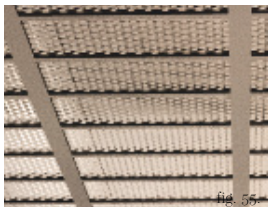


fig. 55.

Perforated black aluminium is a semi- transparent false ceiling.


fig. 56.

Plywood (birch) is the finish of the roof construction in the common area.

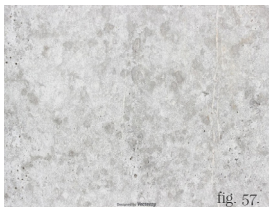


fig. 57.

Concrete is the finish of the deck construction when there is no false ceiling.

Double skin facade. A double skin facade consist of two layers with a gap in between which allows for desired airflows to occur. There are multiple advantages of the system: protection against heat loads, efficient sound insulation and good thermal performance during both summer and winter. Most importantly, it allows for highly transparent surfaces towards south and inviting natural daylight into the space. (Souza, E. 2019).

Trombe wall. Trombe walls are placed multiple places in the facade, and is a passive strategy for heating the building. Through vents in the bottom, cold air is let into the heated space between the glass and concrete and enters the space through vents at the top as hot air. (Hanania, J. et. al, 2015). Also, the walls can contain railings where plants and herb can grow.

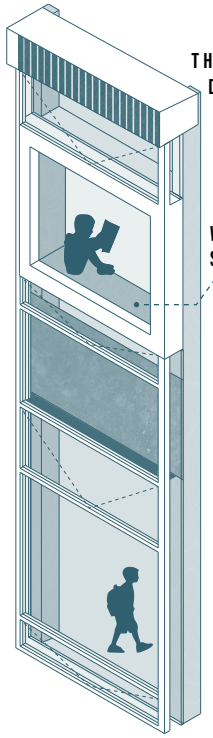


fig. 58. double skin facade

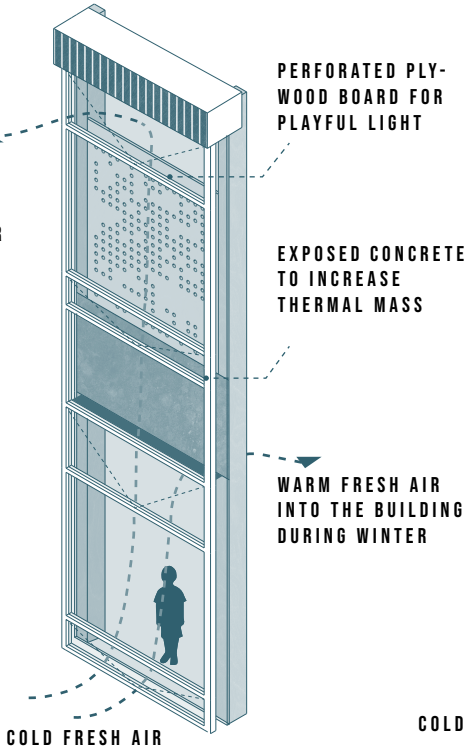


fig. 59. double skin facade

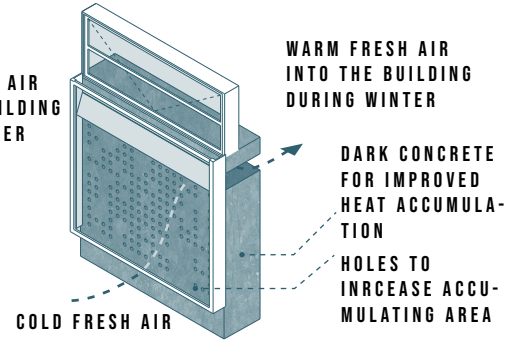
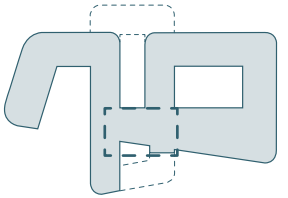


fig. 60. trombe wall



COMMON AREA

The large common room, which is the first one enters from the main entrance, is designed as the beating heart of the building and act as the intersection between all functions. From this area, users can access every part of the building, while also having visual contact with the zones for craft, science, library, administration, experimental garden and Agora.

Spatially, this room separates itself from the others by having exposed wooden construction and tall windows. Through the many double skinned facades, the space is flooded with both diffuse and direct daylight, making the atmosphere change throughout the day.

There is space for 80 seated pupils for common eating during lunchtime, while it will be available for workshops and common activities throughout the day. Large wooden multifunctional furnitures is used to naturally divide the space, while the combined climbing wall/stair encourages for activity. Smaller niches and secluded work zones may be found at the edge and towards the library.

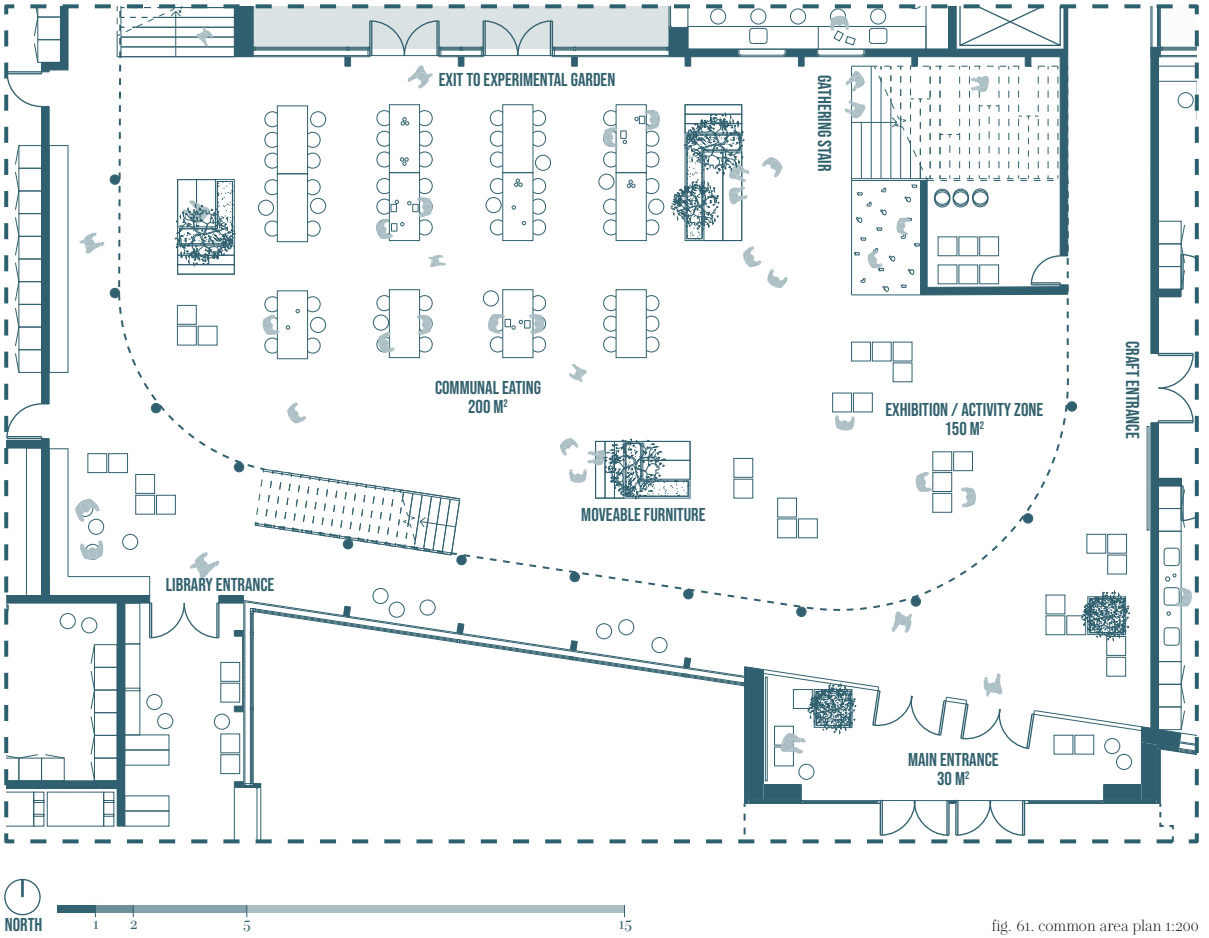
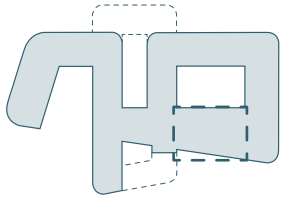


fig. 61. common area plan 1:200

fig. 62. the beating heart of the building



CRAFTS

To create a completely different atmosphere, the craft zone is designed with a higher amount of the robust concrete and complete visibility of the technical installations. The ventilation pipes are coloured, to evoke curiosity of the physical principle of ventilation. The tall space allows for large materials to be carried.

