



The Ladder

a story of two worlds

MSc 3 Research report
Graduation studio Heritage and Architecture, TU Delft

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1. INTRODUCTION

1.1 RESEARCH STRUCTURE

The Hembrug area is a former military production site located just South of Zaandam. Within the fortification “the stelling of Amsterdam” the Hembrug site functioned as the central point where weapons and ammunition were not only produced, but also tested. With the military leaving the site in 2000 it became a large area to redevelop in the metropolitan area of Amsterdam. In this booklet we will focus on one specific ensemble within the Hembrug site, named the Ladder.

The Ladder consists of 5 factory buildings, with a total floor surface of 7400 m², located in the South-East part of the military terrain. Notable is the fact that buildings from different construction periods (1926-1969) are standing in a row, from the outside they seem like separate buildings. However they are connected with each other via passageways indoors. This means that while walking through the ensemble via these passageways you experience the different structural styles of the building and especially the various ways daylight enters the buildings.

This interconnection between the buildings raises questions; how did the buildings develop over time? Do the functions play a role in this development? In order to understand the way this ensemble worked, the historical research about the development of the buildings in relation to the factory processes, has become one of the main focus points of this analysis.

The main research question is:

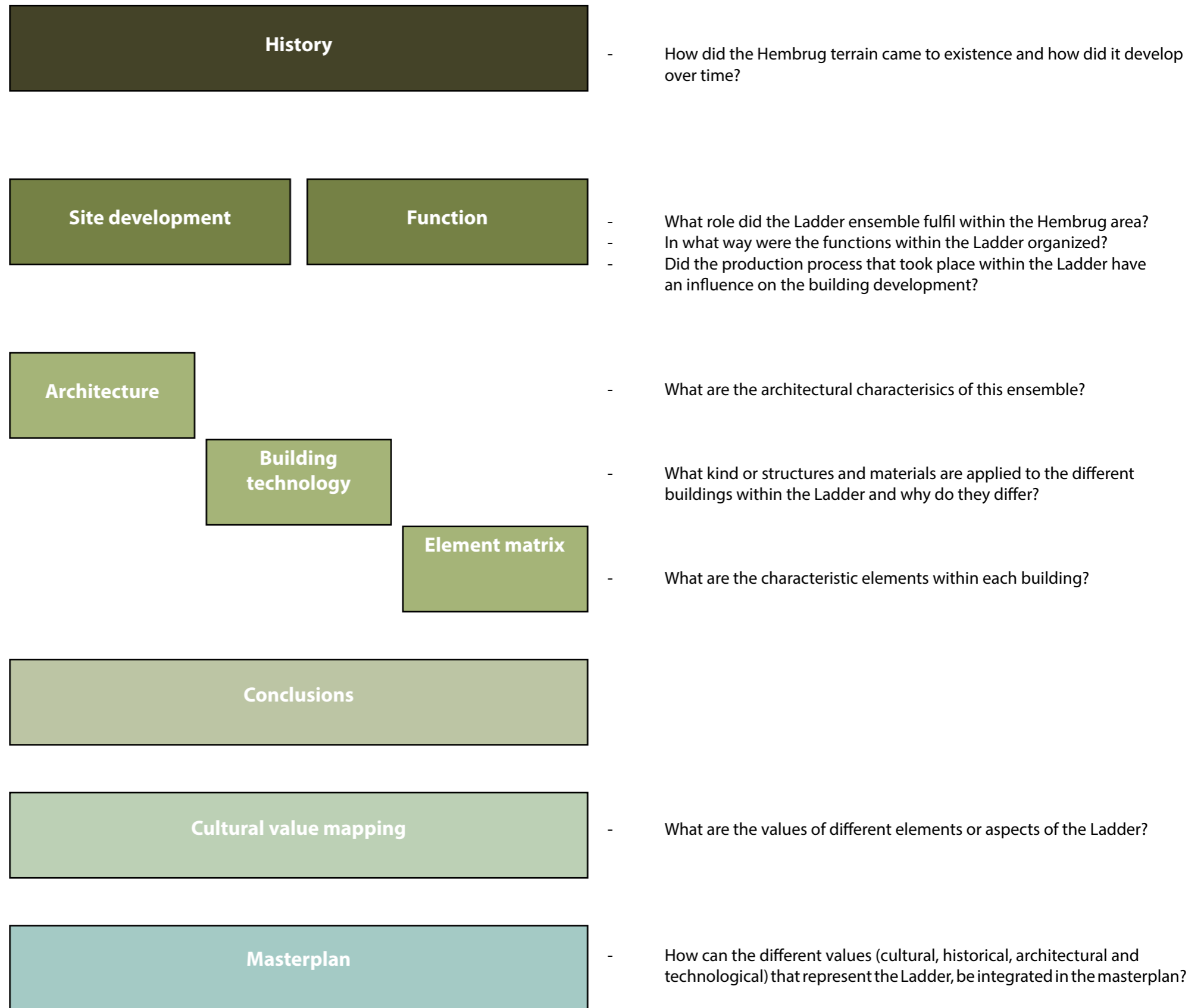
What is the relation between the different buildings of the Ladder ensemble and how did it function as a whole?

Aside from the historical analysis of the ensemble we focused on the current state of the Ladder and its direct surroundings. First the architectural qualities are investigated; sightlines, surrounding atmospheres, facades etc., followed by the analysis of the building technology aspects. Because the different structures and materials are part of the experience of the building, there is no clear boundary between the architecture and building technology analysis. We can state that in these types of buildings the construction is the architecture and the architecture is the construction. In the analysis we provide an overview of building elements from each building to show this overlapping coherence.

To value all the data we collected with our research, a cultural value matrix is set up, which is the product of discussion between the group members about the results from the aforementioned research. With the outcome of this cultural value mapping the base for the re-development of the building ensemble is established. Based on ideas of the new function of the area and the input of the different values a Masterplan is made. In the Masterplan chapter we will go further into detail what functions we envision for the area and how it will function as a whole. During our research we came to the conclusion that the Ladder deals with two different worlds, the internal and the external world. Which leads to our main design question:

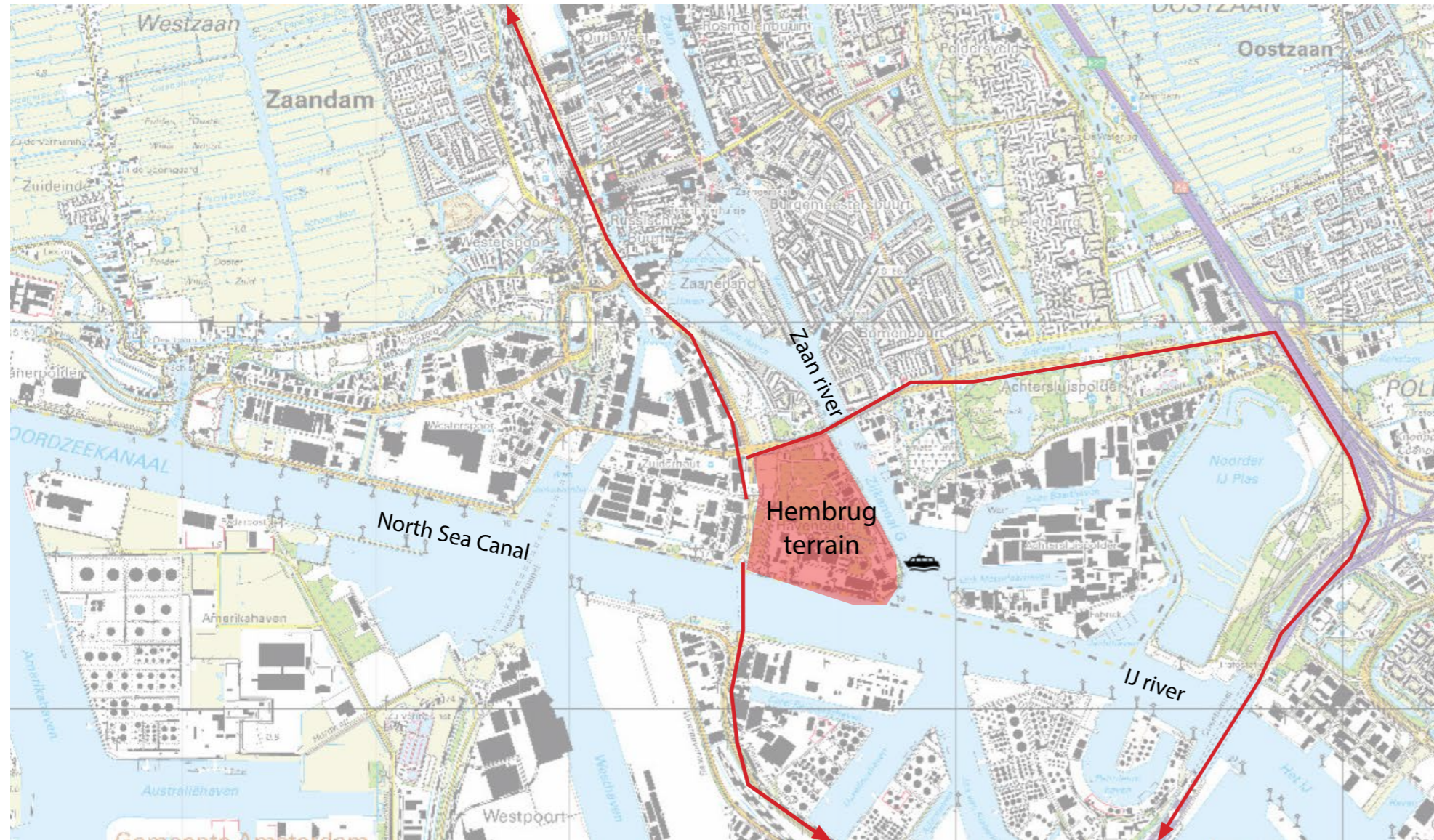
How to deal with these two different worlds?

Historical view on the Ladder 1956,
photo from collection © Hembrug Museum, Zaandam



1.1 REGIONAL SCALE

**by car and bike 2.4 km to train station
of Zaandam**



**by bike/ferry 8.3 km to central
station Amsterdam**

**by car 13 km to central
station Amsterdam**

The Hembrug terrain is located between the cities of Zaandam and Amsterdam, and lies as a peninsula at the crossroads of the Zaan river, the IJ river and the North Sea Canal.

The surroundings are mainly characterized as industrial areas.

The distance between Hembrug and Zaandam station is 2.4km , can be reached by car in 4min and by bike in 8min.

The distance between Hembrug and Amsterdam central station is 13km by car which will take you 19 min, or 8.3km by bike and ferry, which will take you 36 min (via google maps navigation)

At the East side of the Hembrug there also is a possibility to take the ferry which will take you to Zaandam in 15 min or Amsterdam in 45 min. (www.zaanferry.com)

Fig. 1.1.1 Position of Hembrug terrain in relation to Zaandam & Amsterdam (source map underlay: www.topotijdreis.nl, overlay by authors)

1.2 SITE AND ACCESSIBILITY



The Hembrug terrain can be accessed by car, bike or as a pedestrian, via one of the two main entrances, on either the East or West side, most of the area is closed off by a fence. These two main entrances connect to the main access road, which you will use when going to the Ladder.

Fig. 1.2.1 Entrances to the Hembrug terrain. (map edited by authors)

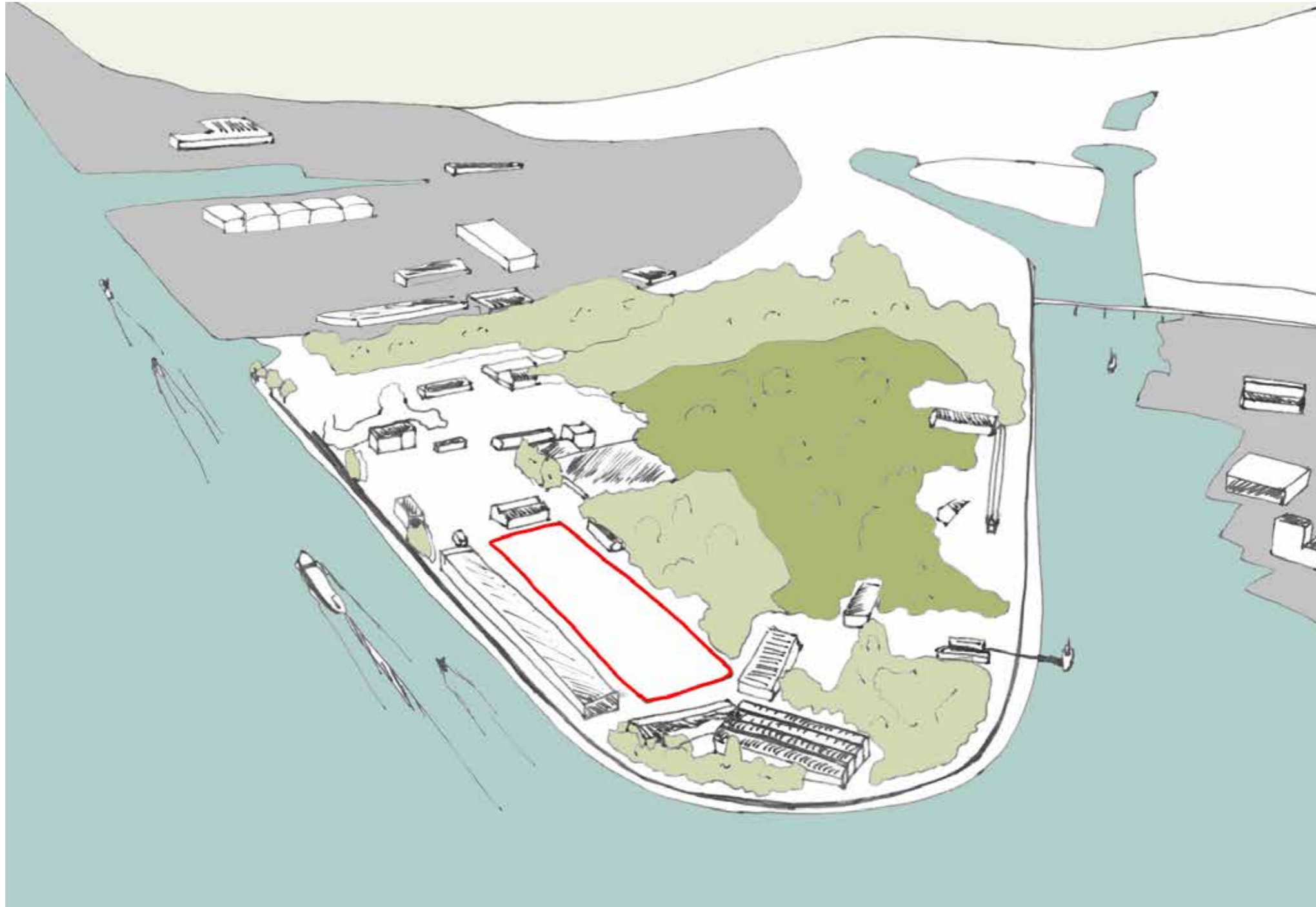


Fig. 1.2.2 The Ladder ensemble plot (marked red) within the Hembrug terrain
(drawing by authors)

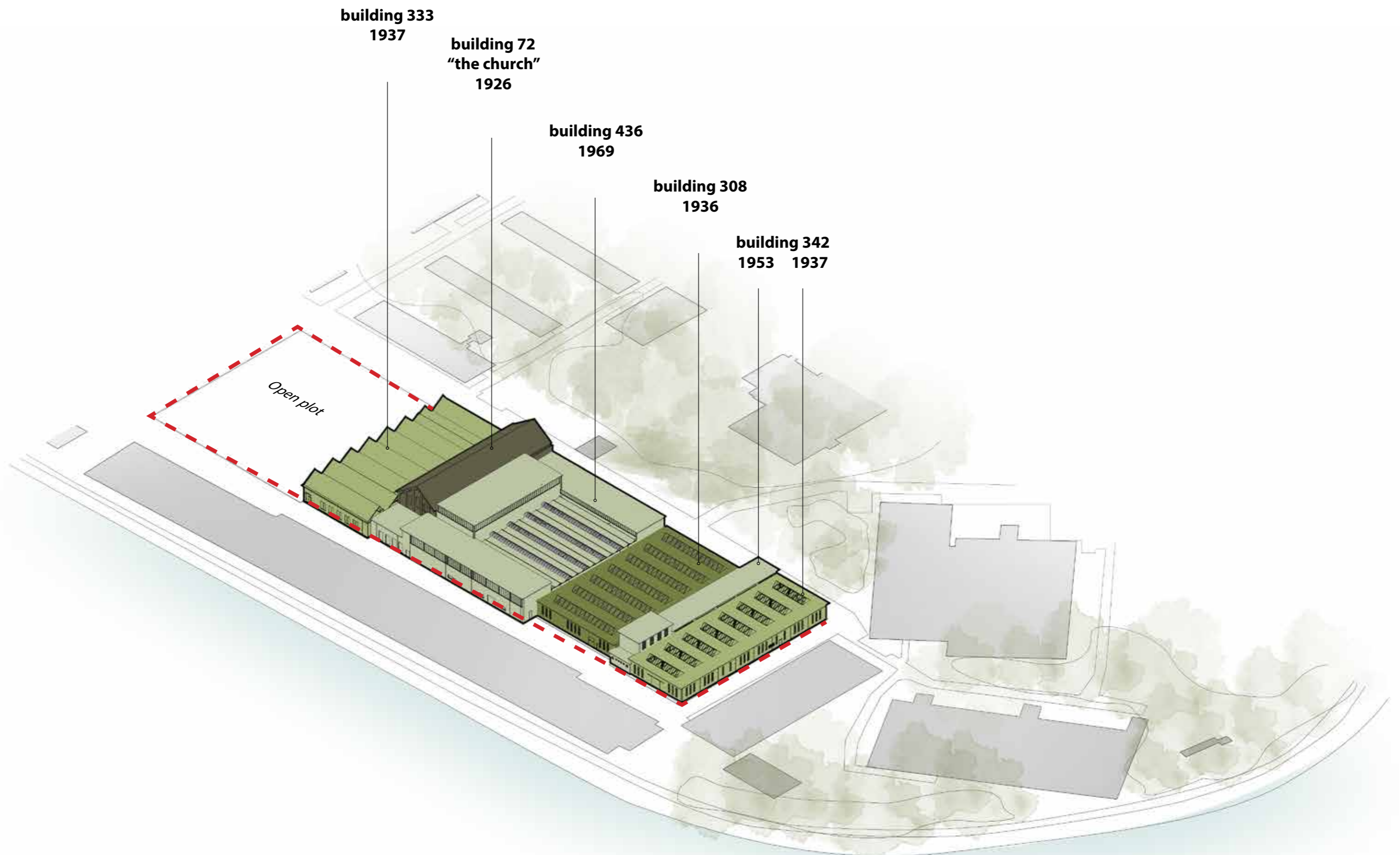


Fig. 1.2.3 The Ladder ensemble plot, with building names and age (drawing by author, building dates and numbers by Steenhuismeurs (2010))



ZAANDAM

Westzaan

Oostzaan

Zaandammer Polder

Landsmeer

Groote Hoorn

Amsterdammer Polder

Polder VIII

De Hoorn

Polder

Kadoelen

Buiksloot Meer

Buiksloot

Buiksloot Meer

Nieuw

Sloterdijk

AMSTERDAM

Spieringhorner binnenpolder

Ook Meer

Stoom-Oranje

2. HISTORY

De Hem

Before the Hembrug terrain became the area we now know, a large part of it was water. With the completion of the North Sea Canal the polder de Hem got expanded into the area that from then on was known as the Hembrug terrain. (fig 2.1.2)

Hembrug Terrain

The military history of the Hembrug terrain is more than a hundred years old. Between 1895 and 2002 the Hembrug terrain was the heart of the Dutch military industry. The authority that was responsible for the production of military artillery in the Netherlands was called the Artillerie Inrichtingen. Previously the military production center was located in Delft. However in 1899, due to the need for production expansion, the main production moved to a new location, the Hembrug terrain (fig 2.1.3). The Artillerie Inrichtingen produced artillery, ammunition, and cartridges for the Dutch army. Moreover, a vast forest area was created in which ammunition, and explosives could be tested and stored. The activities that were carried out on the terrain were kept a secret, thus the area remained isolated from the outside world.

Fortification line- "Stelling van Amsterdam"

The Stelling of Amsterdam is a circle of defensive works around Amsterdam, at a distance of 30 kilometers from the center of the capital. The Stelling van Amsterdam was one of the strongest fortifications in Europe.

The choice of location was a strategic one, because it was located in the middle of the Stelling van Amsterdam, therefore there would be a lot of space to expand. The fact that they located it next to a large body of water was also intentional, because the main mode of transportation was over water.

During wartime the area within the Stelling was safe, and was designed so that the troops could provide their own food and ammunition production to withstand a long-term siege. However, after the development of new techniques and the use of airplanes during the outbreak of WWI, the area within the Stelling lost its initial advantage and was not that safe anymore. (<http://www.stelling-amsterdam.nl> and Holleman, E., Reijke, R. (2006))

Fig. 2.2.1 The greater area of the Hembrug 1882 (Topotijdreis.nl)

First functions Hembrug terrain

The original set-up of the Hembrug terrain was divided into 3 parts (fig 2.1.4). Each part hosted a specific production factory, namely the weapons factory, the pattern factory and the ammunition factory. Each factory had its own entrance and they were separated through the use of wire fencing and ditches.

The Hembrug terrain was the epicenter of the Dutch Army Industry. The following functions came together at the area:

- Artillerie Inrichtingen: Factories for the production of weapons, ammunition, and cartridges.
- General Defense Park: Workshops and supplies for the Stelling van Amsterdam and later other military lines.
- Sector Park Zaandam: Stocks as ammunition, weapons, and fuels for the forts in the Northwestern part of the Stelling van Amsterdam. (Steenhuismeurs 2010)

On the following page there will be a timeline that contains important events in time that had a direct influence on the development of the Hembrug terrain and events related to function.



Fig. 2.2.2 Stelling van Amsterdam, Amsterdam in dark orange (www.werelderfgoed.nl)



Fig. 2.2.3 De Hem 1872 (Topotijdreis.nl)

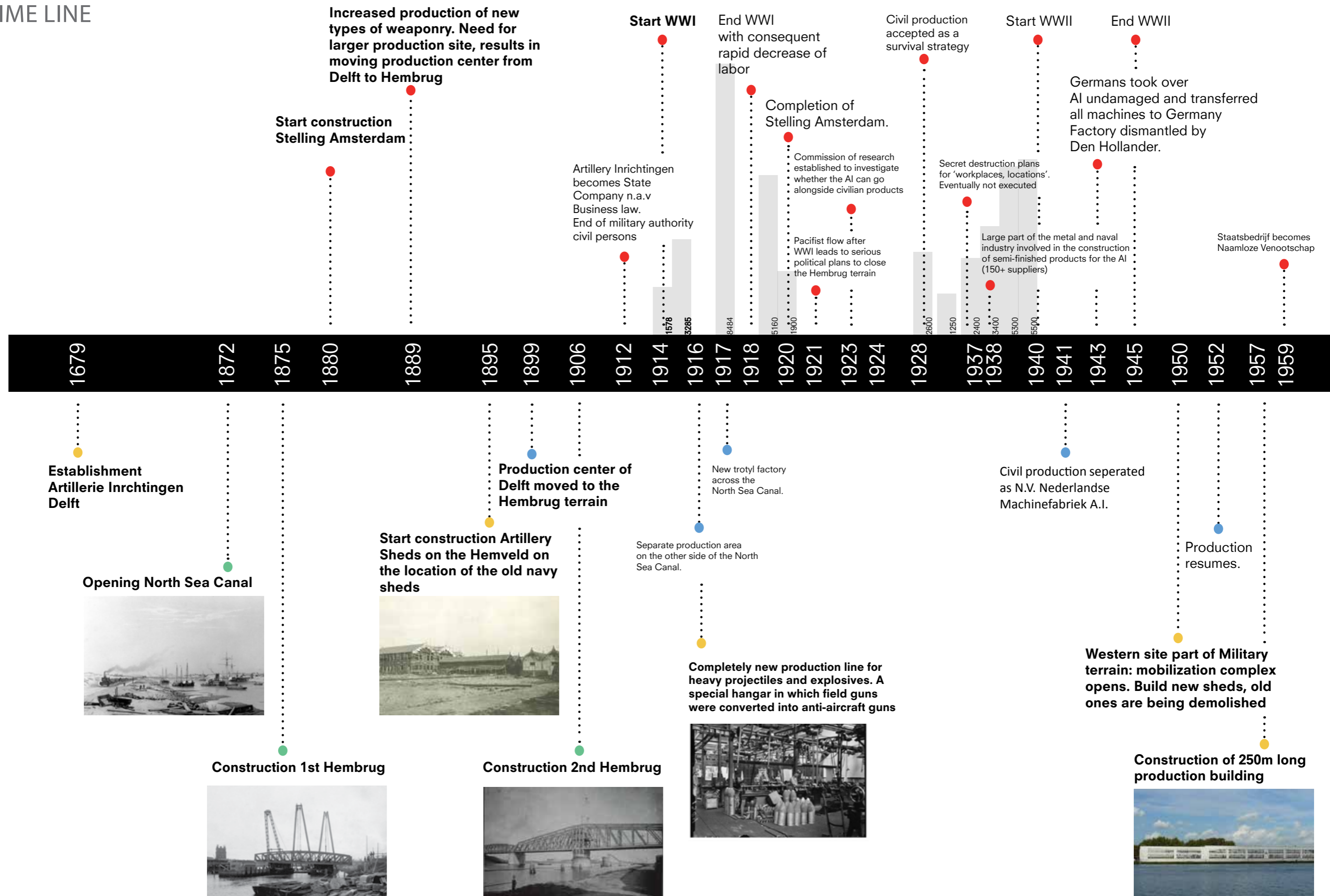


Fig. 2.2.4 First Artillerie Inrichtingen 1899 (Topotijdreis.nl)

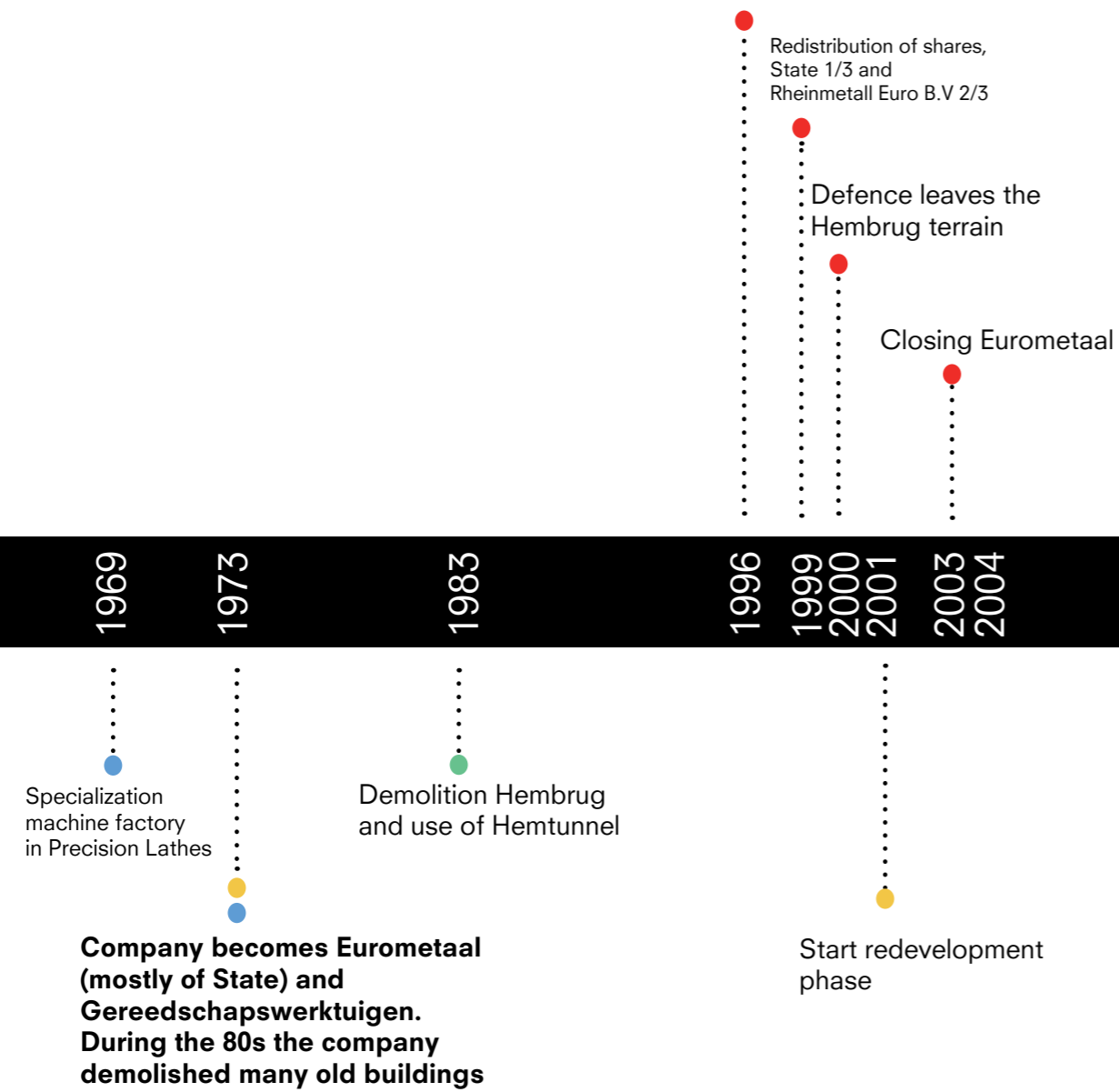


Fig. 2.2.5 3 functional zones Artillerie Inrichtingen 1924. Yellow buildings: gun factory, Blue buildings: cartridge factory, Red: ammunition factory (from SteenhuisMeurs, 2010)

2.1 TIME LINE



Placement of the Stelling van Amsterdam (Defense Line of Amsterdam) on the UNESCO list



Legend

- War Period & Important Events
- Building development at Hembrug terrain
- Function
- Spatial development outside Hembrug terrain

Graphical Representation of increase or decrease of employees related to production process. Reflects a particular point in time.

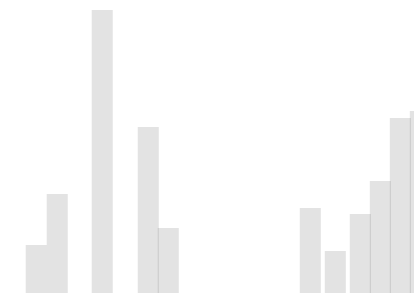


Fig. 2.1.1 Timeline (by authors, content via Goossens, A.M.A (2007), www.stelling-amsterdam.nl, Holleman, E., Reijke, R. (2006))



3. SITE AND FUNCTION DEVELOPMENT

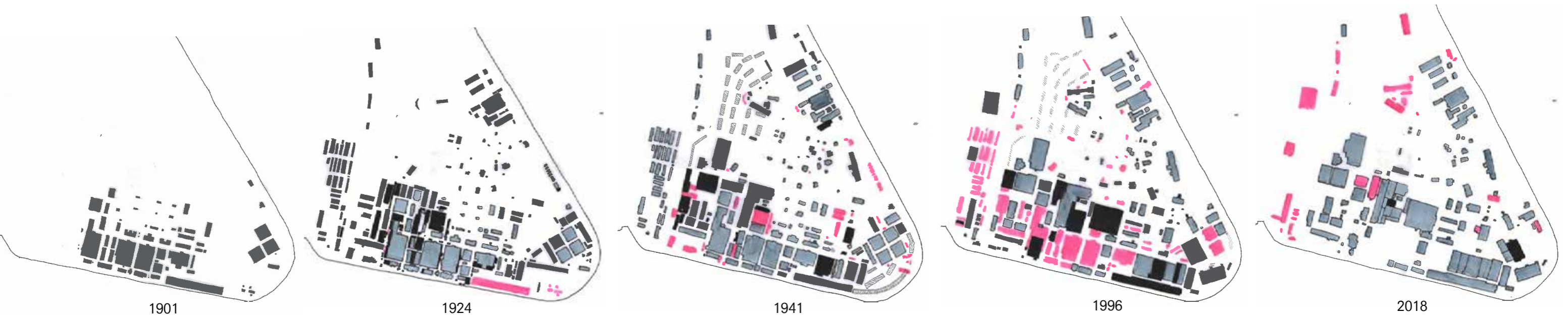
The Hembrug terrain has a rich history where the building development has been a continuous process. Buildings were as easily built as they were demolished and were completely in service of the function.

To get a better understanding of why the Ladder is the way it is today, we asked ourselves the following questions:

- What role did the Ladder ensemble fulfil within the Hembrug area?
- In what way were the functions within the Ladder organized?
- Did the production process that took place within the Ladder have an influence on the building development?

In order to be able to answer these questions, we will look further into the building development of the entire Hembrug site and will then zoom in to the scale of the Ladder. An estimated spatial development of the Ladder is made by studying archival site plans and historical photographs. With morphological drawings we'll investigate whether the Ladder has always been this large building volume or if it has had different grain sizes. By looking at the functions through time and relation between buildings, a better understanding of the activities and production process that took place will be established.

3.1 BUILDING DEVELOPMENT HEMBRUG



Early period of the Hembrug



Demolishing of long Marine shed



Looting of machines by Germans
WWII



Eurometaal takes over production



The Hembrug today



Conclusion based on these images:

What can be learned by looking at the development of the building footprints at certain moments in time is that the building activity is what we suspect, related to major events that took place. This can be seen clearly in the timeline (see page 12-13) where it's also noticeable that with major events like the World Wars there is an increase of product demand, resulting in the need of more employees and the need for more buildings. Buildings have also for the majority only been built in an orthogonal way. Within the period of Eurometaal, a lot of old buildings from the first building period have been demolished, resulting in the large open plots we can see today.

3.2 DEVELOPMENT ENSEMBLE AREA

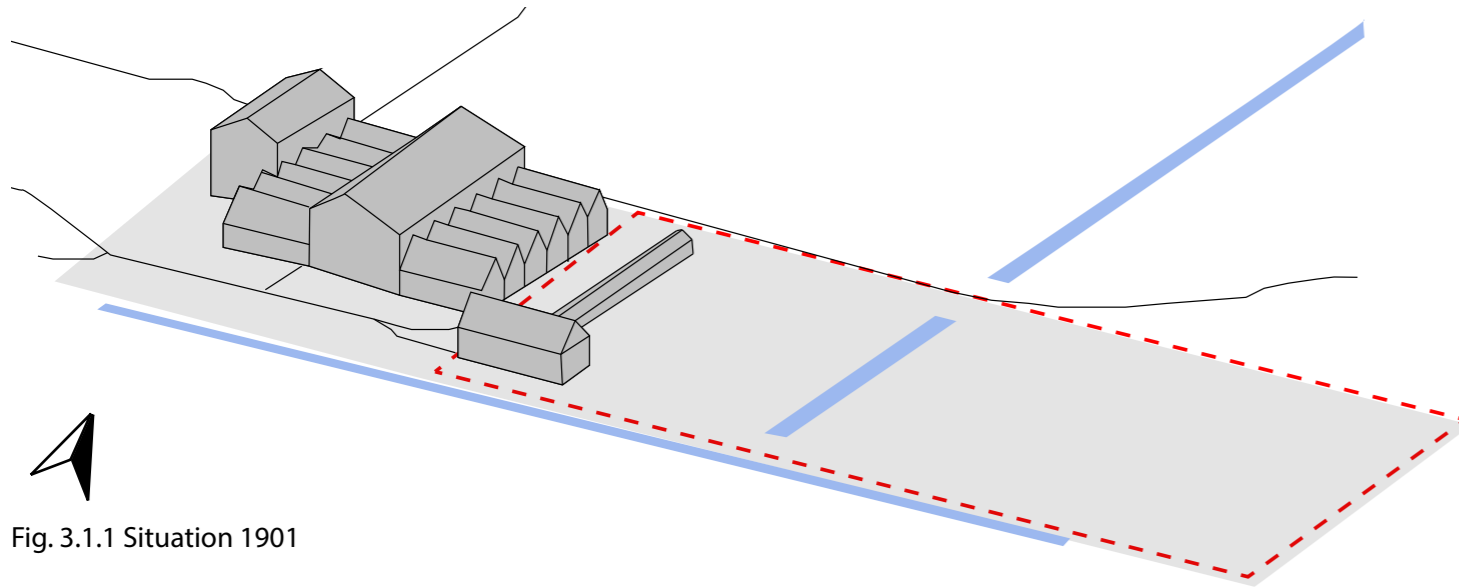


Fig. 3.1.1 Situation 1901

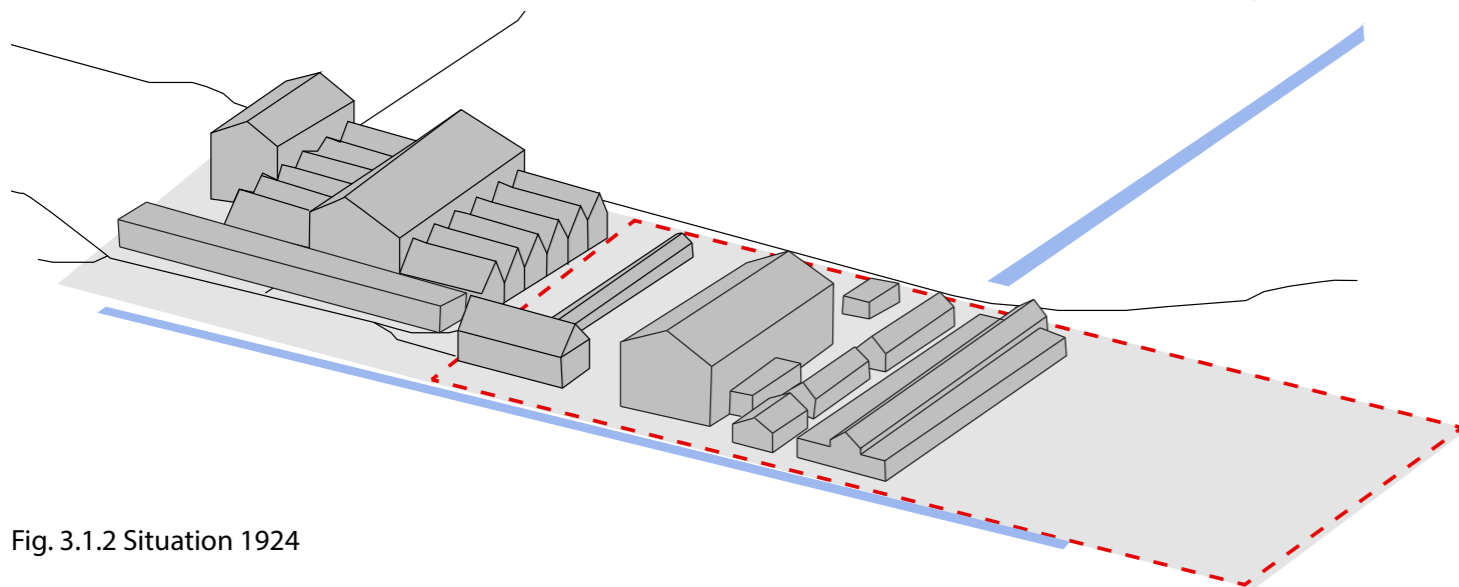


Fig. 3.1.2 Situation 1924

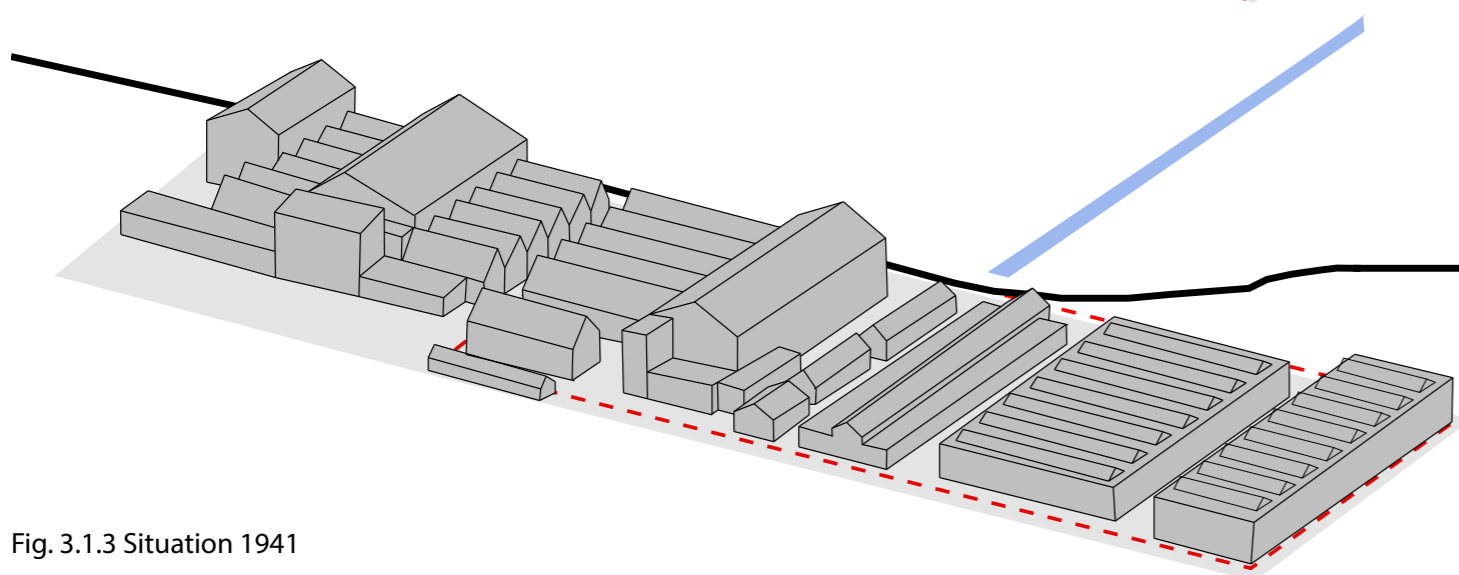


Fig. 3.1.3 Situation 1941

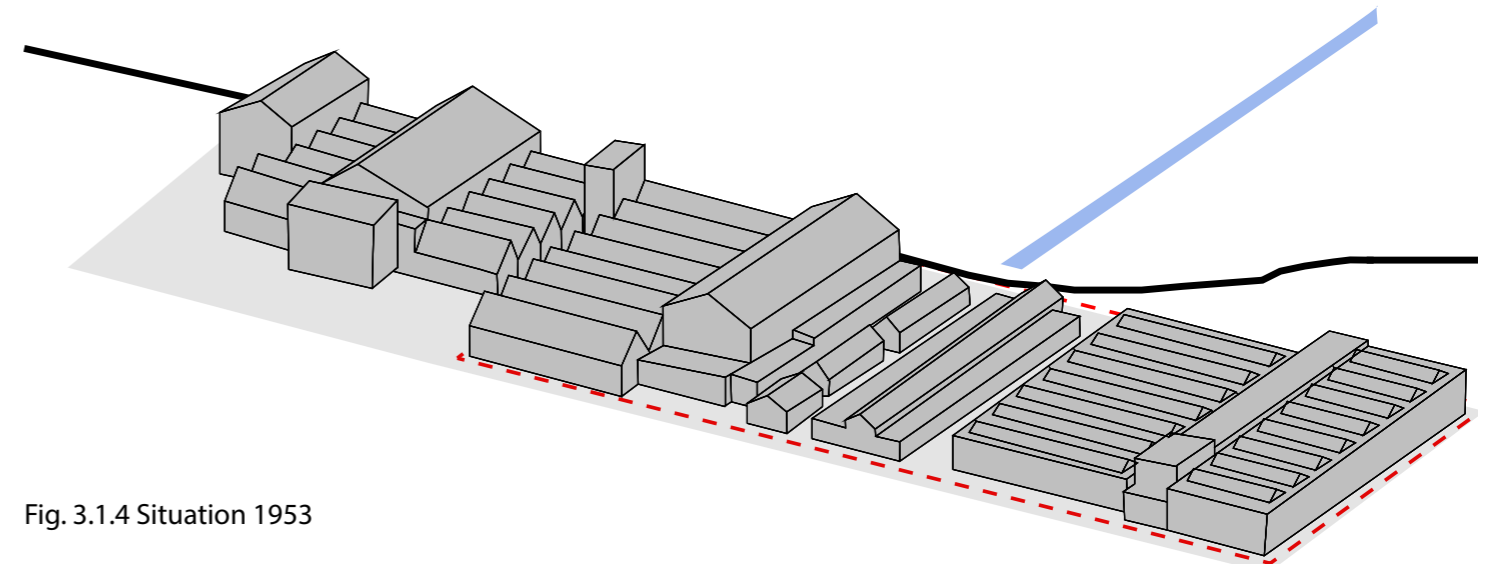


Fig. 3.1.4 Situation 1953

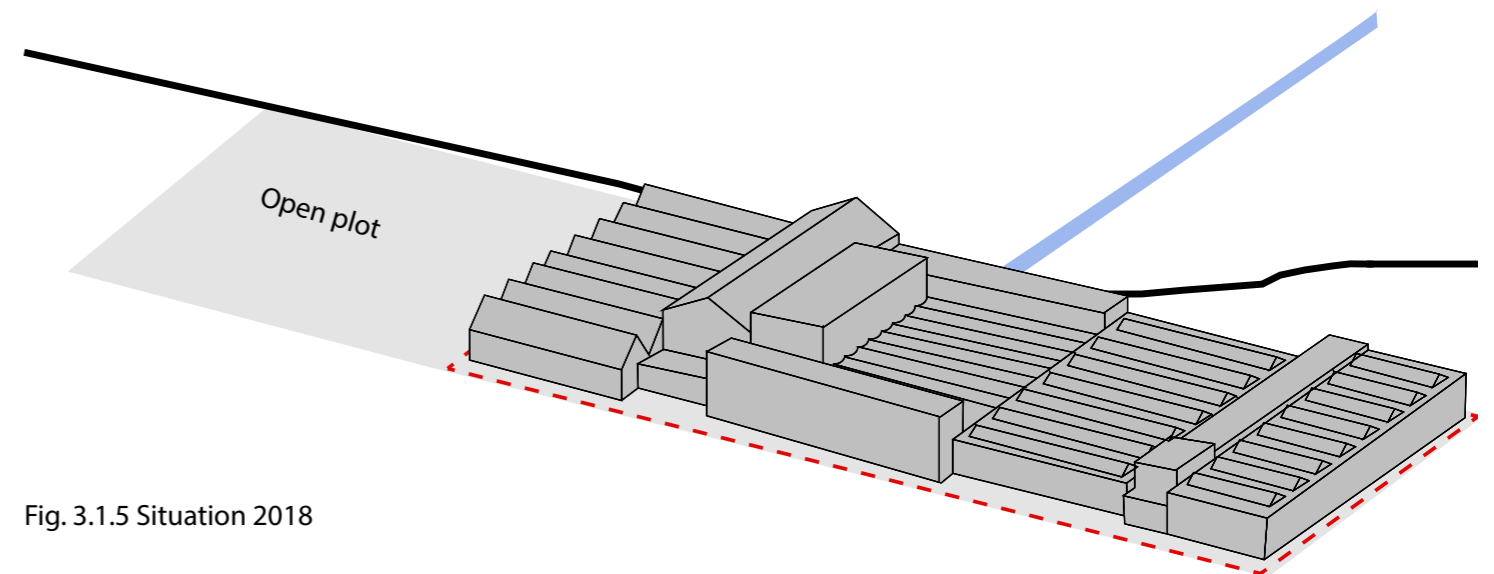


Fig. 3.1.5 Situation 2018

- Entire Ladder ensemble plot
- Current building boundary Ladder
- Water
- Smalspoor

Conclusion:
The building developments within the Ladder ensemble shown in the diagrams are an estimation of the situation at several moments in time and not an exact reconstruction. Noticable is the fact the building height never really exceeded 15m. The building footprints were noticeably smaller in earlier periods.

Over time the production process of ammunition together with the buildings increased in size. Machines got bigger, demand increased, thus the smaller sized buildings had to make way for the larger building volumes we can still see today on the Ladder.

(All diagrams by authors, content source Steenhuismeurs(2010) and NIMH, Nationaal Archief)

1.1 BUILDING FOOTPRINT DEVELOPMENT ENSEMBLE

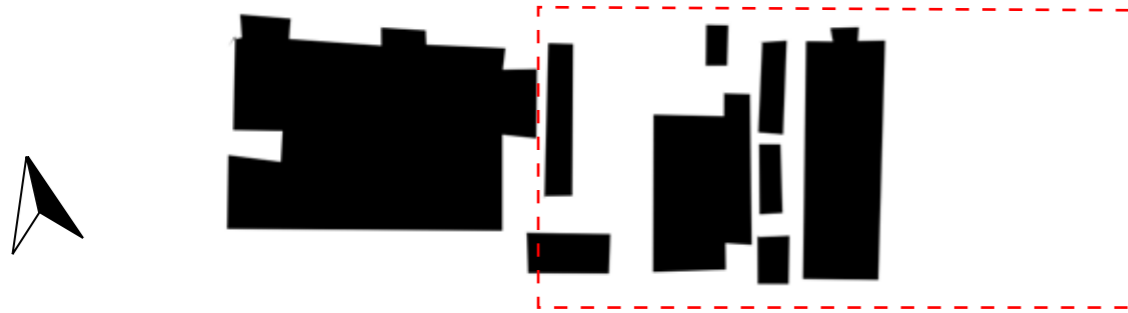


Fig. 3.2.1 Ladder 1931

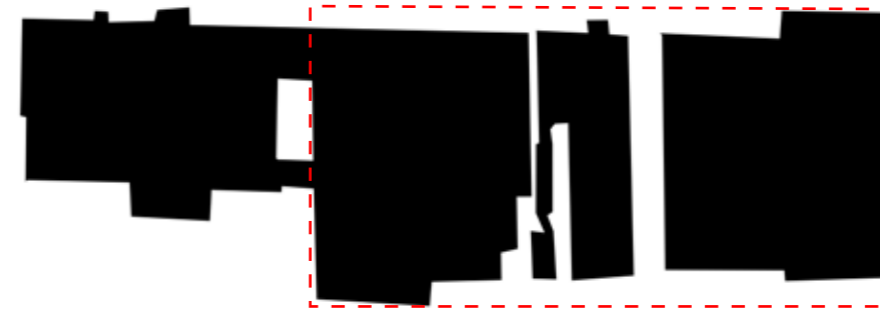


Fig. 3.2.4 Ladder 1953

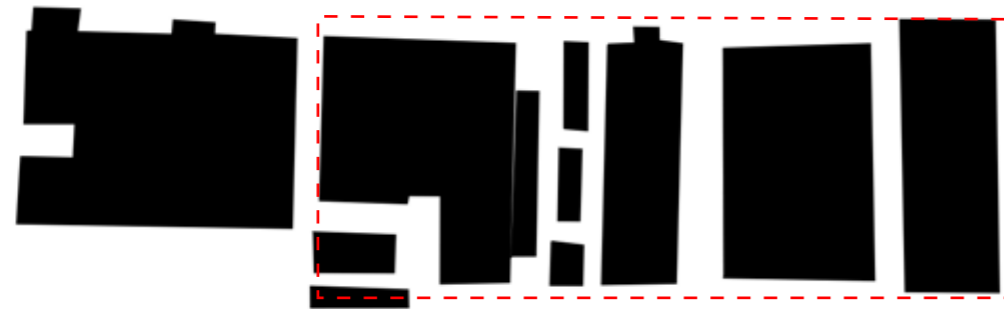


Fig. 3.2.2 Ladder 1937

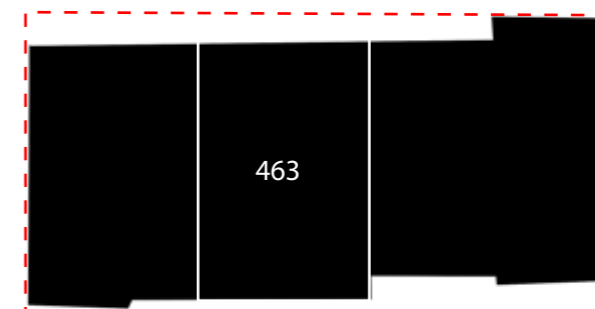


Fig. 3.2.5 Ladder 2018

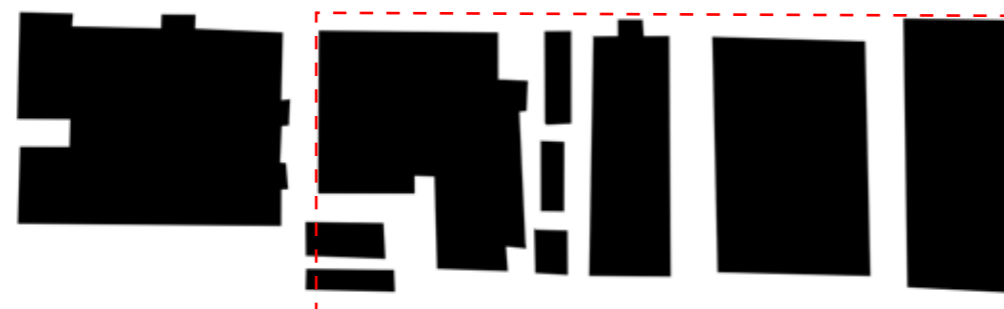


Fig. 3.2.3 Ladder 1940

Conclusion:

It has only been since the placement of building 436 that all the buildings of the Ladder were directly connected to each other. The buildings also seem to have shifted from the west side of the plot, with open space in the east side, to the east side of the plot with open space in the west. We suspect that the reason the building developments within the plot have been moving from the west side to the east side is due to the fact the west side was part of the first building period, from there on they proceeded to expand outwards. In the current situation the west side of the plot is empty due to the demolishing of the foundry, which we suspect is because over time it has lost its function.