The common area for the craft zones is designed as a craftsman square, with research zones divided by movable furniture to display the pupils work. Because the square is in between rooms, two large skylights are placed above the main research zones. Internal windows looking into the different specialized classrooms provides insight in the different activities. Furthermore, perforated plywood boards are placed to improve the acoustic environment.

The two subjects in most need of diffuse light and privacy are placed towards the focus garden in the northern part of the zone, where lessons also may be conducted. Facing the Agora is the metal- and wood workshop. Large openings towards the Agora prolongs the workshop areas, also providing the opportunity to work outside.

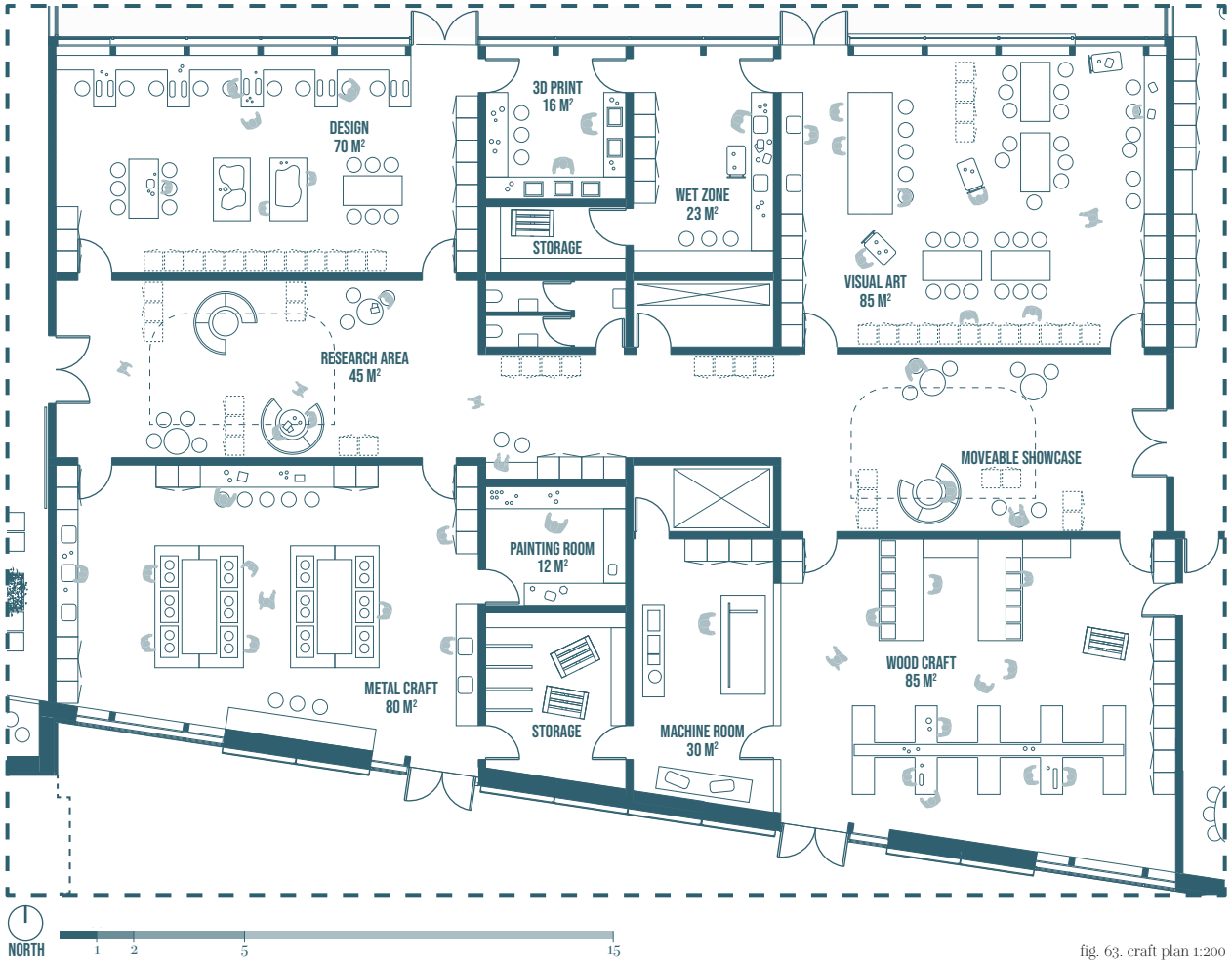


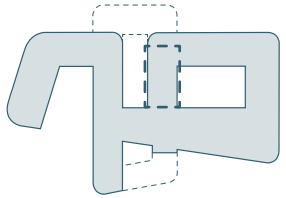
fig. 63. craft plan 1:200

fig. 64. the craftsmans square

SCIENCE

The subjects of nature science is placed in the volume separating the home bases and common rooms. In the hallway, which acts as a space for transit, different ecosystems are displayed.

The zone contains spaces for theory-lessons, research niches and hands-on exercises. As an extension of the biology and nature science rooms, the experiment garden acts as the exterior learning environment for the whole zone.



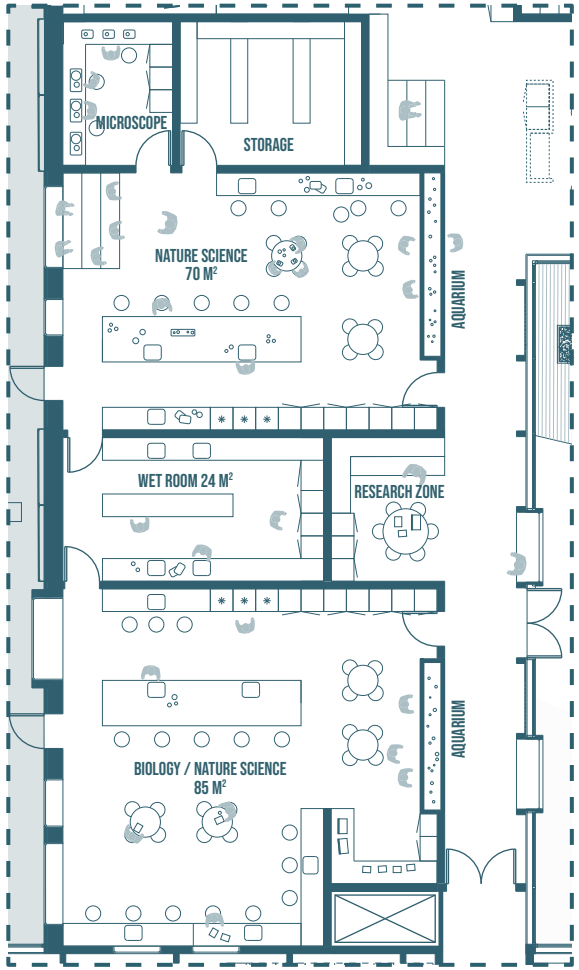


fig. 65. nature science plan ground floor 1:200

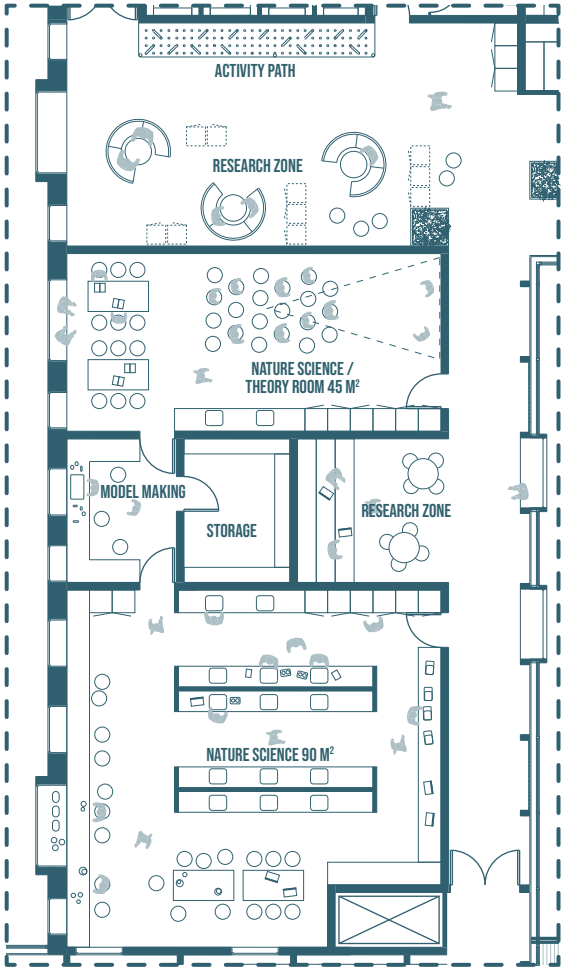
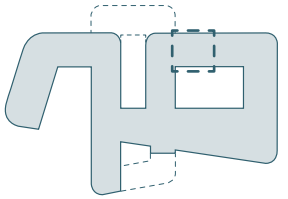


fig. 66. nature science plan 1. floor 1:200

fig. 67.view from research zone



PRE-PREPARATORY (0.-6.)

The northeastern part of the building consist of the pre-preparatory classes from 0.-6. grade. If not accessed from the common room, there are two entrances with associated wardrobes towards the northern play area. Each class has its own home base, providing a more private and undisturbed space for lessons and introductions.

The youngest are placed on the ground floor to secure easier access to the outside areas. On both floors niches and spaces are created by structural cores, group rooms and windows, but as the youngest pupils require more overview and clarity, fewer walls has been placed on the ground floor. The transition space between the toilet core and stairs are used for activity, also activating the non-furnished area.

At the end of the common areas placed towards the focus garden, spaces for ASC is prolonging the available areas for the preparatory classes. The common areas are designed to meet the requirements of problem-based learning, by providing a high degree of flexibility, spaces within the space and the opportunity to both work in groups and individually.

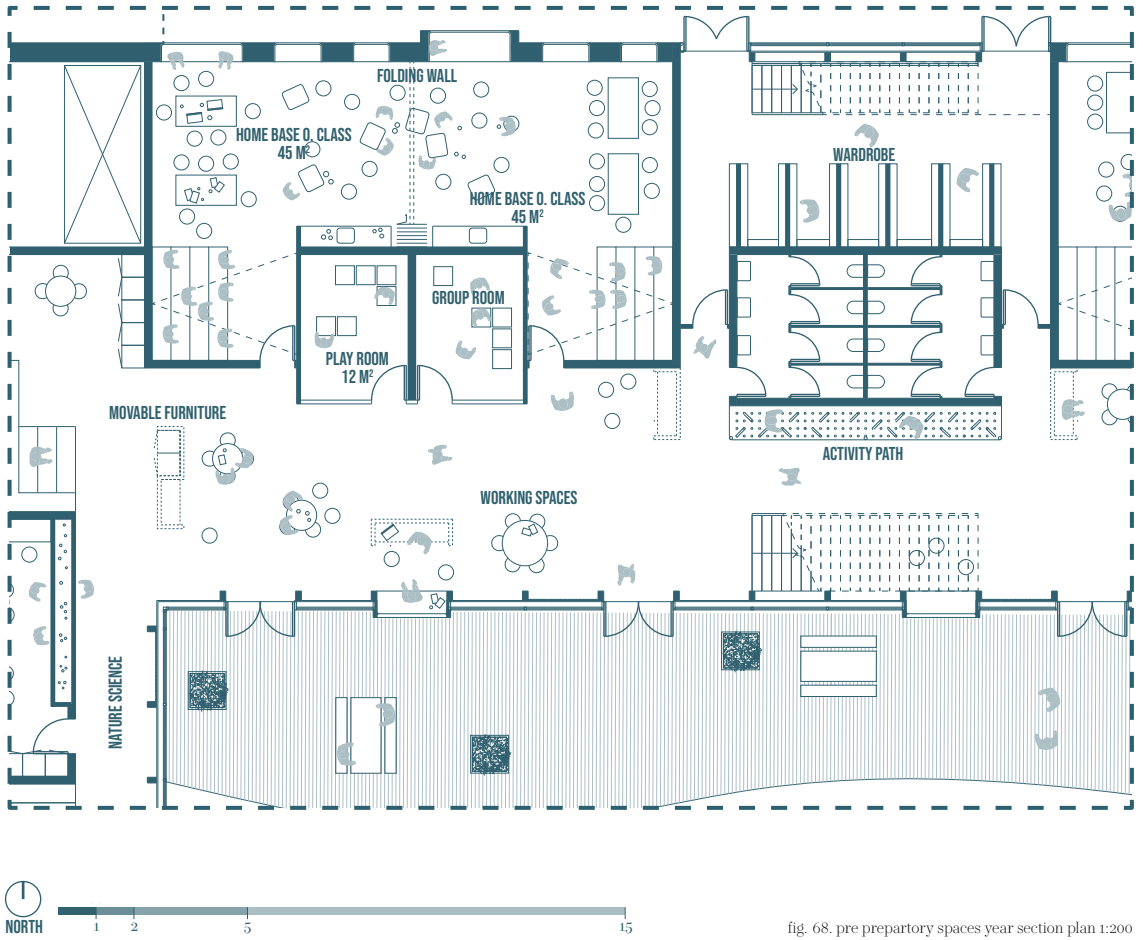
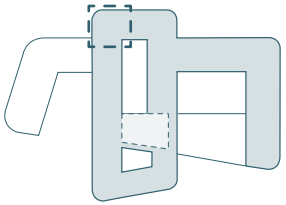


fig. 68. pre prepartory spaces year section plan 1:200



LOWER SECONDARY (7.-9.)

Located in the northwestern part of the building, the classes for lower secondary education are accessed the same way as the preparatory zone, with a small common space and structural core separating the two zones. Two entrances are supplied underneath the lifted volume, but as these classes do not have the same need for a wardrobe, lesser area is provided for this.

The zone consist of more private group rooms and zones to accommodate the need for more individuality in the older classes. Shared workspaces, flexible furniture, window niches and open spaces between rooms offer a variety of places to find contemplation.

A large common area for multiple classes is provided towards north, securing penetrating daylight in the majority of the shared areas. Additionally, the zone has exclusively access to the western roofgarden.