3.3 PRODUCTION PROCESS THROUGH TIME-BUILDING FUNCTIONS

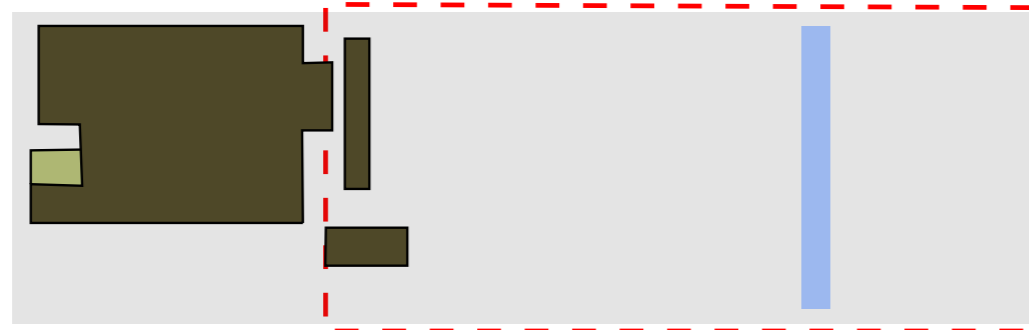


Fig. 3.3.1 Building functions 1901

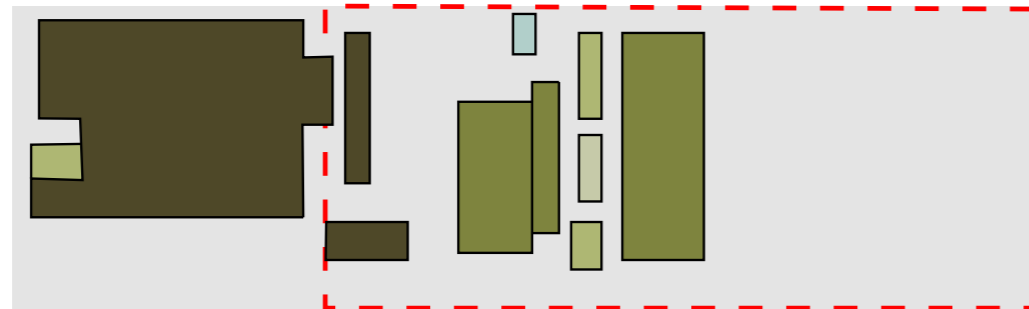


Fig. 3.3.2 Building functions 1931

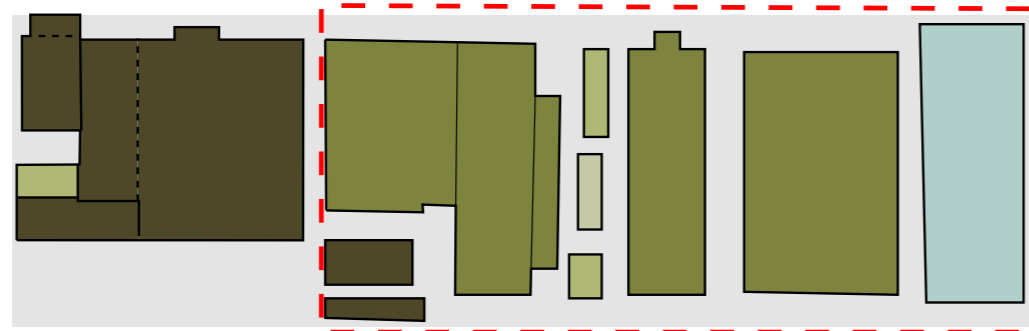


Fig. 3.3.3 Building functions 1937

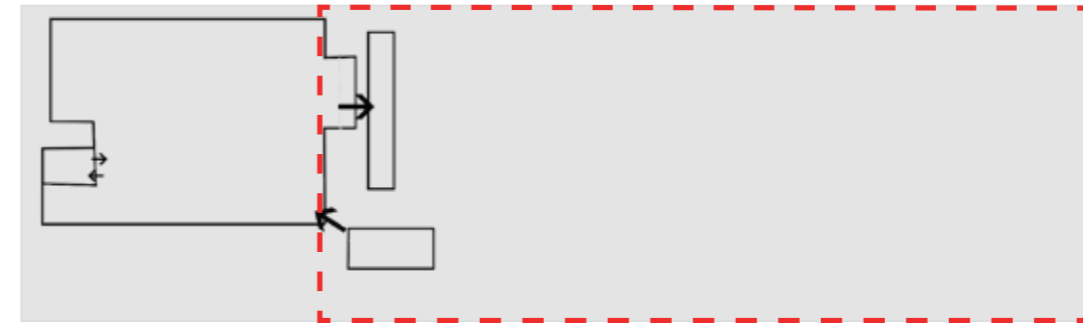


Fig. 3.3.4 Almost no activity yet on the plot where we find the Ladder today.

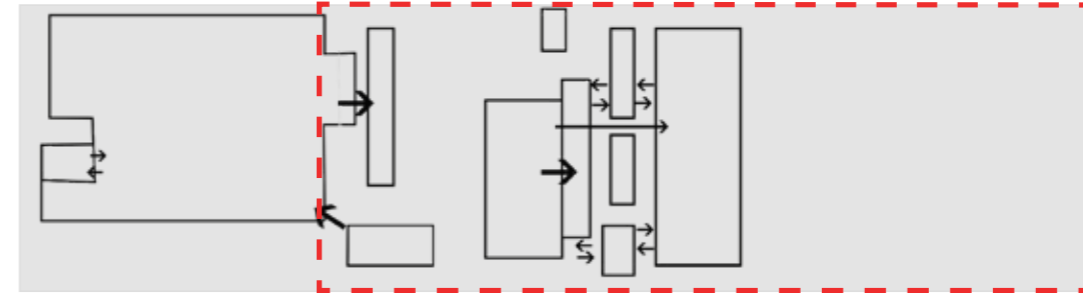


Fig. 3.3.5 Two function "zones", related to either the foundry or the projectile production.

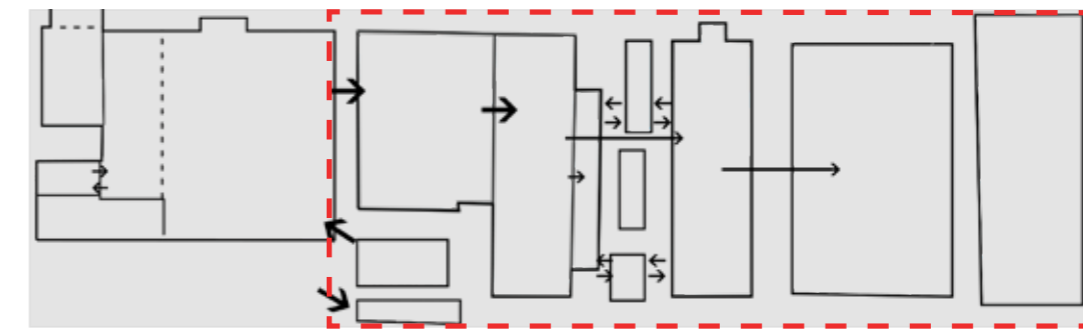


Fig. 3.3.6 Start of functional relation between foundry and projectile production



Foundry for metal
Projectile production

Sanitary
Private

Warehouse
Functional relation between buildings

Entire Ladder ensemble plot
Current building boundary Ladder

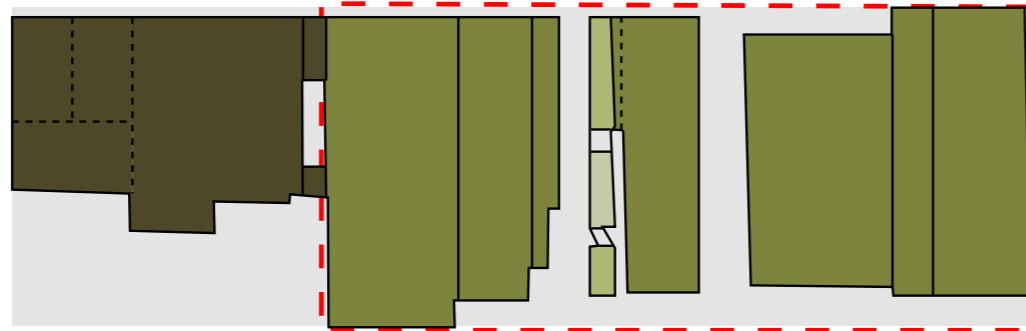


Fig. 3.3.7 Building functions 1953

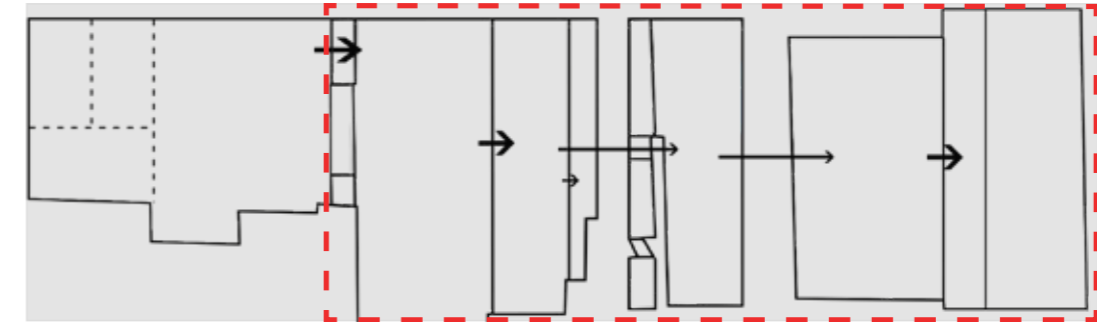


Fig. 3.3.9 1953 Disappearance of old sanitary functions. Production direction moving from left to right begins to become visible.

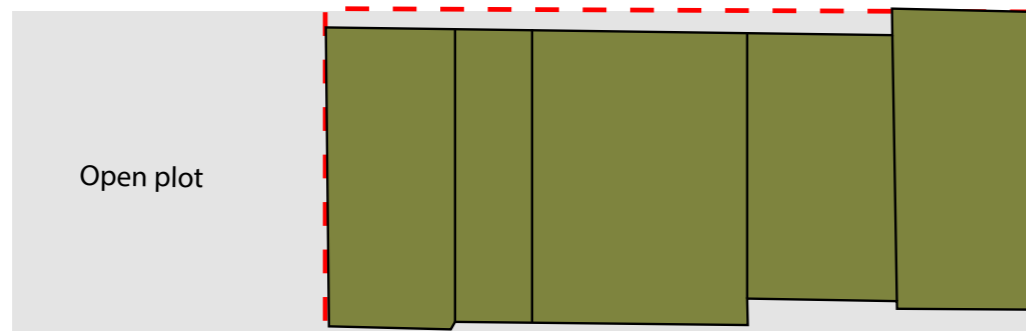


Fig. 3.3.8 Building functions 1996

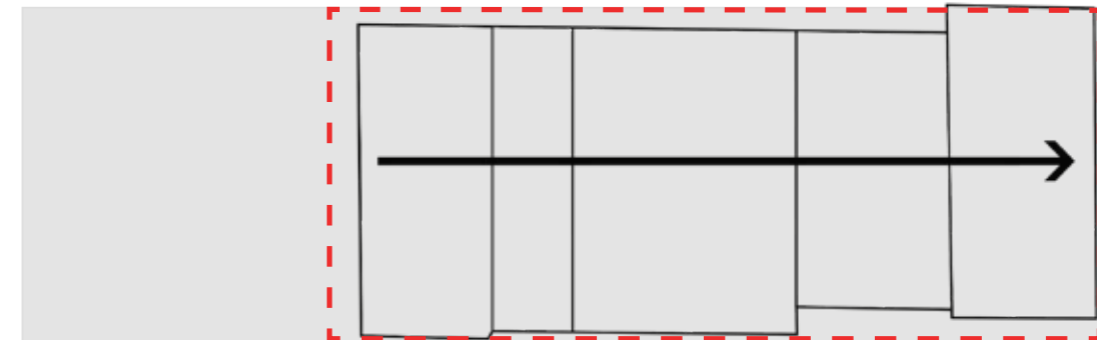


Fig. 3.3.10 1996 Interconnection of buildings. Production begins left and moves through different production stages to the right. From there on it can be transported to the plot in the woods, where the ammunition is loaded into the projectiles.



Foundry for metal
 Projectile production

Sanitary
 Private

Warehouse
 Functional relation between buildings

Entire Ladder ensemble plot
 Current building boundary Ladder

3.4 BUILDING FOOTPRINT DEVELOPMENT



Fig. 3.4.1 Exterior building 333, characteristic saw-tooth roof



Fig. 3.4.4 Exterior building 72, gable roof drawing attention



Fig. 3.4.7 Exterior building 436



Fig. 3.4.2 Interior building 333, Bims concrete elements prominently present



Fig. 3.4.5 Interior building 72, Visible gable roof structure and high ceiling



Fig. 3.4.8 Interior building 436

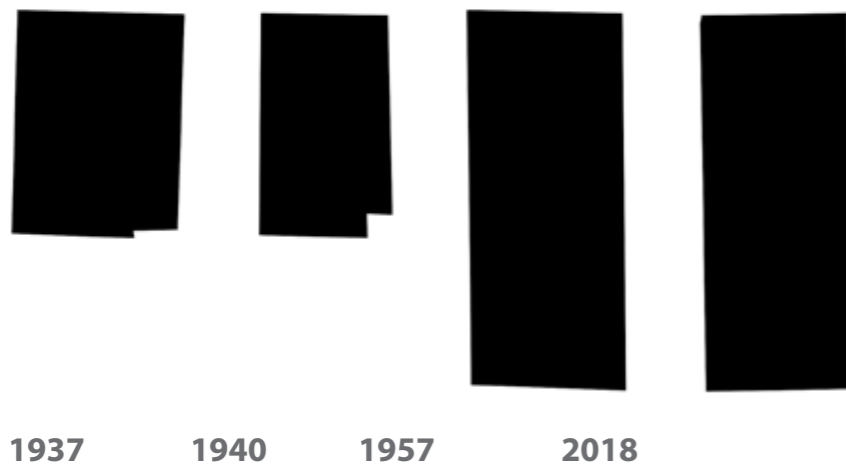


Fig. 3.4.3 Building 333 floor size and shape through time

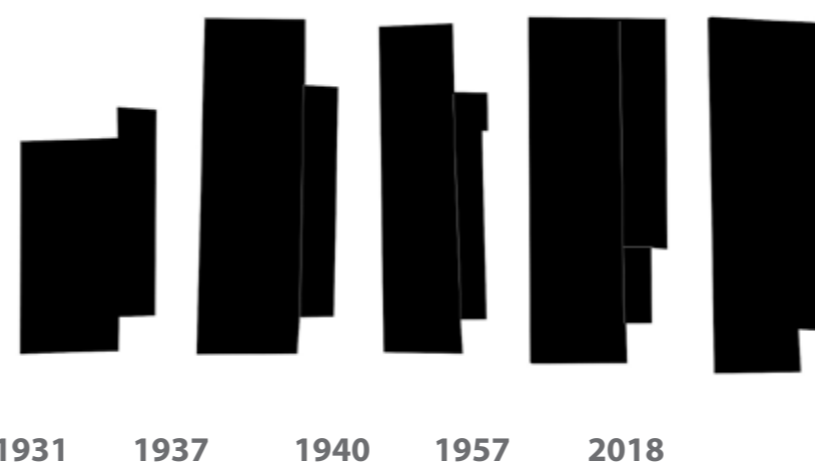


Fig. 3.4.6 Building 72 floor size and shape through time, white line indicates separation within building (A and B)

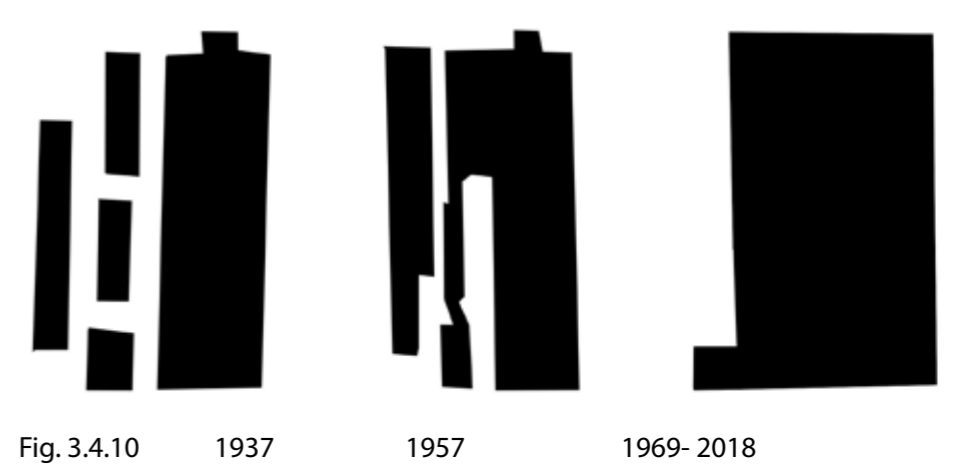


Fig. 3.4.9 Building 436 floor size and shape through time, masses of 1937 and 1957 were completely demolished in favor of building 436

(All photo's taken by authors, diagrams by authors, content from Nationaal archief)



Fig. 3.4.11 Exterior building 308



Fig. 3.4.12 Interior building 308



1937 1940 1953 2018

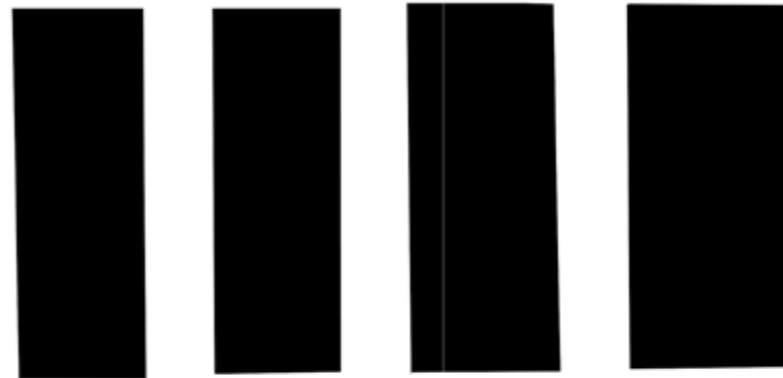
Fig. 3.4.13 Building 308 floor size and shape through time, no changes



Fig. 3.4.14 Exterior building 342



Fig. 3.4.15 Interior building 342



1937 1940 1953 2018

Fig. 3.4.16 Building 342 floor size and shape extended in time, but always a rectangular shape

Noticeable is that with the exception of building 436, which was placed last and at once, each of the 4 other buildings that are still present today have expanded either North or South or stayed the same size. This was the only way possible without having to demolish (parts of) other buildings.

(All photo's taken by authors, diagrams by authors, content from Nationaal archief)

3.5 PRODUCTION PROCESS



Fig. 3.5.1 Building 333 Sawmill projectiles



Fig. 3.5.2 Building 72 Projectiles pressing



Fig. 3.5.3 Building 436 Projectiles pressing



Fig. 3.5.4 Building 333 Employee cutting metal cylinders by hand with a cutting torch, that later on will be pressed into projectiles.

(All top photo's taken by authors, bottom photo's from Archief Zaanstad)



Fig. 3.5.5 Building 72 Large and high projectile pressing machines



Fig. 3.5.6 Building 436 Projectile coming out of the large projectile press



Fig. 3.5.7 Building 308 Production of grenade bodies



Fig. 3.5.8 Building 342 Lathes workshop for turning projectiles

In the beginning, functions within the Ladder were more separated, one part for the foundry and one part for the production of projectiles (see fig. 3.4.1). Later in time you can see that each building has a role in the order in which the production took place. Products moved from building to building with each step. Fig. 3.6.4-3.6.6 and 3.6.9 - 3.6.10 show the activity that took place within the buildings. The large projectile presses in buildings 72 and 436 for example made the high ceiling heights necessary. Buildings were more or less made in the following order; pouring a heavy foundation to hold the large machinery (presses), place the machinery, place the loadbearing structure and built the skin around it.

In the end the Ladder consisted of 5 buildings, interconnected to enhance the production line efficiency. Production started in building 333 with the sawing of metal blocks/cylinders, which were then moved to building 72 where the blocks were heated in high fire in order to be able to press them. Pressing of the projectiles took place in both building 72 and 436. Building 436 also had a cooling installation and a machine in which the metal was ennobled. It then moved on to the centre of building 436 where the pressed projectiles were stored, waiting to be turned. This lathe turning of the projectiles took place in buildings 308 and 342. From there on the production of the projectiles was completed and they were ready to move on to the plot in the woods to be filled and later tested. (Nationaal archief and Archief Zaanstad)

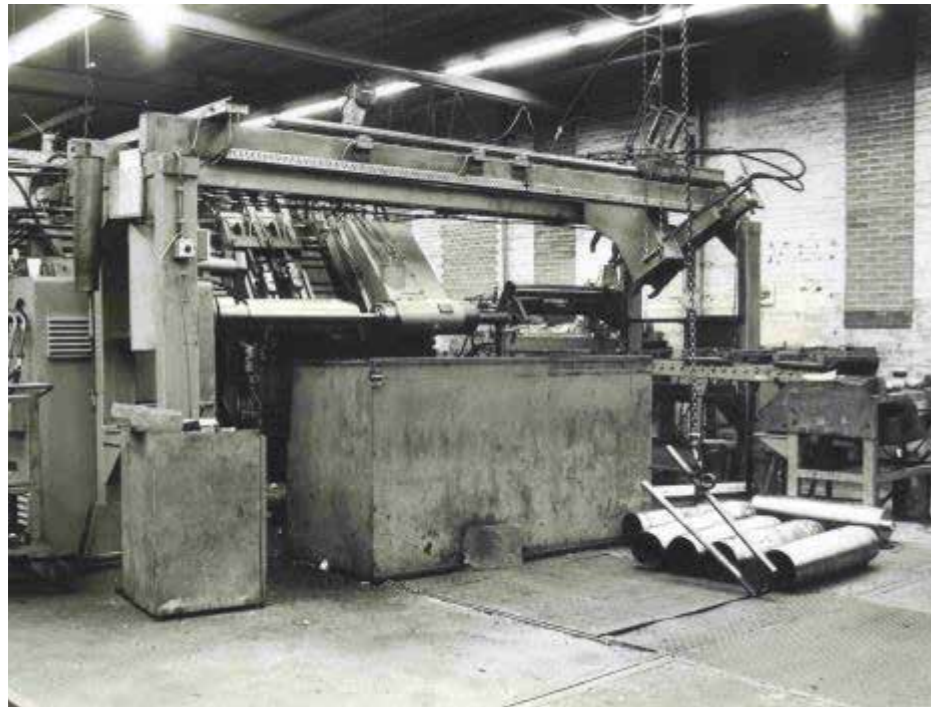


Fig. 3.5.9 Building 308 Large lathe for turning the projectiles

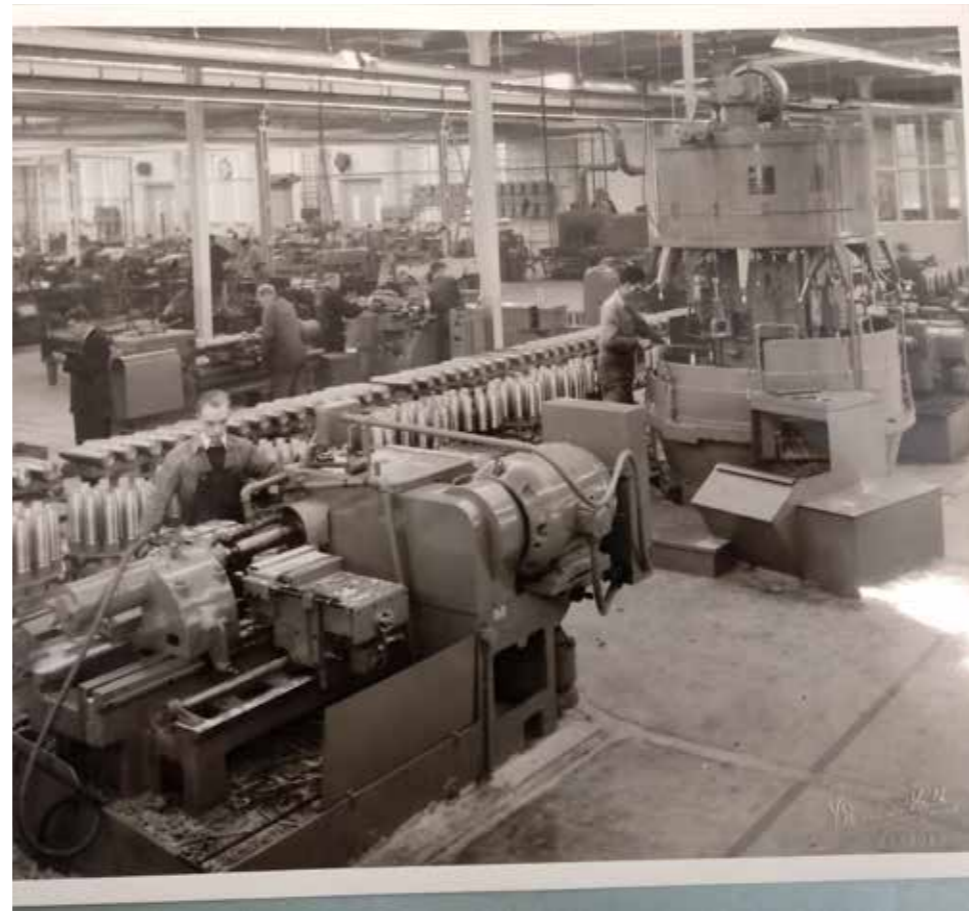


Fig. 3.5.10 Building 342 Projectile quality control and lathes for turning projectiles.

(All top photo's taken by authors, bottom photo's from Archief Zaanstad)



& CO.

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4. ARCHITECTURE

When looking at the Ladder what catches the eye most, is that from an exterior point of view there seem to be five separate buildings. However when you enter the ensemble you soon notice the buildings are interconnected to each other. The direct surroundings of the Ladder also play an important role in the architectural experience of the place.

In this chapter our main question is:

- What are the architectural characteristics of this ensemble?

Starting from a larger scale, we look at the direct surroundings of the Ladder. How is the accessibility, what do you see when nearing the ensemble, what sticks out? Continuing with street profiles and atmospheres; are there different kind of atmospheres or are they all and the same? Moving on to the building ensemble the historical layers of the façade are discussed.

Next we will enter the building. What are the factual numbers of the ensemble, floor space, heights and volumes? Noticeable are the different roof typologies, which will be discussed by looking at a daylight study, in line with that we'll take you along a spatial experience through the Ladder using hand drawings of the spaces.

4.1 SITE RESEARCH OF THE CURRENT SITUATION

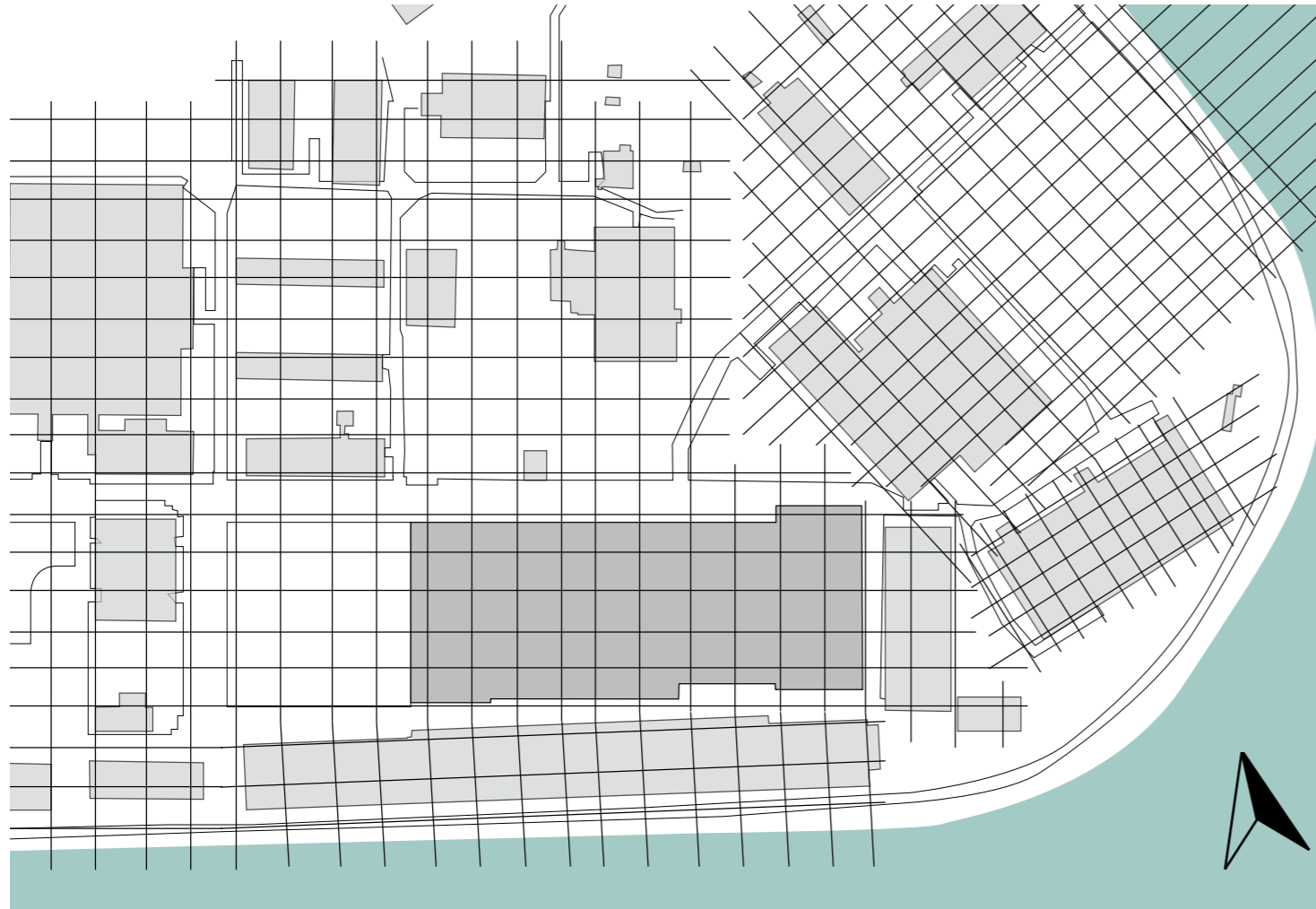


Fig. 4.1.1 building configuration based on building perimeters



Fig. 4.1.2 longitudinal directions of buildings

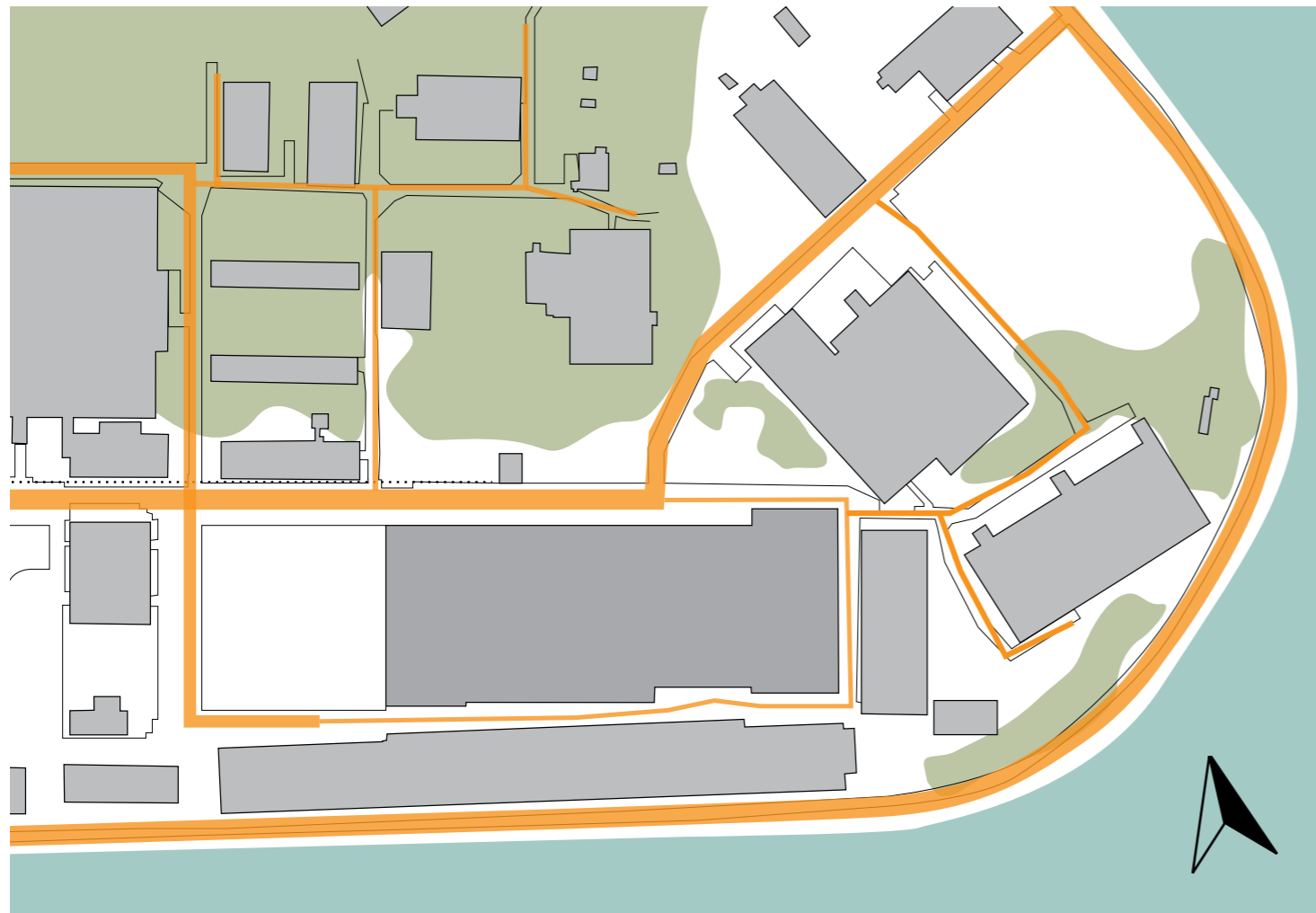


Fig. 4.1.3 main routes

- primary**
- secondary**
- alley**

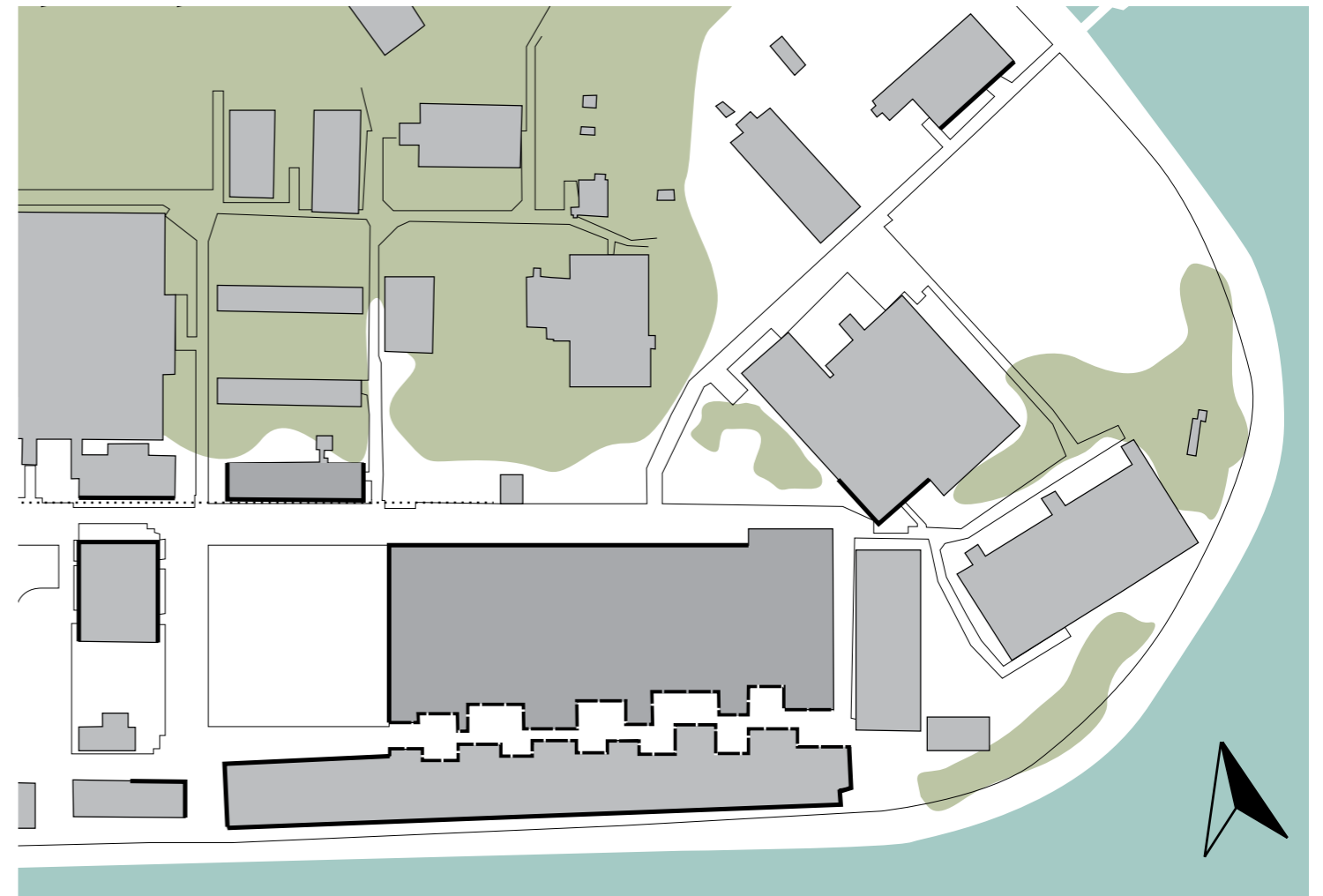


Fig. 4.1.4 clarity of the building lines

- straight building line**
- neutral**
- irregular building line**

4.2 SIGHT LINES

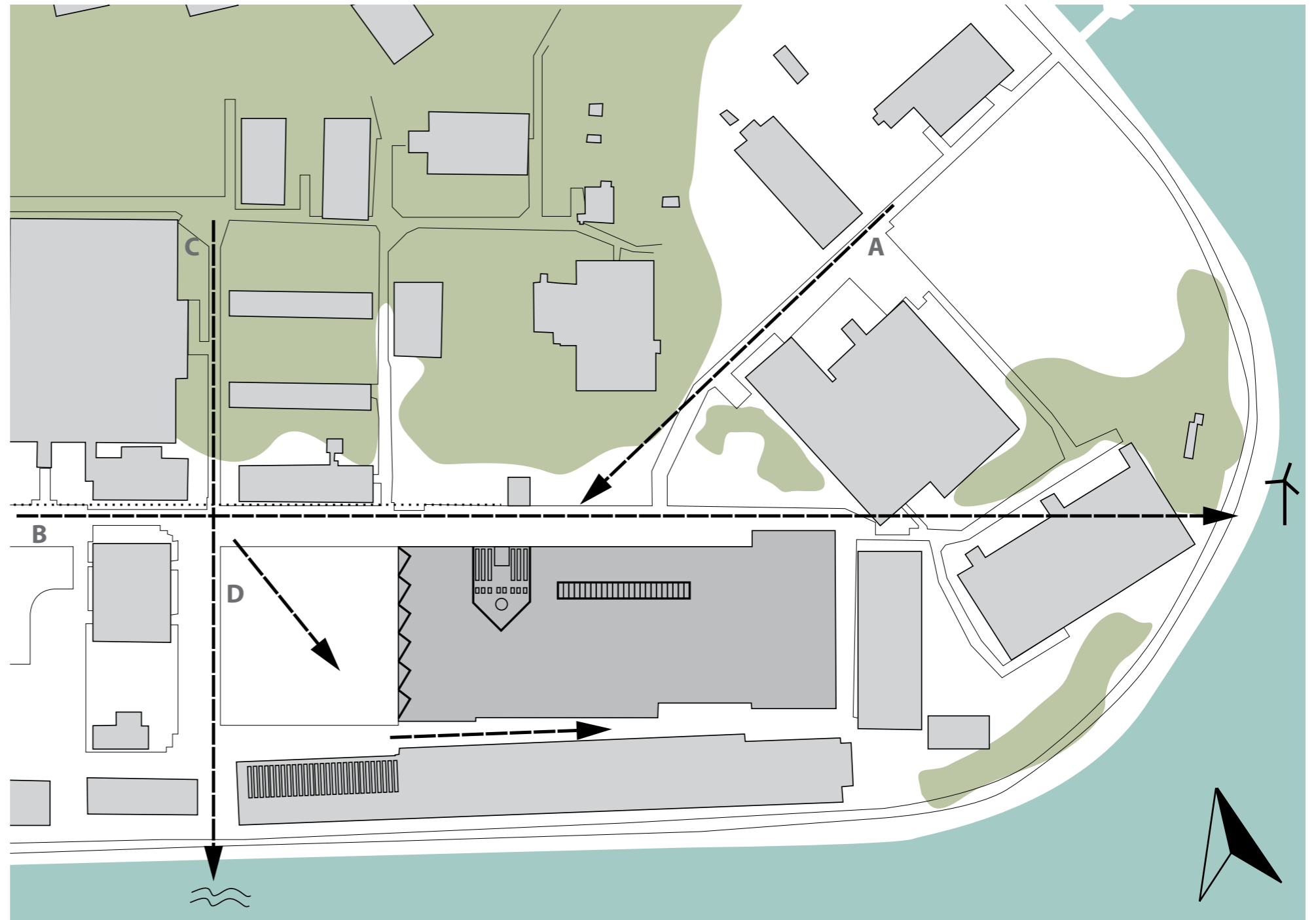


Fig. 4.2.1 Sightline points and noticeable elements when approaching the Ladder

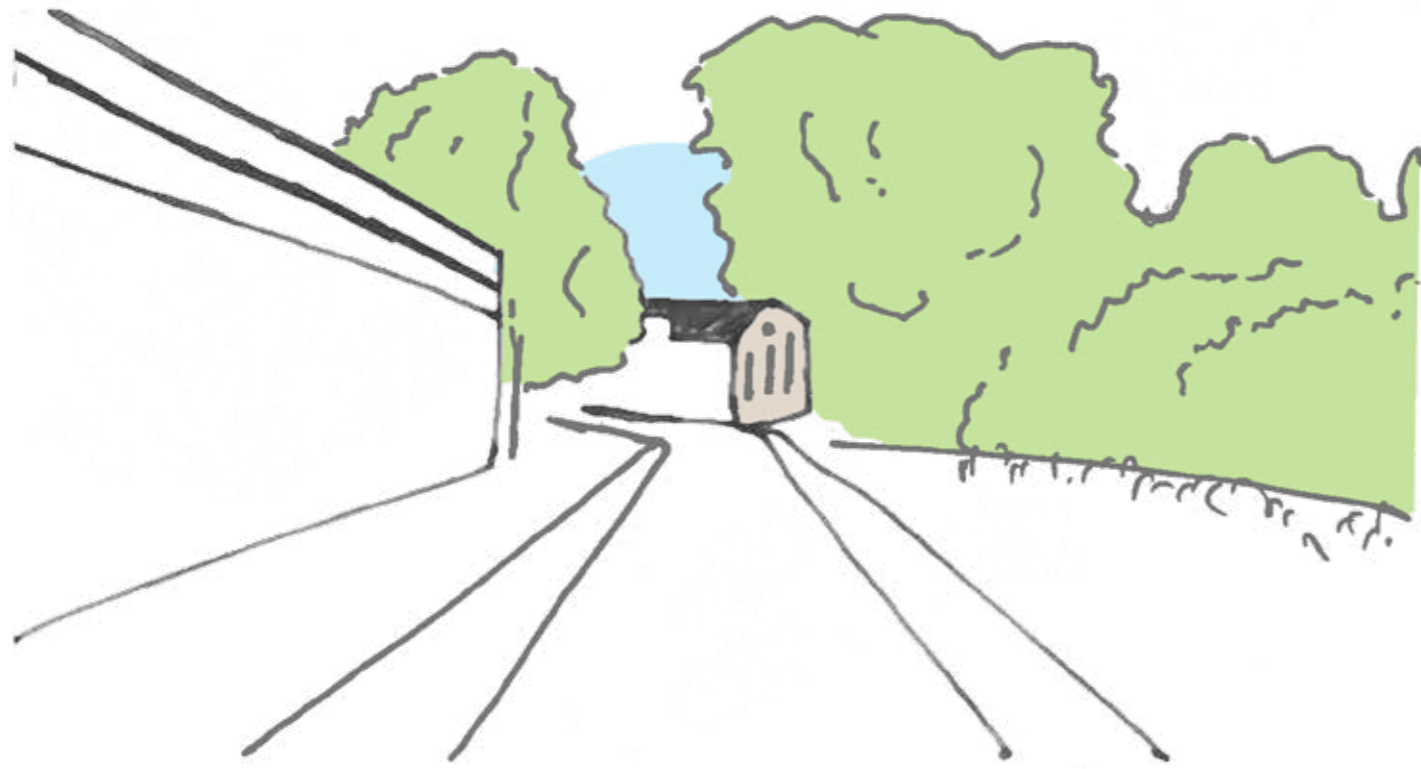


Fig. 4.2.2 A. Sightline to "the Church"



Fig. 4.2.4 C. Sightline towards the North Sea Canal and the industrial area on the other side of the water



Fig. 4.2.3 B. Sightline on the main road, with the windmill in the background, strengthened by steam pipes and long façades



Fig. 4.2.5 D. Contrast between façades in material, colour and rhythm

All drawings by authors

4.3 STREET VIEWS AND PROFILES



Fig. 4.3.1 Streetview and profile Wamperserij towards the East

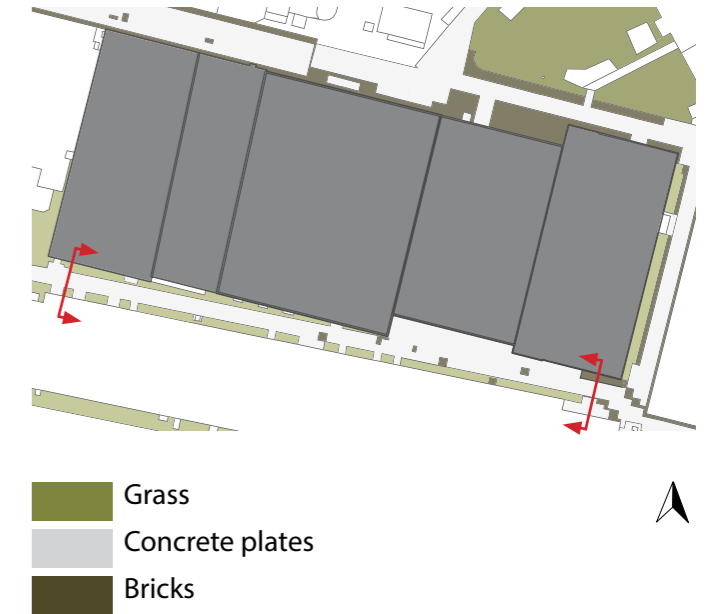
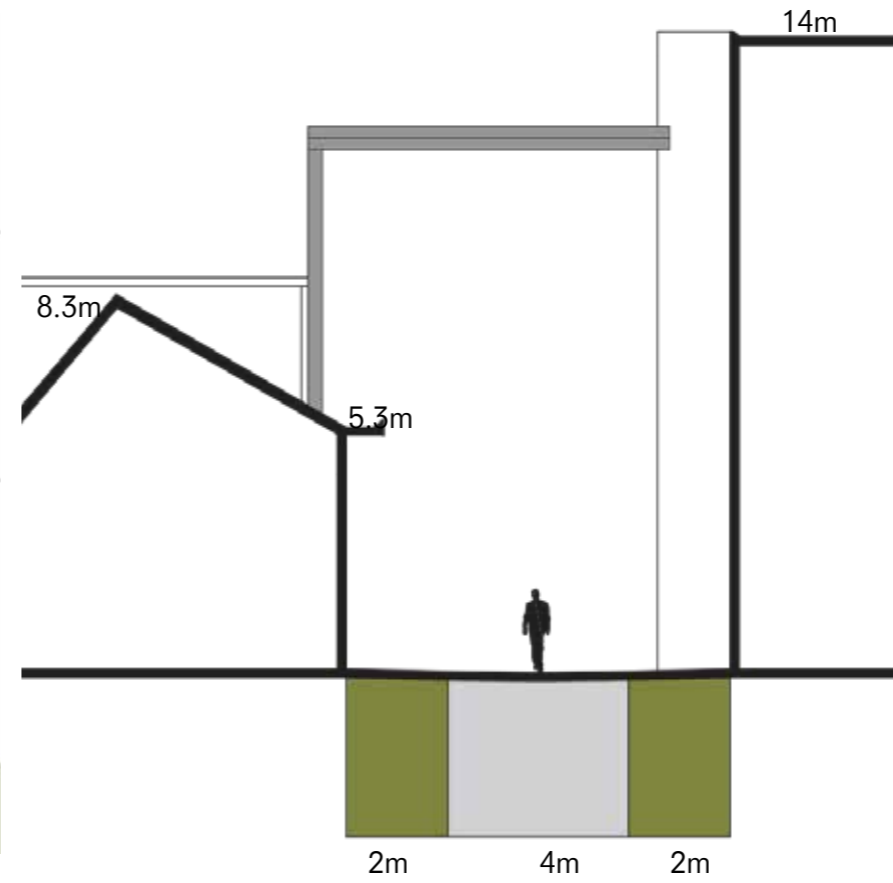
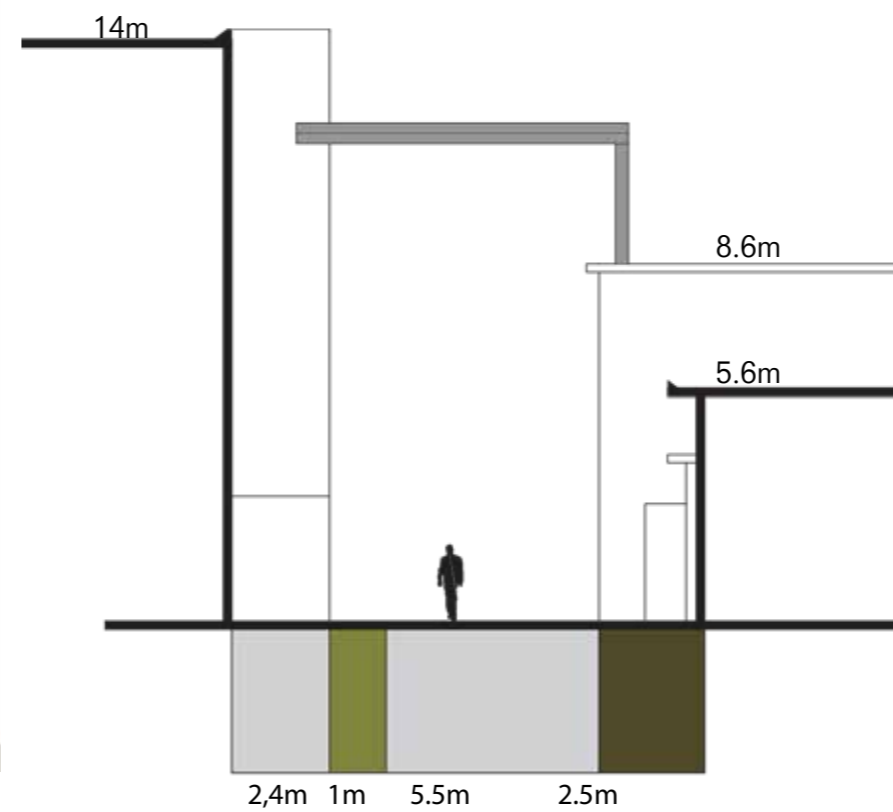


Fig. 4.3.2 Streetview and profile Wamperserij towards the West



All drawings by authors



Fig. 4.3.3 Streetview Lorriegarage towards the North



Fig. 4.3.4 Streetview Lorriegarage towards the South

All drawings by authors

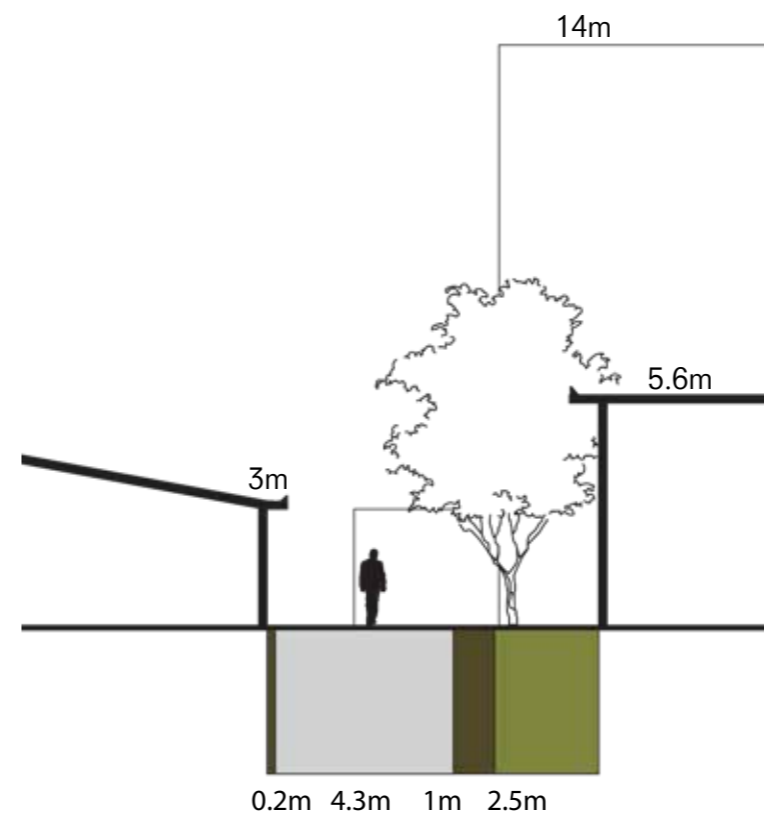
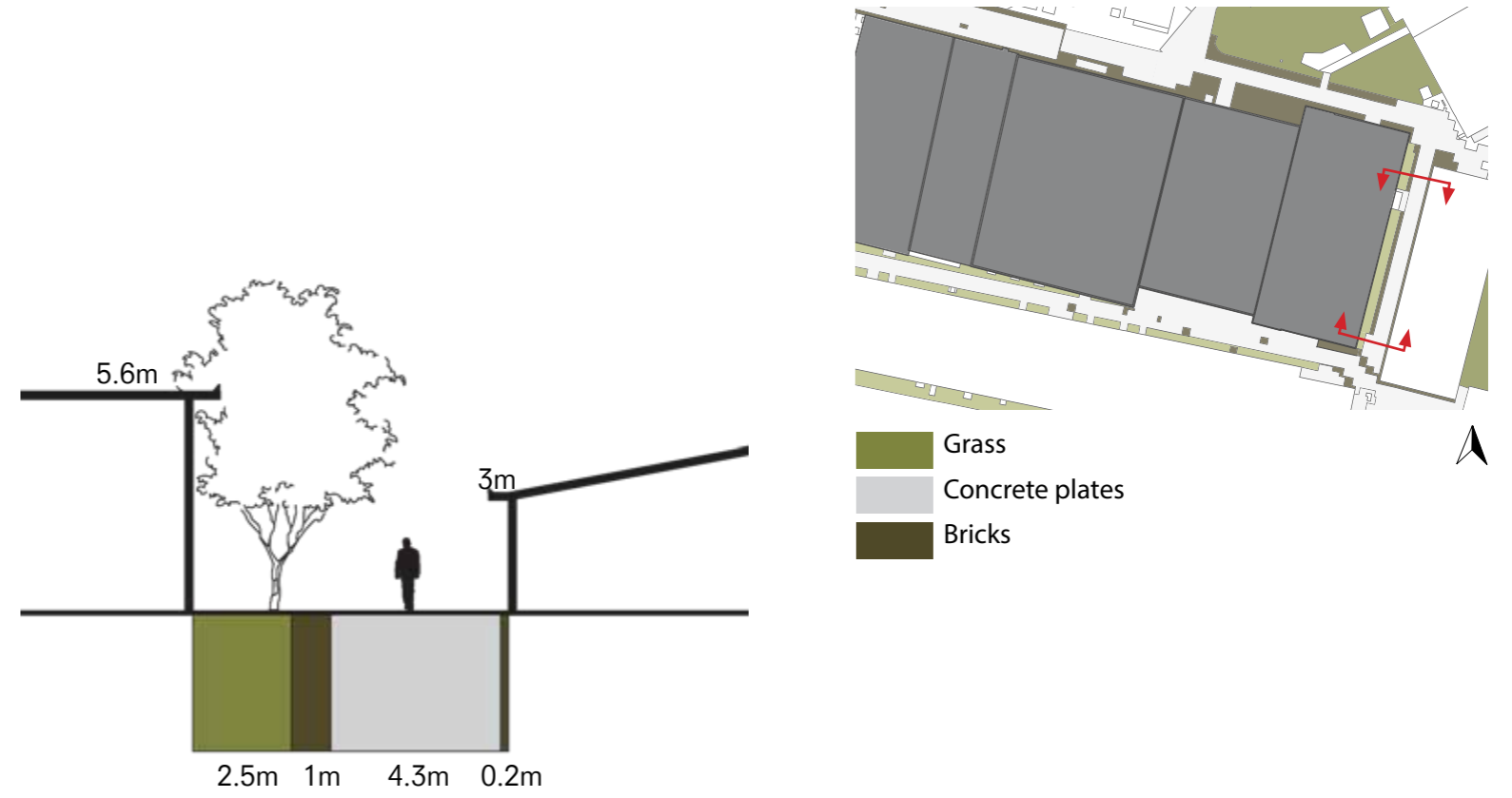




Fig. 4.3.5 Streetview Middenweg towards the West

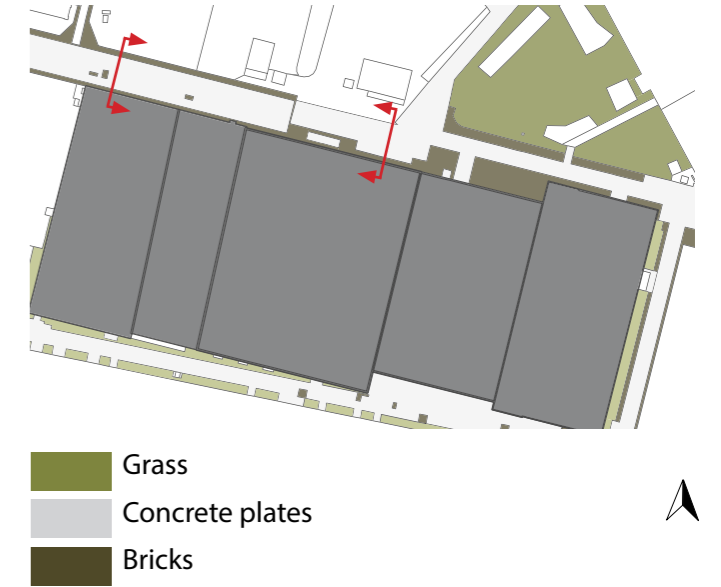
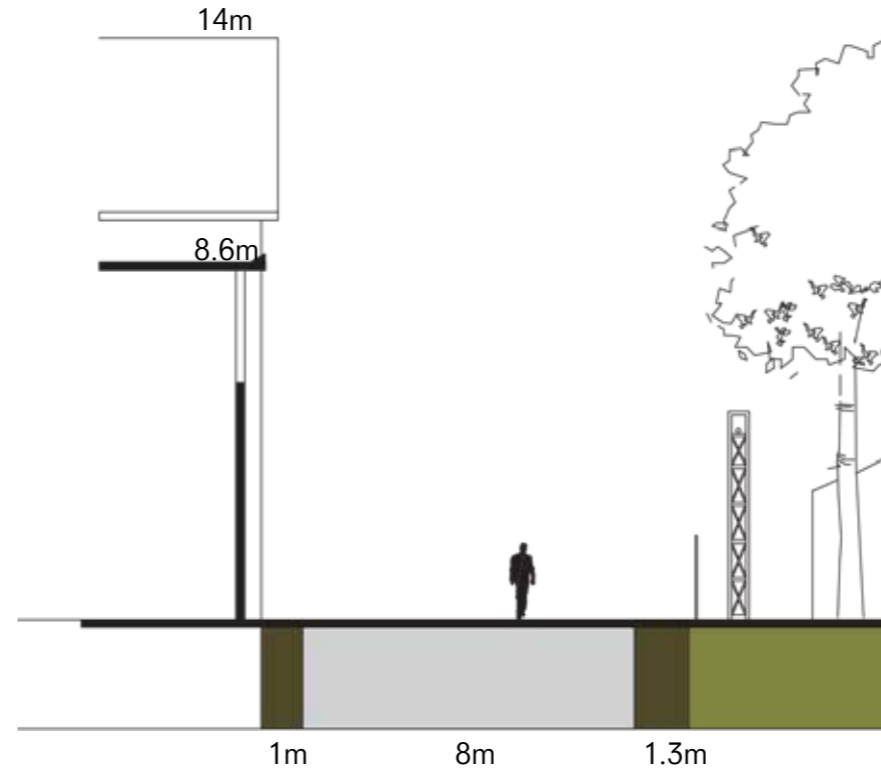


Fig. 4.3.6 Streetview Middenweg towards the East
All drawings by authors

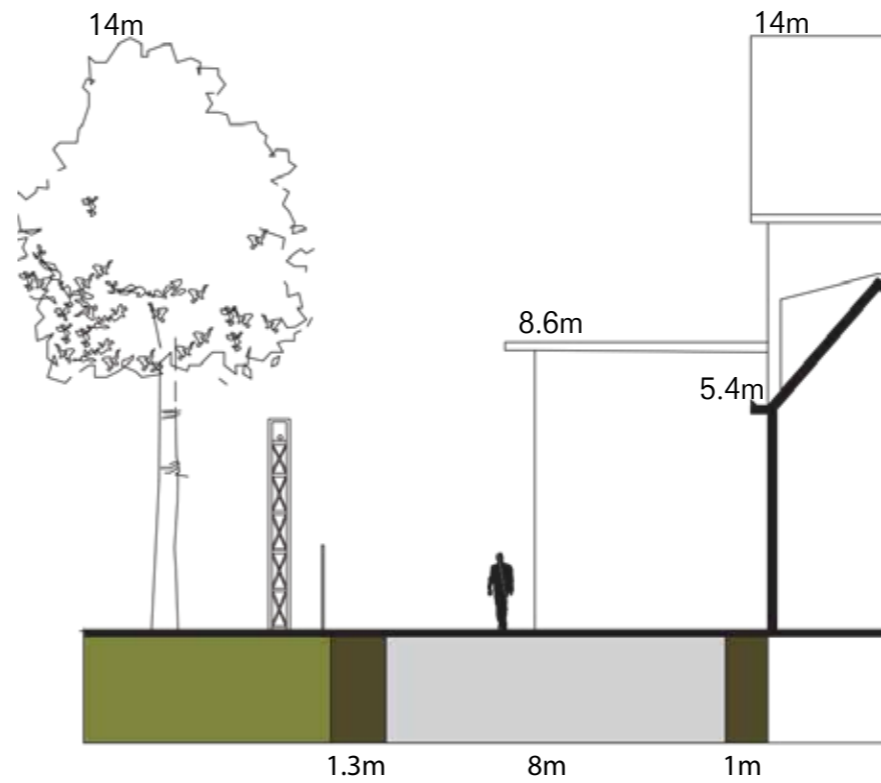




Fig. 4.3.7 Streetview in front of building 333 towards the South

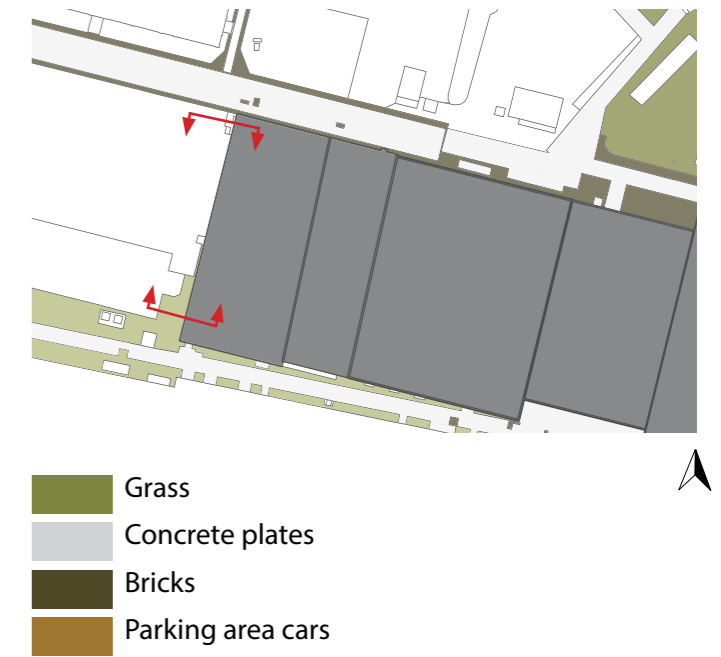
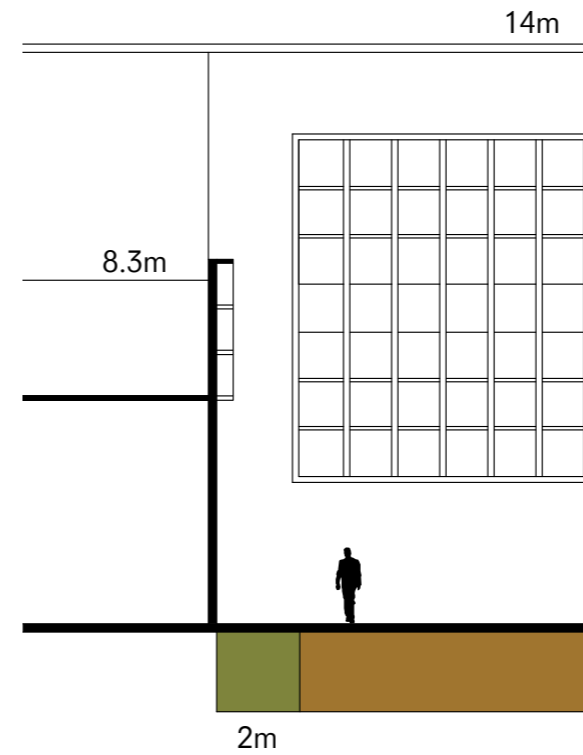
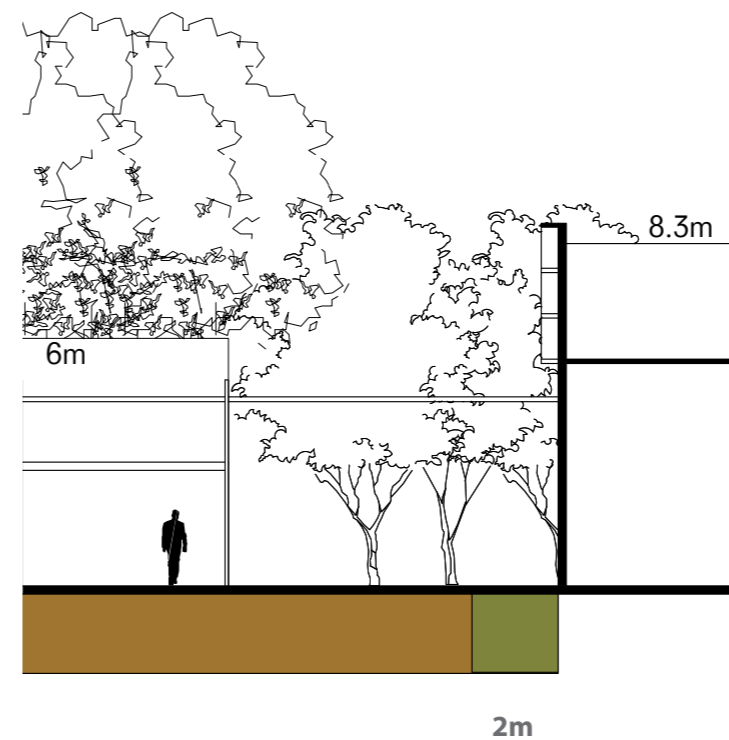


Fig. 4.3.8 Streetview in front of building 333 towards the North
All drawings by authors



Conclusions

The overall feeling when walking around the Ladder is that the spatial experience is very different than what you would expect, looking at the sections. In the street named *Lorriegarage* for example the sections shows the large white building towering above, but in reality the large chestnut tree prevents you from experiencing this. Each side of the ladder has a different atmosphere, ranging from small and intimate to large and industrial and the contrast of industrial and green inbetween.

4.4 HISTORICAL LAYERS FACADE



All drawings by authors, based on Steenhuismeurs(2010)

4.5 FACADE ANALYSIS



Fig. 4.5.1 North façade rhythm windows

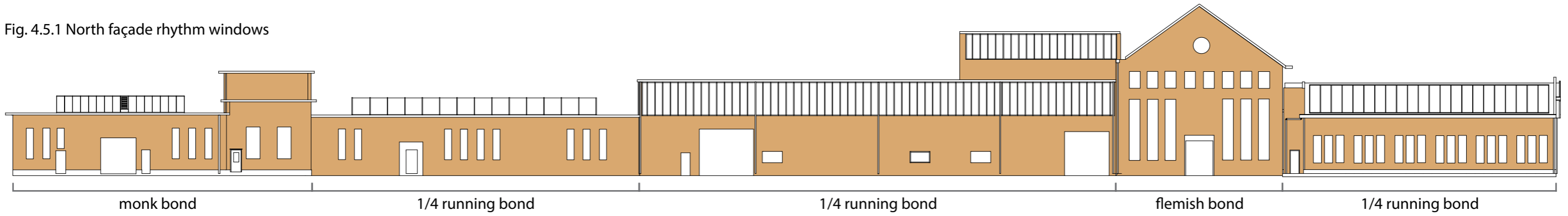


Fig. 4.5.2 North façade materials

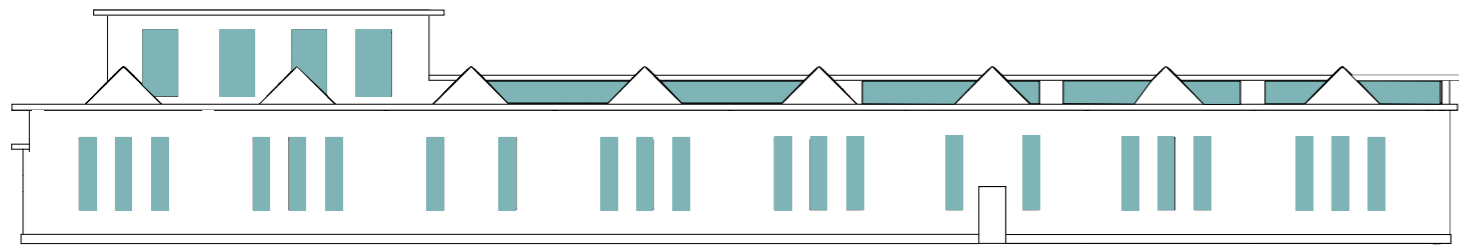


Fig. 1.1.1 East façade rhythm windows

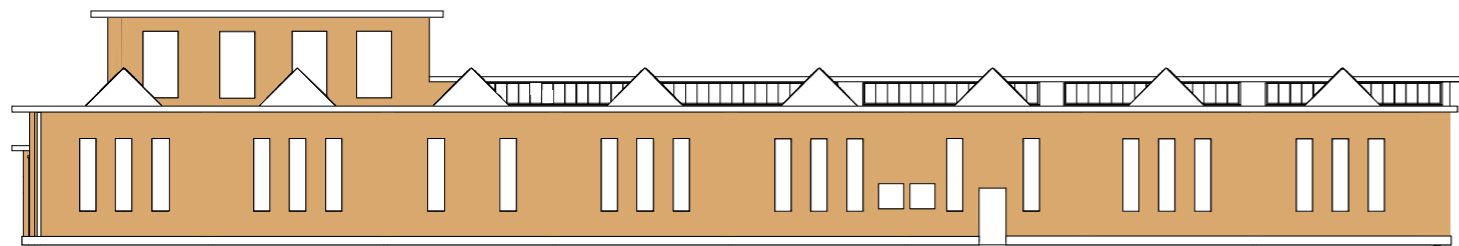


Fig. 4.5.3 East façade materials

All drawings by authors



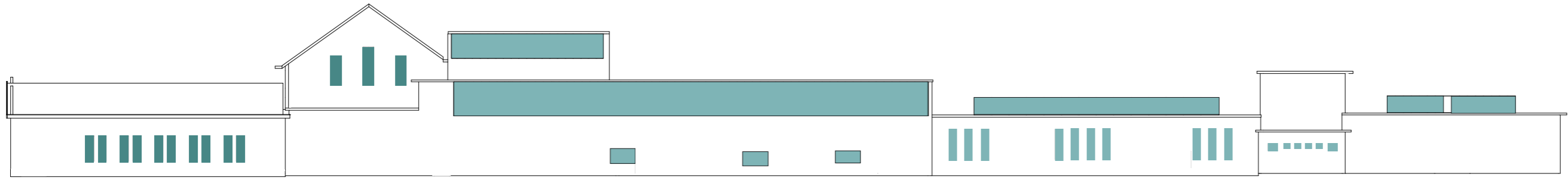


Fig. 4.5.4 South façade rhythm windows

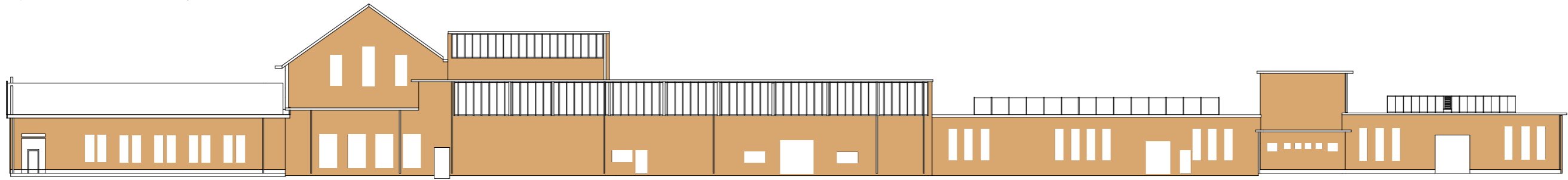


Fig. 4.5.5 South façade materials

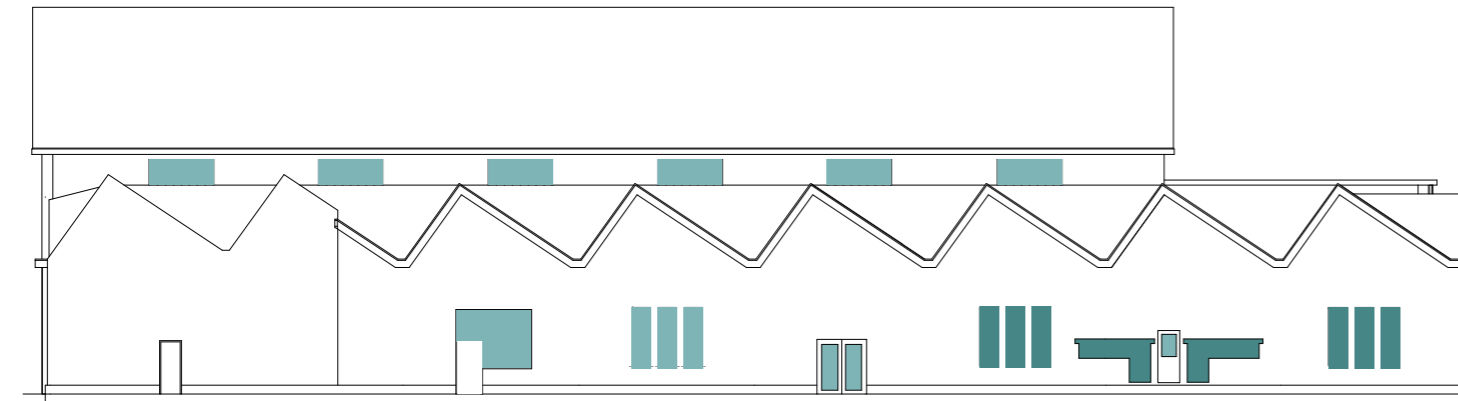


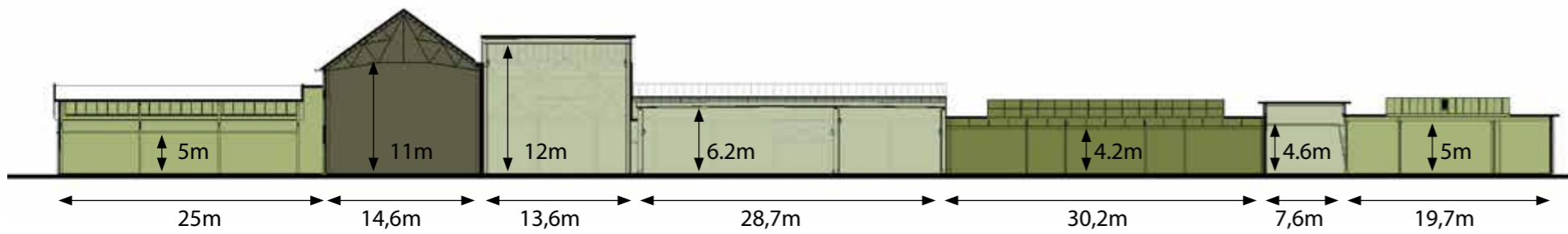
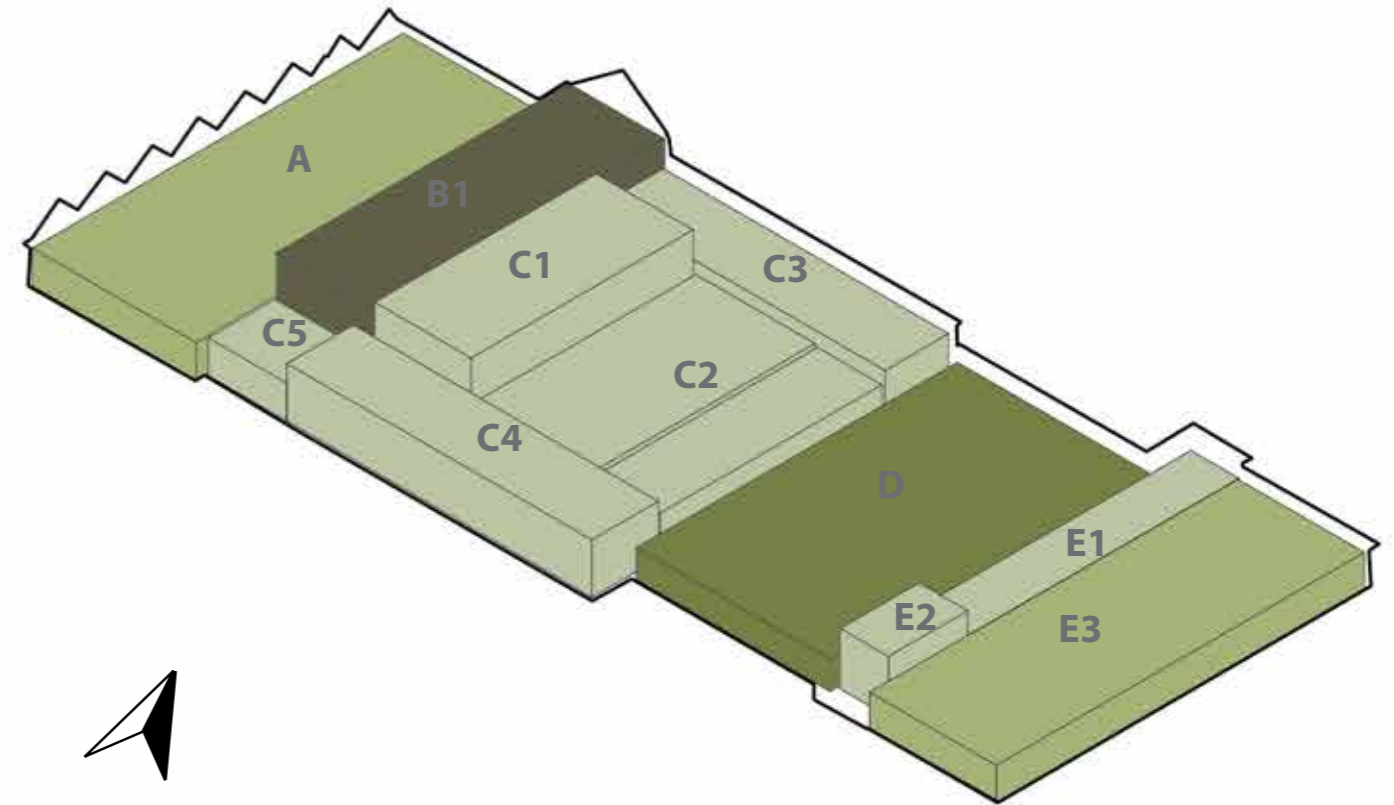
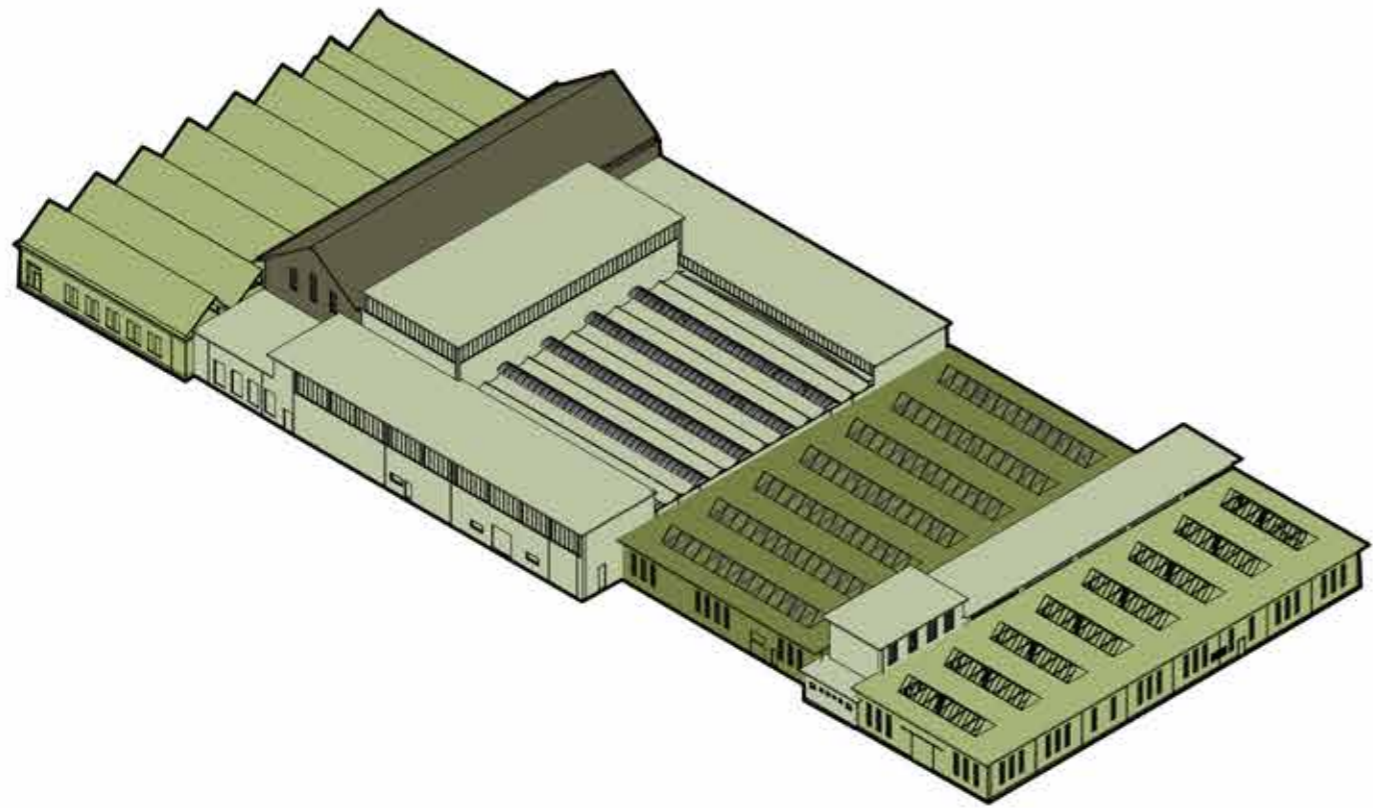
Fig. 4.5.7 West façade rhythm windows



Fig. 4.5.6 West façade materials

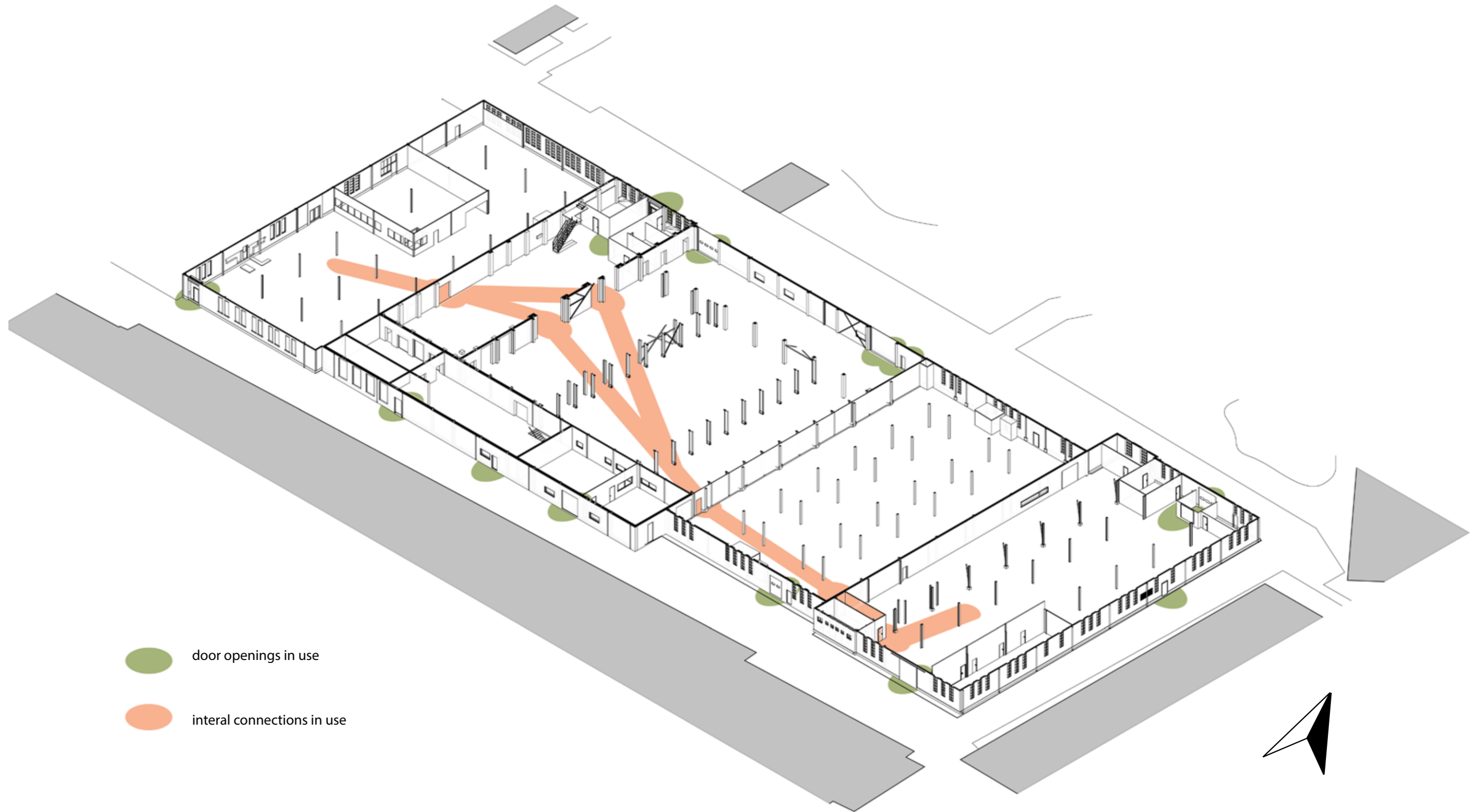


4.6 DIMENSIONS



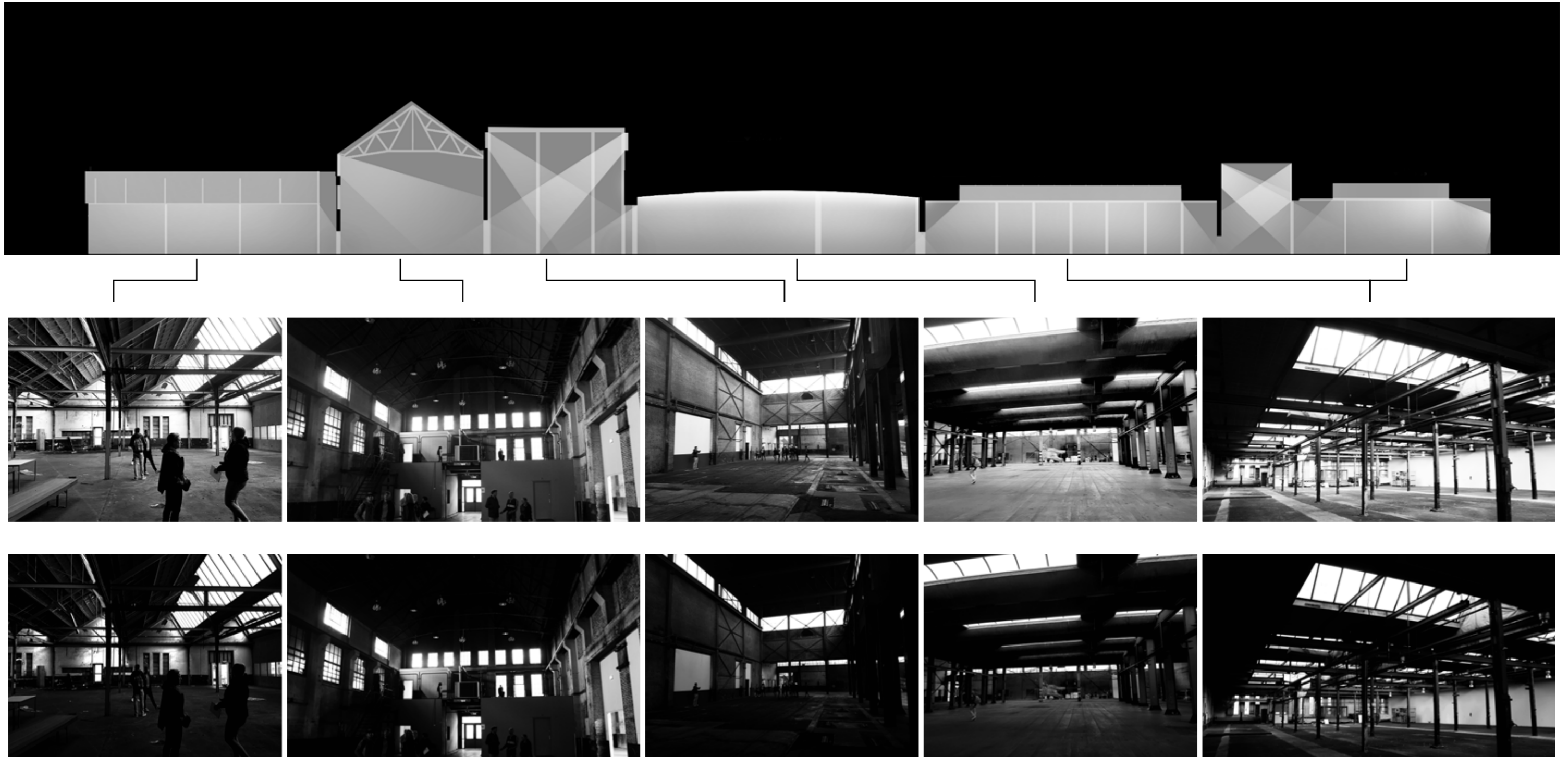
	HEIGHT M	AREA M ²	VOLUME M ³
A	5	1412	7060
B1	11	651	7161
C1	12	497	5964
C2	6,2	945	5859
C3	7,6	421	3200
C4	7,6	470	3572
C5	5	121	605
D	4,2	1438	6040
E1	4,6	301	1385
E2	8	88	704
E3	5	1083	5415
		7427	46964

4.7 INTERNAL AND EXTERNAL CONNECTIONS



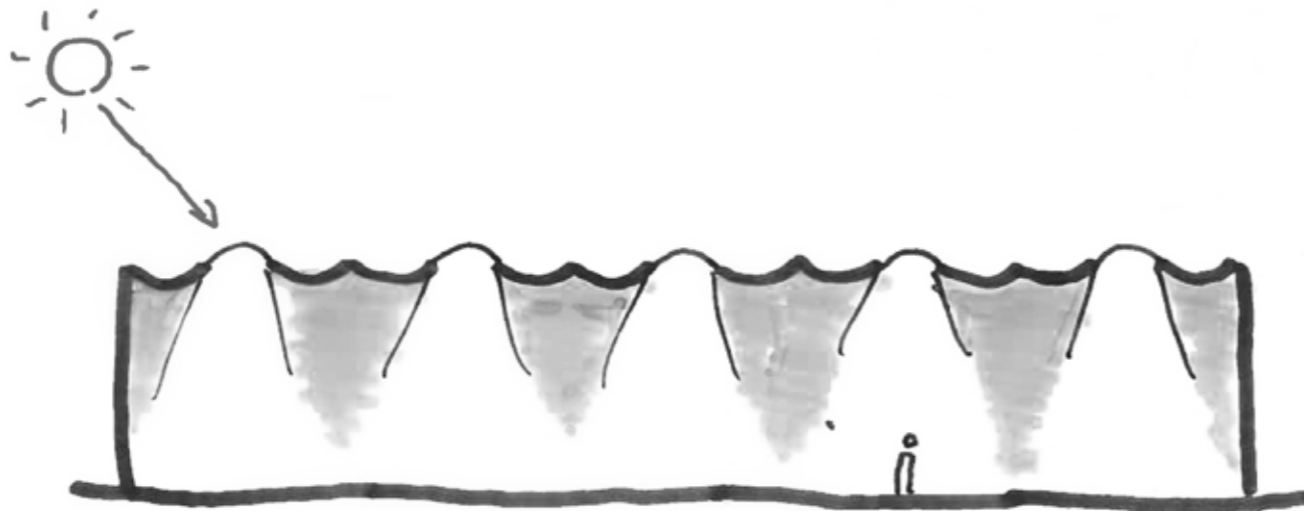
4.8 DAYLIGHT

An important architectural aspect of the building is the sequence of different spaces defined by typical structures and different ways of daylight entering the buildings. The rooflights were necessary to ensure that there was enough light to work in the large factory halls, where the light coming from façade openings was not enough. In this paragraph the different rooflights are compared to each other to explore the atmospheres of the different buildings.

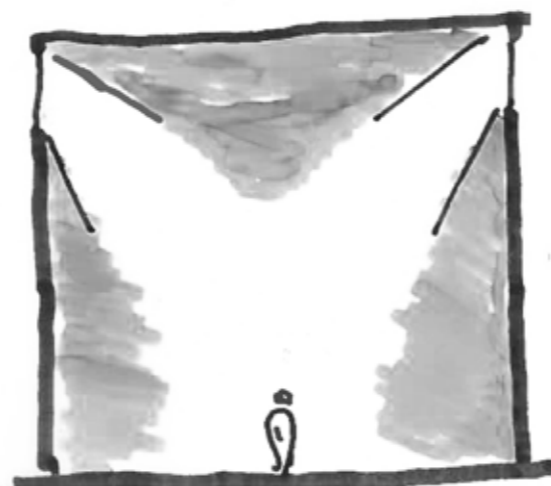




Northern light entering through saw-tooth roof
 Lets in the most daylight, every part of the floor gets the same amount of light. In this building the sawmill was located, this function probably needed this amount of light to prevent accidents from happening.



Top daylight entering through rooflights
 Lets in a lot of daylight, but less spreading on the floor ceiling stays unlit



Daylight entering through vertical windows in façades
 (high against the ceiling)
 Lets in less daylight in the large spaces and the light is less spreaded

4.9 RECONSTRUCTION FAÇADE OPENINGS BUILDING 72



Fig. 4.9.1 original window openings west side 1920-1937
Photo: NIMH



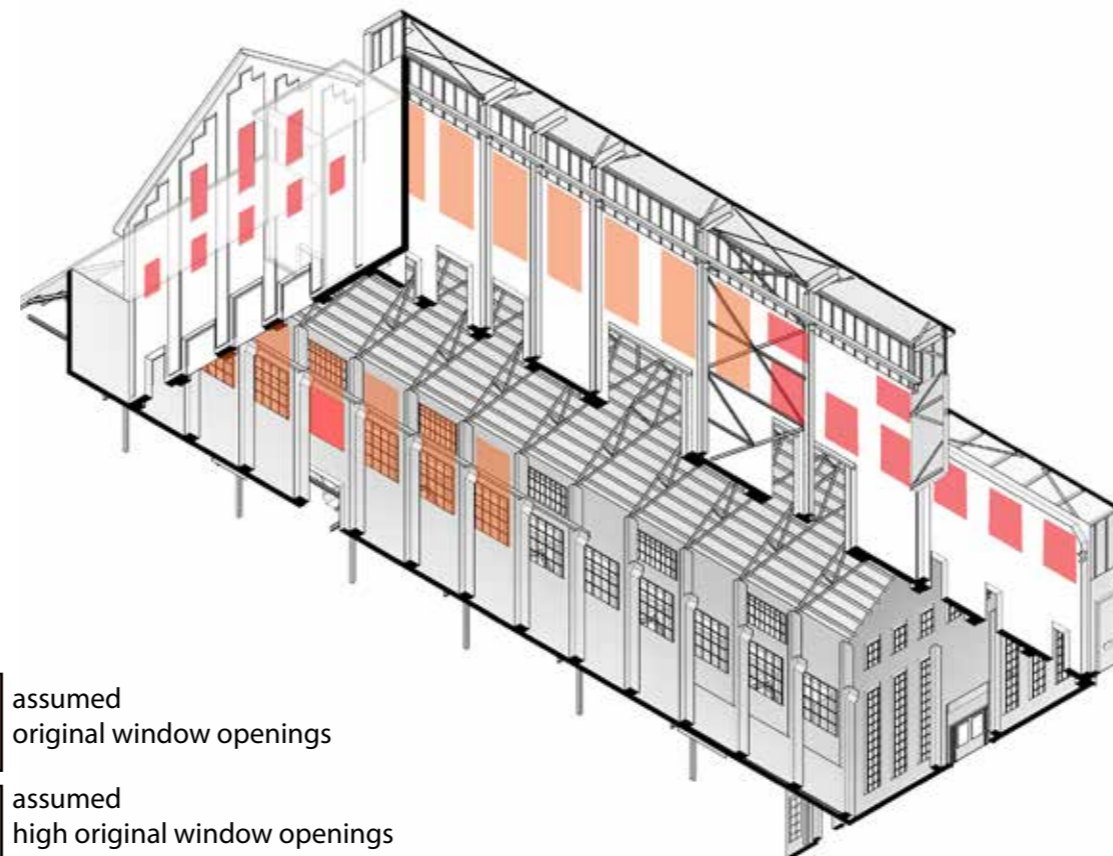
Fig. 4.9.2 original window openings south side 1940-1969
Photo: Archief Zaanstad



Fig. 4.9.3 original window openings east side 1932-1940
Photo: from collection Hembrug Museum



Fig. 4.9.4 Reference photo from the 'cathedral', also located on the Hembrug site. Here all the windows are still open and currently a building is demolished to let more light in (photo from <http://www.zaans-industrieel-erfgoed.nl>)



- assumed original window openings
- assumed high original window openings from before the extension



Fig. 4.9.5 original window openings north side 1940-1969
Photo: Archief Zaanstad

4.10 SAW-TOOTH ROOF BUILDING 333

This building is most recognisable for its shed roof, also called saw-tooth roof. Now it is the only one with this type of roof left in this row of buildings, but you can see on this photograph from 1956 that saw-tooth roof typology once dominated a part of the Hembrug site.