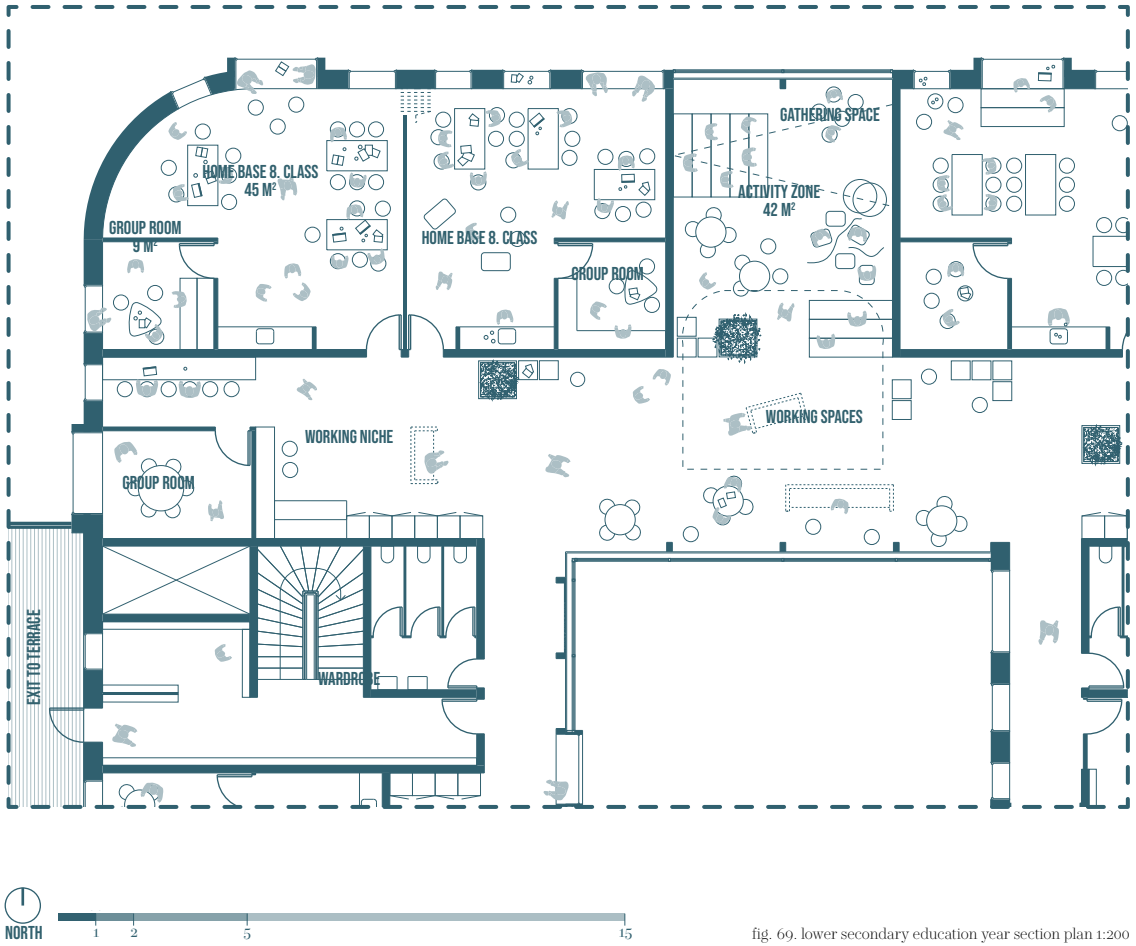


fig. 69. lower secondary education year section plan 1:200

PRINCIPLES FOR EDUCATIONAL SPACES

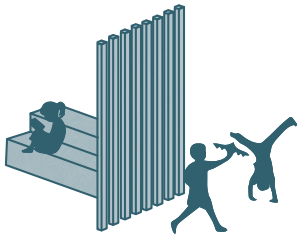


fig. 71. voluntary social participation

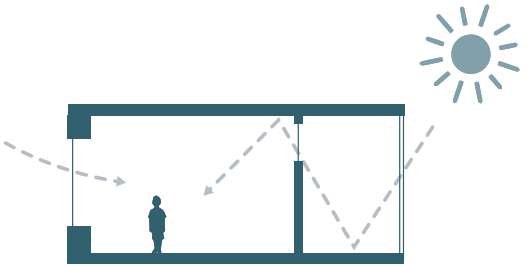


fig. 70. penetrating light while undisturbed

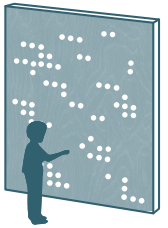


fig. 72. materiality

Spaces within the space. Common areas are designed to accommodate many different needs in terms of the problem based learning strategy. The whole common area may be seen as one large workspace with window niches and flexible furniture for different situations. Closed group rooms are created with a high degree of transparency with glass and lamellas to make the rooms comfortable. Furthermore, the negative space of the group rooms, class rooms and cores creates several niches, where some are further protected with a wall of lamellas. It is expected a high degree of circulational activity in the area between the structural core and stairs. Hence, stations for physical activity are placed here to activate square meters which cannot be furnished because of safety reasons.

Daylight. All home bases are supplied with penetrating light, through the main windows in the facade, and a string of internal windows positioned up against the ceiling. This makes the home bases also exploiting the light supplied from the double skin facade. Closed internal group rooms are secured sufficient daylight through the semi-transparent walls, while the spaces considered deepest in the common areas are supplied with a large skylight, also creating another atmosphere.

Materiality. Different colours are symbolizing the different homebases, while plywood boards with and without acoustic perforation are cladding the non-carrying walls. The load carrying walls are kept in concrete, while the wooden columns carrying the double skinned facade and roof are exposed. Hereby, honest and natural surfaces create a vivid and tactile environment. Window niches for stay, and perforated plywood boards provides a variety in the double skin facade. Semi-transparent ceilings provides extra room height improving the indoor climate, while also exposing the technical necessities in an elegant manner. As a desired feature, the home bases are designed in a way which makes it possible to merge the two rooms internally in each year section.

fig. 73.prepreparatory common area

VERIFICATION OF INDOOR CLIMATE

To verify the indoor environment in terms of thermal and atmospheric comfort, two BSim-models has been modelled. Both models are including infiltration, people load, equipment load, ventilation, lighting and floor heating.

There are no natural ventilation in the models, because of the focus on mechanical ventilation as main strategy. Though, the building is designed to naturally cool off during the summer nights, which would further improve both the thermal and atmospherical comfort by lowering the start level each day. Screenshots from the actual BSim-files can be seen in appendix 5, together with the geometry used.

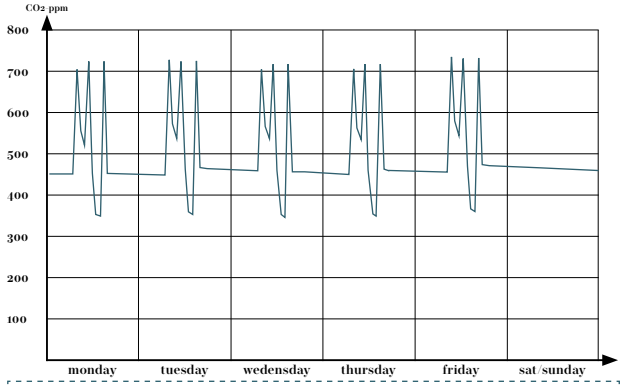
Model 1 is a typical classroom for the 0.-6. grade. The space is placed on the upper level, facing east. Because of the project-based learning model, the room will only have short periods of maximum load (28 children and two adults) before some of the children are assumed to leave the space to find contemplation in the common areas.

As seen in fig. 74 - model 1, the CO2-concentration may vary a lot during a typical day, and as for the thermal comfort, there are only a few hours above 26 degrees.

Model 2 is the large common area. This space has a south facing double-skinned facade, and is predicted to have a very varied people load. Hence, the people load is peaking with 300 persons during 1 hour of the day, and varying between 10 and 80 percent during the rest of the day.

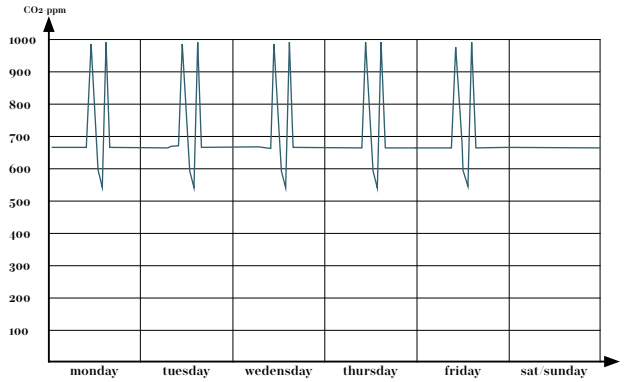
Because of the sudden large loads of CO2, as seen in fig. 74 - model 2, the concentration almost reaches 1000 ppm at some points, but the mechanical ventilation is considered just efficient enough to maintain an acceptable level.

Regarding the thermal environment, it seems to be no problem with having a south facing double-skinned facade, which is in the model as “MicroShade Window”. A reason for this may be the shading from the administration overhang, as well as a low g-value on the window and high thermal mass.



MODEL 1 (CLASSROOM)

hours above 26° C (max 100)	11
hours above 27° C (max 25)	7



MODEL 2 (COMMON AREA)

hours above 26° C (max 100)	10
hours above 27° C (max 25)	2

fig. 74. Bsim diagrams

fig. 75.home base to lower secondary class

DAYLIGHT ANALYSIS

An overall daylight analysis has been made for the whole building. Because of the volume size, the analysis only indicates how the daylight is penetrating the building. A more detailed analysis of a pre preparatory classroom was made in the final part of the synthesis phase (ref. to the program report, p. 144). Through the use of different strategies for daylight, the overall picture is considered sufficient.

Ground floor. All spaces for administrative purposes, teaching and education reaches way beyond the requirement of over 2% in over half of the zone, while the large facade openings in the common areas floods the different niches and spaces with natural light (fig. 76). Though, the some of the deepest areas are experiencing less daylight. As predicted did the cooped up craftsman square not achieve as much daylight as desired. This may be solved by adding more transparency internally in the rooms.