Fig. 4.10.1 Photo from collection Hembrug Museum, edited by author

4.11 SPATIAL EXPERIENCE- ATMOSPHERES



Fig. 4.11.1 (1) Building 333 with the prominent saw-teeth roof



Fig. 4.11.2 (2) Building 72 "the Church" high and dark

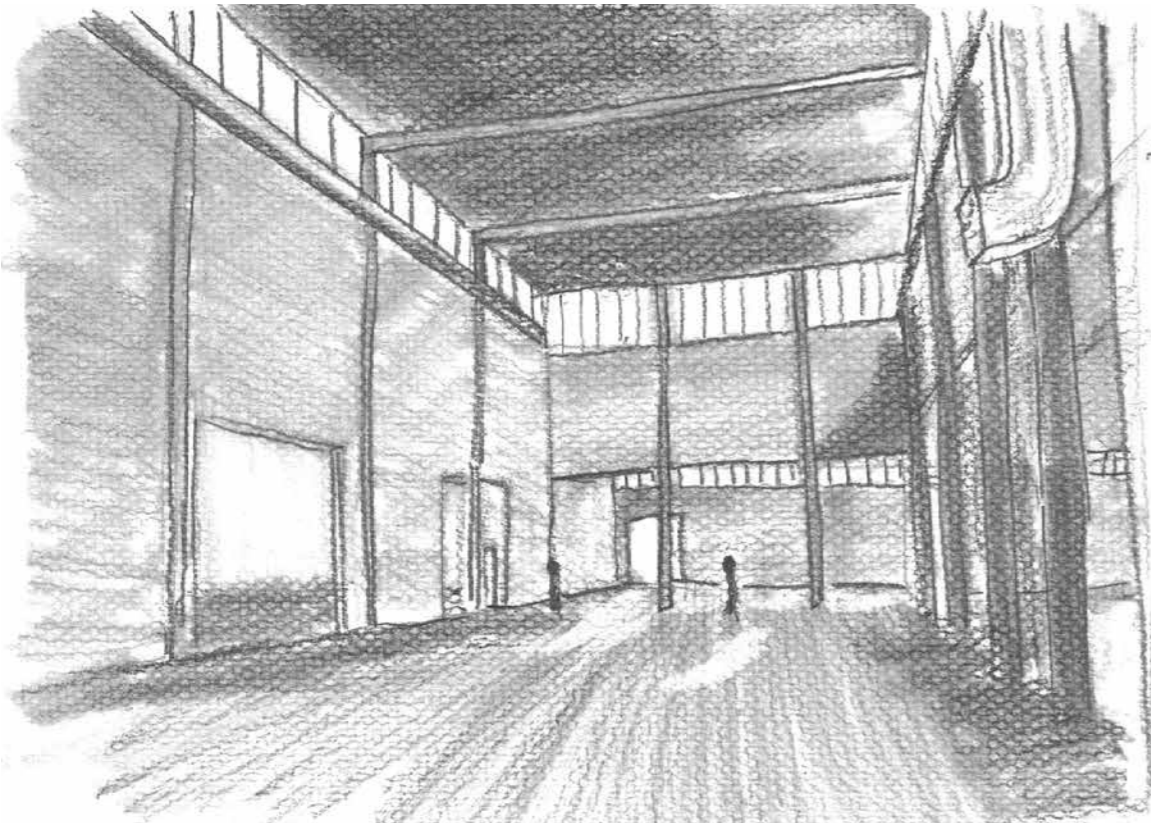


Fig. 4.11.3 (3) Building 436 highest part

All drawings by authors

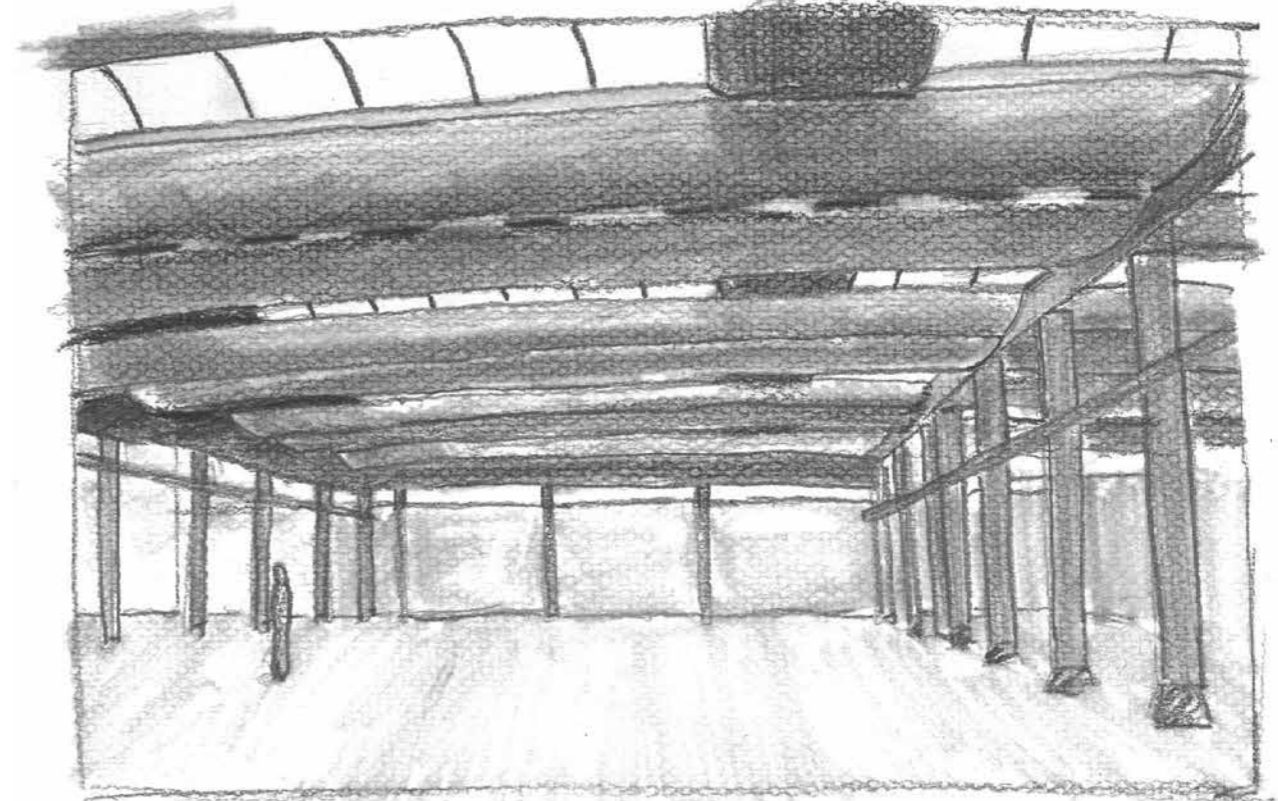


Fig. 4.11.4 (4) Building 436 concrete shells

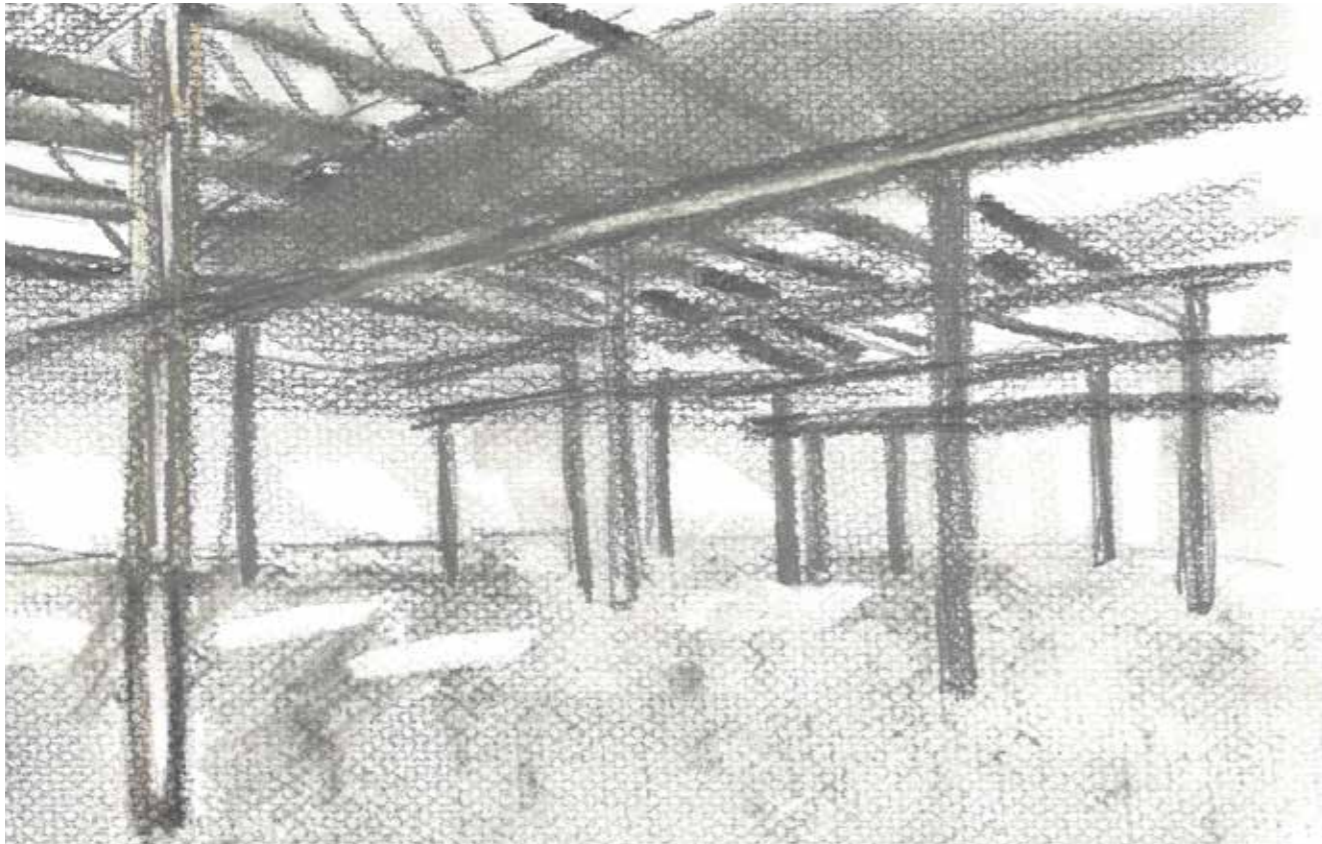


Fig. 4.11.5 (5) Building 308

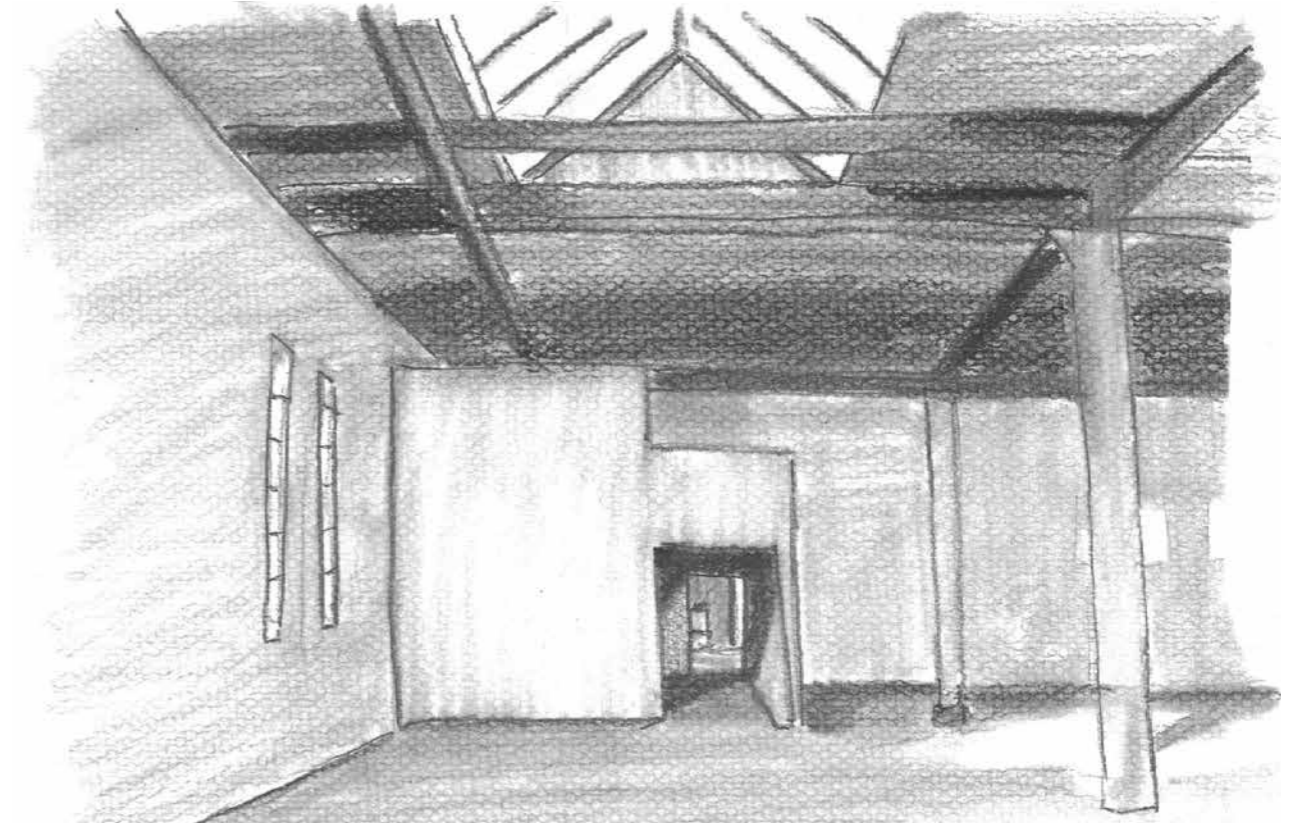


Fig. 4.11.6 (6) Internal connection 342 to 308 and 436

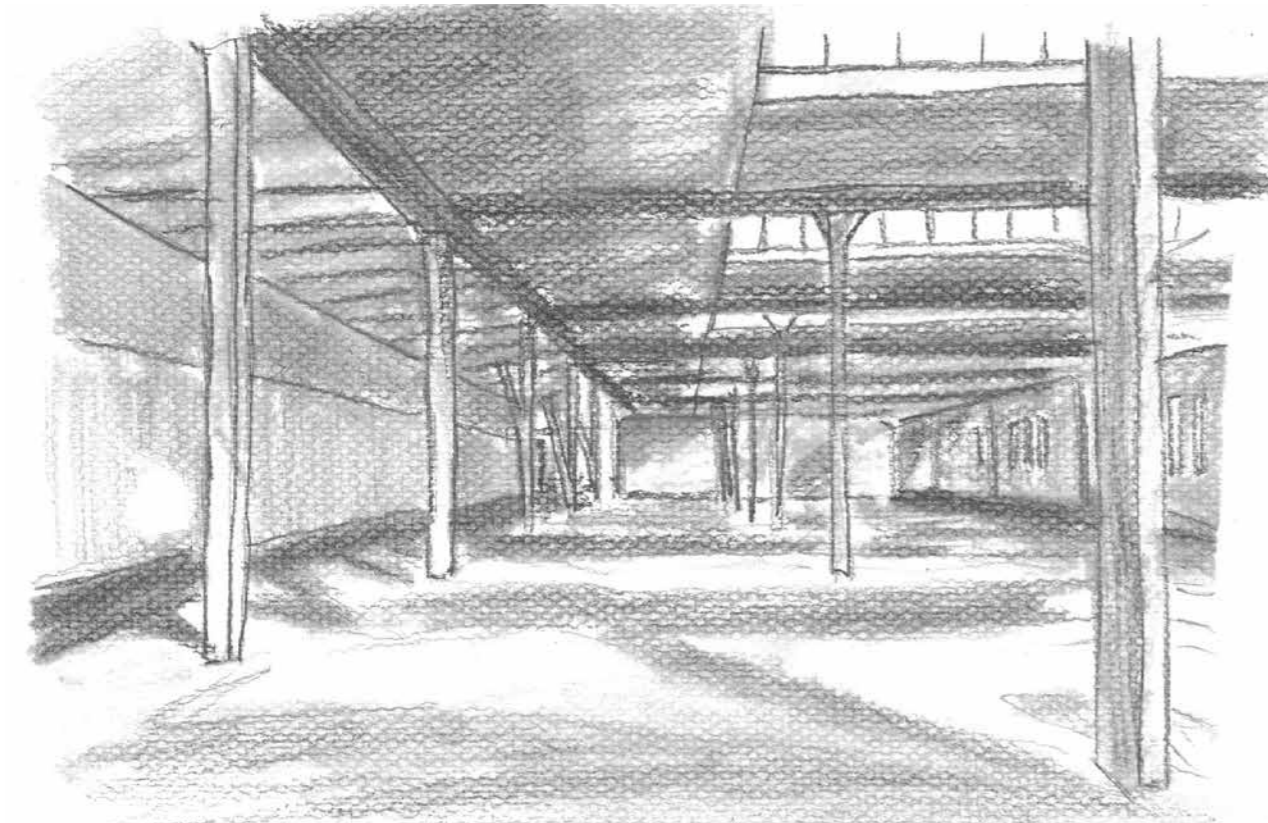


Fig. 4.11.7 (7) Building 342

All drawings by authors



Fig. 4.11.8 Spatial experience route overview

Conclusion:
 There is a noticeable difference in the spatial experience and atmospheres of the separate buildings. The structures, height of the spaces and textures determine the different atmospheres. In building 436 the concrete shells immediately attract the attention, whereas in building 72, the darkness and height catches your eye and lead them to the roof structure with polonceau truss. In building 333 the saw-tooth roof with the bimsbeton roof slabs and incoming light are characteristic.



5. BUILDING TECHNOLOGY

The building structures are a very characteristic and visible part of the building ensemble. Where from the outside the building seems massive and complex, it is the internal structure that reveals how the 5 buildings work and how they differ. By looking at the different structures we get familiar with the construction techniques used, so it can be integrated in the cultural value assessment in the last part of this booklet.

The question asked for this chapter:

What kind of structures and materials are applied to the different buildings within the Ladder and why do they differ?

Because the different structures and materials are part of the experience of the building, there is no clear boundary between the architecture and building technology analysis. Except that within this chapter we focus more on the level of measurements, materials and detailing.

5.1 STRUCTURE OVERVIEW

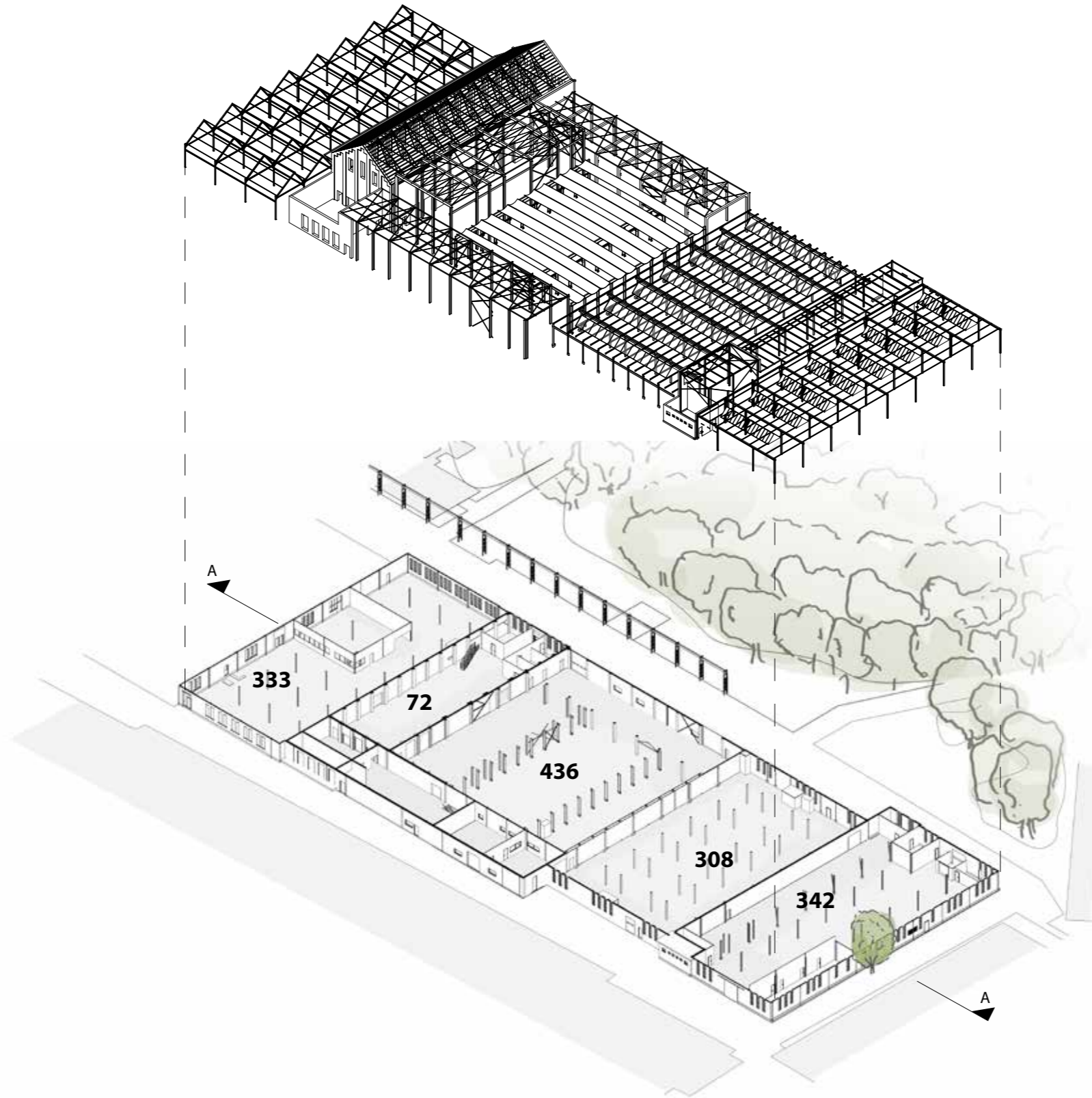
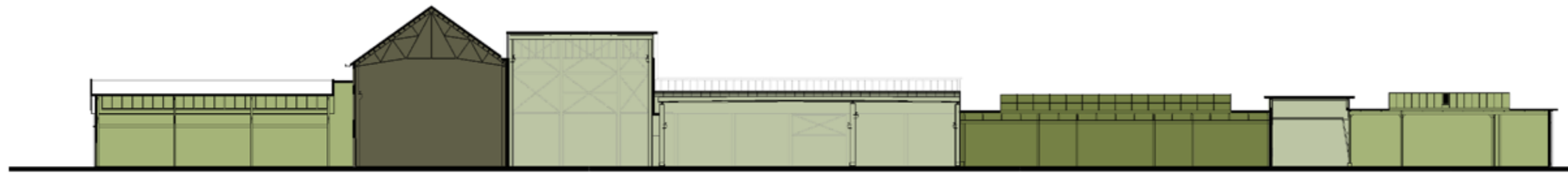


Fig. 5.1.1 overview of the structure in relation to the site (by authors)



section A-A' 1:500

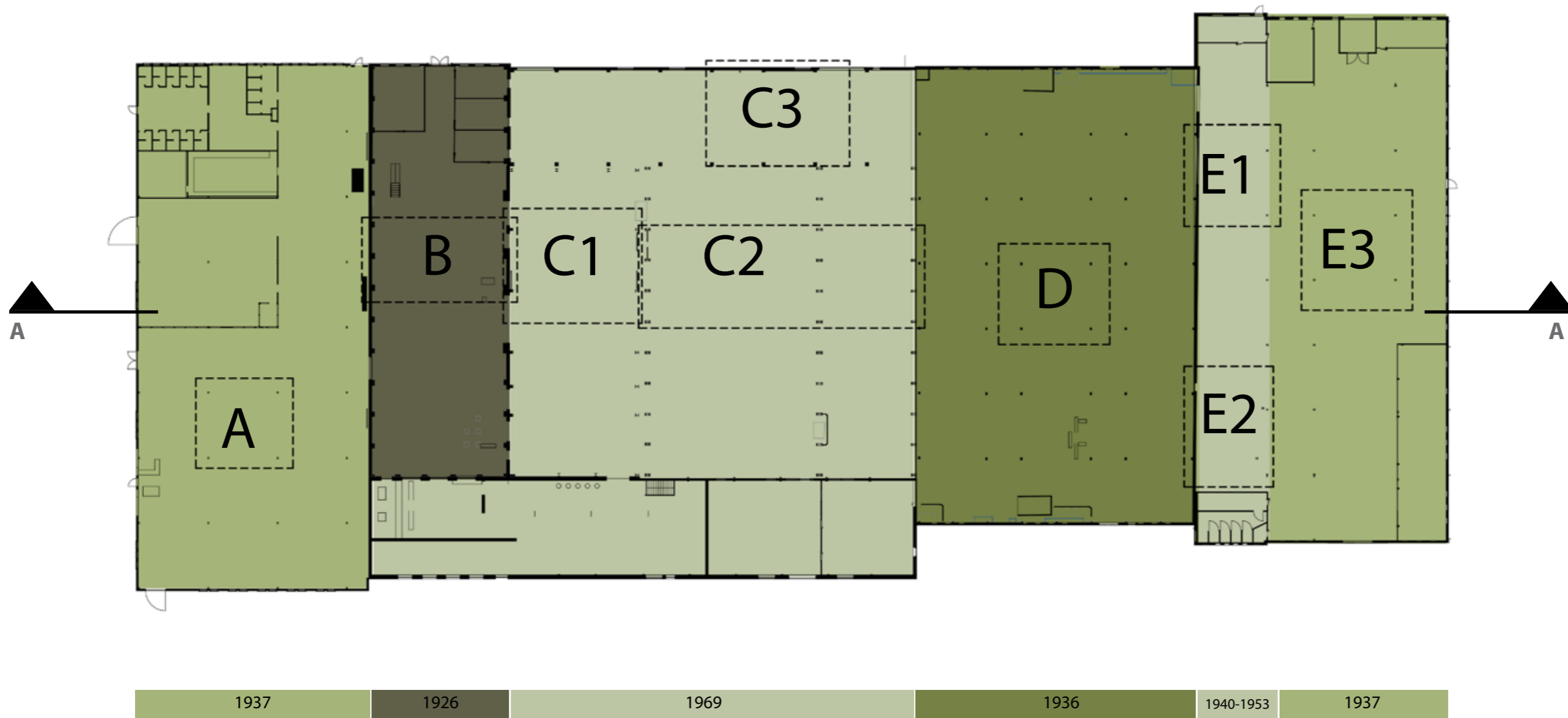
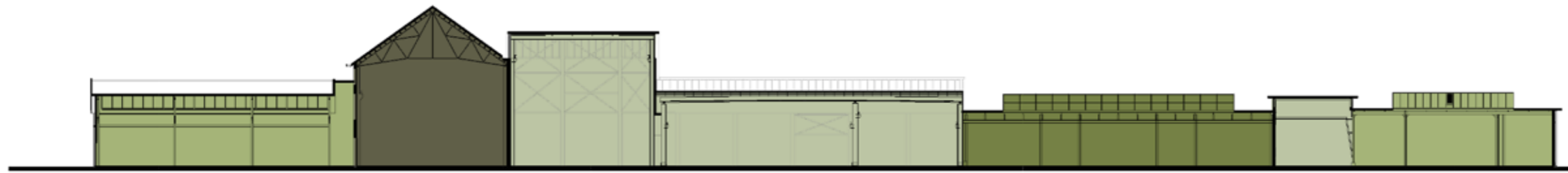


Fig. 5.1.2 Overview of the different structures and location of the fragments, which are investigated on the following pages, floorplan 1:500

All drawings by authors





section A-A' 1:500

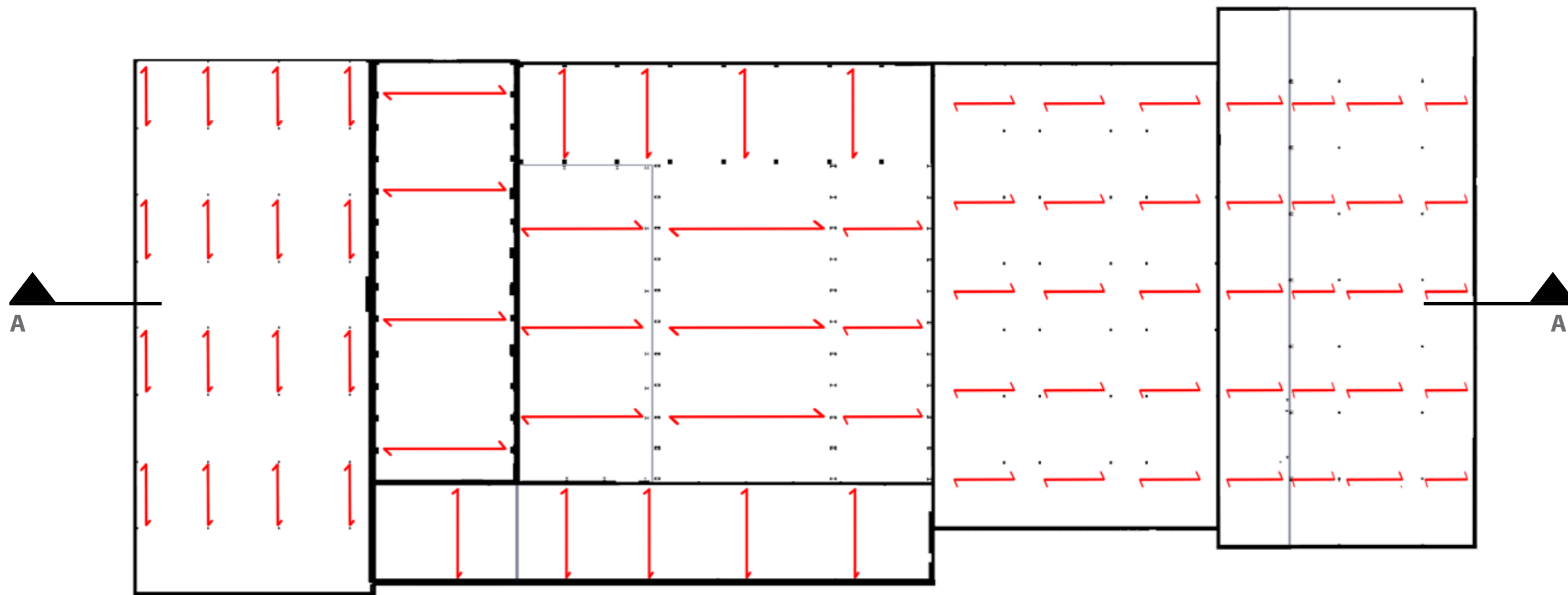
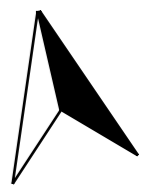


Fig. 5.1.3 Overview of the structures with primary span direction
Floor plan 1:500

All drawings by authors



5.2 STABILITY

Fig. 5.2.1 Load bearing and stability walls. The older structures, especially building 72 have walls as load bearing structure which as well provide the stability for these buildings. (by author)

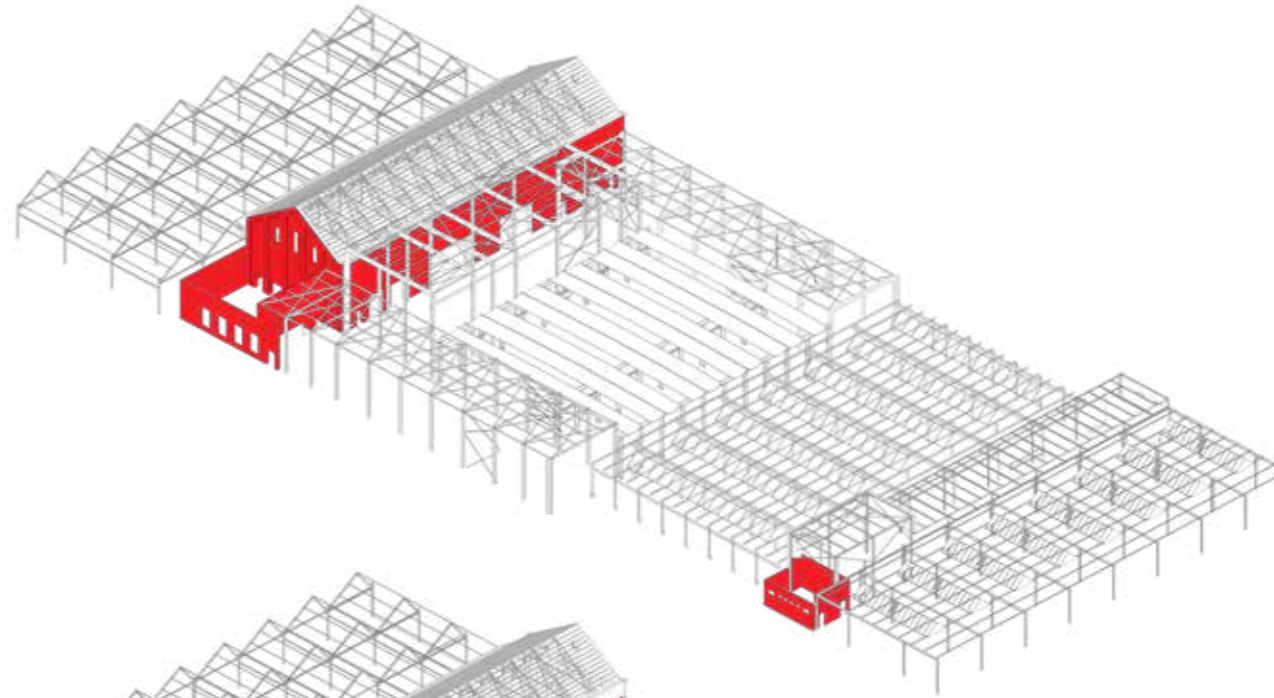


Fig. 5.2.2 X-bracing . The last added stuctures, building 436 and a part of 342, contain wind bracing for stability. (by author)

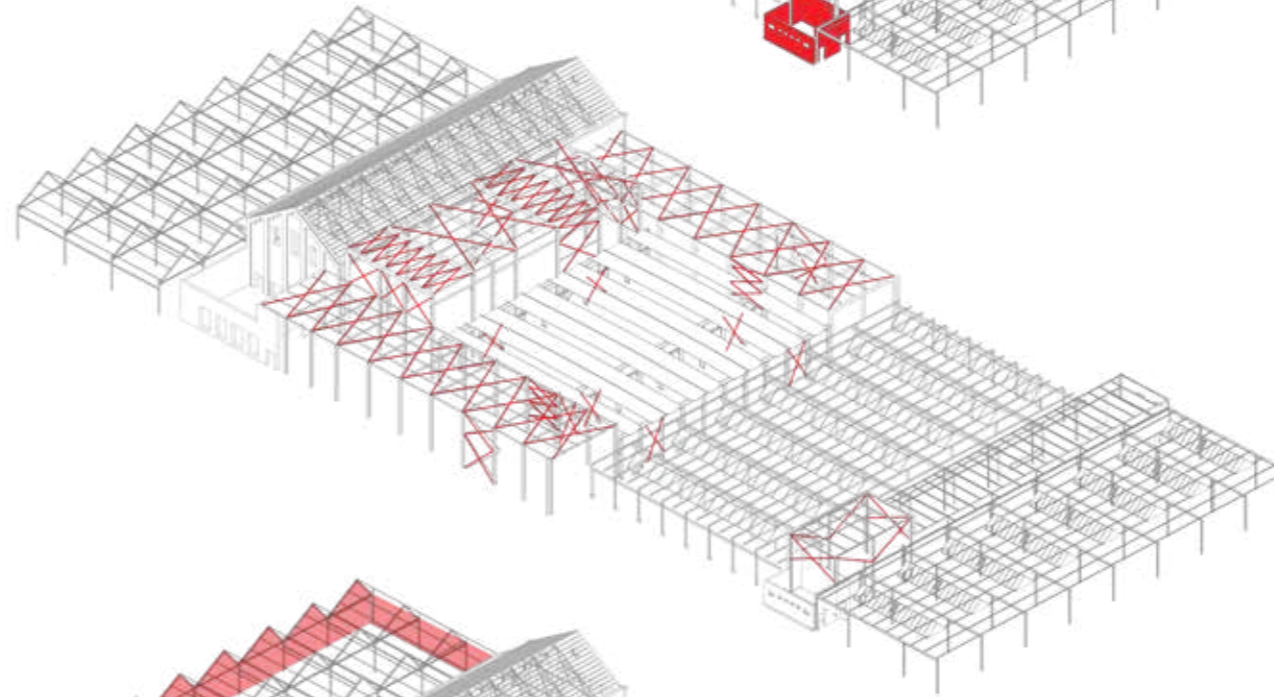
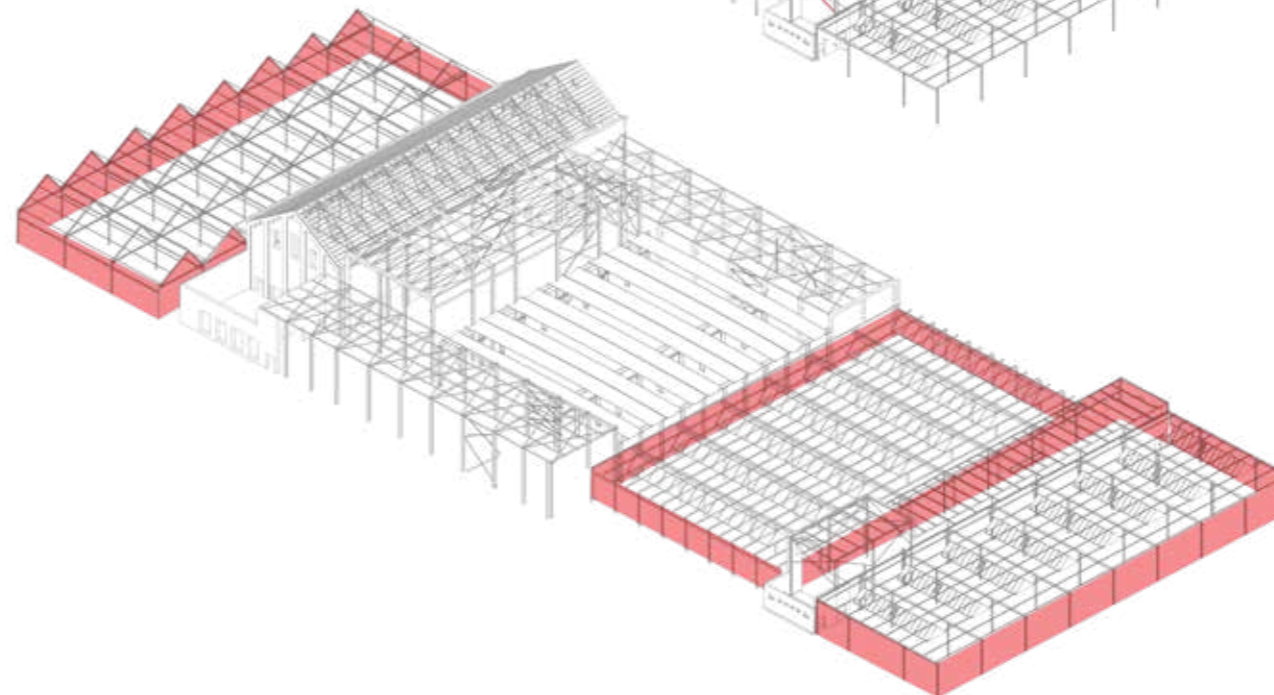


Fig. 5.2.3 Walls supporting the stability. These walls are not directly necessary for stability, but in the case of alterations and/or removal of these walls, the stability of the structures must be checked. (by author)



5.3 STRUCTURE FRAGMENTS

Fragment A

Building name:	333
Building year:	1937/1938
Structure type:	steel frame made of HEA profiles
Connections :	welded connections and steel plates
Span:	7050 x 7500 mm
Stability:	windbracing underneath roof and steel plate connections
Roof type:	sawtooth roof
Roof material:	Bims concrete see "5.8 Bims beton" on page 116
State of material (structure):	Rust on several columns, broken windows in roof



Fig. 5.3.1 Structure A (photo by authors)

All drawings by authors

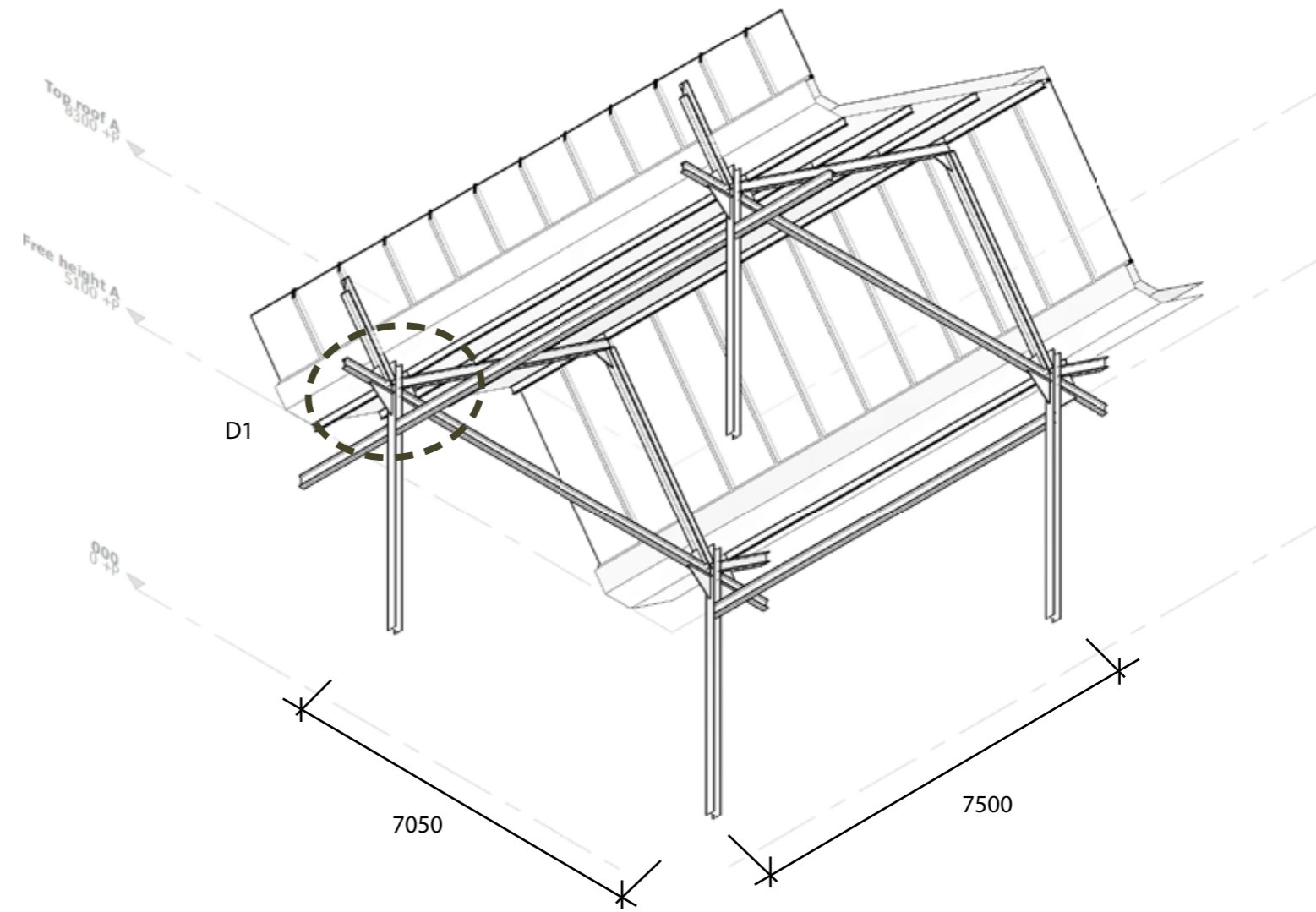


Fig. 5.3.2 fragment of structure A with detail structure (see appendix)



Fragment B

Building name:	72
Building year:	1926
Structure type:	brick walls, polonceau truss
Connections :	riveted steel truss
Span:	14500 mm
Grid distance:	3400 mm
Stability:	brick walls
Roof type/material:	gable roof wood structure with bitumen roofing
State of material (structure):	leakage of the roof



Fig. 5.3.3 Structure B (photo by authors)

All drawings by authors

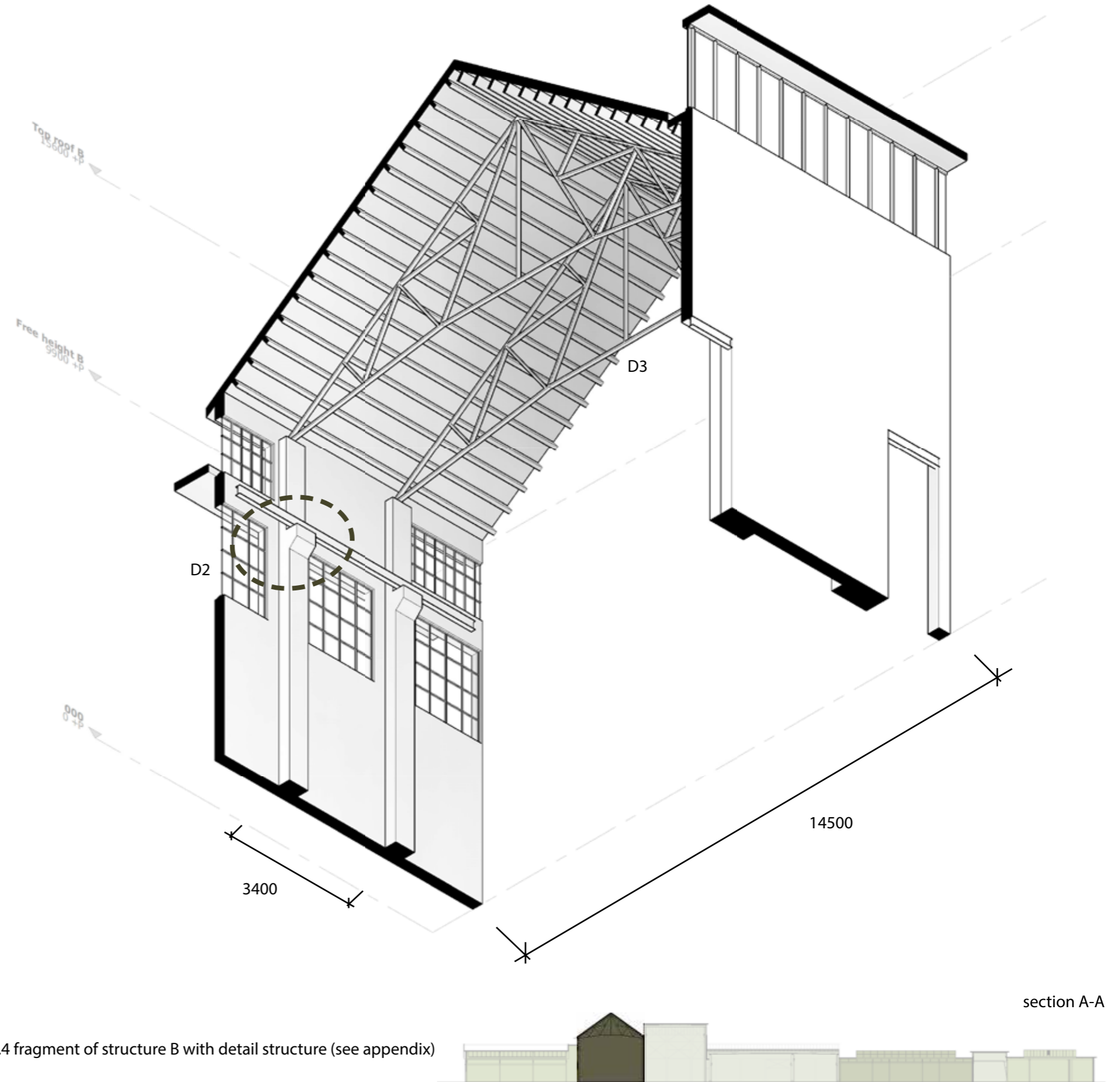


Fig. 5.3.4 fragment of structure B with detail structure (see appendix)

Fragment C1

Building name: 436
Building year: 1969
Structure type: steel frame
Connections : welded steel
Span: 14000 mm
Grid distance: 6630 mm
Stability: windbracing
Roof type/material: Hollow bimsbeton panels
State of material (structure): Asbestos façade panels



Fig. 5.3.5 Structure C1 (photo by authors)

All drawings by authors

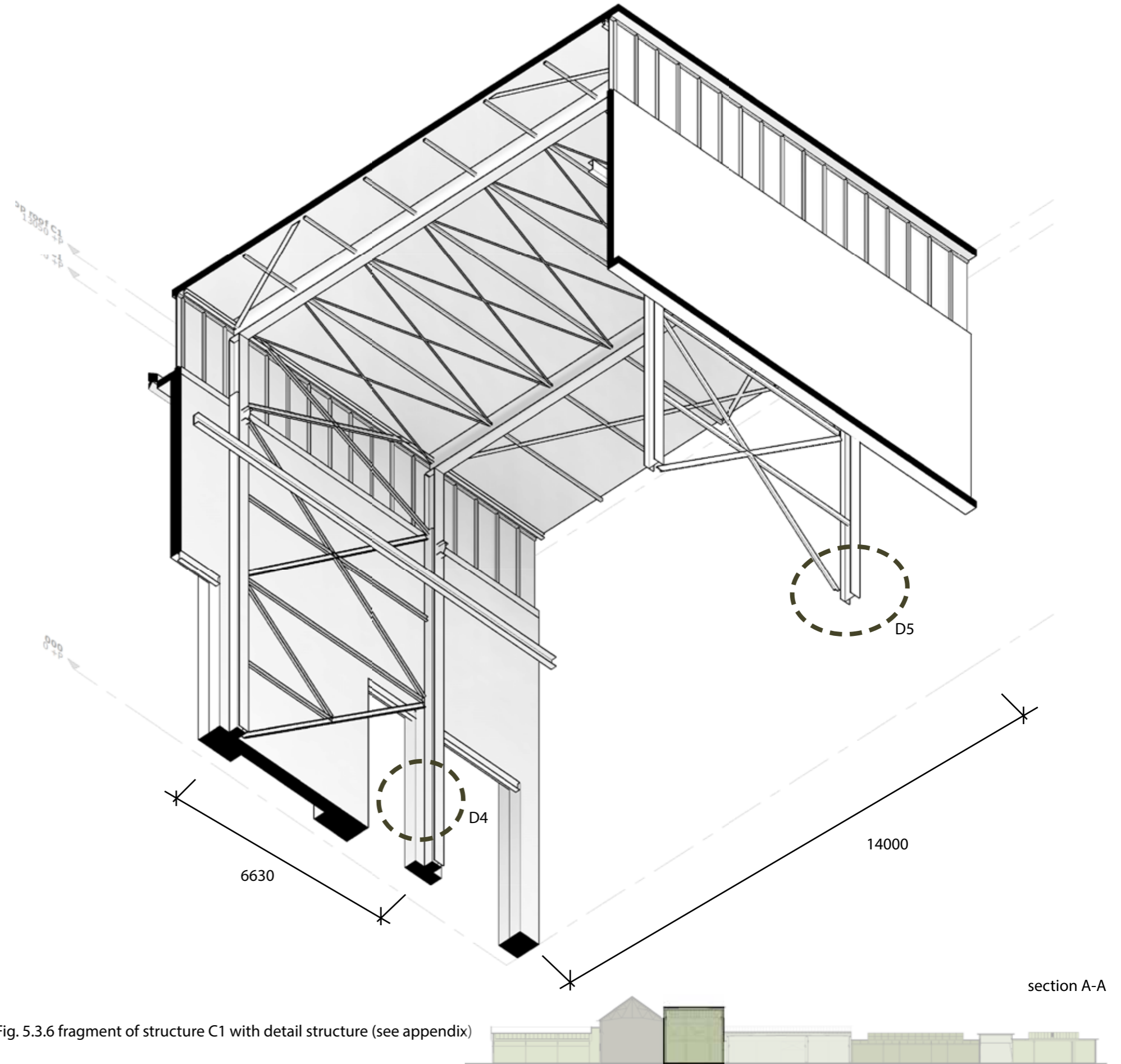


Fig. 5.3.6 fragment of structure C1 with detail structure (see appendix)

Fragment C2

Building name: 436

Building year: 1969

Structure type: steel frame with double curved concrete shells
see "5.7 thin concrete shells" on page 64

Connections : welded steel / bolted steel

Span: 18100 and 9700 mm

Grid distance: 3320 mm

Stability: windbracing

Roof type/material: bitumen on concrete

State of material (structure): dirt and pollution on roof lights



Fig. 5.3.7 Structure C2 (photo by authors)

All drawings by authors

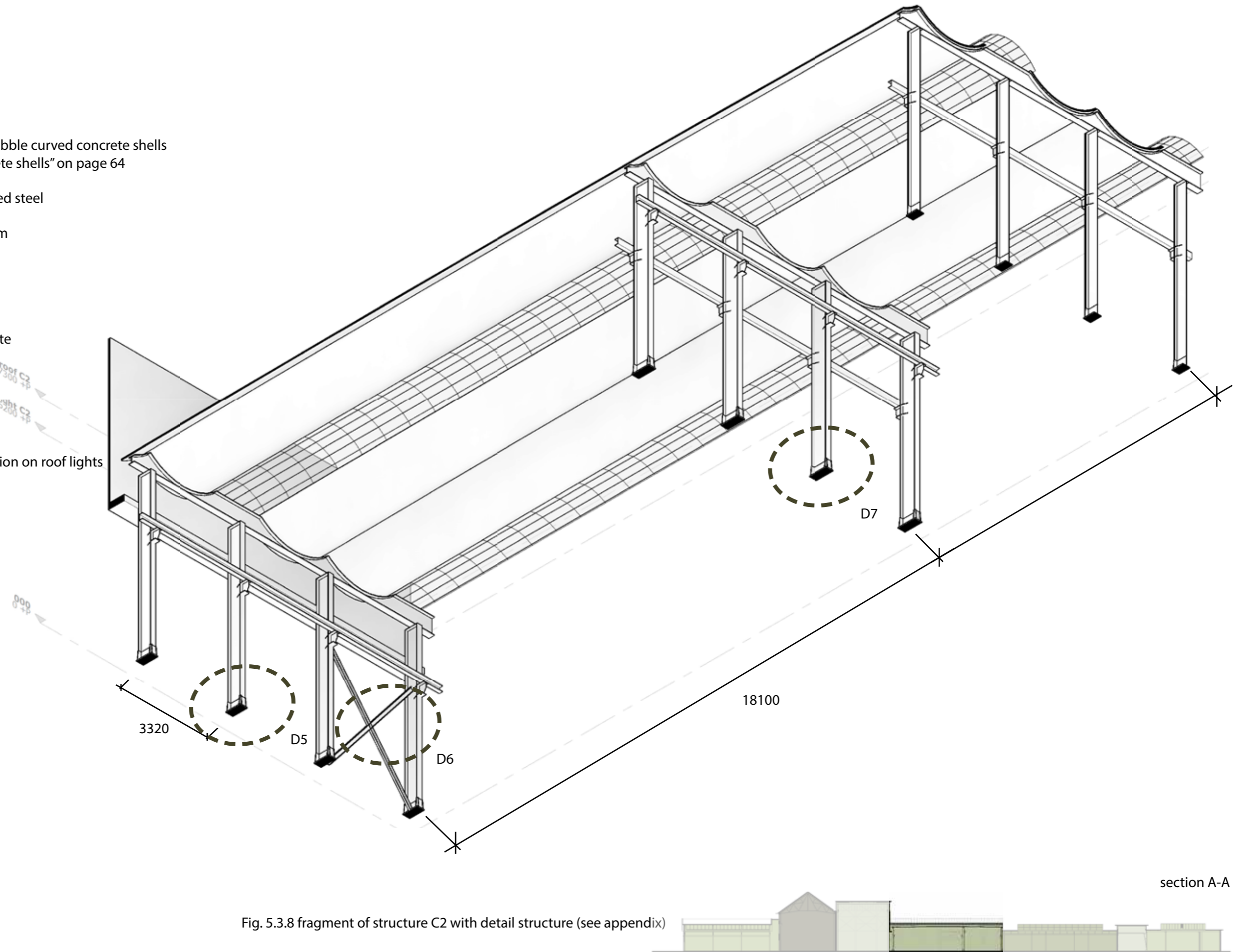


Fig. 5.3.8 fragment of structure C2 with detail structure (see appendix)

Fragment C3

Building name:	436
Building year:	1969
Structure type:	steel frame (packed with fireproof material)
Connections :	welded steel (probably)
Span:	9770 mm
Grid distance:	5590 mm
Stability:	windbracing
Roof type/material:	flat roof, bimsbeton
State of material (structure):	heavy leakage in large parts of the roof



Fig. 5.3.9 Structure C3 (photo by authors)