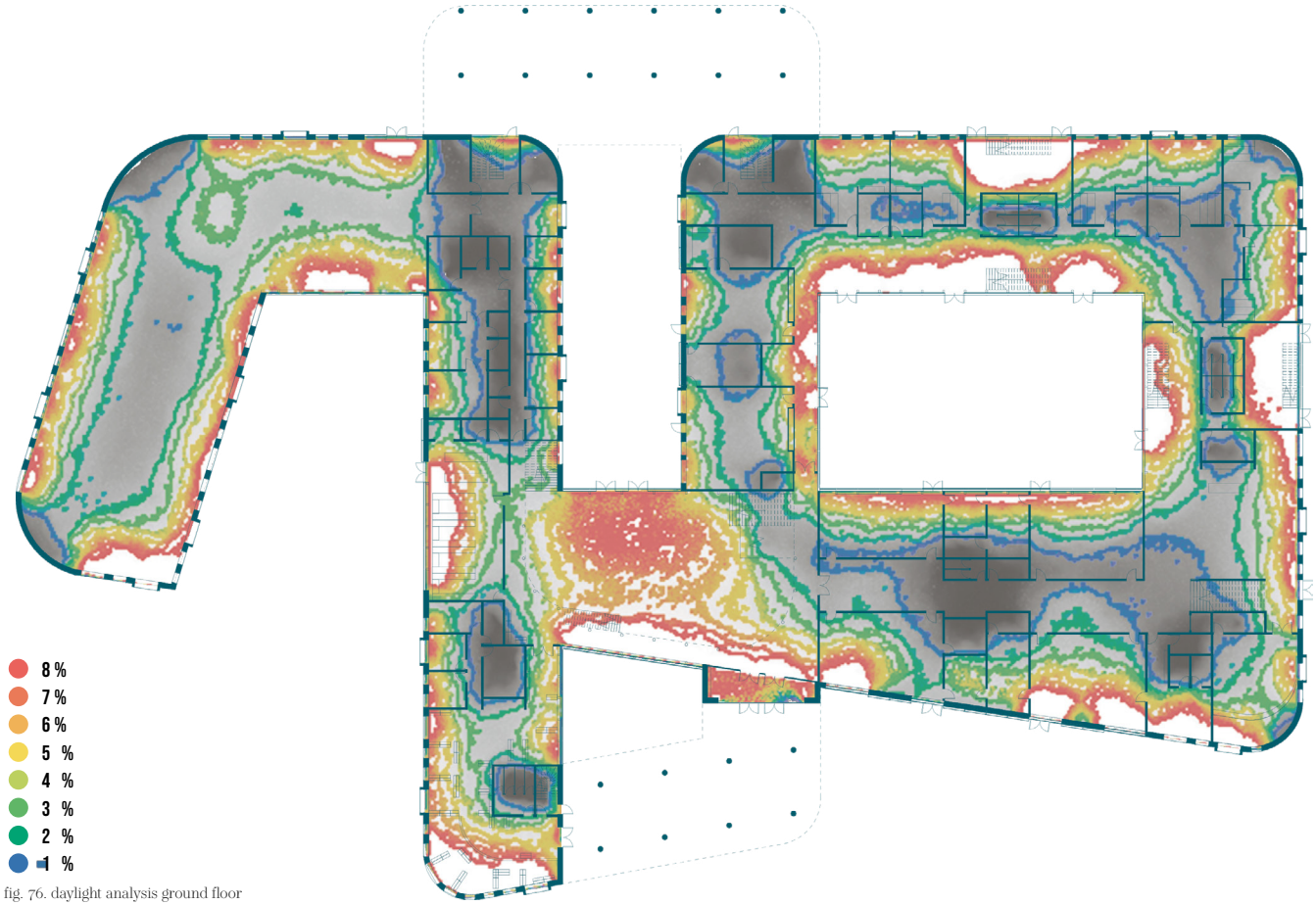


fig. 76. daylight analysis ground floor

First floor. Also on the first floor, a majority of the spaces are sufficiently lit. As the focus were put merely on the design of the pre preparatory classes, the western classrooms for lower secondary education has not reached the requirement of 2% in half the zone, which could be solved with more glass in the facade (fig.77). Areas for science are also experiencing some lack of light, but as the space is on the first floor, there is a possibility to add a skylight.

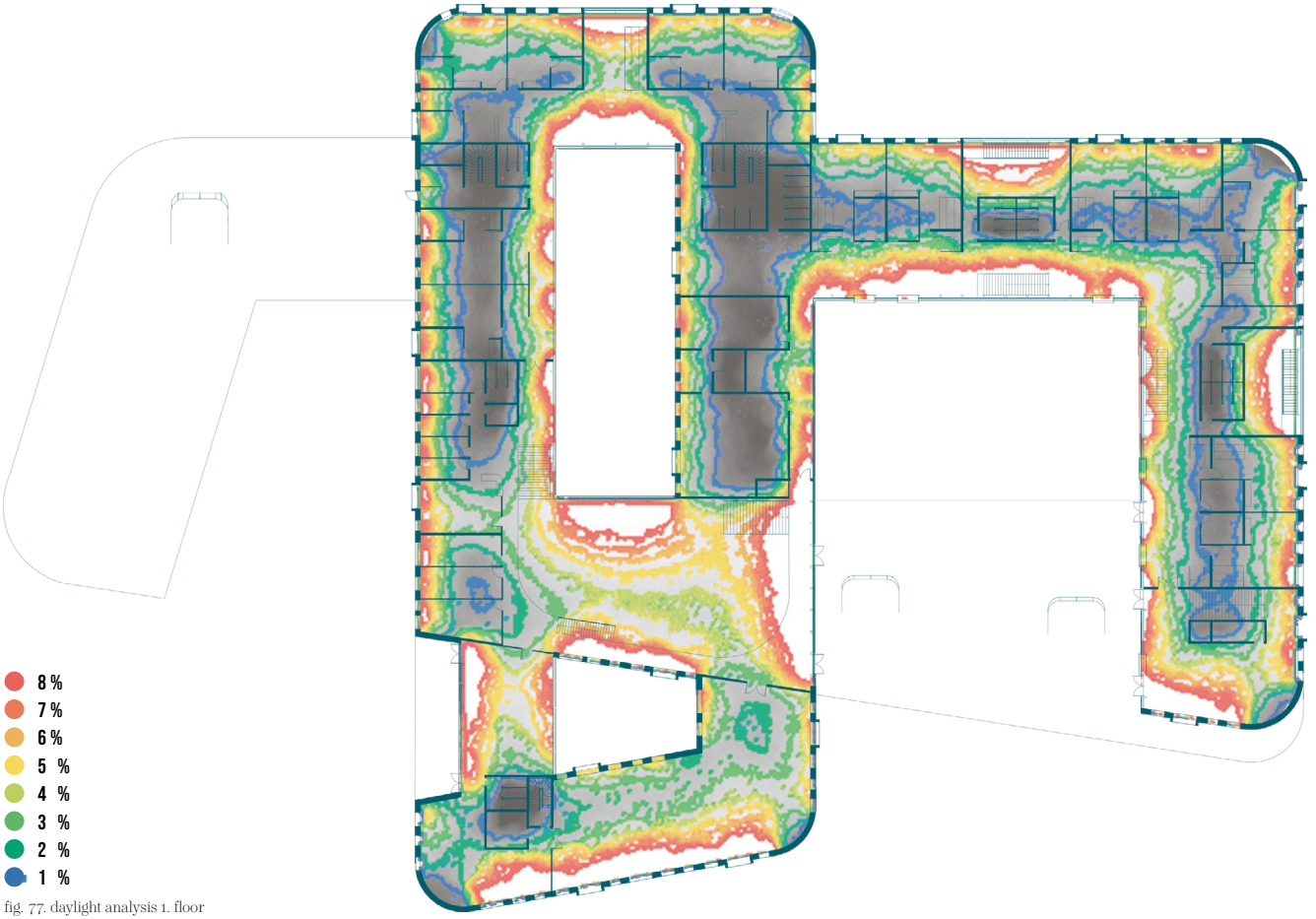


fig. 77. daylight analysis 1. floor

VENTILATION

Natural ventilation and night cooling. The building is designed to allow for an efficient night cooling strategy through natural ventilation (fig. 78). Small openings in parts of the window are placed in the classrooms. The air penetrates through these openings, then through the internally placed windows between the classrooms and the common area, where it rises by thermal buoyancy to the skylight after collecting heat from the accumulating concrete parts. As an option single-sided ventilation can be used manually in the classrooms throughout the school day as well.

Mechanical ventilation. Because mechanical ventilation is an efficient and reliable way of keeping a sufficient indoor climate, as well as being able to recover over 80% of the heat, it is the main ventilation strategy of the building. The maximum dimension of the distribution pipes is 400mm (calculation in appendix 6), hence the lowered ceiling in the distribution area is placed +800 mm. Four different principles are used for the appearance of the ventilation. In the classrooms and offices with sedentary activities, diffuse ventilation through Rockfon Blanka acoustic reducing ceiling panels is used as shown in fig. 79 (Rockfon, 2018). In the common area, a semi-transparent wired mesh ceiling is used. This improves the acoustic climate and lowers the ceiling to accommodate the children scale, while the semi-visible pipe system still creates awareness of the technical operations in the building. In specialized classrooms and craft zone, the pipes will be fully visible and create a more raw atmosphere. In the large common room, there are no lowered ceiling nor technical installations, because of the establishment of displacement ventilation with air supplied from the floor. This strategy is considered more efficient for tall spaces with a large people load, and can still be ran on the same system.

Ventilation strategy. The strategy is based on 4 systems each, with its own aggregate, all run through a VAV control system (appendix 2). The two main aggregates are placed in the two infrastructural key points of the building form. From here the pipes run along the hallways supplying all rooms (fig. 80 and 81). The aggregate for craft is positioned in the middle of the zone, while the system for science are placed with one of the main plants, which are zones where process ventilation and a higher ventilation rate is needed.