All drawings by authors

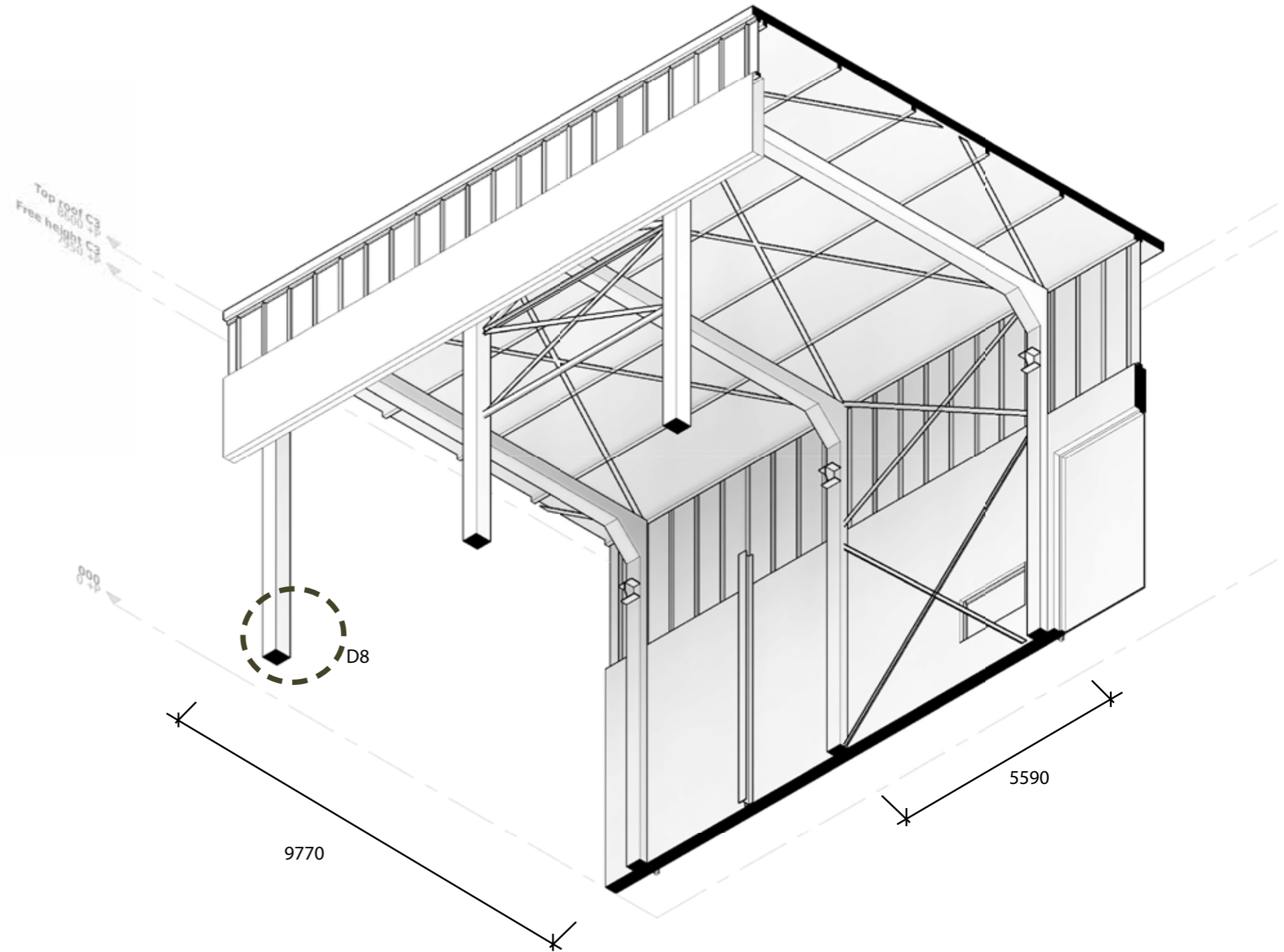


Fig. 5.3.10 fragment of structure C3 with detail structure (see appendix)



Fragment D

Building name: 308
Building year: 1936
Structure type: steel frame
Connections : riveted
Span: 7530 x 7020mm
Stability: brick walls
Roof type/material: flat roof with roof lights, Bimsbeton
State of material (structure): not seen during visit



Fig. 5.3.11 Structure D (photo by authors)

All drawings by authors

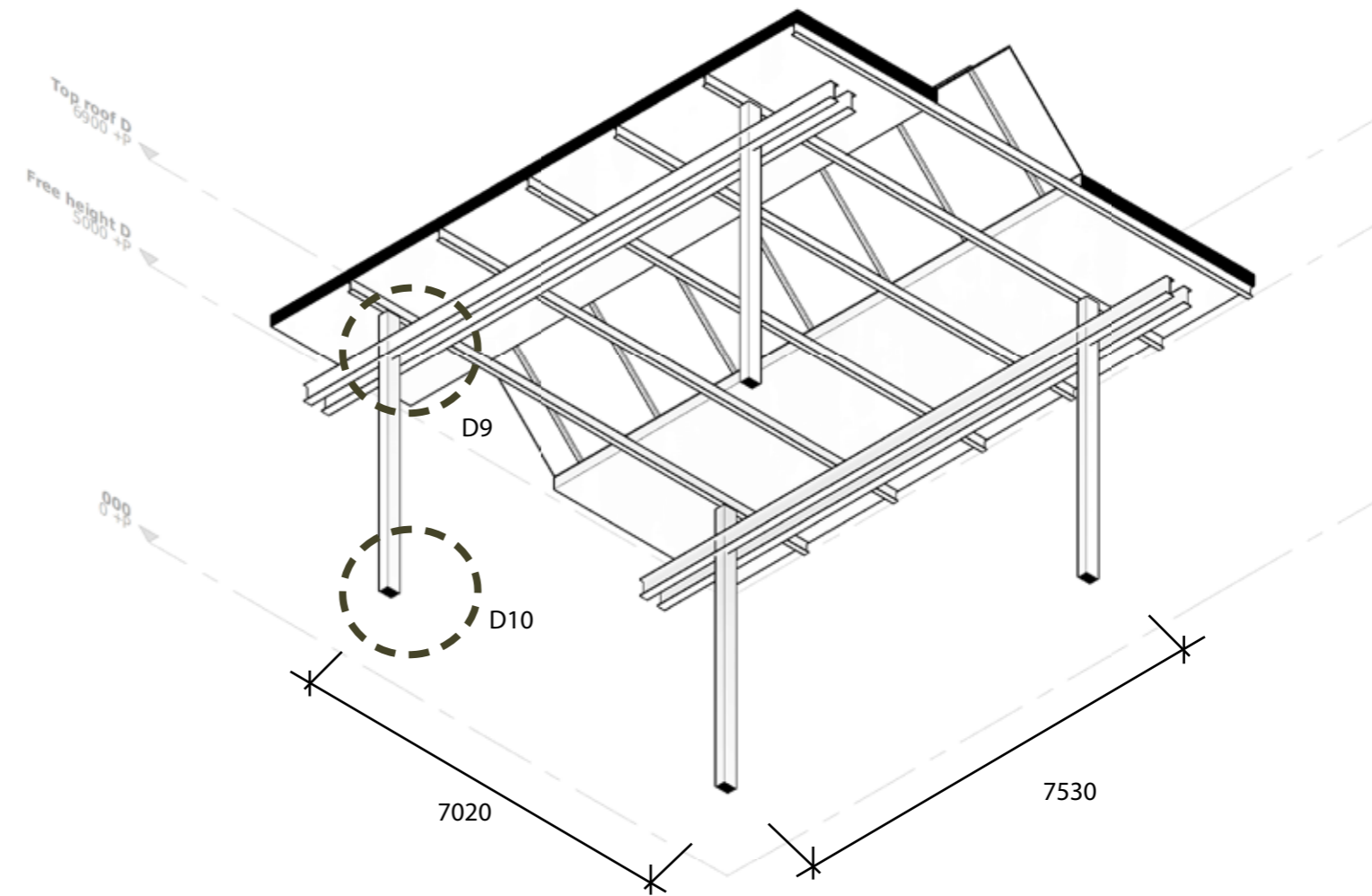


Fig. 5.3.12 fragment of structure D with detail structure (see appendix)



Fragment E1

Building name:	342
Building year:	1937
Structure type:	steel frame
Connections :	welded + bolts
Span:	7500 mm
Grid distance:	7000 mm
Stability:	stone wall
Roof type/material:	flat roof, Bimsbeton
State of material (structure):	all windows broken and covered with wooden panels

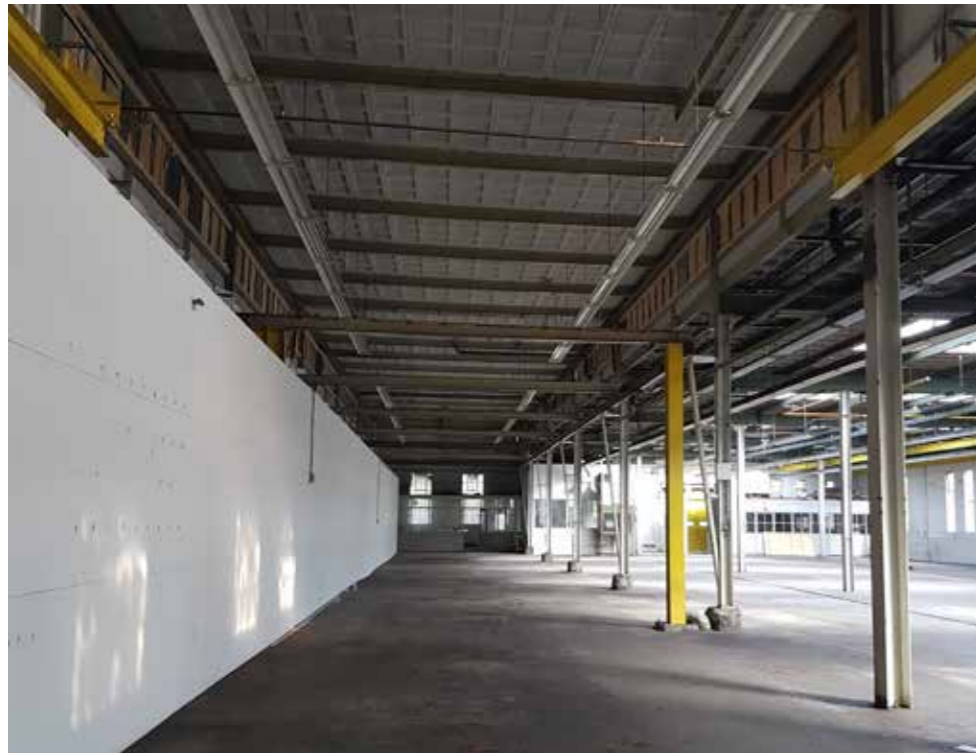
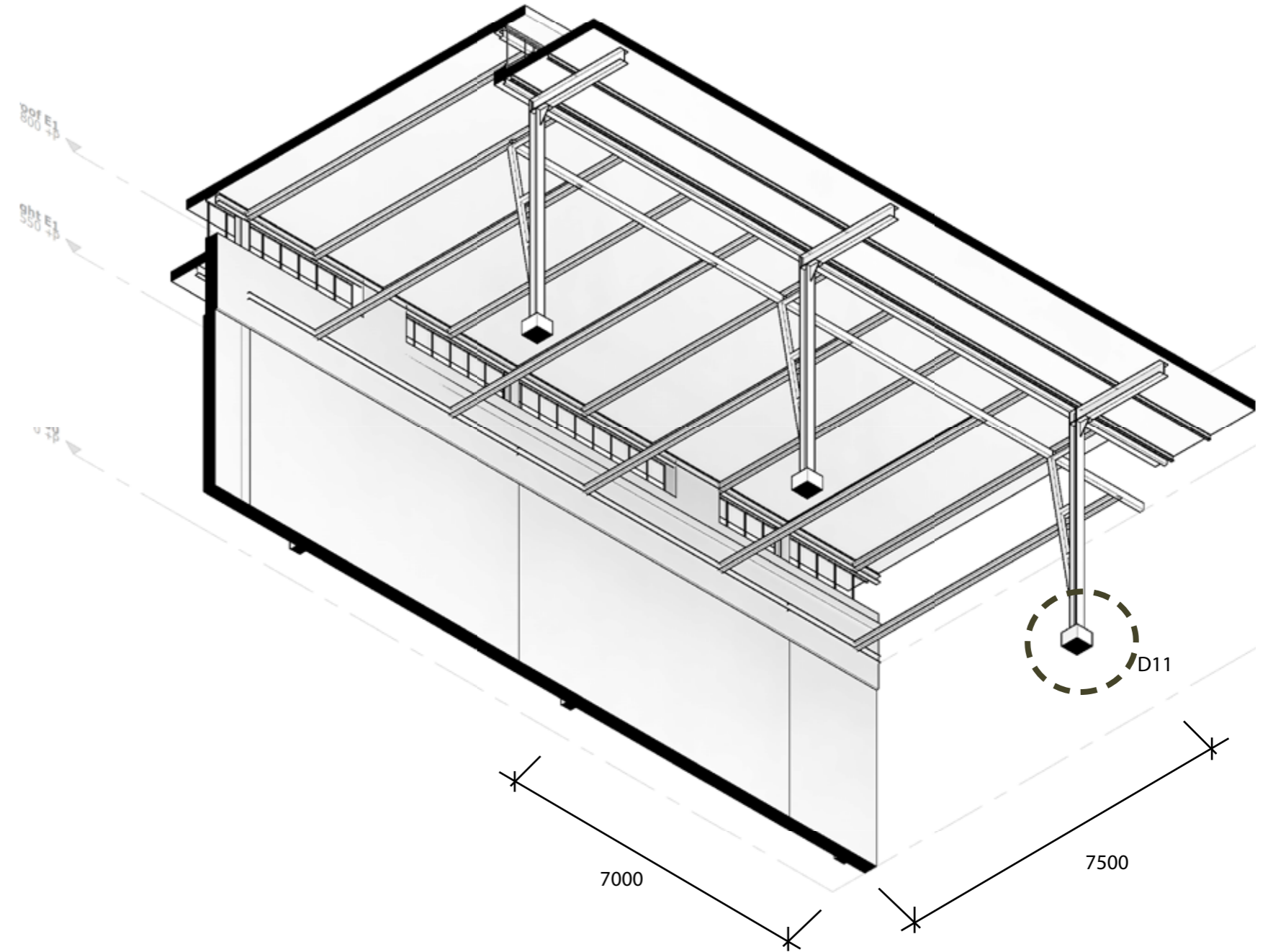


Fig. 5.3.13 Structure E1 (photo by authors)

All drawings by authors



section A-A

Fig. 5.3.14 fragment of structure E1 with detail structure (see appendix)



Fragment E2

Building name:	342
Building year:	1937
Structure type:	steel frame
Connections :	welded + bolts
Span:	7500 mm
Grid distance:	6075 mm
Stability:	windbracing
Roof type/material:	flat roof, Bimsbeton
State of material (structure):	several broken windows



Fig. 5.3.15 Structure E2 (photo by authors)

All drawings by authors

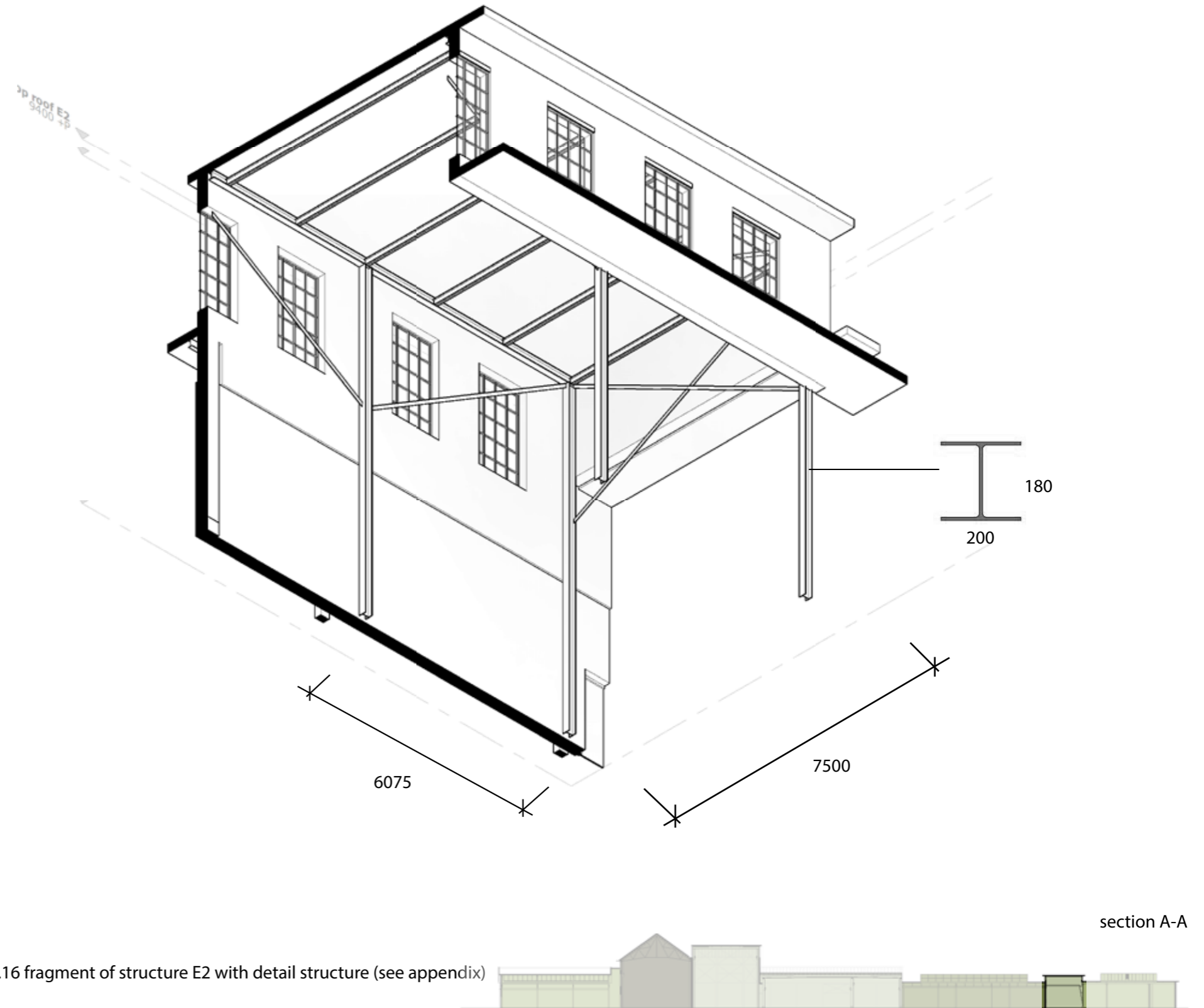


Fig. 5.3.16 fragment of structure E2 with detail structure (see appendix)

Fragment E3

Building name:	342
Building year:	1937
Structure type:	steel frame
Connections :	welded + bolts
Span:	8660 mm
Grid distance:	7000 mm
Stability:	windbracing
Roof type/material:	flat roof with roof lights, Bimsbeton
State of material (structure):	roof plates are at a certain place extra supported by wooden beams



Fig. 5.3.17 Structure E3 (photo by authors)

All drawings by authors

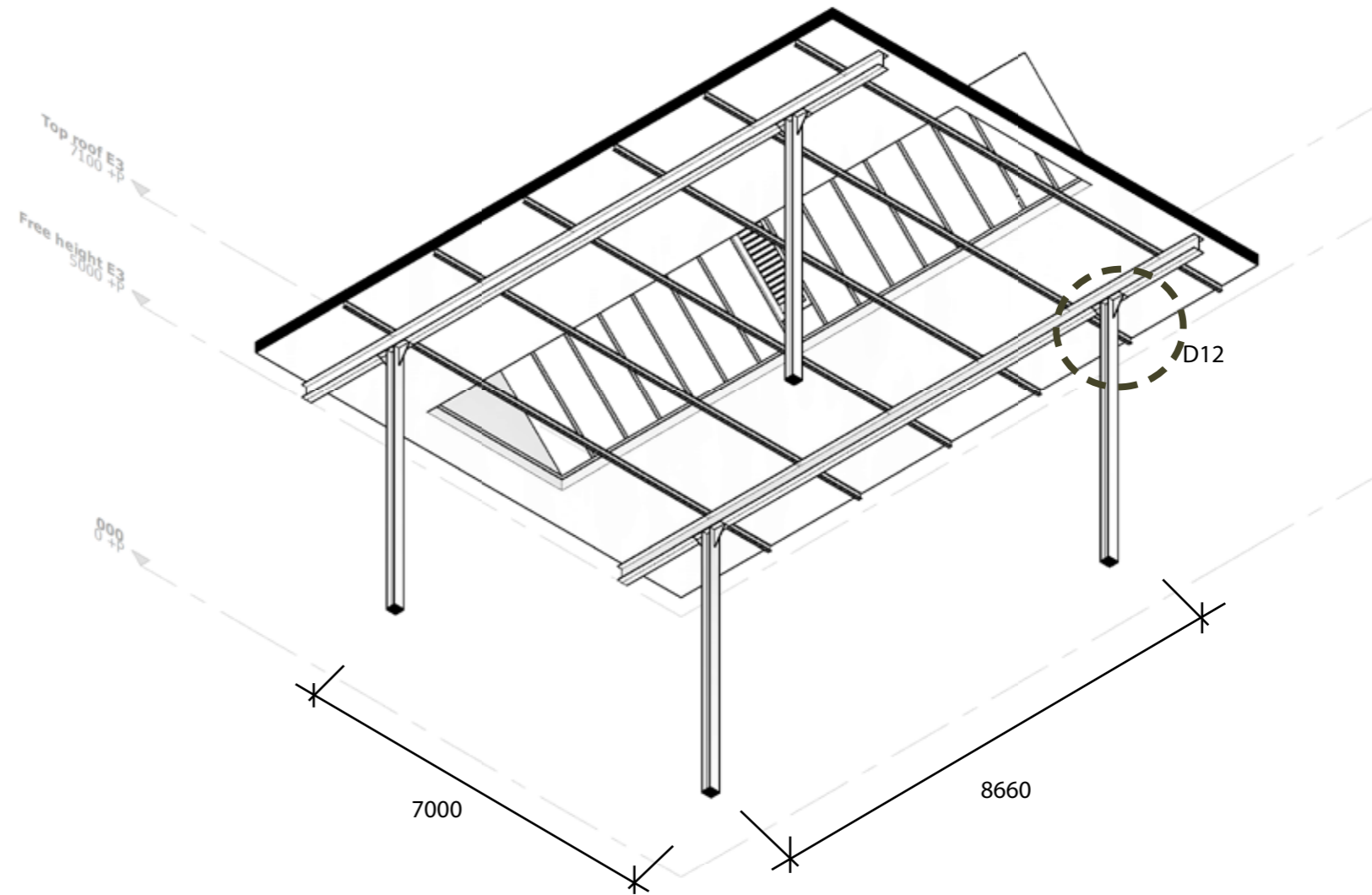
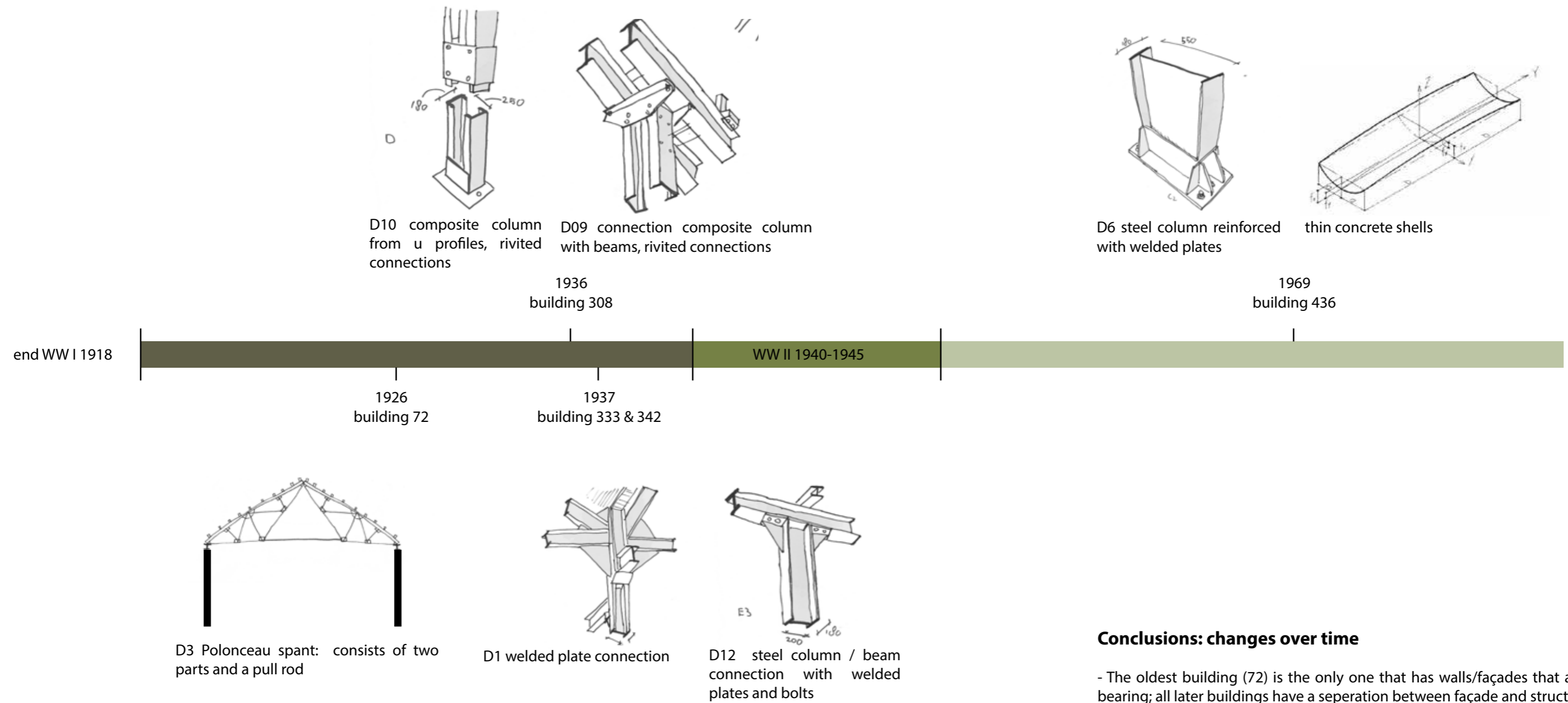


Fig. 5.3.18 fragment of structure E3 with detail structure (see appendix)



5.4 TIMELINE STRUCTURE

This timeline is meant to compare the different structures, materials and details used in the different buildings overtime. More details linked to the fragments from the previous paragraph can be found in the appendix.



Conclusions: changes over time

- The oldest building (72) is the only one that has walls/façades that are load bearing; all later buildings have a separation between façade and structure.
- Changing in detailing; from compound profiles and rivets to IPE profiles and welded connections.
- Changing in roof materials; from wood panels to Bimsbeton and concrete shells which are the roof material and the spanning structure at the same time.

5.5 THIN CONCRETE SHELLS

In building C, we can find an unfamiliar type of concrete structure, which is clearly different from the steel structure in the other four halls. At first sight you can see that the concrete beams are double curved. With this information it was possible to find precisely this type of structure in the book *Manual of Precast Concrete Construction* (volume 1 & 2). This book, translated from German, has been published in the late 1960's, which is also the building period of building C (1969). The name for this construction is prestressed concrete hyperbolic paraboloid shells German name: flächentragwerke. In the interest of this cultural-historical research, we need to know why this construction type is used, how it is made and especially if it is commonly used in that period or not.

Short history of concrete shells

Although concrete has been used for thousands of years, concrete shells are a product that have been introduced in the beginning of the 20th century. Since then steps were made in the development of the reinforcement of concrete and the acceptance of concrete as a finishing material. During the world wars concrete was cheaper than steel and wood, and cheap labour made it possible to experiment with the material in form of a thin shell. Large concrete plates and shells were economically beneficial, because they functioned as the loadbearing and space enclosing component at the same time. They also reduced the number of components in the building process.

After WWII organic forms became popular again, with a lot of experimentation in the 50's and 60's, but after 1975 it disappeared as a construction type. In the few decades this type of construction has been applied, concrete shells were used for a lot of different functions, from factories to train stations and even theatres and churches.

In some cases, they were meant to be visually extraordinary and futuristic, this can be seen in the works of Félix Candela and in some projects of Oscar Niemeyer.

There were and are some examples of concrete shell built in the Netherlands; the old Rotterdam station and platform roofs (demolished) by Sybold van Ravesteyn in 1957, the main building of the ANWB in Wassenaar, built in 1959 (is assigned to be a protected monument) and of course some of the other buildings on the Hembrug site, which mostly can be found in the forest part.



Fig. 5.5.1 Building C (436) (photo by authors)



Fig. 5.5.2 ANWB building, Wassenaar, The Netherlands
Räumliche Dachtragwerke: Konstruktion u. Ausführung, p. 141

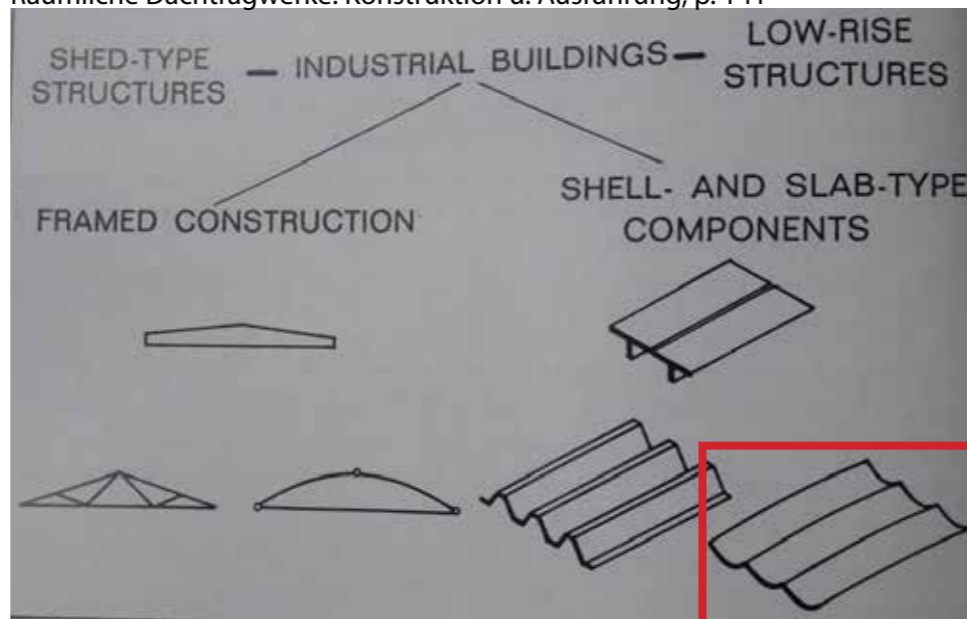


Fig. 5.5.3 overview of structure types.
of Precast Concrete Constructions Vol. 1, p. 24

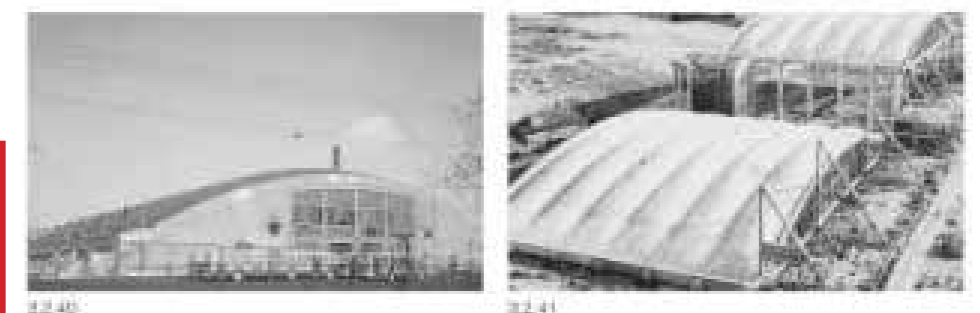
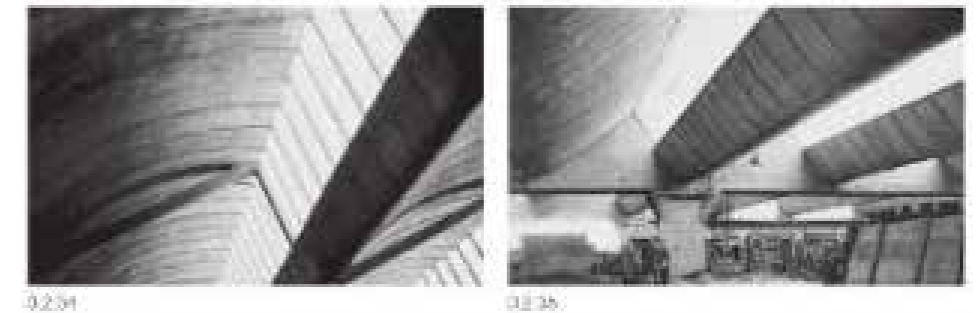
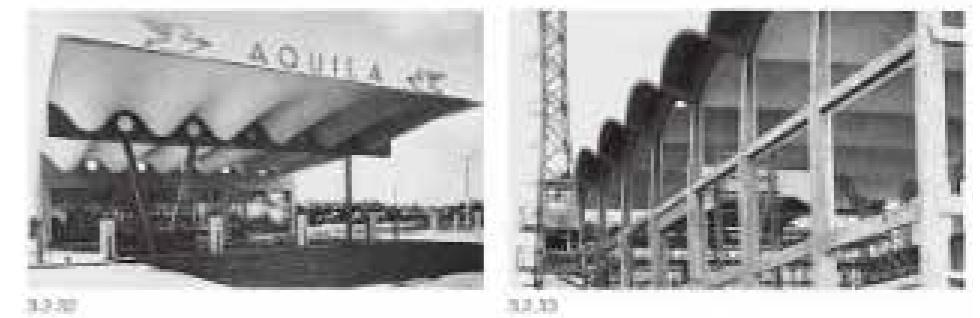


Fig. 5.5.4 overview of flächentragwerke structures.
Atlas, p. 155

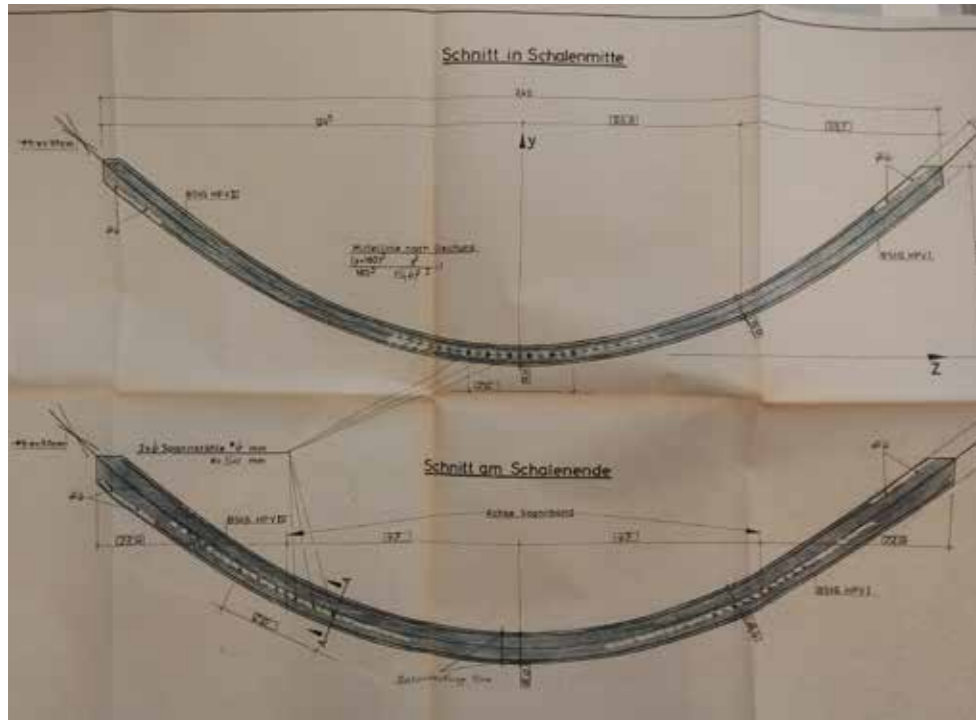


Fig. 5.5.5 technical section of the shells used in building 436 archive Zaanstad

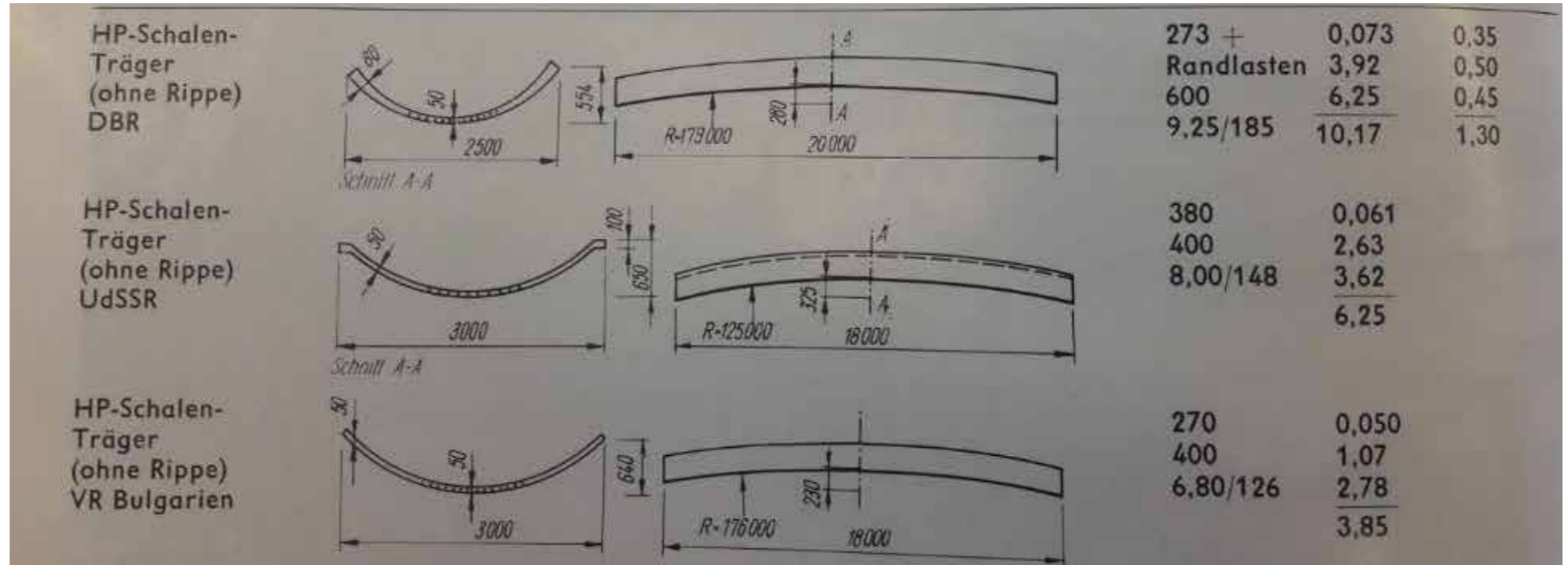


Fig. 5.5.6 overview HP-shell constructions
Räumliche Dachtragwerke: Konstruktion u. Ausführung, p. 272



Fig. 5.5.7 drawing information, drawings made by NORMKO Archief Zaanstad

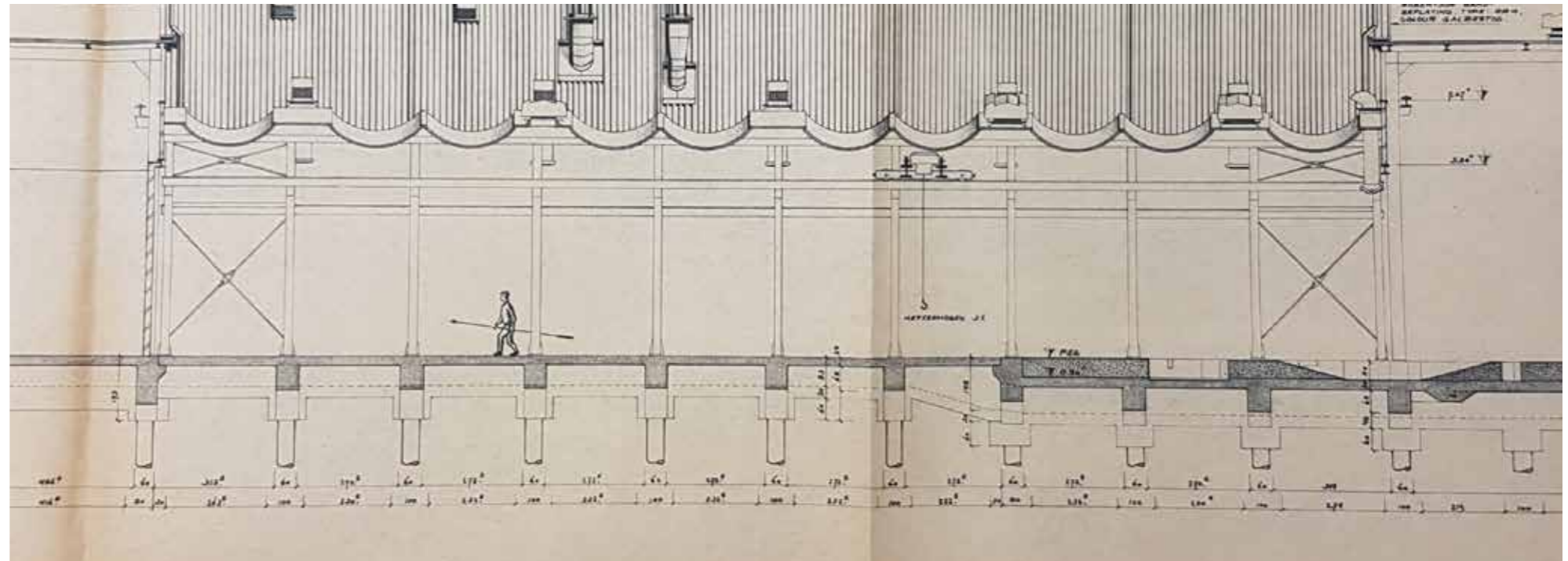


Fig. 5.5.8 section of building 436 Archief Zaanstad

Construction and transportation of prestressed concrete hyperbolic paraboloid shells

Thin concrete HP-shells are prefabricated in factories. In large moulds, reinforcement steel is tensioned and concrete is poured in. This can be seen in Fig. 5.11.8 and Fig. 5.11.9. The shells used in building 461 are 18.5 and 9 meters long (from drawings we know that it is not one span, but two) and 2,49 meters wide. In figure 5.4.12 the dimensions of a truck are drawn with the maximum sizes of elements that can be transported, here the 18,5 meters is indicated.

At the building site a crane that lies on tracks within the scaffolding, lifts the shells onto the already build and placed beams, which are made of concrete, see Fig. 5.11.13, but in building 436 are made in steel. In this way a roof construction with such a large span can be constructed easily and fast. The finishing materials and rooflights are placed afterwards.

Why this structure type isn't used anymore

Although you would think that this way of construction is practical for one-story buildings, it is not used anymore. In his research paper about thin concrete shells Gabriel Tang describes several reasons that led to the loss of concrete shell structures. The most important reasons for losing the application of this type of construction are the changing costs of labour, the "impractical" morphology of shells, competing materials and the passing of engineers that were masters in designing these elements and did this complex analysis.



Fig. 5.5.9 adjusting the reinforcement Manual of Precast Concrete Constructions Vol. 1, p. 42



Fig. 5.5.11 transportation Manual of Precast Concrete Constructions Vol. 1, p. 44

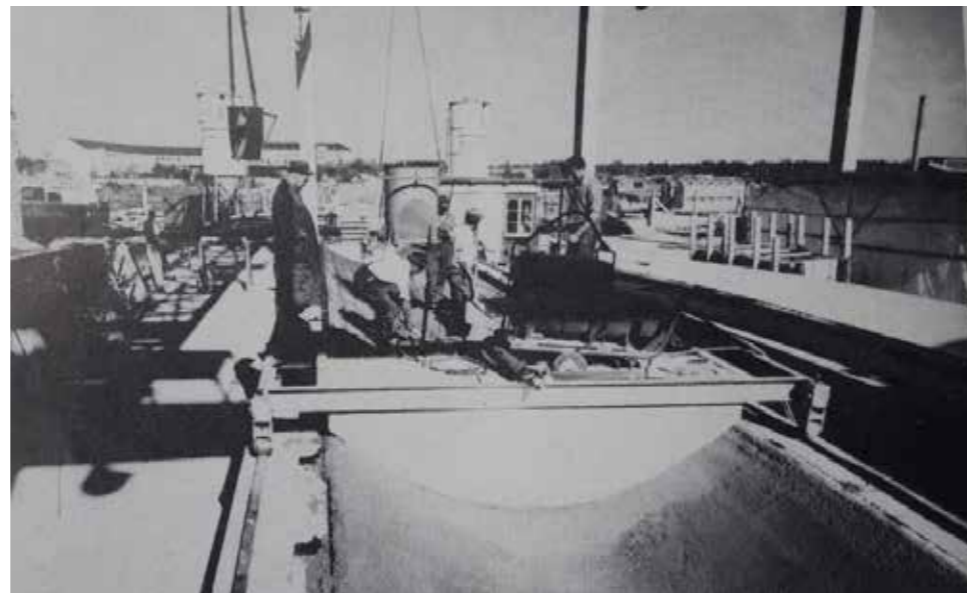


Fig. 5.5.10 pour off concrete for a thin shell Manual of Precast Concrete Constructions Vol. 1, p. 44



Fig. 5.5.12 unnamed example. Manual of Precast Concrete Constructions Vol. 2, p. 281

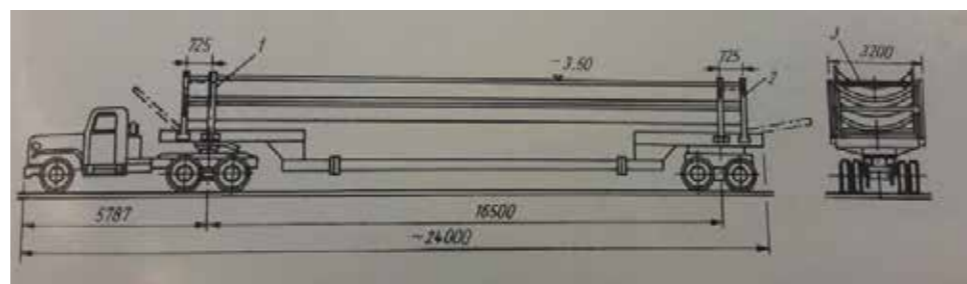


Fig. 5.5.13 transportation sizes of HP shells Räumliche Dachtragwerke: Konstruktion u. Ausführung, p. 283

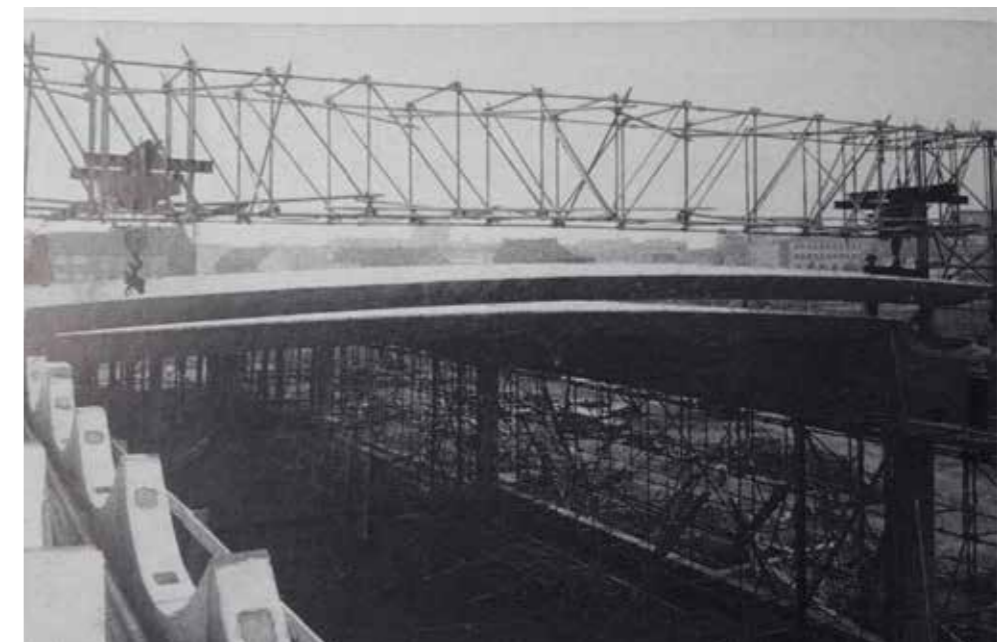


Fig. 5.5.14 placing a shell in its frame Manual of Precast Concrete Constructions Vol. 1, p. 42

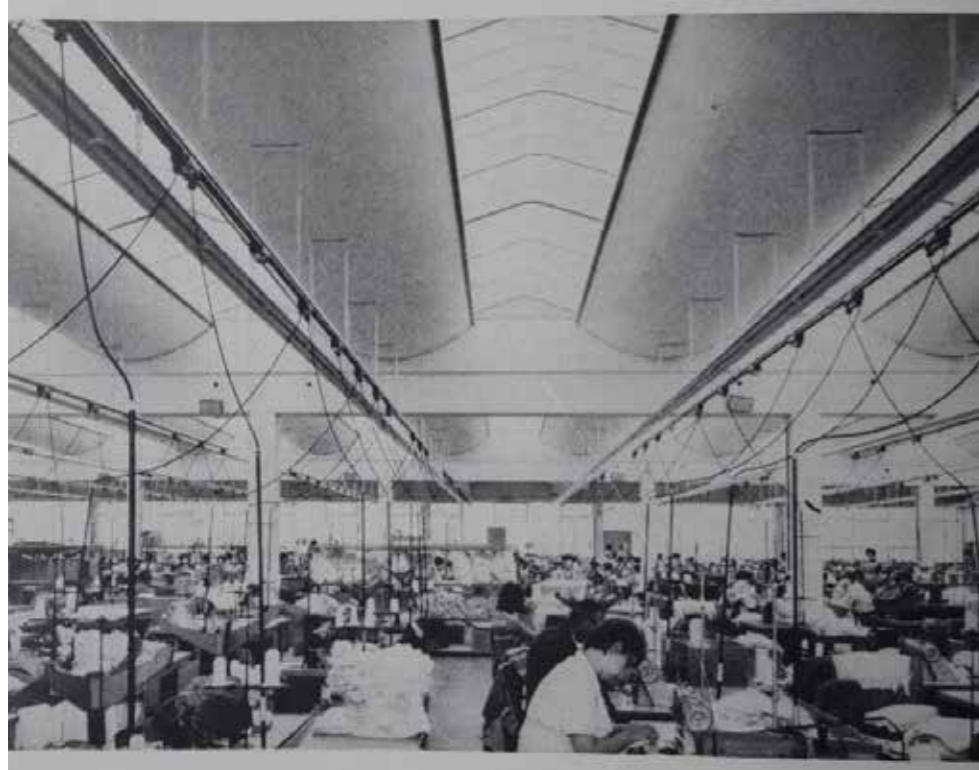


Fig. 5.5.15 unnamed example. Manual of Precast Concrete Constructions Vol. 2, p. 282



Fig. 5.5.16 "Petersberg Pavillion" near Halle(Saale), Germany, by Herbert Müller, photo 2009, source: pavillon-petersberg.de

Conclusion HP-shells

The HP-shell was not meant to be aesthetically unique, but they were meant to be functional and cheap in a period where material was expensive, but manpower was affordable. There are still some examples of buildings, designed by Siberkuhl and Müller, left in Germany, which you can see in the figures on this page. It is unknown how many are still remaining and how much of them are demolished; some still have their original function, and some are renovated, such as the Volksschwimmhalle Lankow, which has become an apartment building, Fig. 5.11.17.

We would like to state that the HP-shells in building 436 on the Hembrug site are special because of multiple reasons. First of all, it is the only example of HP-shells we found in the Netherlands. Secondly, in relation to the adjacent structures, it shows a phase in time, where (prefab) concrete is used (instead of steel) to make a large and light factory space.

We know that around the 1960's a German company acquired an undisclosed amount of shares and could influence the way buildings were built and production processes were organized on the Hembrug site. Our hypothesis is that this German company brought this building method over from Germany or that they were already familiar with it. So, this building shows also the German intervention on the Hembrug site.

Interesting to know is that the TU Delft researchers and students are working on contemporary versions of thin shells, made of new materials and with new construction techniques, because the principle of large spans and surfaces and less material is still interesting in the construction field.



Fig. 5.5.17 Gymnasium, today the National Center for Rhythmic Gymnastics, Halle-Neustadt by Herbert Müller, Photo by Ralf Lotys, 2013.