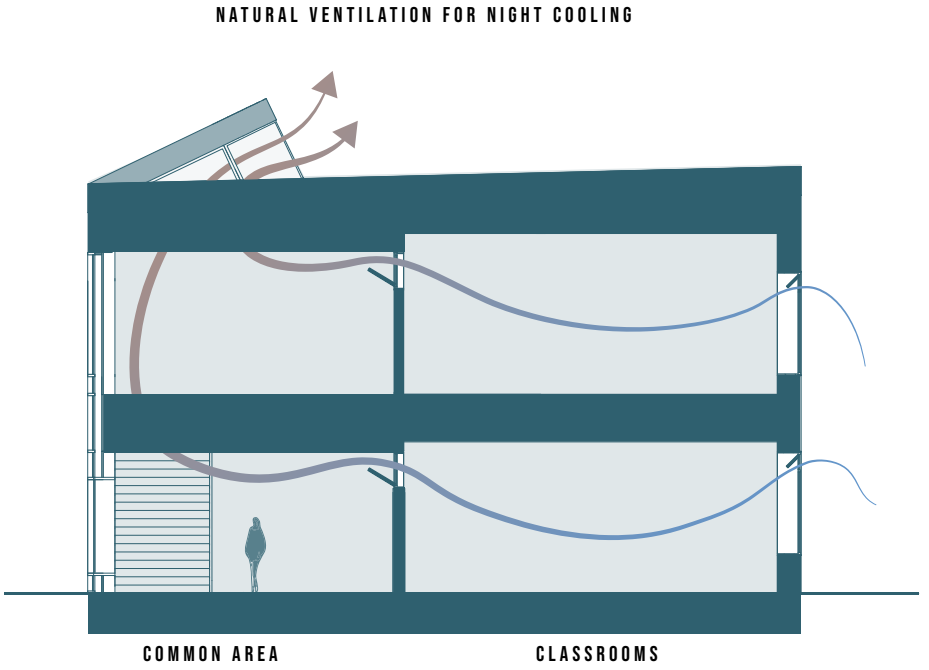


fig. 78. natural ventilation principle section

PRINCIPLE FOR MECHANICAL VENTILATION SYSTEM

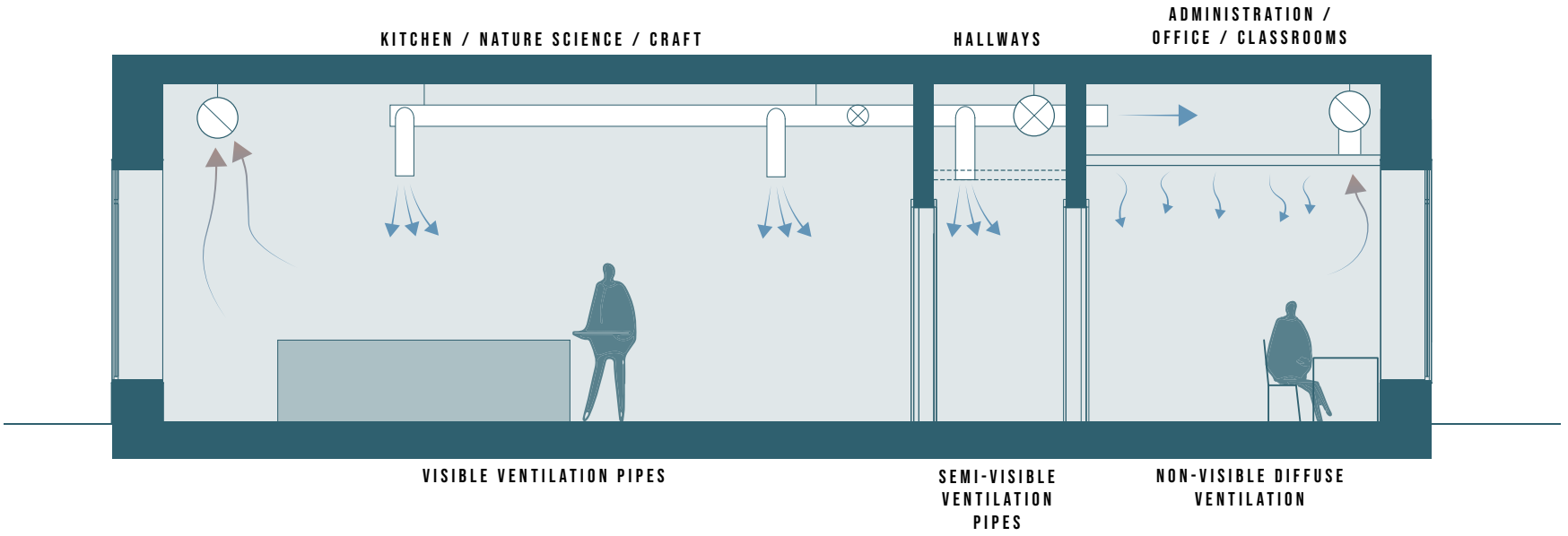


fig. 79. mechanical ventilation principle section

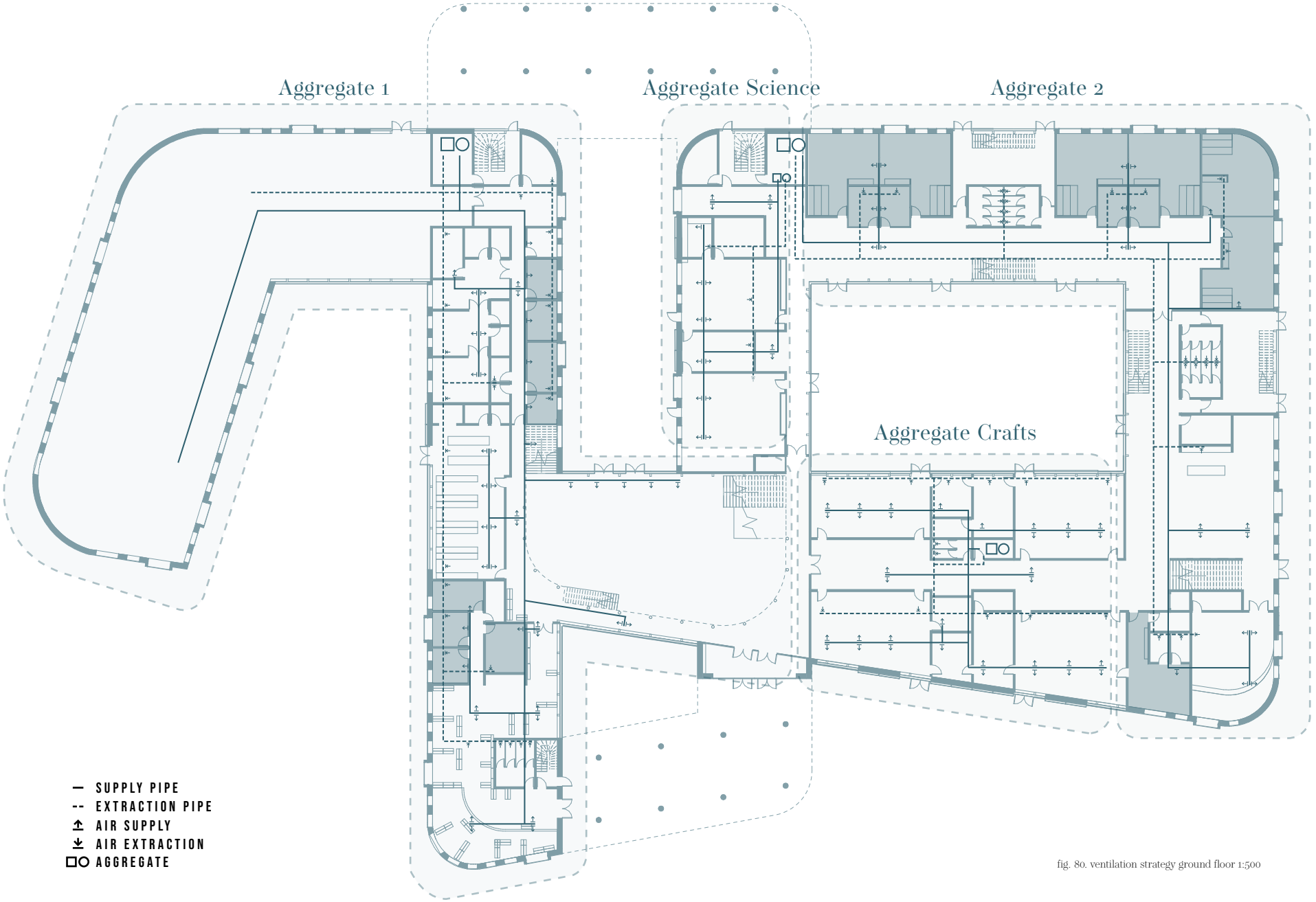


fig. 80. ventilation strategy ground floor 1:500

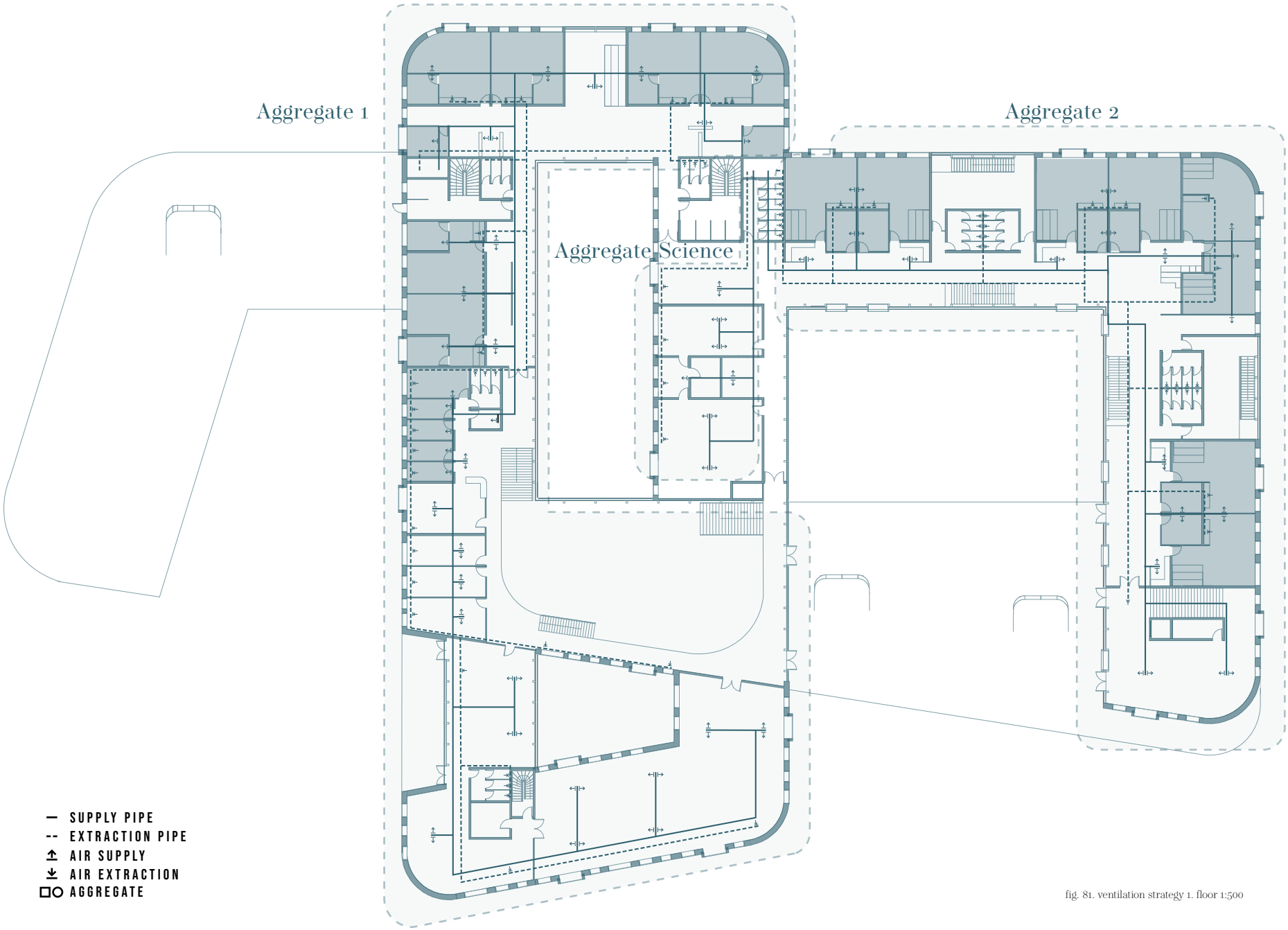


fig. 81. ventilation strategy 1. floor 1:500

FIRE STRATEGY

Categories. The fire strategy is based on the demands from the Danish Building Regulations 2018 (Bygningsreglementet 2018). The building is separated into different application categories based on functions and number of persons. Educational spaces for less than 50 persons, follow the demands for category 2 and risk group, while all common areas for more than 50 persons follow requirements for category 3 and risk group 2. In both these categories the users of the specific building section, are presumed not aware of the escape routes, but are able to bring themselves into a safety. The office area for the teachers follows category 1 and risk group 1, where the users are aware of the escape route and they are able to bring themselves into a safe place.

Fire compartments. Classrooms and other separated rooms for less than 50 persons and smaller than 150 m^2 are constructed as fire compartments with at least one exit to the escape route. The classrooms will furthermore be constructed with three rescue openings, which is illustrated by the yellow arrow in the fire strategy, to secure all persons in the room can be rescued or make oneself known to the rescuer. All fire compartments with a door to the terrain, will not need any rescue openings. In the classrooms the walking distance from any point to the exit will not exceed 30 meter. All specialized classrooms are designed with two exits to the escape route.

Fire sections. To avoid spreading the fire, the escape routes are constructed as separated building sections within separated fire compartments. The escape route leads to fire sections with emergency exits to the terrain. There is no longer than 30 meters from any fire compartment to a fire section. Doors in the escape route that will be used of more than 150 persons will open in the direction of the escape route.

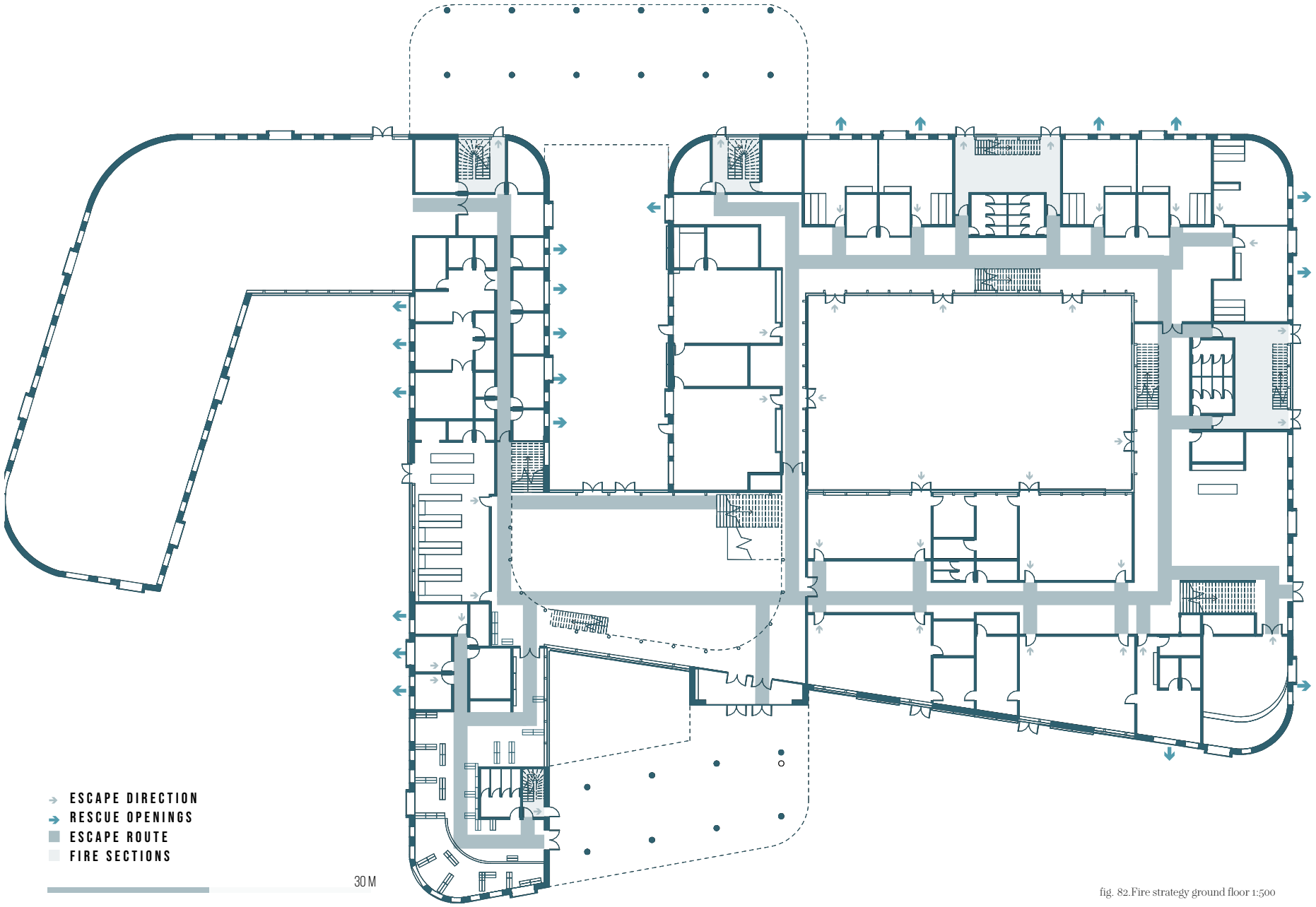


fig. 82.Fire strategy ground floor 1:500

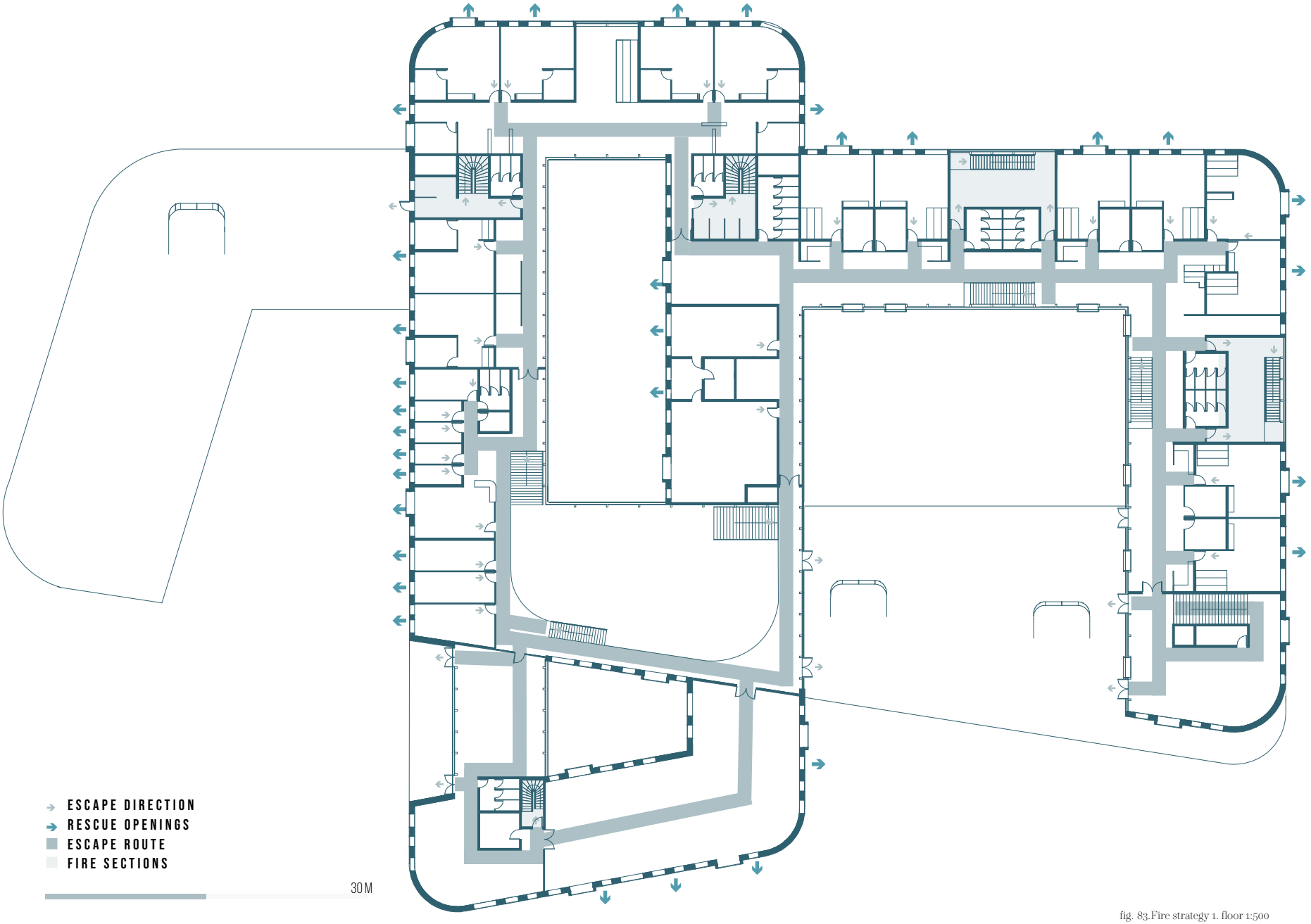


fig. 83.Fire strategy 1. floor 1:500

fig. 84. entrance of Byens Skole

CONCLUSION

Byens Skole is a proposal for a school, in which accommodates the requirements from the public school reform, while simultaneously generating a new social core in a small society with a high amount of socially deprived children. In an innovative way, the school tries to promote local pride, while also respecting the town and its traditions.
Through the design, individual needs for development are considered through a large diversity of spaces. Elements from healing architecture, with a special focus on natural daylight and materials, secures a safe feeling, as well as enhancing a learningful day at school.

The school and its outside areas acts as a pedagogical tool, with visible active and passive strategies, also making the school a Net Zero Site Energy Building. It has been put an effort into creating facilities for the children to form a prudent relationship with the material world we live in.

The school is a proposal of a building satisfying the individual for the majority of the people.

fig. 85. site photography

REFLECTION

Covid-19 crisis. Nobody saw the situation coming. The time we were to enjoy the last semester of a five year long education with the co-students were brutally taken away without anything to do. It was extremely stressful; not only were the world at a never-seen-before breaking point, but the uncertainty of our future reached a new all-time high.

It took a lot of effort and energy to adapt to the new situation of writing a group Master Thesis without being able to meet physically, but after a few weeks when the situation was more settled, the new routines became the new normal. The group kept virtual meetings three times during the day, describing and discussing the prior findings and conclusions.

As the weeks went by, we started to find comfort in the situation. Maybe, just maybe, because we are only having these short meetings discussing the most essential progress, we are more efficient, compared to if we sat together? Did we get more individual experience by being forced to think independently and not ask anyone else for help before trying? Was this a learningful experience reflecting upon the reality of the architectural business where a lot of communication actually happens virtually? The questions are relevant, and as we can not compare it to a world without COVID-19, there is no right or wrong conclusion. Regardless, the experience has taught us a lot.

The proces. For the first time, which may be a result of the experiences from the internships last semester, we really felt that we designed with the engineering parameters, and not against them. The final concept is the result of many hours of analyzes, tests and solutions based on energy, indoor climate and light. By exploiting the tools we have been served throughout the education at AAU, we could boost our arguments for the chosen design. By connecting the building to the “physical world”, we felt that it was becoming a whole other level of designing. Maybe the COVID-19 situation forced us to find arguments that were quantitative to present virtually? Though, this was not only the actual analytical approach, but also the understanding of the physical concepts and their relation to architecture of for instance the double skin facade.

The different scales. Was the size combined with the complex functionality of the building too large for a Master Thesis written by students with close to no experience with educational architecture? It has been an extremely challenging task to go into detail with so many square meters.

That said, the process of designing a building of this size for the smallest in our societies has been extremely learningful. We saw, that more than designing the small details, it was important to develop concepts and strategies which could be utilised several places in the building. Additionally, the finding of a "flexible" volumetric concept, tolerating both functional and analytical nudges was important to reach the level of detail. This is in line with the idea of this being a sketching project, ready to be projected.

Concepts and strategies were developed for the Agora and rest of site, but the idea of passing on the sustainable visions all over the site did not reach the desired level of detail. It has been a demanding task to jump back and forth between the masterplan scale, and the design of the niches in the common area. Early in the phase, the group had many ideas, visions and thoughts on how to incorporate sustainability as a educational feature in a school building, but all of the wanted features could not be designed as a consequence of the large scale.

The school building. Early in the process, we experienced the difficulty of designing to meet the requirements of a problem based school. The possibilities are endless, and when looking at award-winning cases, they all do it different. Based upon our user interviews, we found our own way, but there is no way of knowing if this is a sufficient solution or not. Furthermore, we found that a school is a complex building where the art is to make all functions come together.

When presenting the final concept, solutions and strategies, a lot of text has been written. This is to emphasize the theoretical approach from the presentation, trying to incorporate the acquired knowledge from the program. Though, it has been impossible to cover all the tiny details which has evoked the final result both in the presentation and process folder. There is no doubt that we did ourselves a favor of establishing a highly theoretical and detailed program, and all information it covers should be perceived as one large argument for the final design.

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FIGURES

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