Fig. 5.5.18 Renovated Volksschwimmhalle Lankow to apartments, original architect Herbert Müller, Schwerin, Photo from www.volksschwimmhalle.de



Fig. 5.5.19 Lorriegarage 1961 - 1966 Hembrug terrain. (Photo taken by Emma van Asselt)

5.6 FAÇADE FRAGMENTS

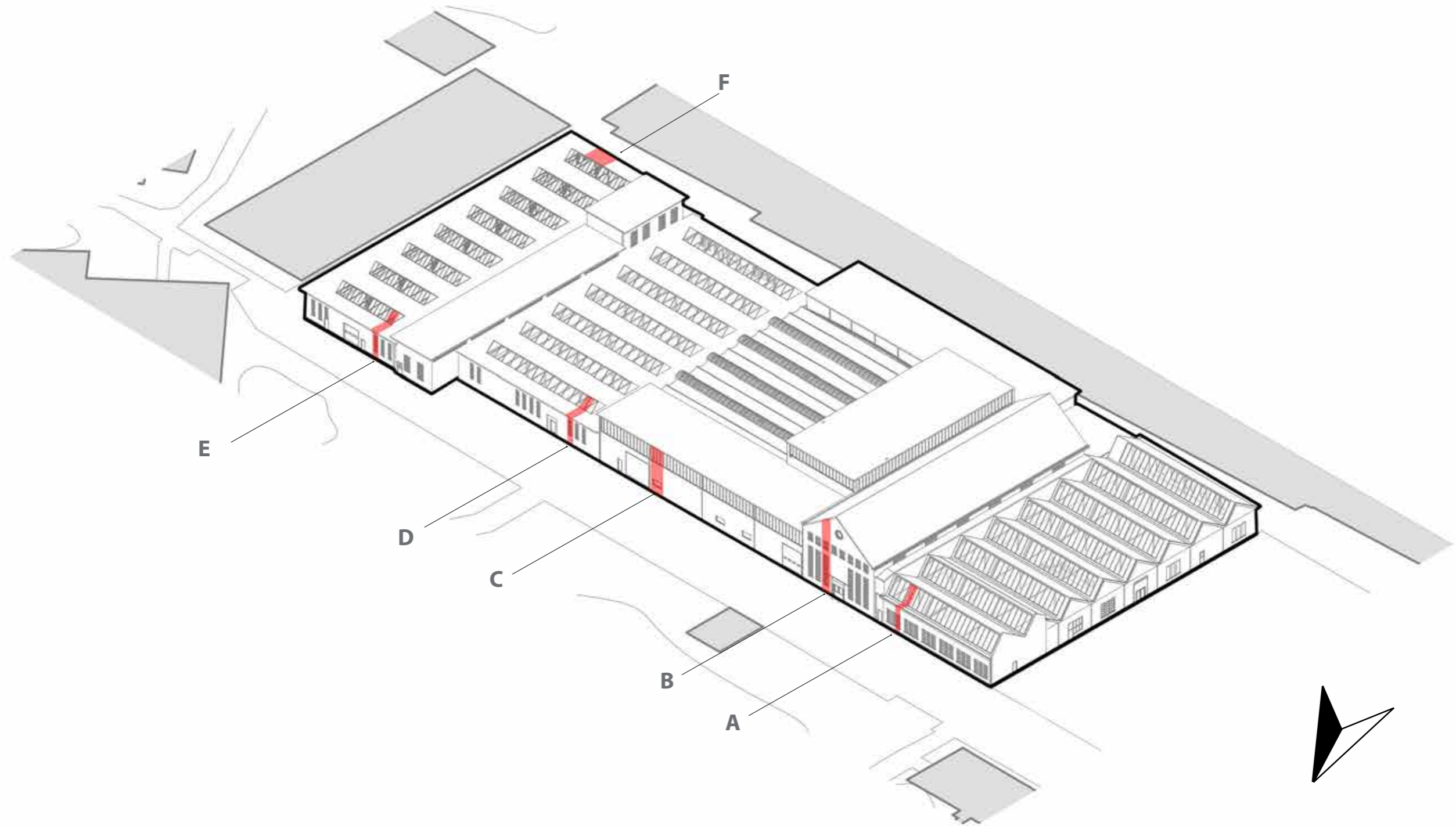
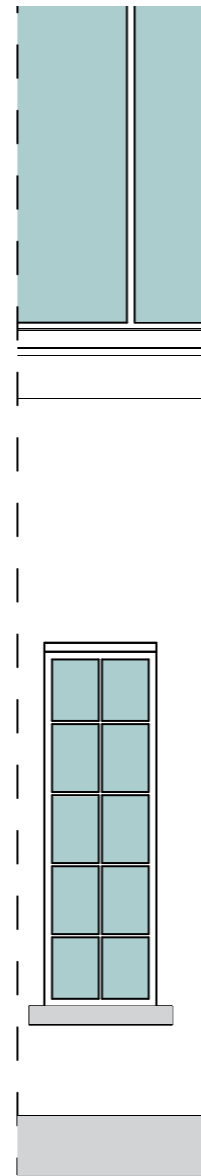
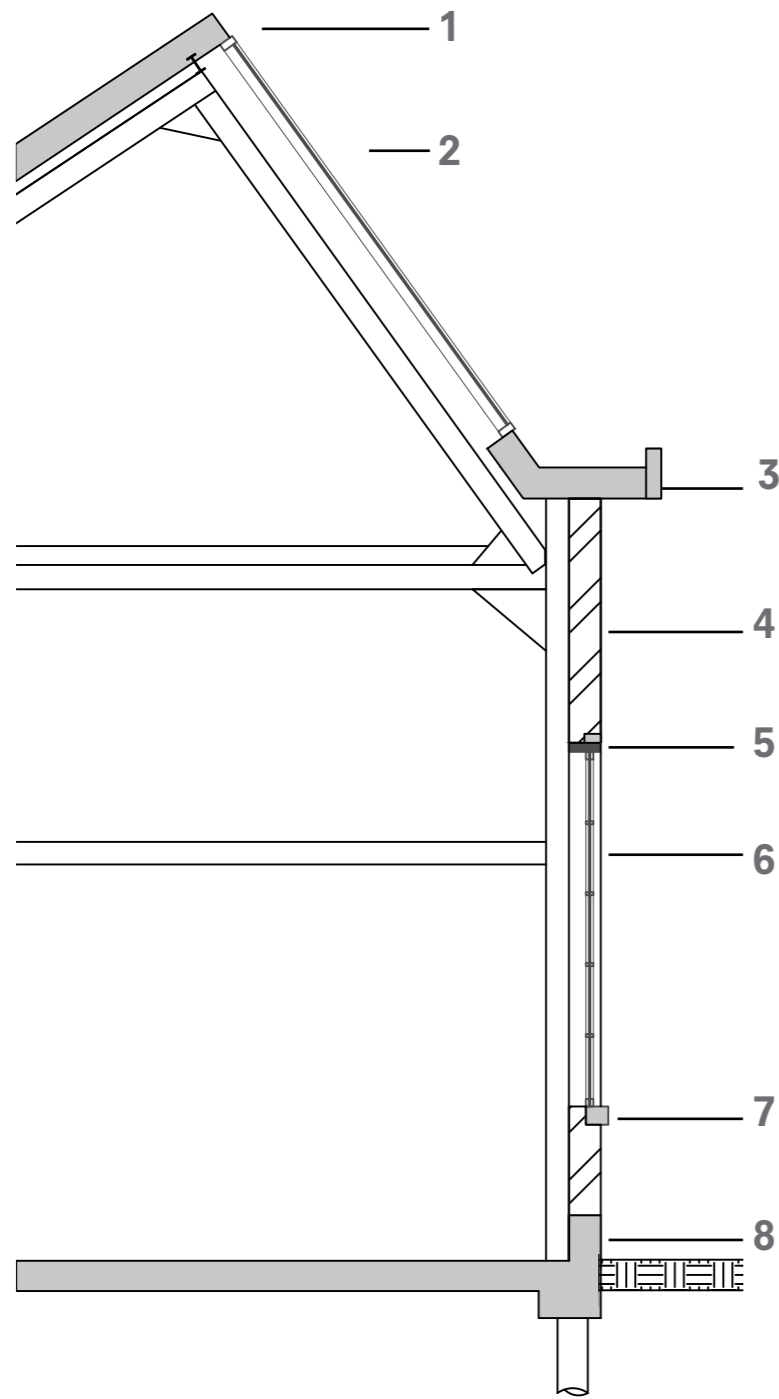


Fig. 5.6.1 Overview of section locations (by authors)

FRAGMENT A-A' 1:50



BUILDING 333

1. Prefabricated bimsbeton roof panels with bitumen finishing layer
Poor insulation
2. Sloping roof made of steel frame
3. Bimsbeton eaves
4. 1/4 Running bond on brick masonry 'klezoorverband'
210x50 mm
No insulation applied
5. Concrete lintel
6. Steel window frame 740x2345 mm
7. Concrete window sill
8. Concrete plinth
9. Cast in situ concrete pile foundation

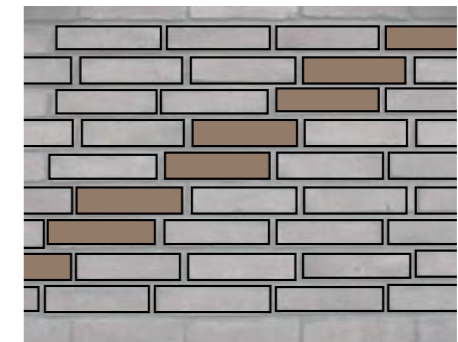
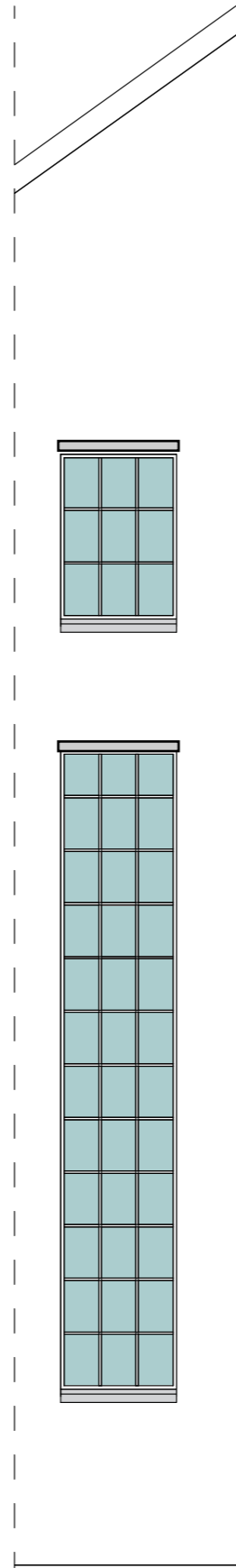
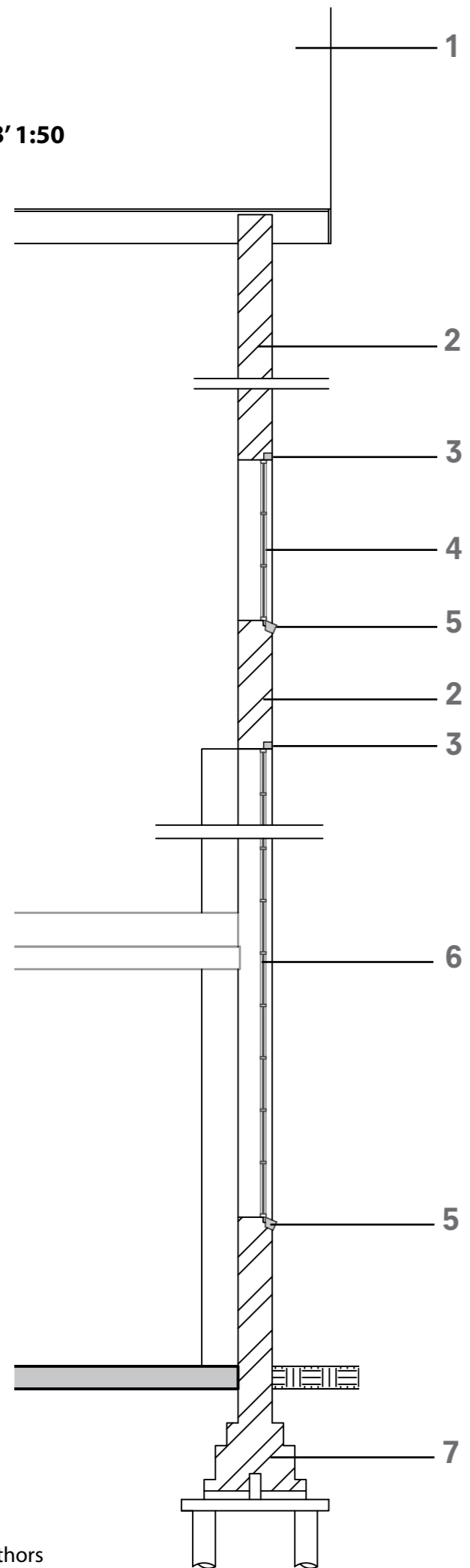


Fig. 5.6.2 1/4 Running bond on brick masonry (drawing by authors)



FRAGMENT B-B' 1:50



BUILDING 72

- 1. Wooden roof structure
No insulation applied
- 2. English bond in brick masonry
210x50 mm
Poor insulation
- 3. Concrete lintel
- 4. Steel window frame 1000x1416 mm
- 5. Concrete window sill
- 6. Steel window frame 1000x5500 mm
- 7. Amsterdam pile foundation

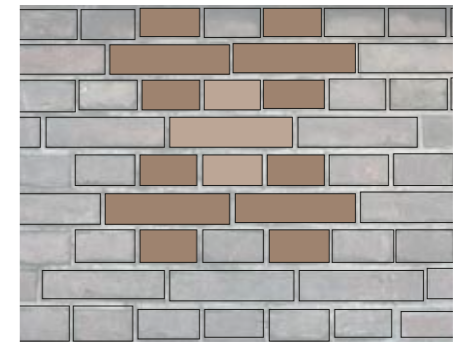
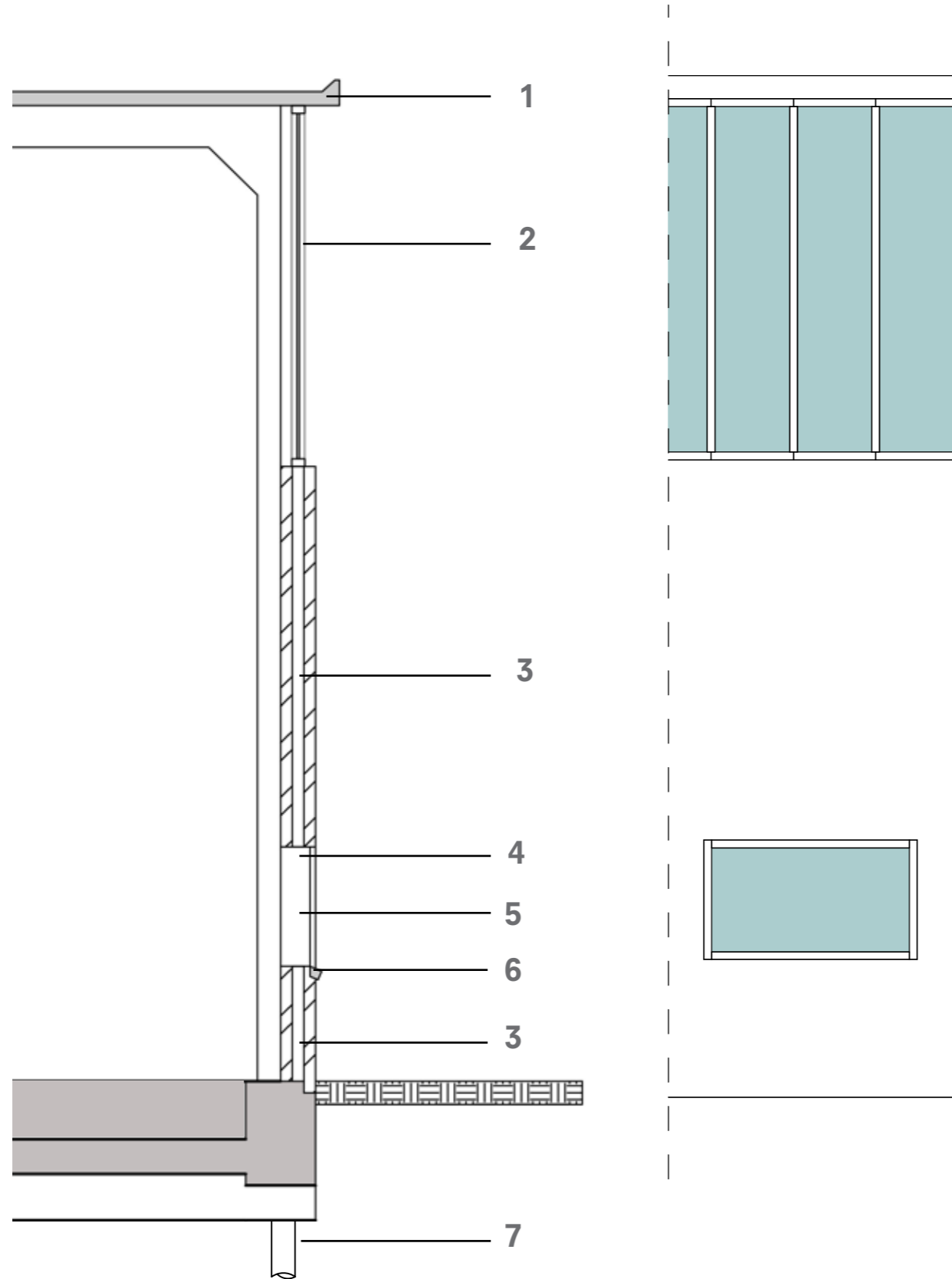


Fig. 5.6.3 Flemish bond (drawing by authors)

All drawings by authors



SECTION C-C' 1:50



BUILDING 436

1. Prefabricated bimsbeton roof pannels
90x1000x2100 max
Poor insulation
Eaves ca 300 mm
2. Steel window frame 'stoeltjesprofiel'
3. 1/4 Running bond on brick masonry 'klezoorverband'
210x50 mm
Cavity 100 mm without insulation
4. Steel lintel
5. Ventilation opening 1840x1030 mm
6. Glazed bricks window sill
7. Cast in situ concrete pile foundation

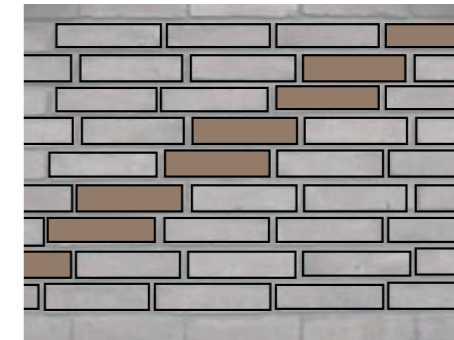
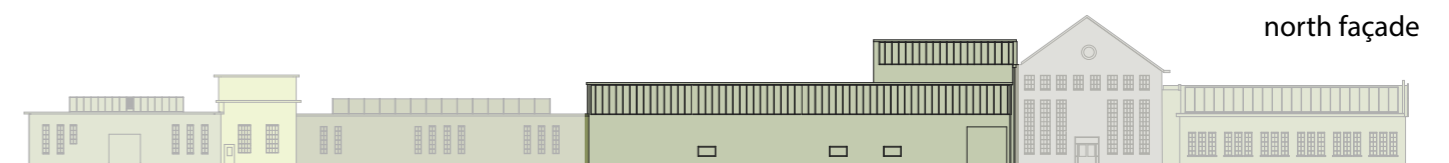
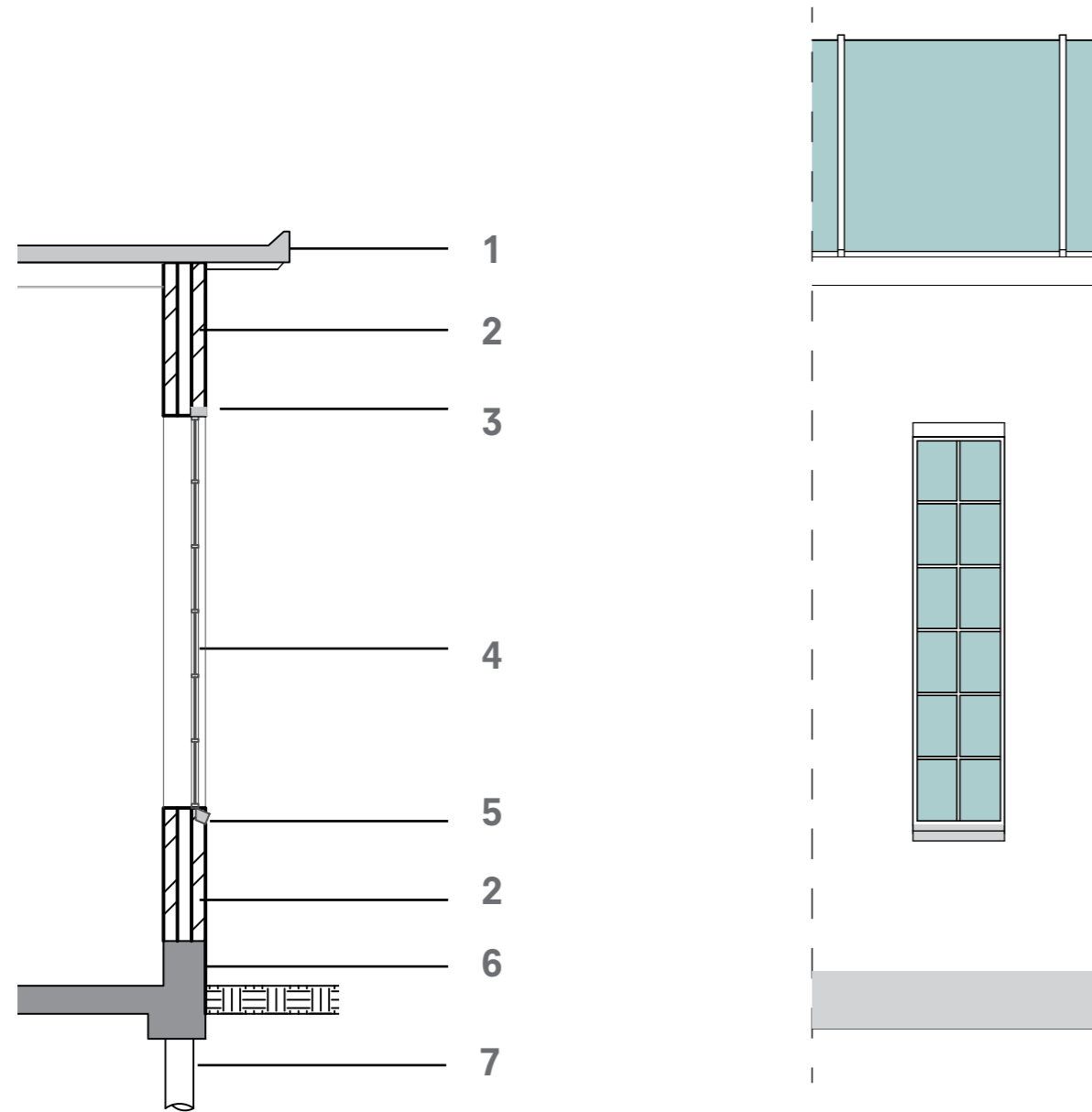


Fig. 5.6.4 1/4 Running bond on brick masonry (drawing by authors)



north façade

SECTION D-D' 1:50



BUILDING 308

- 1. Prefabricated bimsbeton roof pannels
90x1000x2100 max
Insufficient
Eaves ca 600 mm
- 2. 1/4 Running bond on brick masonry 'klezoorverband'
210x50 mm
Cavity 100 mm without insulation
- 3. Concrete lintel
- 4. Steel window frame 'stoeltjesprofiel'
660x2793 mm
- 5. Concrete window sill
- 6. Concrete plinth
- 7. Cast in situ concrete pile foundation

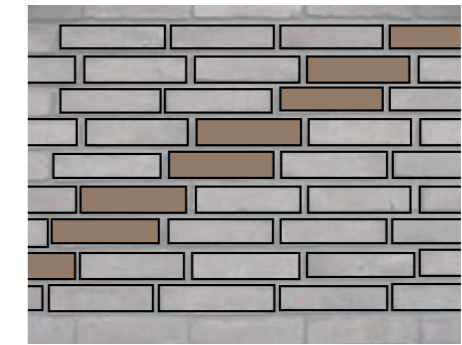
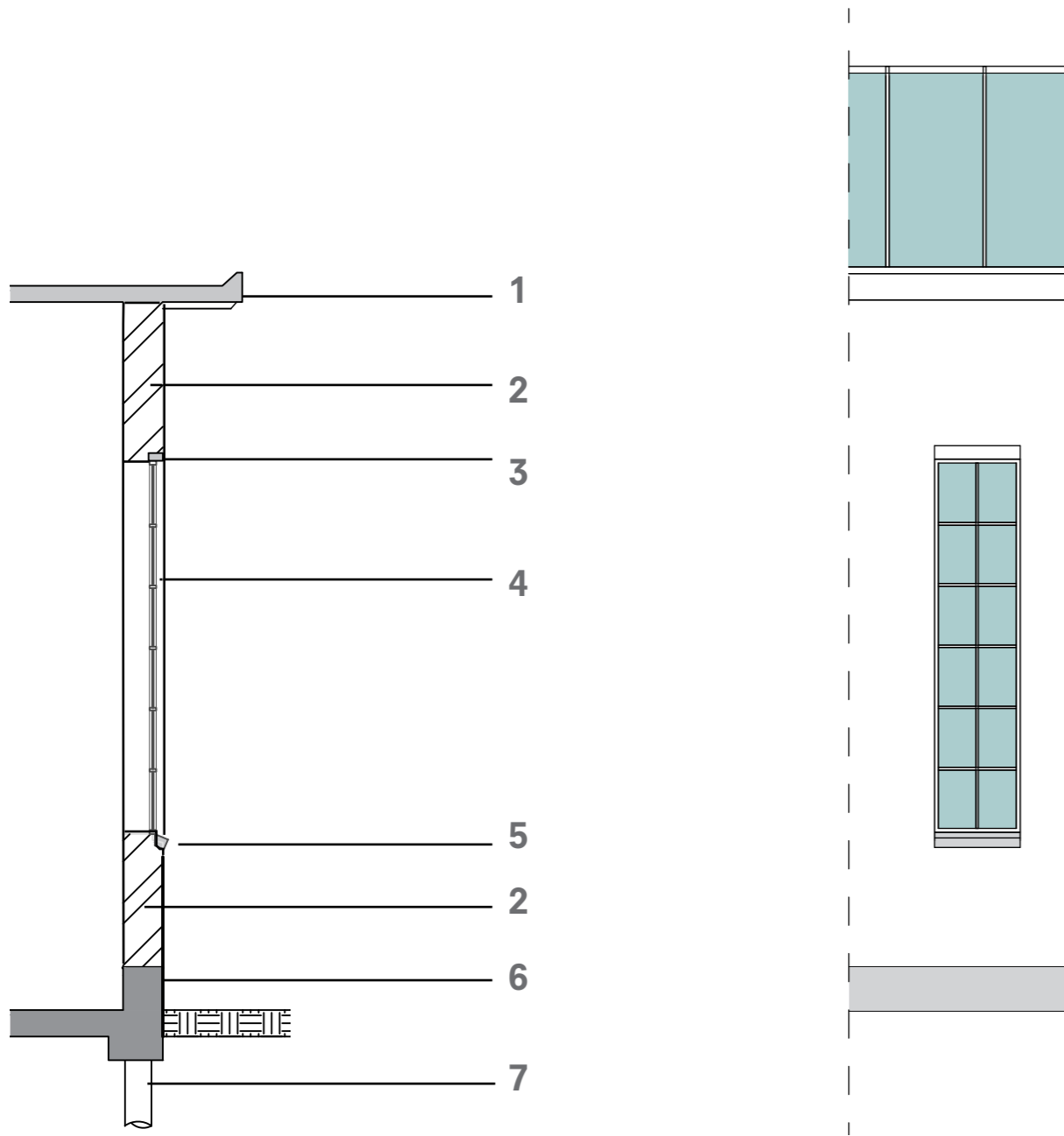


Fig. 5.6.5 1/4 Running bond on brick masonry (drawing by authors)



SECTION E-E' 1:50



BUILDING 342

- 1. Prefabricated bimsbeton roof pannels
90x1000x2100 max
Poor insulation
Eaves ca 600 mm
- 2. Monk bond in brick masonry 'kettingverband'
210x50 mm
No insulation applied
- 3. Brick lintel
- 4. Steel window frame 'stoeltjesprofiel'
650x2820 mm
- 5. Concrete window sill
- 6. Concrete plinth
- 7. Cast in situ concrete pile foundation

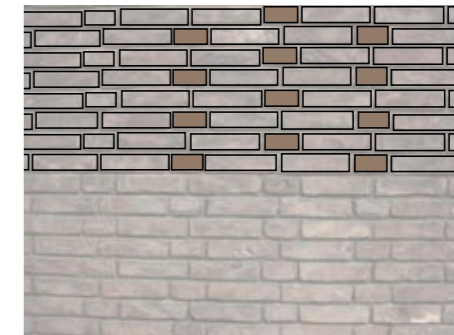
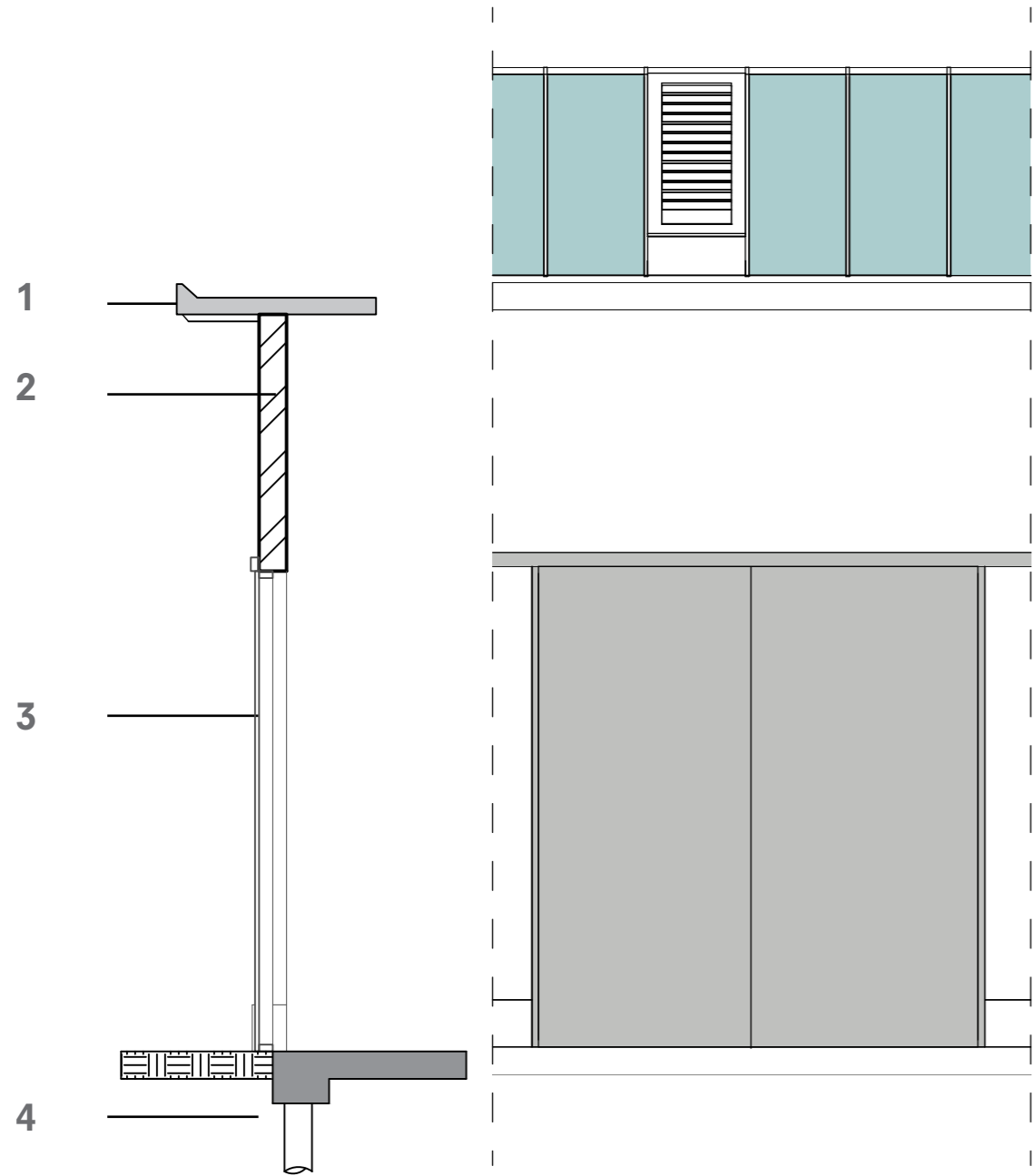


Fig. 5.6.6 Monk bond on brick masonry (drawing by authors)



SECTION F-F' 1:50



BUILDING 342

1. Prefabricated bimsbeton roof pannels
90x1000x2100 max
Poor insulation
Eaves ca 600 mm

2. Monk bond in brick masonry 'kettingverband'
210x50 mm
No insulation applied

3. Steel warehouse door
3300x3600 mm

4. Cast in situ concrete pile foundation

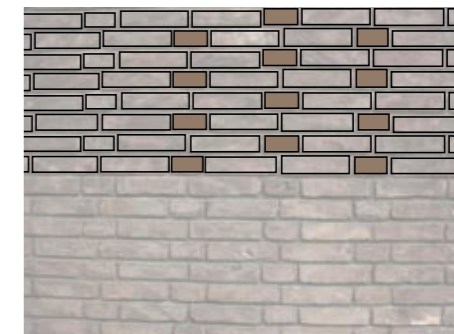


Fig. 5.6.7 Monk bond on brick masonry (drawing by authors)



5.7 TEXTURES, SERVICES & BUILDING STUFF

**Skin
exterior**



Skin services

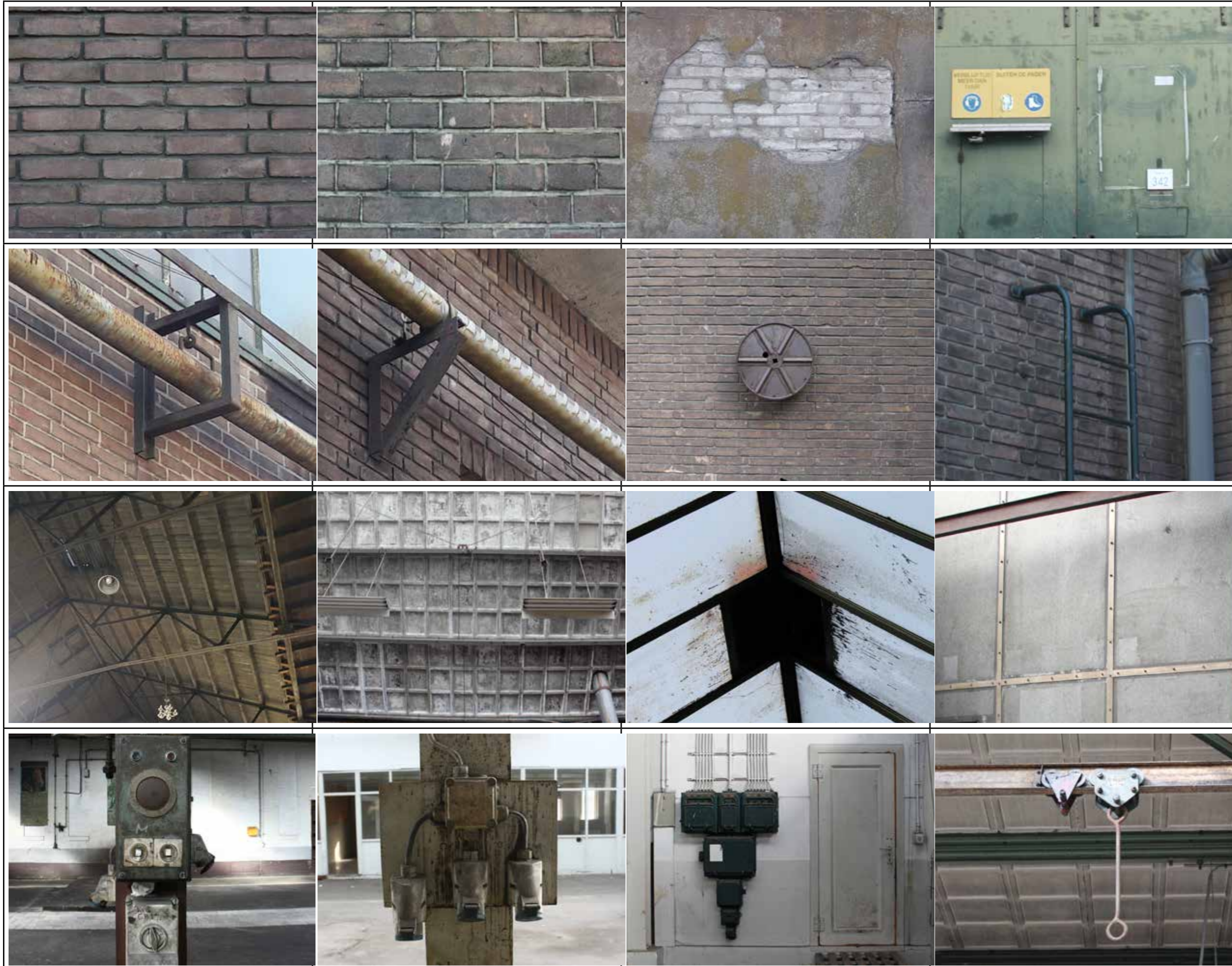


Surfaces interior



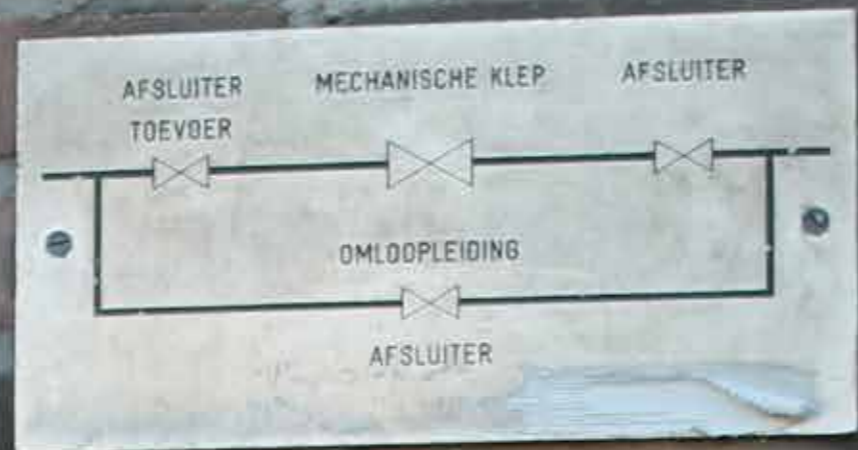
Services interior





Conclusion

The different textures on the surfaces of the interior and the exterior reveal how the buildings were built, adapted and used overtime. Masonry is the main material used for constructing the facades and therefore dominant in the façade surfaces. The façade openings, made from steel window frames and concrete window sills are local interruptions. On the ceilings, the Bimsbeton panels are a very present texture. The leftover service elements, such as faucets, cranes, electricity cabinets and fire extinguishers, are the clearest evident of the former use.



6. RESEARCH CONCLUSIONS

This chapter contains the conclusions of the questions formulated for this research.

The matrix is a collection of elements within the building ensemble of the Ladder that we find most characteristic. For each building small drawings are made of the elements that in our opinion represent them most.

6.1 RESEARCH CONCLUSIONS

History

- How did the Hembrug terrain come to existence and how did it develop over time?

Initially, the military production centre of the Netherlands was located in Delft and The Hague, they however reached their expansion limit at the end of the 19th century and had to look for a new location. At the same time, the Stelling of Amsterdam was being constructed, the Hembrug location was in the centre of the Stelling. With the location being a strategic one, near a large body of water and with plenty of space to expand in the future, the move to the Hembrug was made. Within the Hembrug, the building development started off at a relatively small scale. However, with the important events in time, such as WWI and WWII there is an enormous increase in building development visible. During the period of Eurometaal in the 1970s, a lot of old and large buildings of the first building period have been demolished, resulting in the large open spaces which are still visible today.

Site- and function development

*- What role did the Ladder ensemble fulfil within the Hembrug area?
- In what way were the functions within the Ladder organized?
- Did the production process that took place within the Ladder have an influence on the building development?*

The first period of the existence of the Hembrug terrain the Ladder had a small part in the production, the plot was only occupied by the foundry. During the period of WWI until the start of WWII there was a high demand of weaponry. The increase of the military production resulted in an immense building development. The Ladder was part of the ammunition factory and was focussed on the production of projectiles and grenade bodies.

Over time the functions within the Ladder went from being pretty separated from each other, into a structured sequence. We assume that the internal connection that is still there, was introduced to increase the production efficiency. Starting from building 333 in the West and internally moving with each production step towards building 342 in the East, from there on it was ready to be transported to the plot in the woods.

The development of the production process has had a large influence on the building development of the Ladder. The production process grew from a relatively small scale, with smaller machines, into a much larger scale, with even larger machines like the 3000 ton press. Very noticeable is the fact that this ensemble is clearly built according to the factory hall typology, where first large foundations are poured, then the large and heavy machinery is placed and after that a shell is placed around it.

Together with the Changing zone ensemble, the Ladder is the only remaining building ensemble that has this size and where the buildings are directly attached to each other.

Architecture

- What are the architectural characteristics of this ensemble?

What we discovered during our research is that the Ladder consists of two worlds. The external world, where you can find a variety of different atmospheres on each side of the ensemble. From large contrasts between high industrial buildings and the green plot in the woods, to the quiet small scale alley where a large chestnut tree grabs your attention.

Moving inside of the Ladder you enter another world, where you can walk from the east side of the ensemble (building 333) to the west side of the ensemble (building 342) via the internal passageways. Here you experience a sequence of different heights, structural typologies, daylight principles and at a certain point you have no idea where you are, because there is no visual connection possible to the outside world.

The internal heights of the spaces, the different structures and different textures and the way daylight enters are the main aspects that create the difference in atmospheres.

Building Technology

- What kind of structures and materials are applied to the different buildings within the Ladder and why do they differ?

From the research derived that the structural and detailing differences and the contrast between them are contributing to different atmospheres. From small and precise detailing in the smaller buildings, to large welded IPE columns and beams in the larger buildings. Because the buildings of the Ladder are built in a time span of circa 50 years, the development in detailing and material use is visible. The church (building 72) with its load bearing masonry walls with steel trusses, is the start of the historical layering. Furthermore, there is a variety of steel structures with different ways of detailing. Last but not least, the unique hyperbolic thin concrete shells in building 436, show a phase in time where concrete is used to enclose spaces and make large spans. Due to the visibility of the variety of detailing, the structure becomes a part of the architectural experience. This means that the structure is important in telling the story of these layers of time and should be taken into account when looking for a suitable re-development.

The existing structures are over dimensioned therefore able to carry more than just the roofs. The state of the structures is overall good and usable for future use, especially if you compare them to the state the façades are in, which do need more attention and repair.

6.2 CHARACTERISTIC ELEMENTS MATRIX

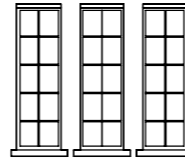
BUILDINGS

333

Building Form

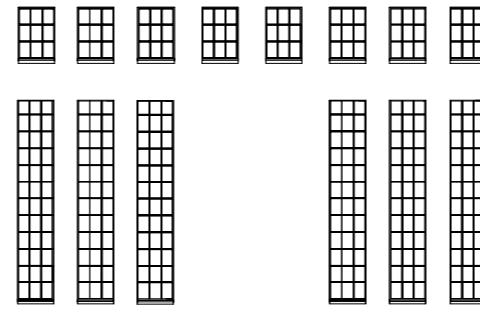
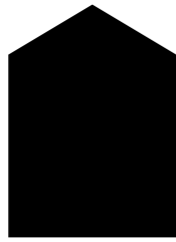


Façade Openings

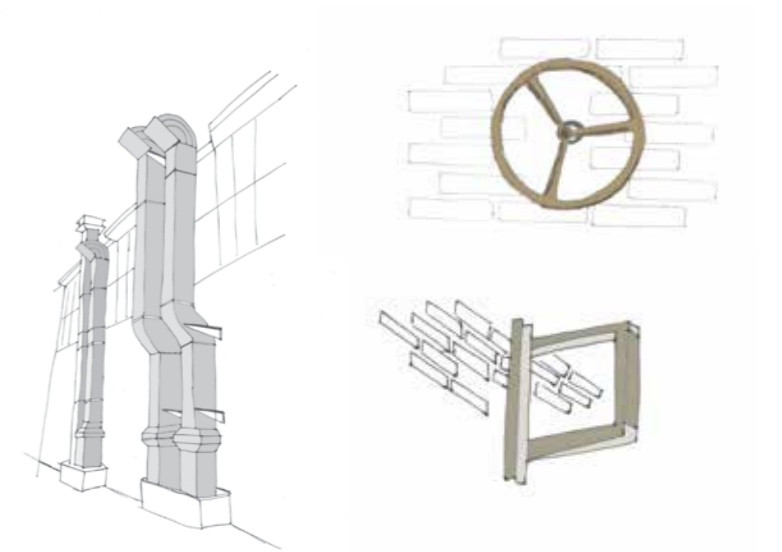


Façade Elements

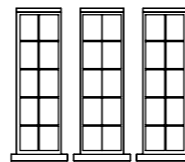
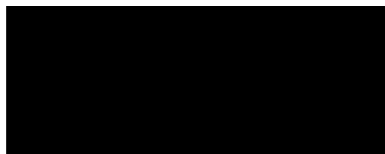
72



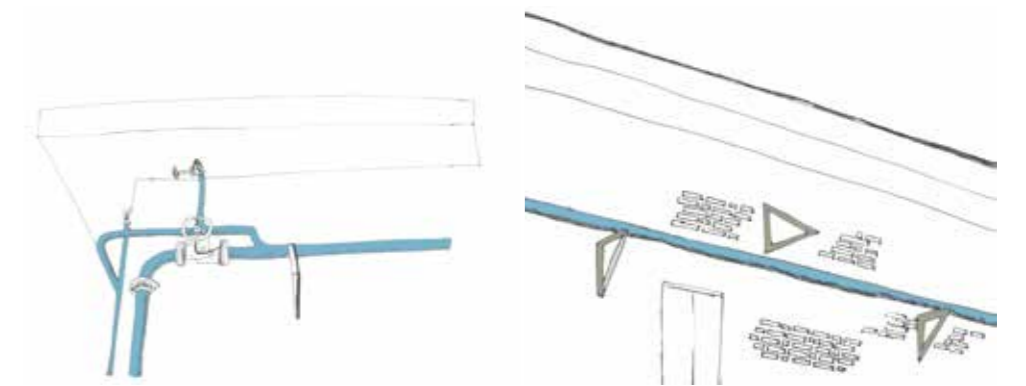
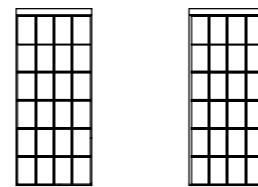
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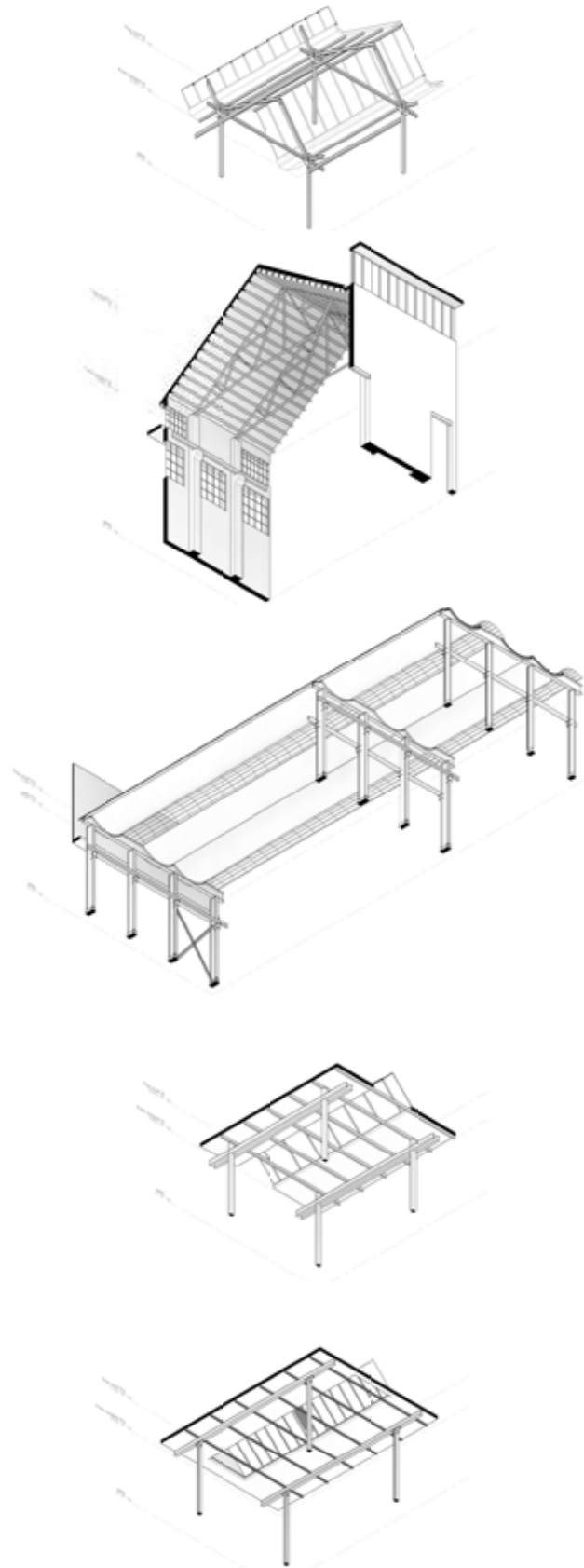
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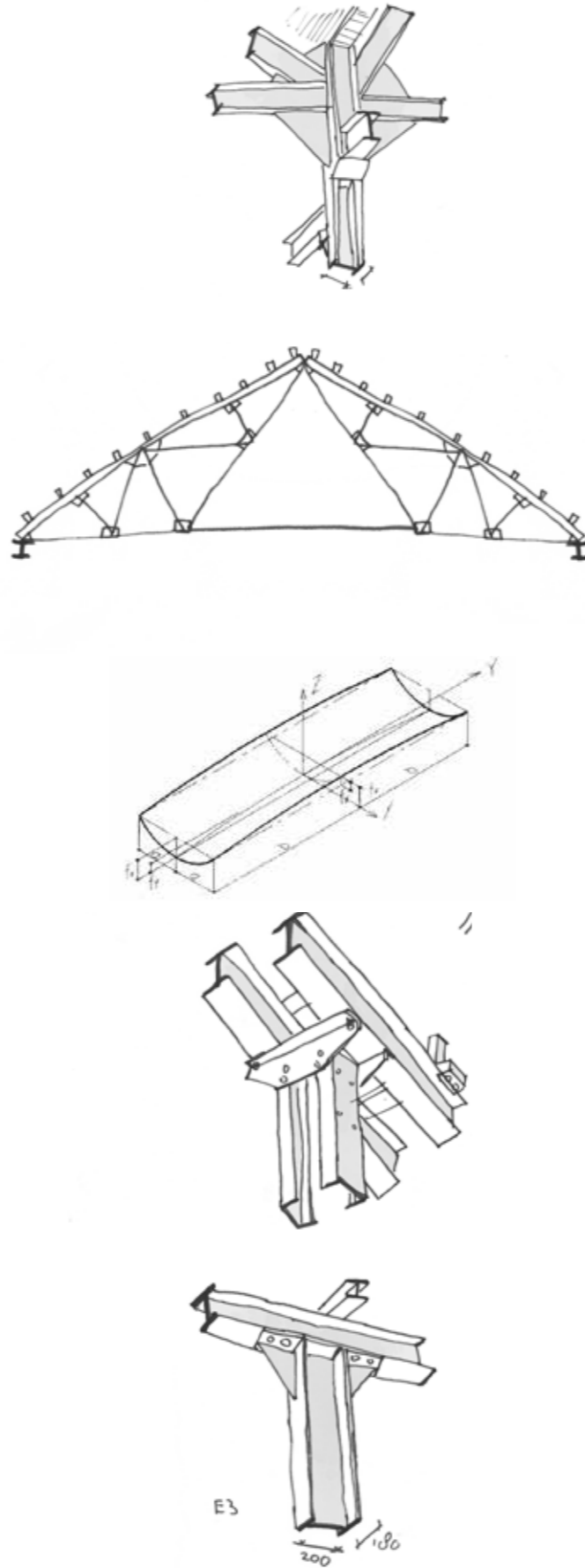
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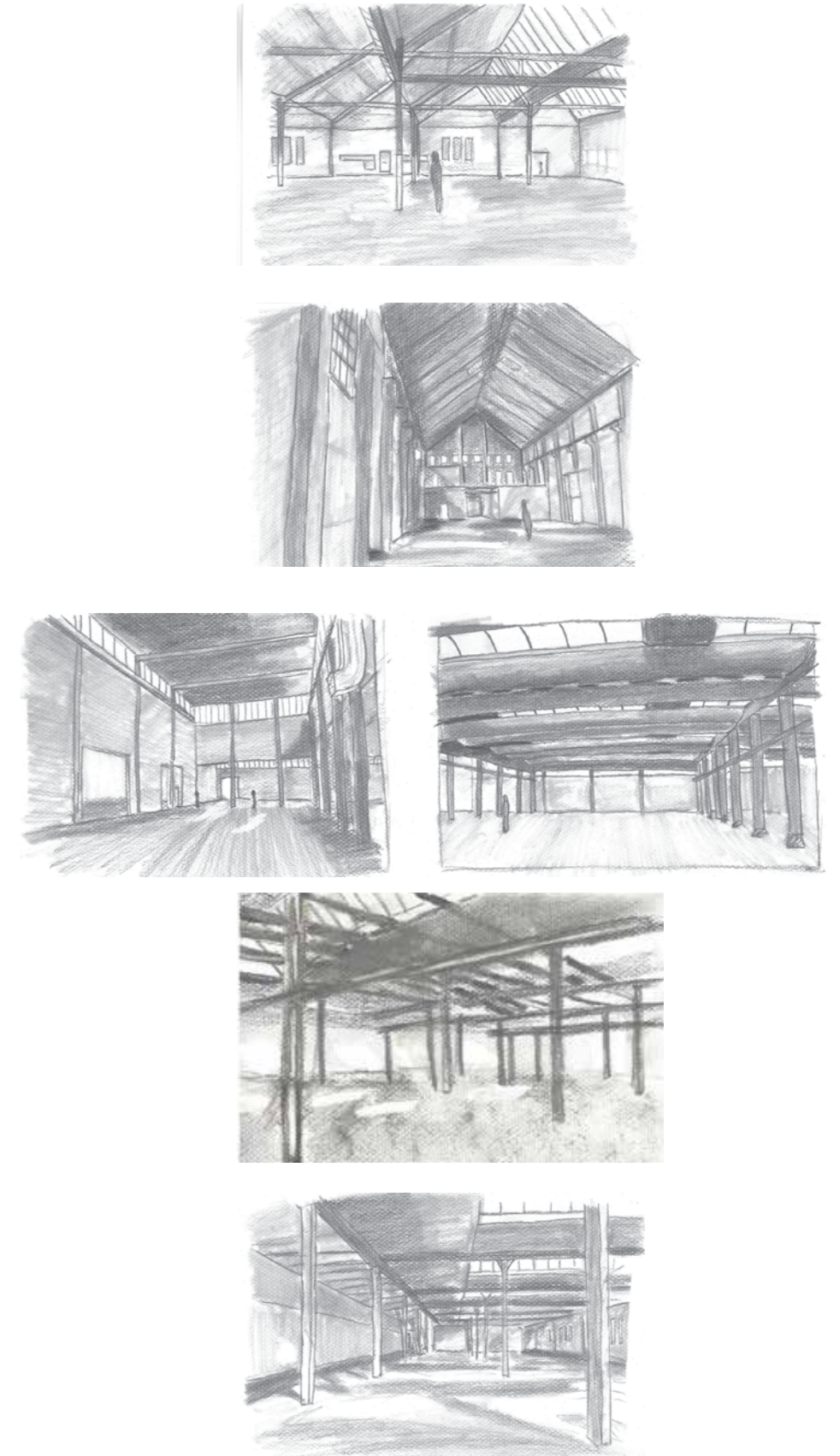
Construction Principles



Construction Details



Spatial Experience





7. CULTURAL HISTORICAL VALUE

During the research a large number of facts and observations have been collected. These contain historical facts such as dates and events, cultural facts such as the former uses, material facts; stuff that is still around and tell their own story but also the intangible aspects, such as spatial experiences. But how do you value all these aspects? The cultural value matrix on the next pages is a tool to compare values through discussion. This discussion is an important aspect to have different points of view on the different topics involved. On the vertical axis the matrix describes the different scales of the project; from the whole site (the Hembrug area) to the interior elements and also include the intangible spirit of place. On the horizontal axis the different types of values are described, from historical to contemporary values and from art to rarity values.



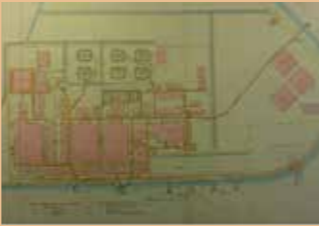


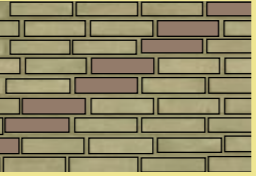
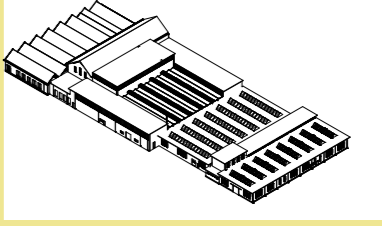
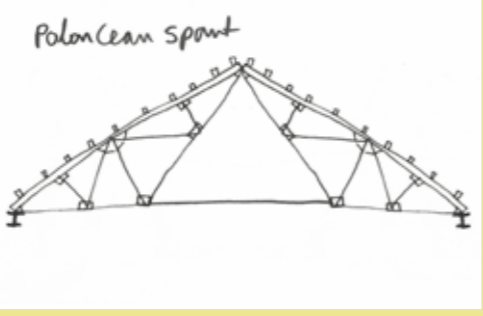

In order to value the ensemble we have chosen to introduce 4 levels of importance, ranging from a very positive value to a negative value, which in turn will all be represented by a specific colour.


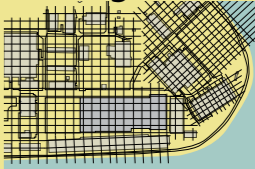






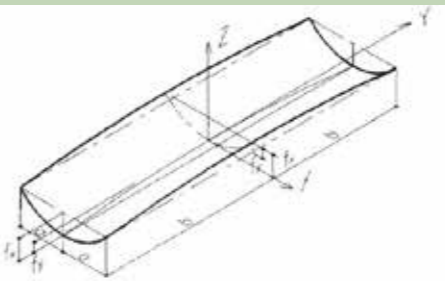

Green (Very Positive values): represents the essence of the Ladder and must be preserved carefully.

Yellow (Positive values): important for the project, but can be interpreted in different ways.

Orange (Neutral values): indifferent for the current state of the building or for the transformation.

Red (Negative values): are better off demolished/removed in order to enhance the experience of the very positive values.

	Age value	Historical value	Intentional commemorative value	Non intentional commemorative value
Surroundings / settings	1895 Start building AI 	1872 Construction of the North Sea Canal 1875 First Hembrug bridge 1880 Start building Stelling of Amsterdam 1889 Introduction new weapons 1906 Second Hembrug bridge		Important production area for weapons in the Netherlands
Site	main axis 	Main Structure  1941 Separation civil / AI production		Creative workspaces and events (since 2004) Sightlines 
Skin exterior	South facade 72  Brick masonry facade 			Variation building height 
Structure	Polonceau spant 	Saw teeth roof typology  Various typologies according to different time periods		

Use value	New-ness value	(relative) Art value	Rarity value	Other Relevant value
<p>1899 Production center moved from Delft to Zaandam:</p> <ul style="list-style-type: none"> - more space for expansion - safer location 				<p>Green zones</p>  <p>Building Orientation</p> 
<p>1914 WWI:</p> <p>huge increase in production many new buildings</p> <p>1973 Eurometaal demolishes many buildings</p>			<p>Internal connections</p> 	<p>Different atmospheres</p>  <p>Chestnut tree</p> 
<p>Asbestos</p> <p>Visibility of functional / non-aesthetic alterations</p> 		<p>Industrial elements</p> 		<p>Returning window style</p> 
<p>Various roof typologies</p> <p>Closed openings</p> <p>" Form follows function "</p>			<p>Thin hyperbolic concrete shells</p> 	<p>Pit for 3000t pres</p> 

Age value

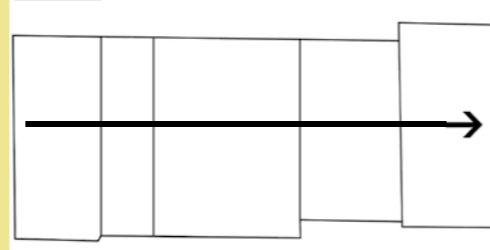
Historical value

Intentional commemorative value

Non intentional commemorative value

Space plan

Productionprocess



event spaces: flexibility, floor height



Surfaces interior

Visual connections between spaces



Services

Lifting elements



Stuff

Electricity and lights

Spirit of place










Visibility of structure

- Large open building volumes
- Different roof typologies

Spatial Experience



Use value	New-ness value	(relative) Art value	Rarity value	Other Relevant value
<p>Open floorplans</p> 				
<p>Wells in floor</p> 				
<p>Construction used for machinery</p> 		<p>Industrial elements</p> 		<p>Pipelines and ducts</p> 
<ul style="list-style-type: none"> • Open floor plan • Interconnected spaces • Different ways of daylight entering 		<p>Industrial elements / atmosphere</p> 	<p>Concatenation from 1969 till nowadays</p>	

7.1 EXPLAINING MOST CHARACTERISTIC VALUES

Main axis



Besides being part of the historical route, the axis in front of the north side of the Ladder is also one of the main sightlines when approaching the ensemble from the west. Furthermore, the axis forms the border of the transition between the area of the Ladder and the Plots in the Woods.

South facade 72



The south façade of building 72 'the church' was built in 1926. This is presumably the oldest part of the Ladder ensemble. In contrast with the other buildings, this facade has brick masonry details. Therefore it has a high exterior aesthetic value. We suggest to open up / demolish parts in order to make the façade visible again.

Green zone



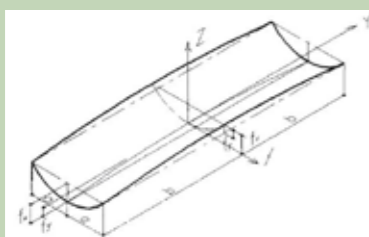
The green zone at the north side in front of the Ladder ensemble determines the border between the industrial character of the area of the Ladder and the green peaceful environment of the Plots in the Woods area. This green zone enhances the quality of the street in front of our ensemble, and is part of the history of the site and should be preserved.

Chestnut tree



We highly value the chestnut tree on the east side of the Ladder. It should be preserved as it contributes to the ambiance of this side of the ensemble.

Thin hyperbolic concrete shells



As discovered in the research, the hyperbolic concrete shells is a unique construction and as far as we know the only one existing in the Netherlands. The structure is highly valued and should be preserved as a whole.

Various typologies according to different time periods

In the past the ensemble grew and shifted multiple times. We value the presence of the different historical layers and believe that it is part of the identity of the Ladder.

Internal connections



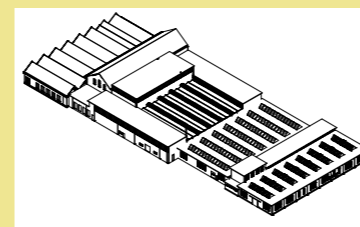
The former projectile production process resulted into an internal interconnection of the spaces. This is an important aspect of the function and the development of the site through time. Therefore, the interconnection between spaces should be preserved or interpreted in a new way.

Different atmospheres



While walking around the Ladder we experienced different atmospheres such as calm walking areas, more fragmented ones, or intimate corners. The scale and height of the surrounding buildings contribute to this ambiance. It is important to enhance the qualities of the different atmospheres and not to lose human scale when adding new building volumes in the future.

Variation building height

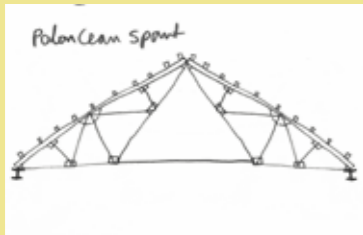


Window composition



The returning composition of the vertical rectangular windows are a characteristic part of the facade of the Ladder. Therefore it should be taken into consideration in the re-development of the building.

Polonceau spant



The polonceau spant principle has an important age value. Besides that it also contributes to the spirit of place of building 72, 'the church'. Therefore we believe it should be preserved in the re-development but adaptations are possible.

Industrial elements



Along the façade there are visible traces of industrial services. These elements were essential for the functioning of the building. They have a historical value and are suggested to be kept visible.

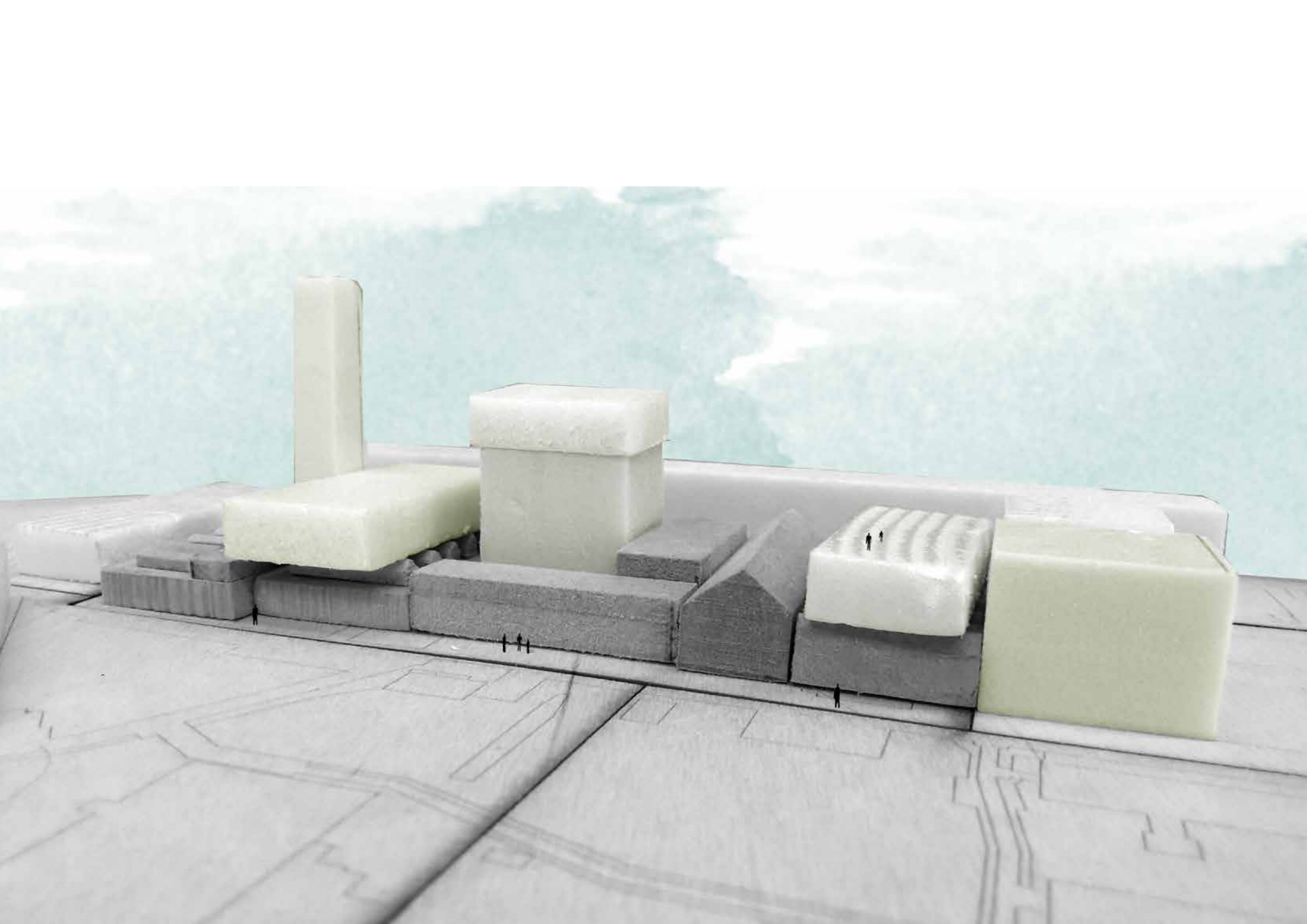
Flexibility floor height



The varieties in floor heights from space to space have great potential regarding the flexibility of the re-development of the interior of the ensemble.

Asbestos

There are traces of asbestos in parts of the façade of building 436 which should be removed.



8. MASTERPLAN FOR THE LADDER

We start this chapter with an overview of the ideas we have for the master plan of the Ladder, this includes our ideas about the direct surroundings of the building ensemble. What are the connections/relations between for example the Ladder and the Waterfront? What are the qualities of these different places and which do we want to preserve, enhance or change? We also express our ideas regarding the future of the existing buildings, which parts are of significant value that they should be preserved/restored and which ones offer the potential space to expand the volume of the Ladder.

The possibility to be able to expand is of great importance in order to make the re-development of the Hembrug terrain a future proof and full functioning area. To have an idea on how much we could possibly increase the volume, we tested different scenarios with various cubic meters. By doing physical model studies we got a better understanding of the aesthetical and spatial possibilities, what could work and what definitely wouldn't work.

Zones

North

Car free zone
Keep the main axis as a separation between the industrial area and forest 'plobbos'
Maintain green structure

East

Preserve facade
Retain small-scale character by 'offsetting' backwards potential high building volumes
Preserve chestnut tree

South

Retain variation in building heights and human scale
Preserve the alley by keeping the ground floor space open
Pedestrian zone: strengthens the atmosphere of the alley

West

Add new building volumes to the existing empty plot
Strengthen the axis towards the water

Existing buildings

Retain visibility of internal historical connections: production process, concatenation of spaces

Important in between spaces relationship

Industrial elements contribute to the character of the ensemble and its area

Take into account asbestos facades

Building 72

Preserve shape of the building in its totality
Restore window openings: enable daylight entering, enhance architectural experience
South facade visible in its totality

Building 436

Preserve concrete shell construction in its totality
don't built on top of the structure

Building 333

Keep the saw-tooth roof principle and its architectural experience, own interpretation is possible

General conditions

Maximum building height accent 30 m

New buildings must take into account not blocking daylighting of existing buildings

Strengthen sightline towards water with new building volumes

Possible internal or external public connection between north and south zone

main program

- Public character ✓
- Mixed-use ✓
- Combination living & working spaces possible ✓
- Large-scale housing ✗

8.1 AREA PROGRAM

The Ladder is surrounded by the ensembles of the south cape, and the waterfront which includes the building of the Kogelfabriek. The site is situated on the border of the south corner of the Hembrug terrain, and the Plofbos forest. At this point a smooth transition is made from the forest area which has a more intimate and peaceful character than the industrial ambiance of the Ladder and its direct context. Moreover, the geographical position of this area at the crossroads of the Zaan river, the IJ and the North Sea Canal make the area visible but also accessible from the water.

Furthermore, the establishment of the cultural center and hotel of the Kogelfabriek will have a great impact on its surrounding ensembles, as a big number of visitors is expected to be attracted by its program.

As a result of the position of the Ladder within the Hembrug terrain and the function of the Kogelabriek, the area of the south corner seems perfect to form a cultural and recreational cluster. The main programmatic strategy will include mixed used facilities with a public character. Within this program the Ladder redevelopment will act as a meeting-, leisure-, entertainment-, and cultural hub where in parallel visitors will be able to experience the different historical layers through the architecture of the building ensemble.

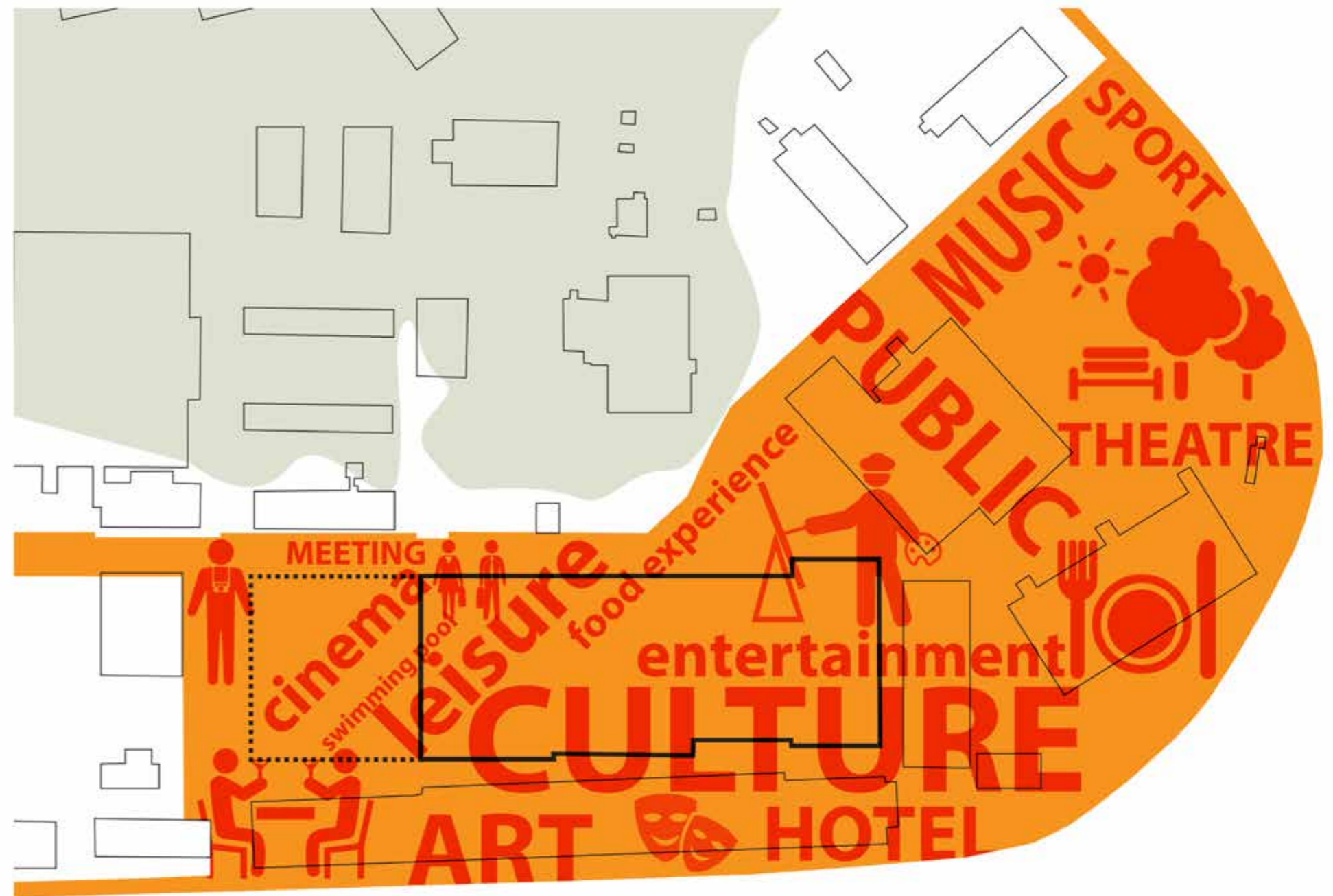


Fig. 8.1.1 Functional vision for the Ladder and its surroundings (by author)

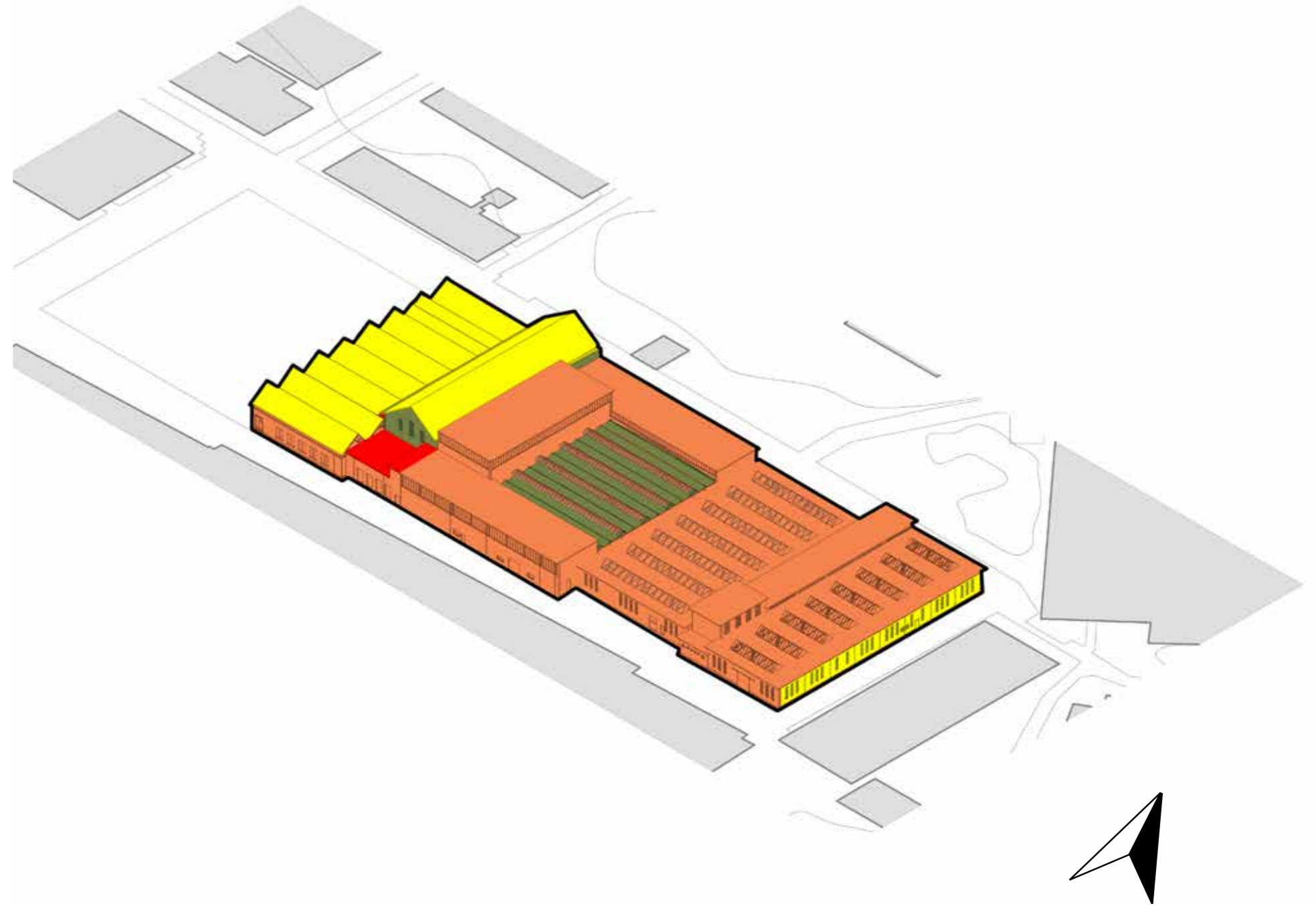
8.2 VALUATION BUILDING SKIN FOR RE-DEVELOPMENT

This valuation is an important guideline for the upcoming re-development. It is based on historical research and personal interpretation and valuation of the existing building ensemble and its direct surroundings. Green are the parts that are meant to be preserved in the masterplan, such as building 72, the 'church', for its historical(age) value and its prominent place within the ensemble. The green colour does not mean that the building is monumental or untouchable, but the form, typology and structure is highly valued and must be kept intact, technical improvements are allowed.

To restore the façades of building 72, surrounding building parts should be adapted (red); to restore old window openings and to make the detailed south façade visible again.

Between green and red two other colours are used. Orange is everything that is neutral, change or preservation in the architectural design is optional. Here the architects have the possibility but also the responsibility to apply their own interpretation of the building ensemble.

Yellow is the colour used for the value between orange and green. Here the shape and form of the elements are important for the internal or external experience, but they can be interpreted or upgraded in a new, modern way.







-  preserve
-  preserve in style/form, own interpretation possible
-  neutral
-  to be demolished

Fig. 8.2.1 valuation building skin seen from South (by authors)

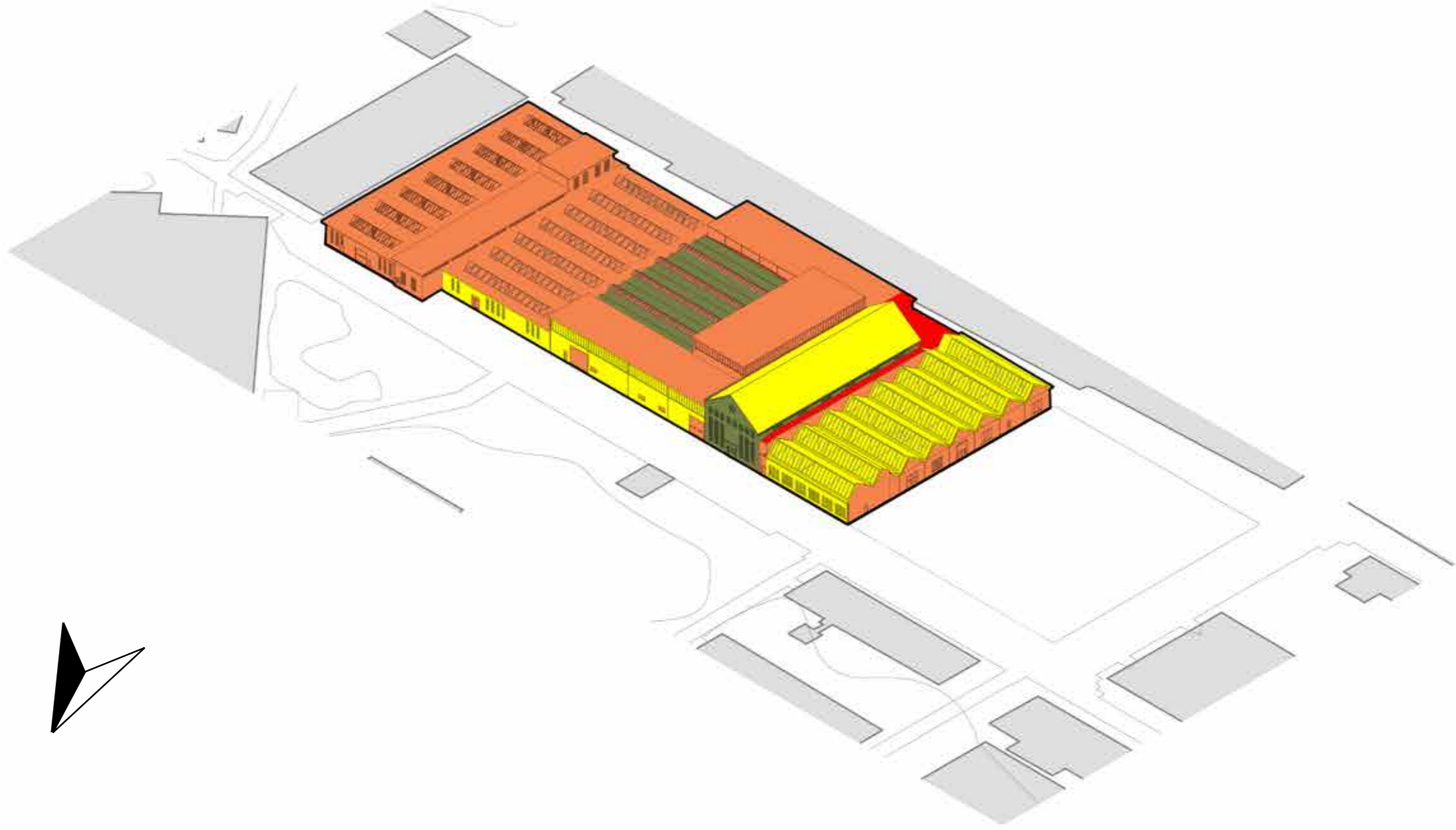


Fig. 8.2.2 valuation building skin seen from North (by authors)

8.3 VALUATION BUILDING COMPONENTS

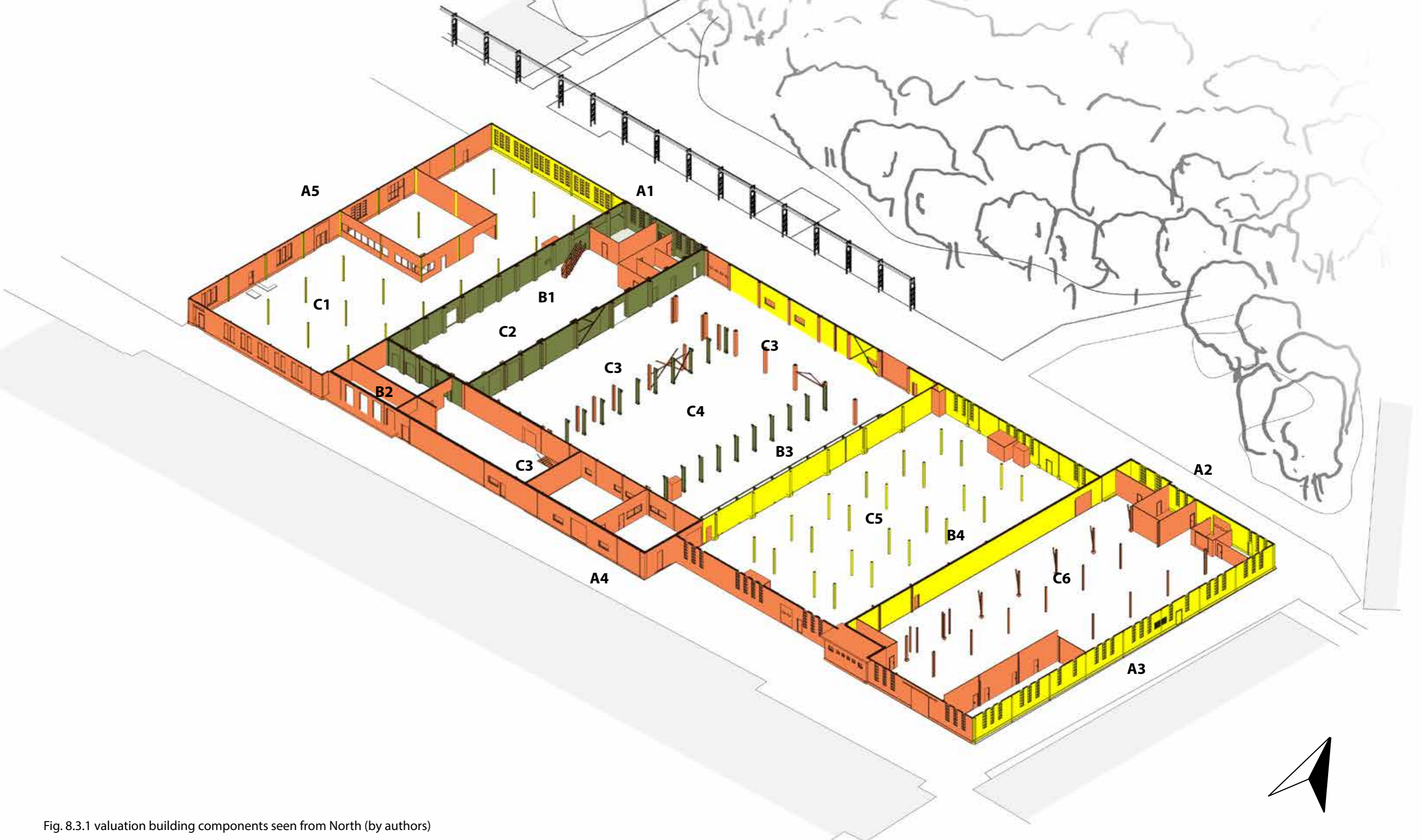


Fig. 8.3.1 valuation building components seen from North (by authors)

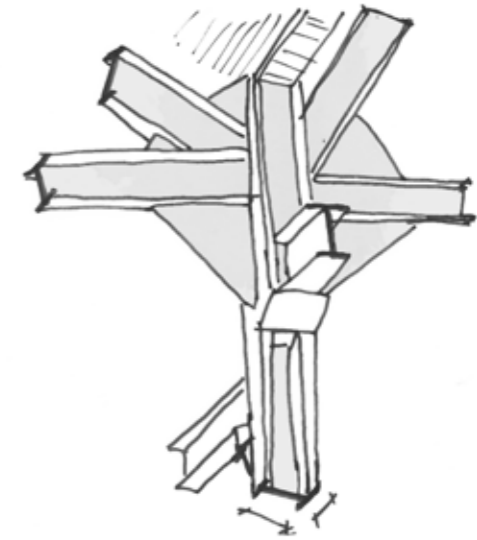
A. Façades/building line/streets



B. Interior walls



B. Structures



A1. North Façade - main road

The longitudinal straight line of the north façade determines the main axis. Moreover, this axis is an historical reference of the main road that was situated on the same position in the past.

A2. North Façade- narrowing

By the offset of the building line, the street becomes narrow. This makes the space more intimate and it becomes clear that the main road is ending here and a new area begins.

A3. East Façade

The street next to the East façade we value because of the feeling of human scale, the building heights of both building 342 and the one next to it enforce the feeling.

A4. South Façade

This façade is the complete opposite of the East façade due its irregularity, height differences, unclear façades, and lack of unity. We appreciate the contrast in especially the irregular building line, but this facade can use some sort of renewal.

A5. West Façade

Now it is the only one with this type of roof left in this row of buildings, but saw-tooth roofs once dominated a part of the Hembrug site. The shape of the roof is important, but the façade isn't.

B1. Building 72

First of all, this building is the oldest of the ensemble, which makes it important for the historical layering of the whole. Its age is visible in the materials, which differs from the other buildings but also in the altered and bricked doors and windows. The later added interior walls and mezzanine are not important.

B2. Walls in front of building 72

This part, built in 1969, is directly built in front of the oldest and most detailed south brick façade of building 72. Demolishing would make building 72 visible again, but would ignore the historical layering. A solution in between is more appropriate.

B3 & B4.

These walls are important for the visible history of the ensemble because they were former exterior walls and still show evidence of those times by bricked doors and windows.

C1. Structure building 333

These large structural details are appreciated for their visibility and relation with the saw-tooth roof shape. Once this structure was not only used to keep the roof up, but also had a relation with the production process and the steam driven belts.

C2. Structure building 72

The only building of the ensemble where the walls are the main load bearing structure, 14,5-meter span with Polonceau spant.

C3. Structure building 436 - halls

These structures are neither visually nor technically interesting but do show a layer in time.

C4. Structure building 436 - HP-shells

The HP-shells on the Hembrug site are special because of multiple reasons. First of all, it is the only example of HP-shells we found in the Netherlands. Secondly, in combination with the adjacent structures, it shows a phase in time, where (prefab) concrete is used (instead of steel) to make a large and light factory space. Our hypothesis is that these German investors took this building method with them or were already familiar with it. So, this structure shows also the German influence on the Hembrug site.

C4. Structure building 308

This structure is very detailed in its composition of different profiles and riveted connections, which makes it different from the IPE profiles and welded connections we see in the other buildings.

C6. Structure building 342

These structures are neither visually nor technically interesting but do show a layer in time.

8.4 PUBLIC SPACE AND ROUTING

- Mixed use traffic zone**
Following the primary route, this main axis connects 'the Ladder' ensemble with its surroundings and the waterfront. Can be used by pedestrians, motorized vehicles, and cyclists. The axis in the north acts as a transition between the Plofbos forest and the area of the Ladder.
- Pedestrian only zone**
These zones are meant for pedestrians only. Within this zone visitors can experience the different atmospheres around the building ensemble. At set times, the zone is accessible to motorized vehicles to load or unload cargo.

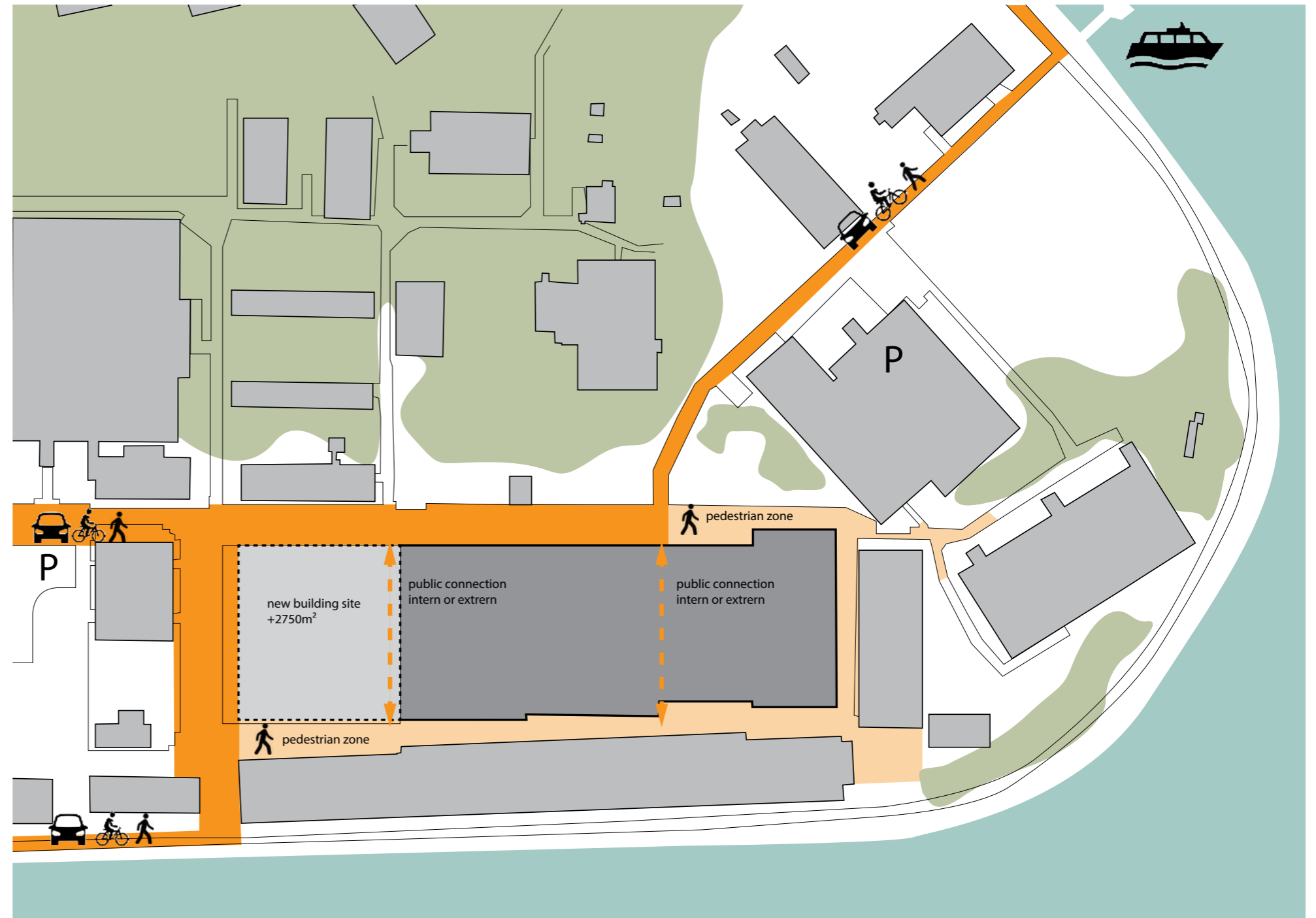


Fig. 8.4.1 Public space and routing map (by authors)

8.5 STRATEGIES

As a result of the Ladder analysis we came to three main themes we value the most that will determine the re-development of the ensemble within its context:

Interconnection of internal spaces

The former ammunition projectile production process resulted into an internal interconnection between the buildings of the Ladder. This is an important aspect of the function and the development of the site through time. Therefore, the interconnection between spaces should be preserved or interpreted in a new way by enhancing this quality and/or make internal visual relationships between buildings.

Human Scale

There are various fluctuations in terms of scale, from larger building volumes to smaller ones. In order to preserve the existing character of the area it is important not to lose the human scale when adding new building volumes in the area.

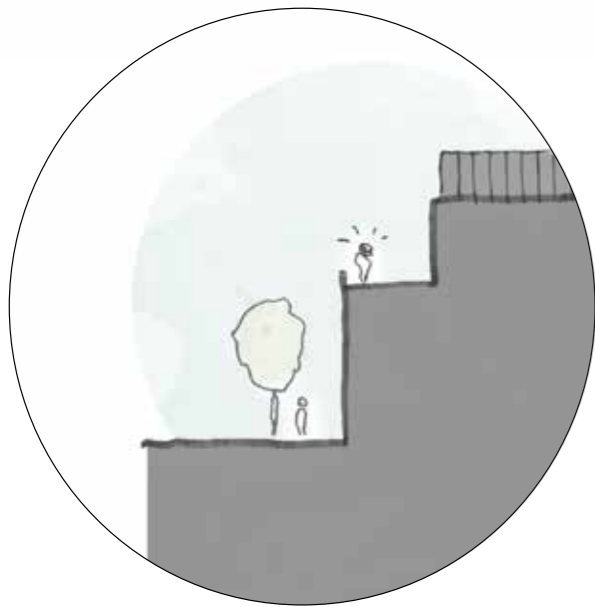
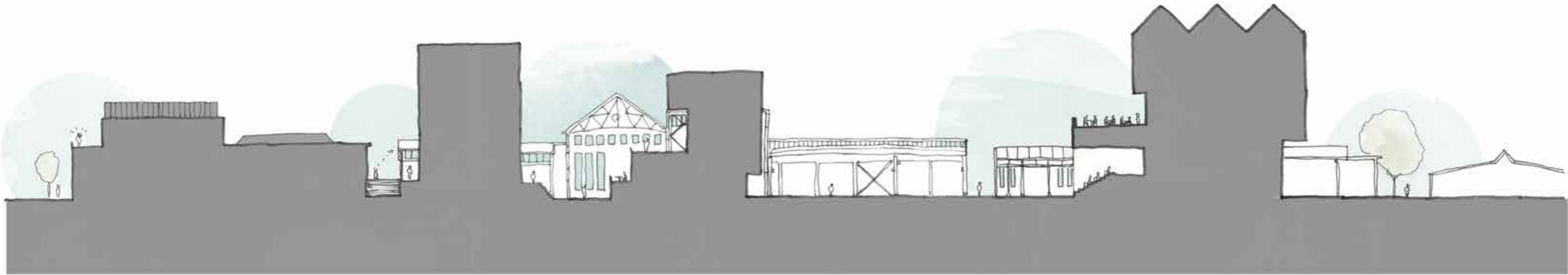
Different atmospheres; internal and external

We can state that the internal spaces depict a different world than the direct surroundings. Inside we deal with different atmospheres created by the architecture of each building unit of the ensemble. Around the Ladder different atmospheres are experienced, like quiet alleys, transitioning zones, from a peaceful to a more industrial environment, but also walkways which seem to be abandoned.

By strengthening the qualities of each zone these different atmospheres will be crucial in maintaining the sense of place and the visitors experience of the Ladder.

Strategy 1: Human Scale

In this small research we take a closer look at the boundaries between public space and large building volumes when added to the Ladder. How can the current feeling of human scale be preserved/ transform into fitting possibilities?



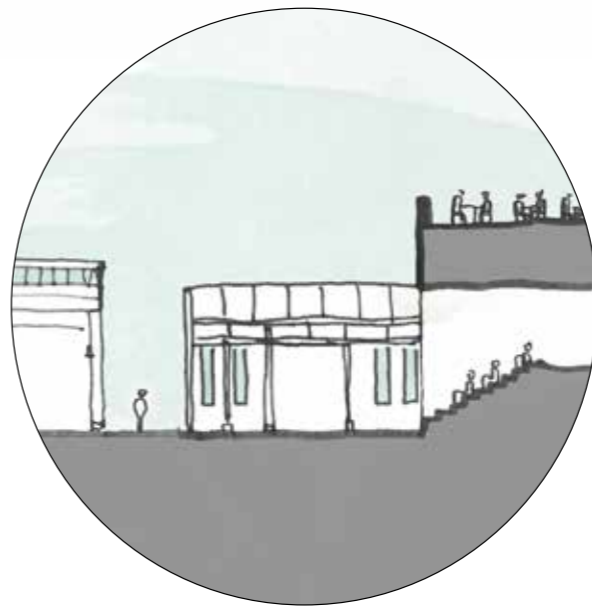
visible connection between people
+ differences in roof heights



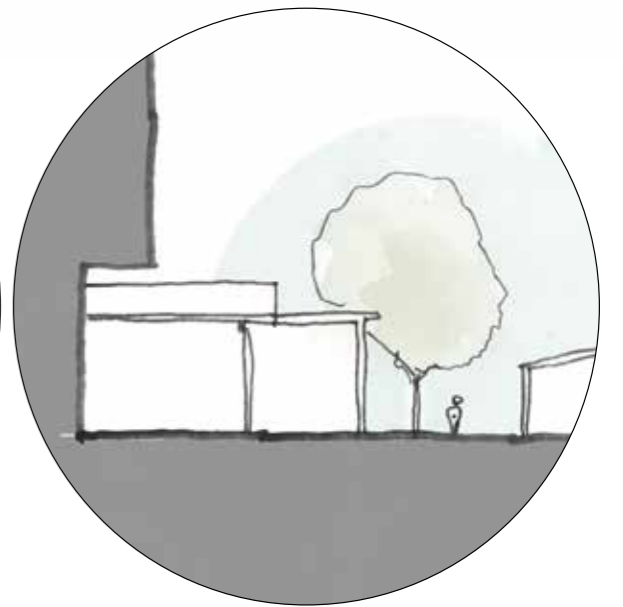
visible connection of original
form and detailing of facades



height differences between floors
+experience the open spaces
on different levels



public connection between the
north and south zone
+ interaction old/new and open closed

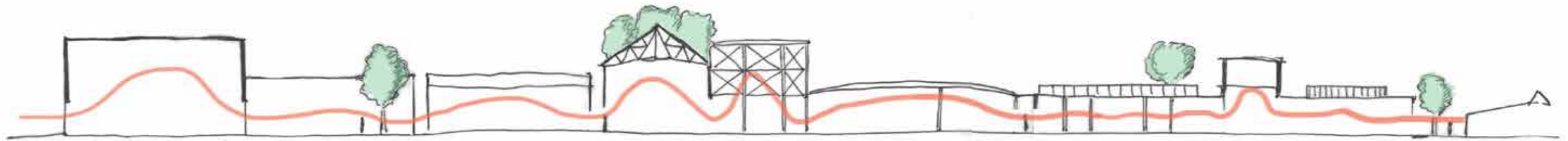


setting back high volumes in relation to the
existing facades to preserve human scale
passages

Strategy 2: Interconnection internal spaces

In this small research we take a closer look at the sequence caused by the interconnection of the internal spaces.

From the outside the ensemble seems to consist of five separate building units, moving inside different atmospheres are revealed where the height of the different spaces contributes to various experiences



Strategy 3: Different atmospheres

In this small research we take a closer look at the different atmospheres around the Ladder. What are the qualities now and how can they be preserved or rather enhanced and what is the relation between the Ladder internal and external? The strength of the experience of the Ladder will partially lie in the different atmospheres, with none of them being the same.



New connections "cutting" through the Ladder. New atmosphere created with the addition of new volumes.



Making the Warmperserij a pedestrian zone only. Creating a new lively area, where a direct relation to the Waterfront ensemble is preferred.



Keeping the small intimate scale of the Lorriegarage intact, a quiet transitionzone with the nice chestnut tree supporting this small scale. Added volumes on the building left(308) set back in relation to the existing facade.



The Middenweg, North facade of the Ladder is a connecting access road, with motorized traffic. Opening up the facade at certain points to make new connections within the Ladder and its surroundings. Remaining the contrast between the industrial facade and the plot in the woods opposite it.

8.6 ZONING DIRECT SURROUNDINGS

The surrounding area will be characterized by zones where their qualities are enhanced in the re-development and where different atmospheres can be experienced.

- Transition zone**
The main axis will remain its character, acting like a border between the industrial character of the area surrounding 'the Ladder' ensemble, and the peaceful green landscape of 'the Plofbos' forest.
- Vibrant leisure zone**
Creating intimate spaces where the visitor, instead of just passing will be invited to stay for a longer time.
- Quiet leisure zone**
Keeping the atmosphere and making it a calm walking area
- Connecting zone**
Connecting different atmospheres; internal or external spaces.

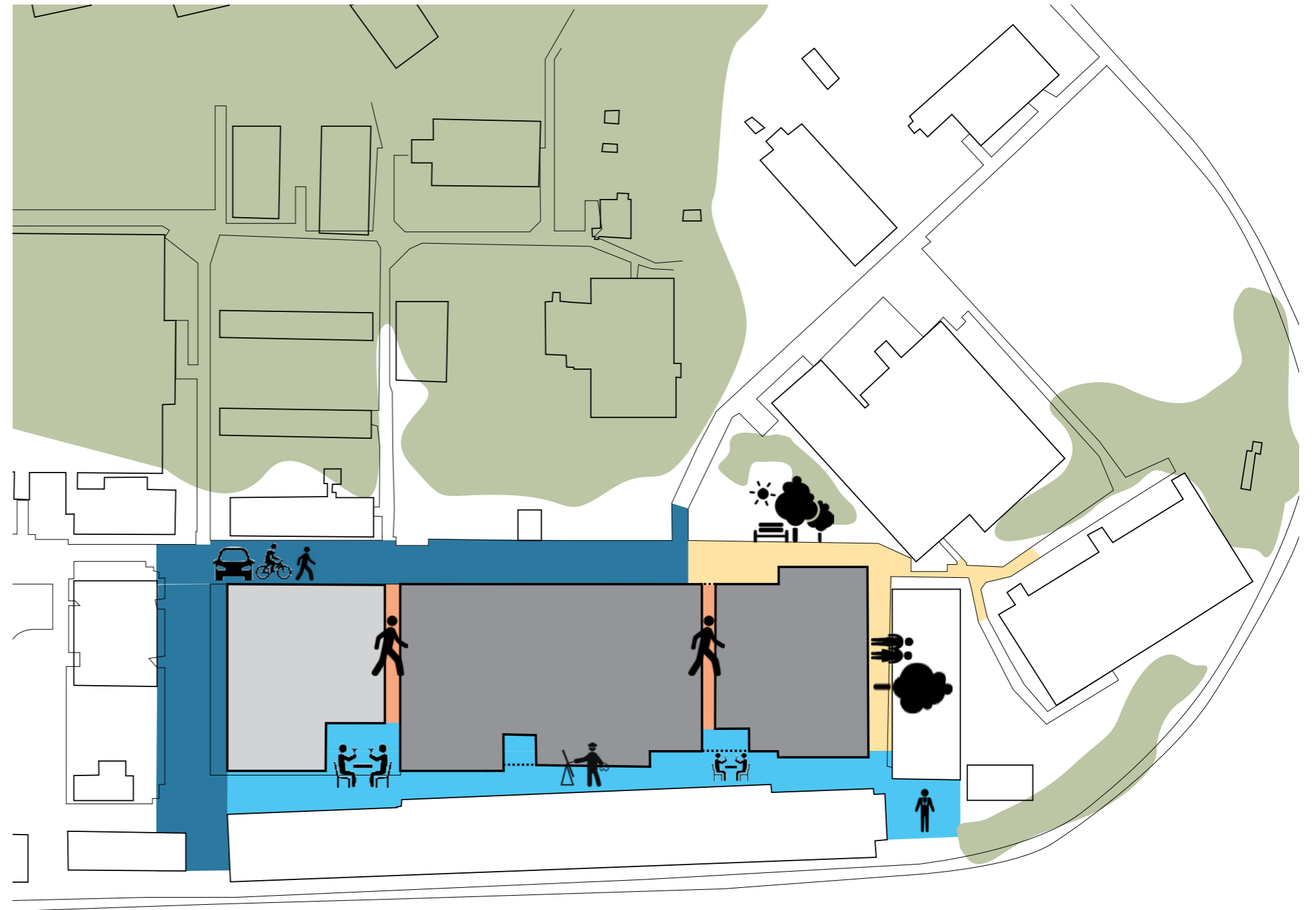
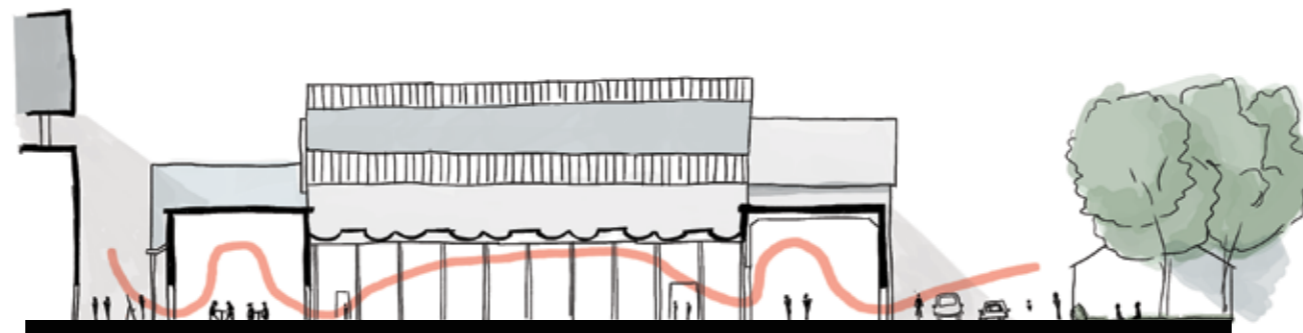
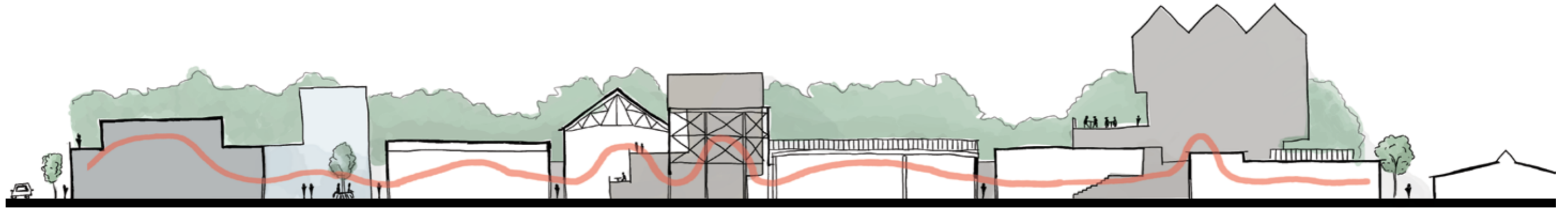
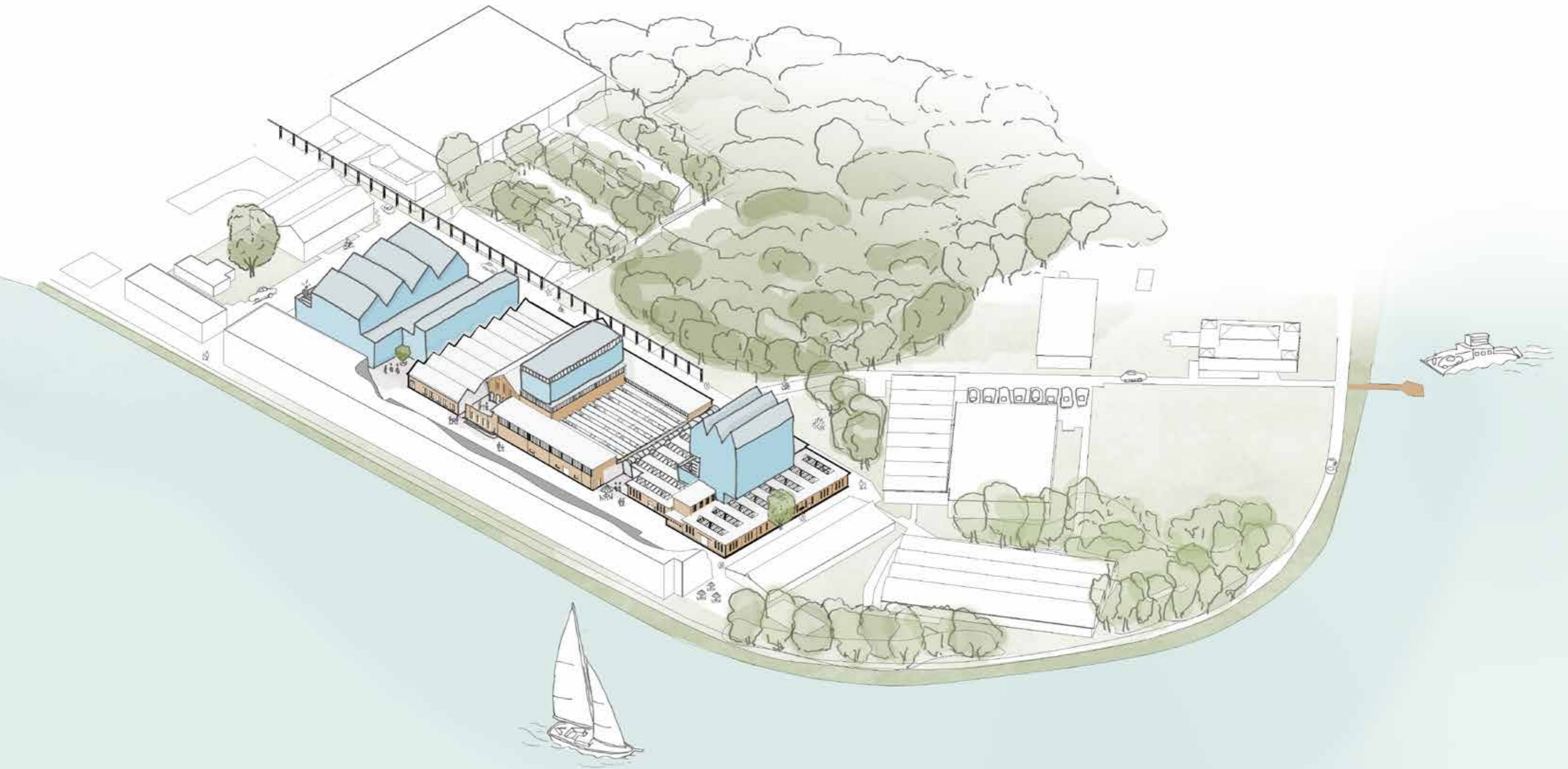


Fig. 8.6.1 Zones direct surroundings of the Ladder (by author)

8.7 MASTERPLAN SECTIONS



8.8 MASTERPLAN OVERVIEW



8.9 SOURCES

Chapter 2 History

Goossens, A.M.A (2007). Het Staatsbedrijf der Artillerie Inrichtingen, Een uitgebreide beschouwing van het bedrijf dat in de roerige jaren 1935-1945 de spil was van de Nederlandse wapen- en munitie productie. Stichting de Greb Leiderdorp.

Holleman, E., Reijke, R. (2006). Het verleden, heden, toekomst, Hembrugterrein. Stichting Uitgeverij Noord-Holland

Provincie Noord Holland. Leidraad Landschap en Cultuurhistorie 2018
Retrieved 08 October 2018 from: <https://leidraadlc.noord-holland.nl/structuren/sva-nhw/>

Steenhuismeurs. (2016). Hembrugterrein Zaanstad: Gebiedsrapporten omgevingsplan.

Chapter 5 Building technology

Tang, G. (2015). An Overview of Historical and Contemporary Concrete Shells, Their Construction and Factors in Their General Disappearance. International Journal of Space Structures,30(1), 1-12. doi:10.1260/0266-3511.30.1.1

Tihamer, K. (1968). Manual of Precast Concrete Construction: Principles, Roof and Floor Units, Wall Panels (Vol. 1). Berlin: Baurverlag.

Tihamer, K. (1971). Manual of Precast Concrete Construction: Industrial Shed-type and Low-rise Buildings, Special Structures (Vol. 2). Berlin: Baurverlag.

Denslagen, Willem F. Restauratievademecum: Prefabrication in concrete. Staatsuitg., 1985.

Oosterhof, J. (1988) Bouwtechniek in Nederland: constructies van ijzer en beton, gebouwen 1800-1940 Overzicht en typologie. Delft: Delftse Universitaire Pers, Rijksdienst voor de Monumentenzorg.

Rühle H. Räumliche Dachtragwerke: Konstruktion u. Ausführung. Verl. für Bauwesen, 1970.

Other

Jonge, W de and Kuipers, M (2017) Designing from Heritage: Strategies for Conservation and Conversion. TU Delft - Heritage & Architecture

Archives:

Nederlands Instituut voor Militaire Historie (NIMH), Den Haag
Nationaal Archief, Den Haag
Gemeente Archief Zaanstad



9. ATTACHMENTS

Little old box in building 308, function unknown, photo taken by authors

9.1 DEVELOPMENT ENSEMBLE IN MAPS

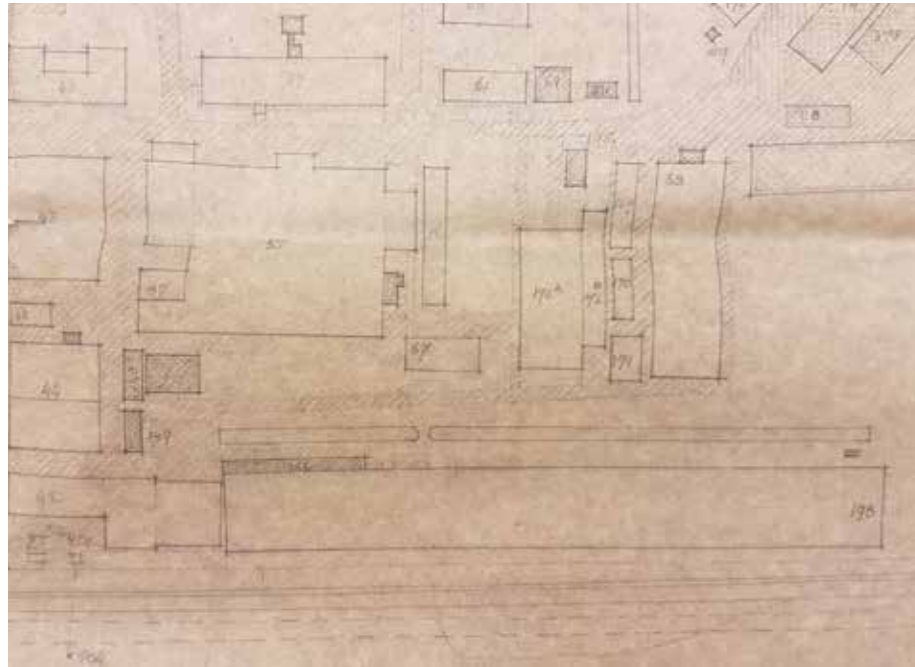


Fig. 9.1.1 Ladder 1931 (drawing National Archive)



Fig. 9.1.2 Ladder 1937 (drawing National Archive)

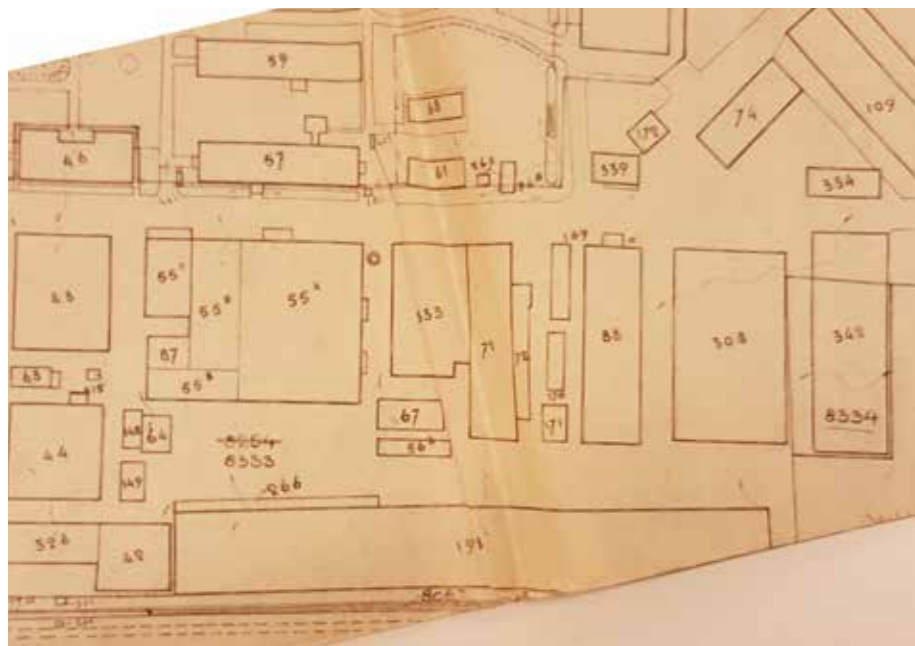


Fig. 9.1.3 Ladder 1940 (drawing National Archive)

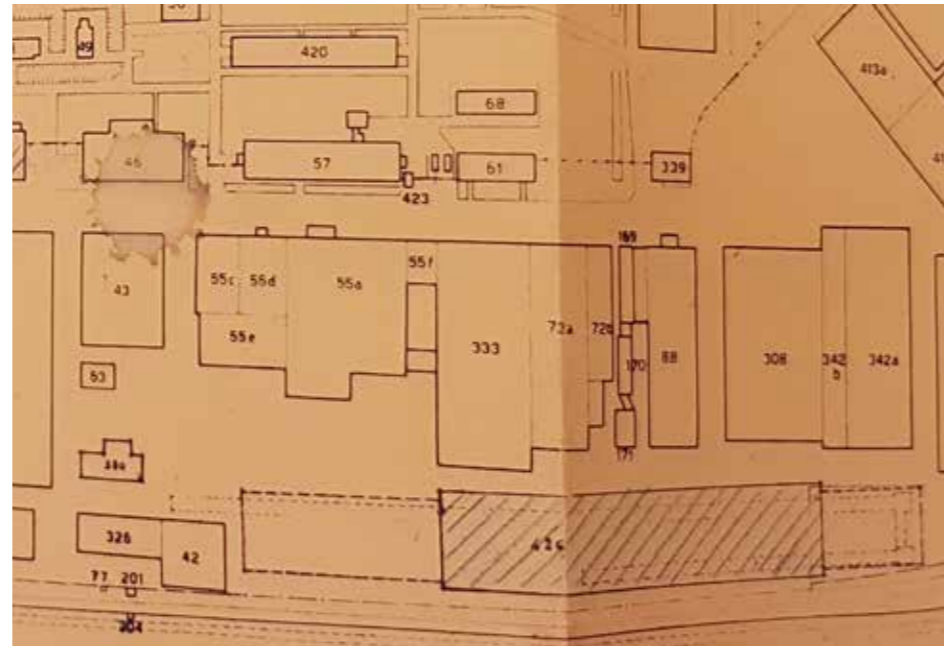


Fig. 9.1.4 Ladder 1953 (drawing National Archive)

These archive drawings are used as underlayers to see the development of the ensemble building masses, but also of the individual buildings masses through time. Period 1937-1953 and the current situation.

Building functions through time

- 55A: Foundry
- 55B: Model making
- 55C: Painting workshop
- 55D: White foundry
- 55F: Unknown, but related to foundry
- 333: Sand cleaning and later sawmill projectiles
- 72A: Projectiles pressing
- 72B: Cooling well for projectiles
- 87: Laundry room foundry
- 88: Projectile turnery
- 169: Laundry- and changing room
- 170: Private building #2
- 171: Bathhouse
- 195: Factory warehouse leather waste
- 308: Warehouse and later production of grenade bodies
- 342: Warehouse for brass and later lathes workshop for turning projectiles

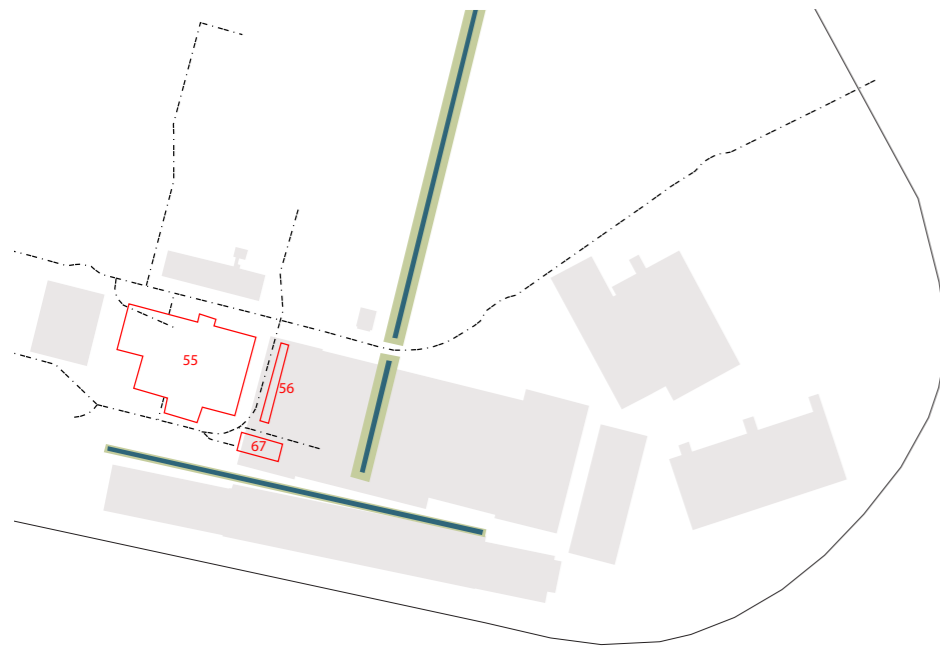


Fig. 9.1.5 Ladder 1901



Fig. 9.1.6 Ladder 1924

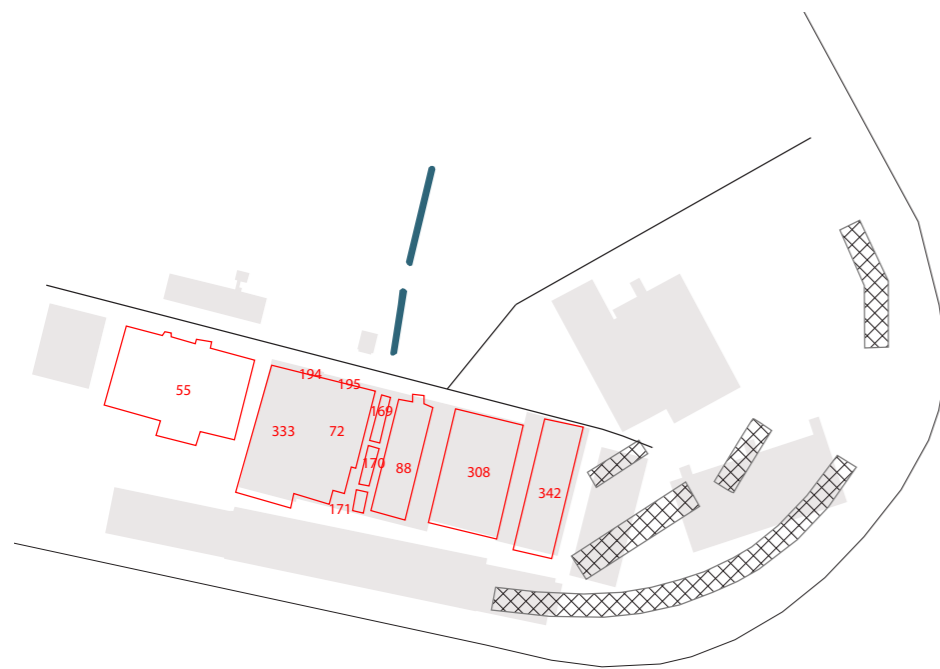


Fig. 9.1.7 Ladder 1941

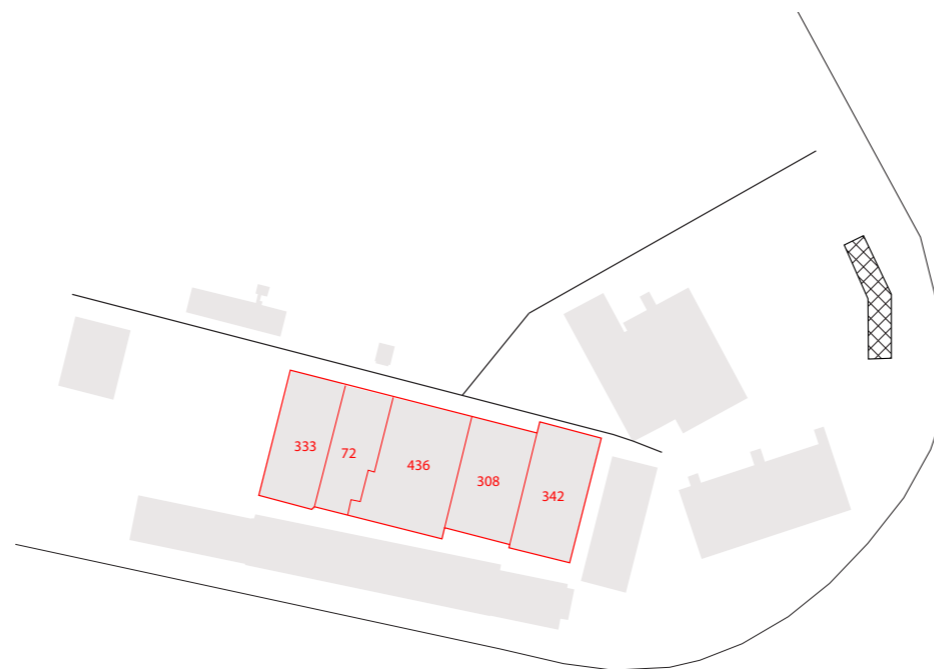








Fig. 9.1.8 Ladder 1996-now

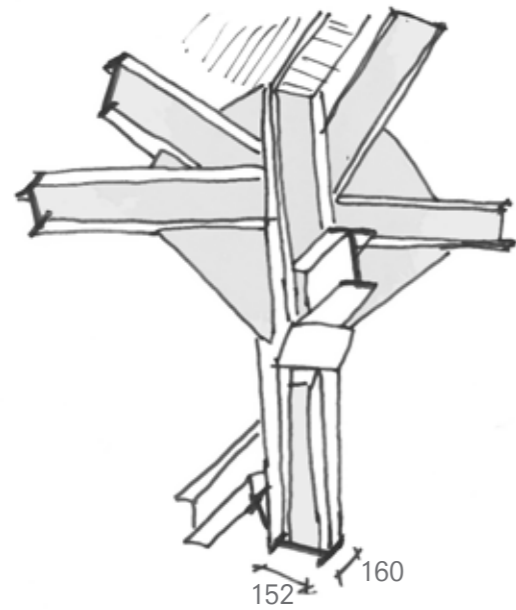
Development of the Ladder through time. At a certain moment in time there was a ditch (body of water) directly next to the buildings. This probably functioned as a cooling water source for the production process. During WWII there are also several bunkers visible. The only one remaining now is the one at the South cape. The main road going from East to West has always been there. Up until around 1940 there also was a narrow-gauge railway that transported products and supplies within the Ladder, but also to the docks at the waterfront of the Hembrug. Unfortunately there is no trace of them, because of the placement of the large concrete (road) plates.

-  Bunker
-  Buildings anno time of drawing
-  Buildings anno 2018
-  Quay
-  Body of water/ditch
-  Narrow-gauge railway

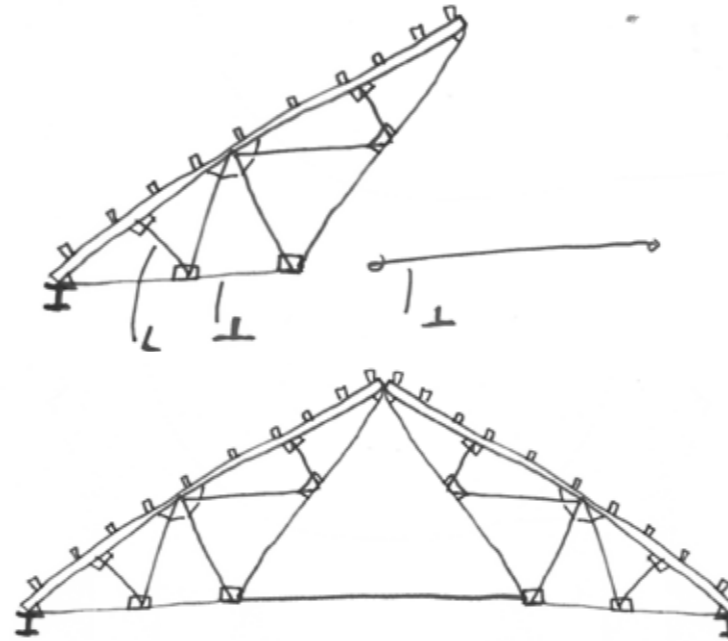
N
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9.2 DETAILS

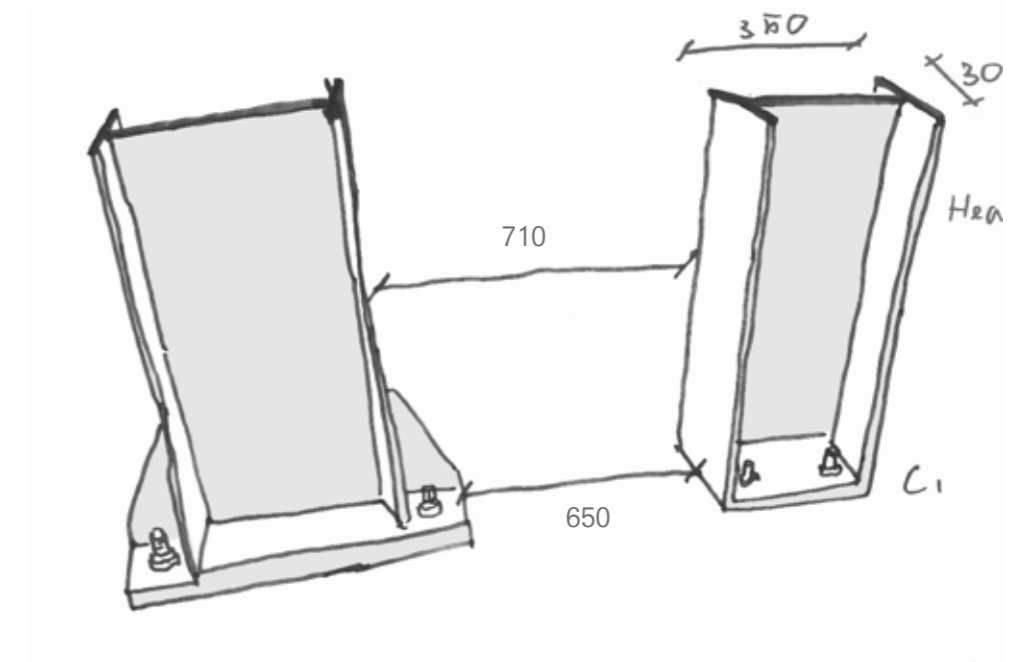
See chapter 5 for locations of the details



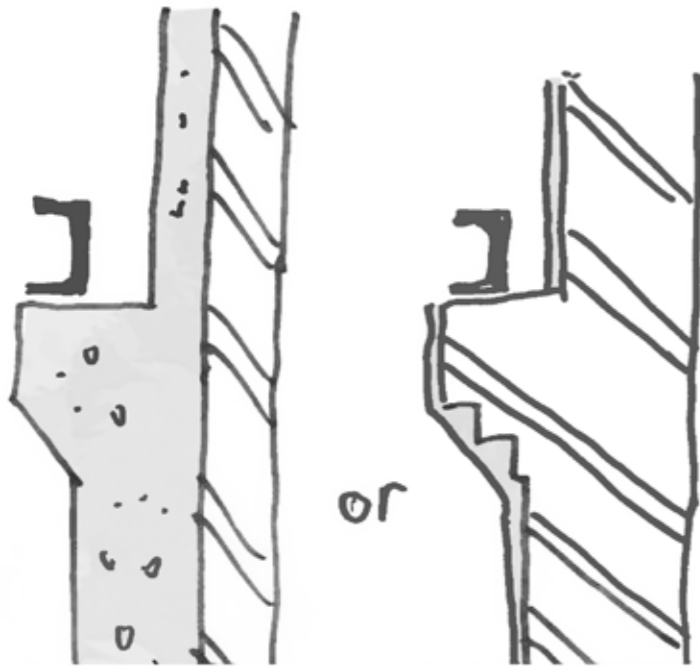
D1 welded plate connection



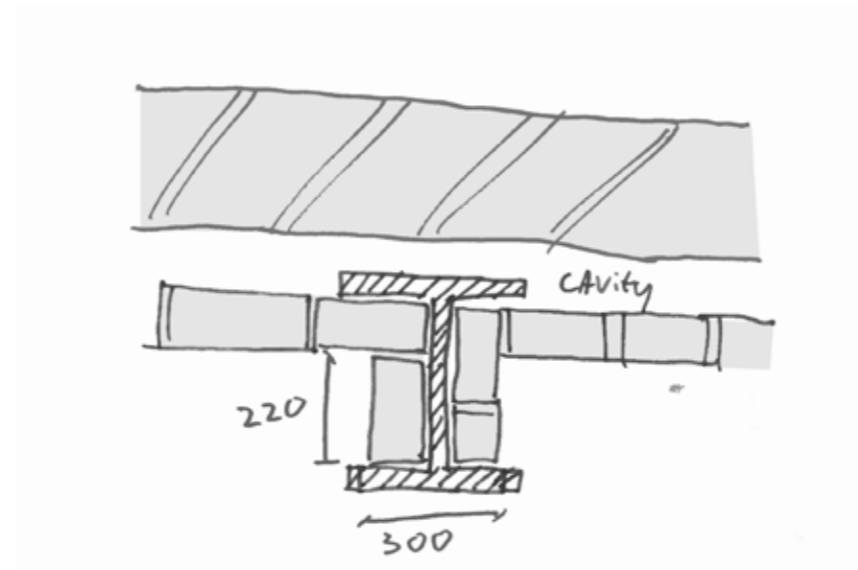
D3 Polonceau spant: consists of two parts and a pull rod



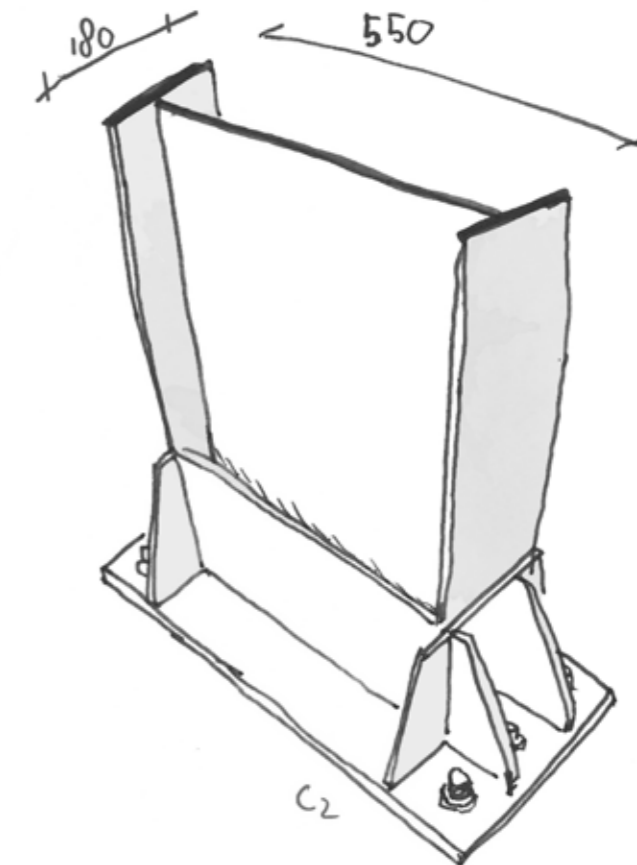
D5 space between 2 types of structure, left: C2 and right C1



D2 (vertical) columns of concrete or masonry with plaster, not yet clear

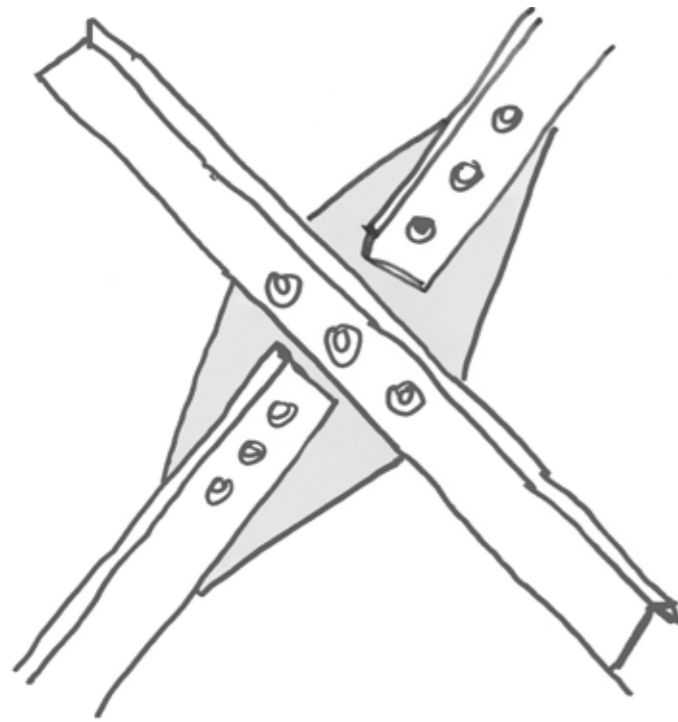


D4 (horizontal) steel column in masonry wall

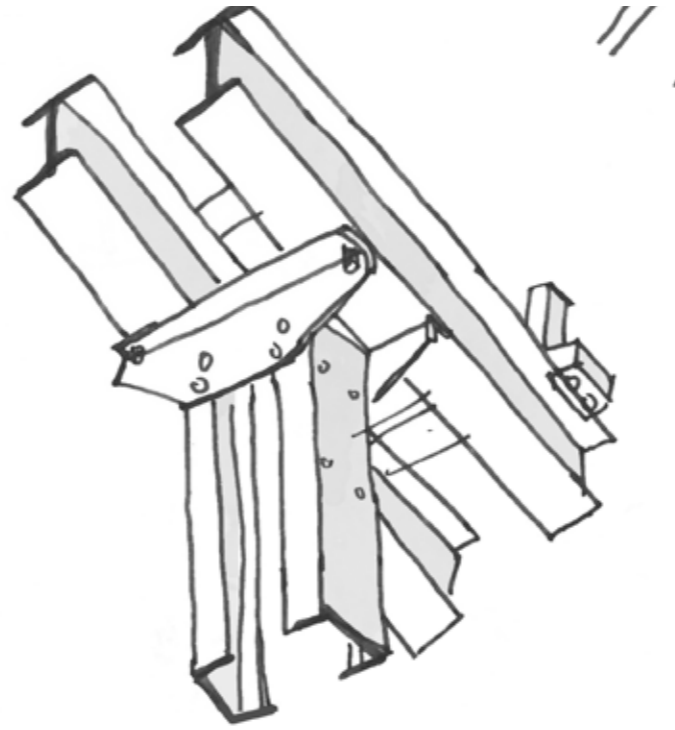


D6 steel column reinforced with welded plates

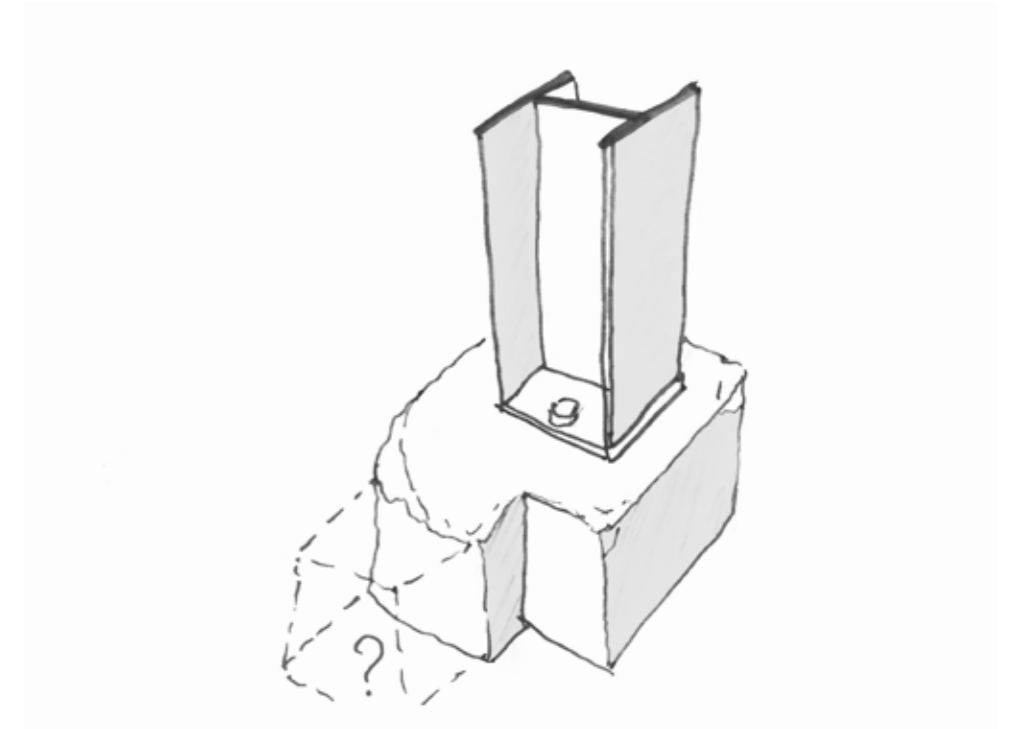
All drawings made by authors



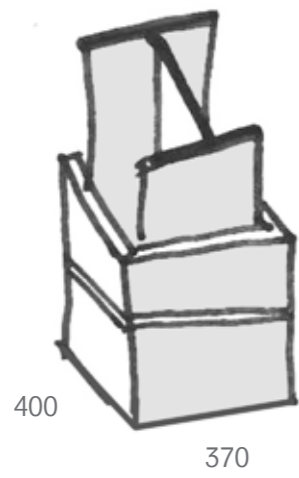
D7 wind brace connection with L-profiles



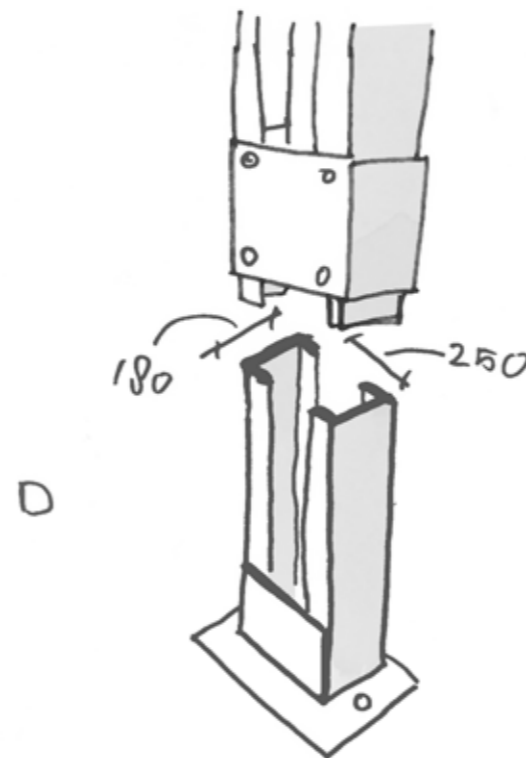
D09 connection composite column with beams



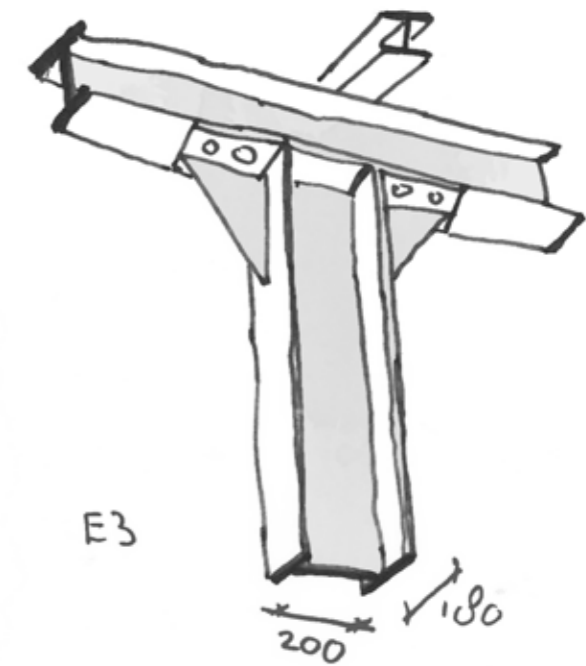
D11 column on concrete pedestal, traces of a concrete wall visible



D8 packed column, material unknown



D10 composite column from u profiles



D12 steel column / beam connection with welded plates

9.3 ROOF MATERIAL: BIMS BETON

Bims (pumice) is a light and porous material from volcanic origin, used as an aggregate in bimsbeton (pumice concrete), instead of gravel or sand. From 1915 roof panels of bimsbeton were made in the (steel) factory of De Vries Robbé & Co. Because this company designed and produced both the steel structure as the roof panels, we can find this combination a lot in factory halls from this area. In 1916 the concrete factory was changed in a separate subsidiary: the N.V. Betondak, see poster.

The panels that are used in buildings A, D and E are the solid cassette panels with the standard size of 50 x 50 cm and probably a thickness of 8 cm. The advantages of bimsbeton panels are that they are, relatively light weight, possess some temperature and sound isolation and it doesn't require any aesthetical finishing. Because the material is porous, it needs a waterproof coating on the roof surfaces.

In building C (461) bimsbeton has also been applied in the building of 1959. This time around the panels were larger and more flat. On the drawings of the roof of building C we can read that the Bimspanels were hollow, 90 mm thick, 1000mm in width and up to 2100mm long. On top of that a material with a descent of 1:200 is placed.

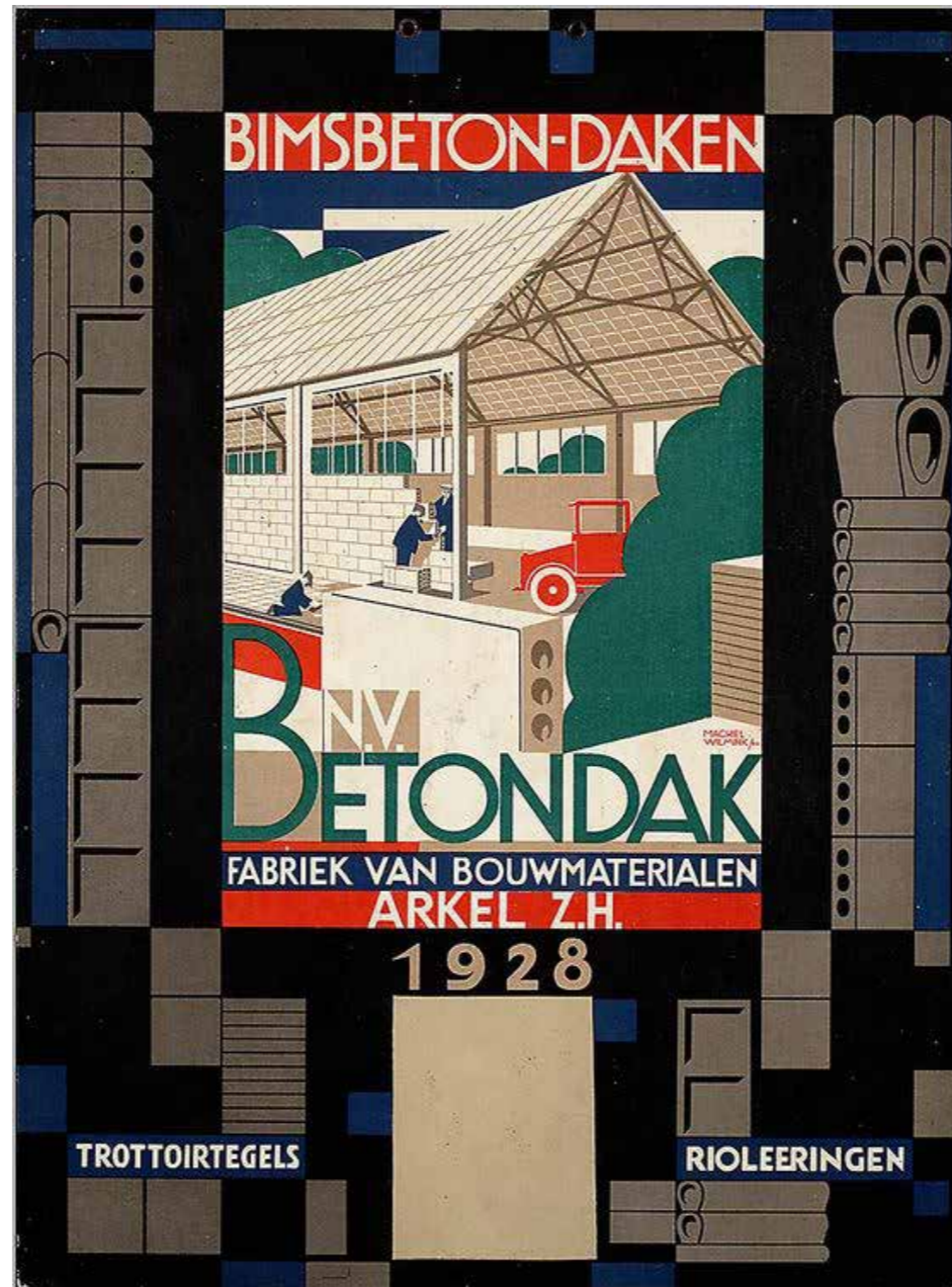


Fig. 9.3.1 poster Bimsbeton 1928

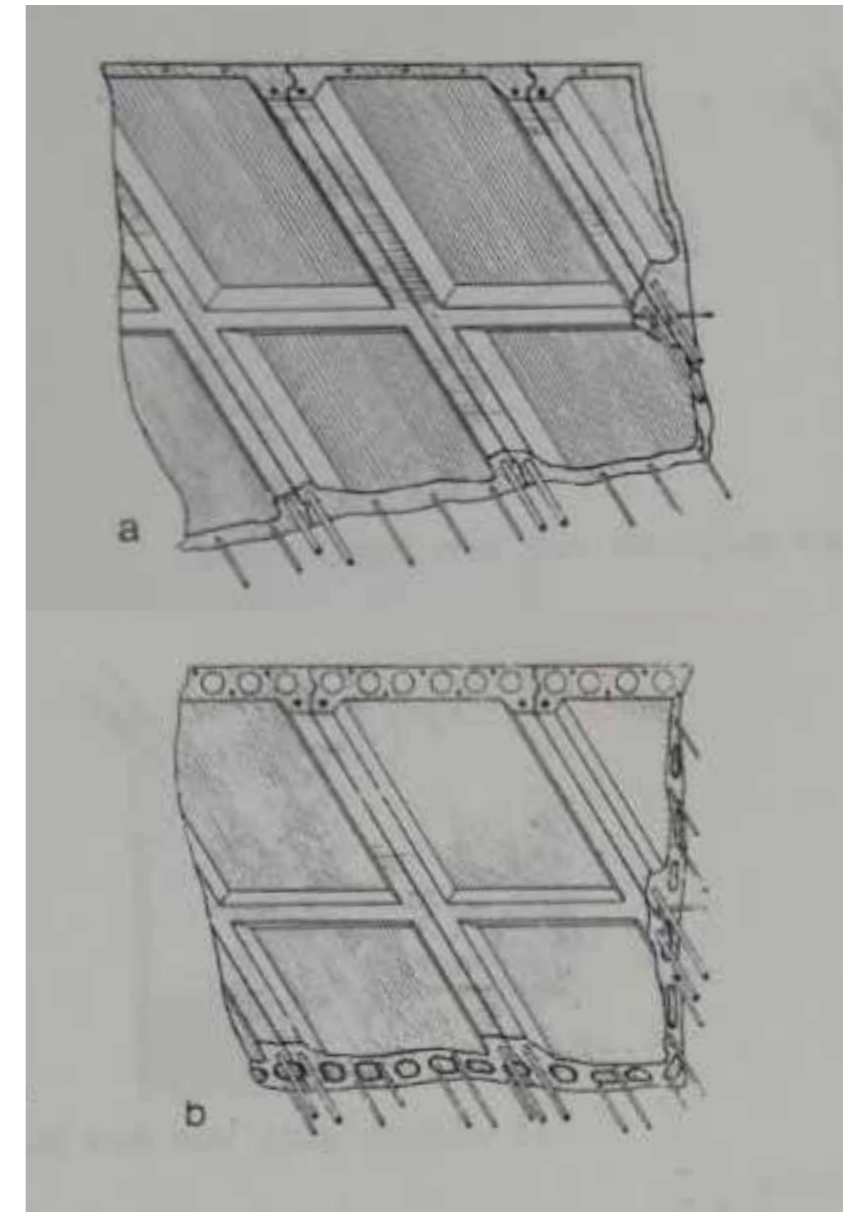


Fig. 9.3.3 principles of prefab Bimsbeton (a) massive, (b) hollow.

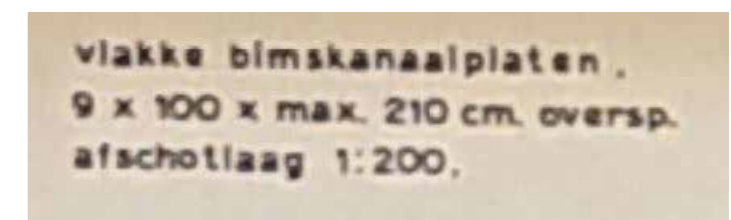
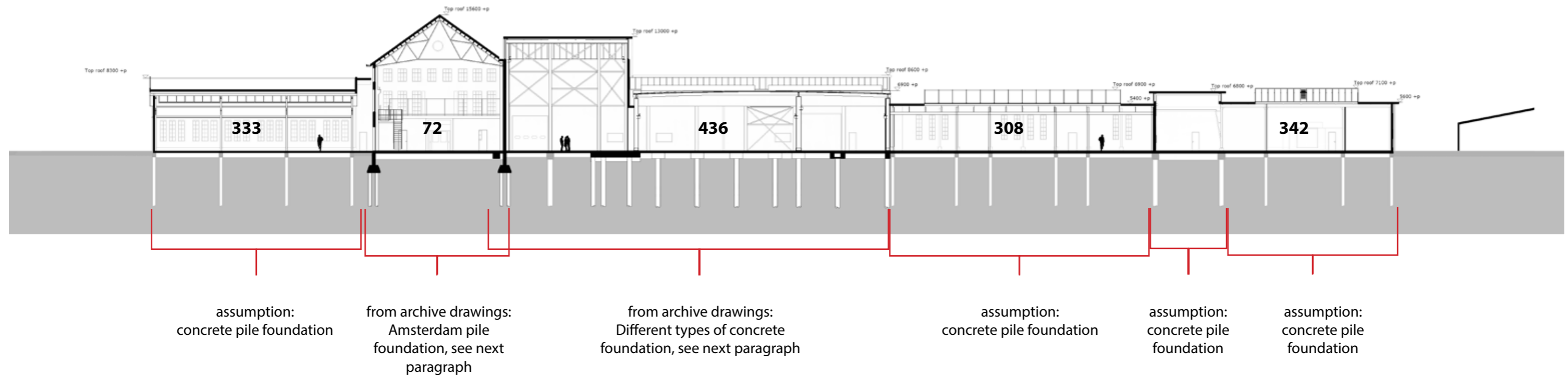


Fig. 9.3.2 text on drawing building 461 (Archief Zaandam)

9.4 FOUNDATION OVERVIEW



drawing by author

9.5 FOUNDATION BUILDING 436

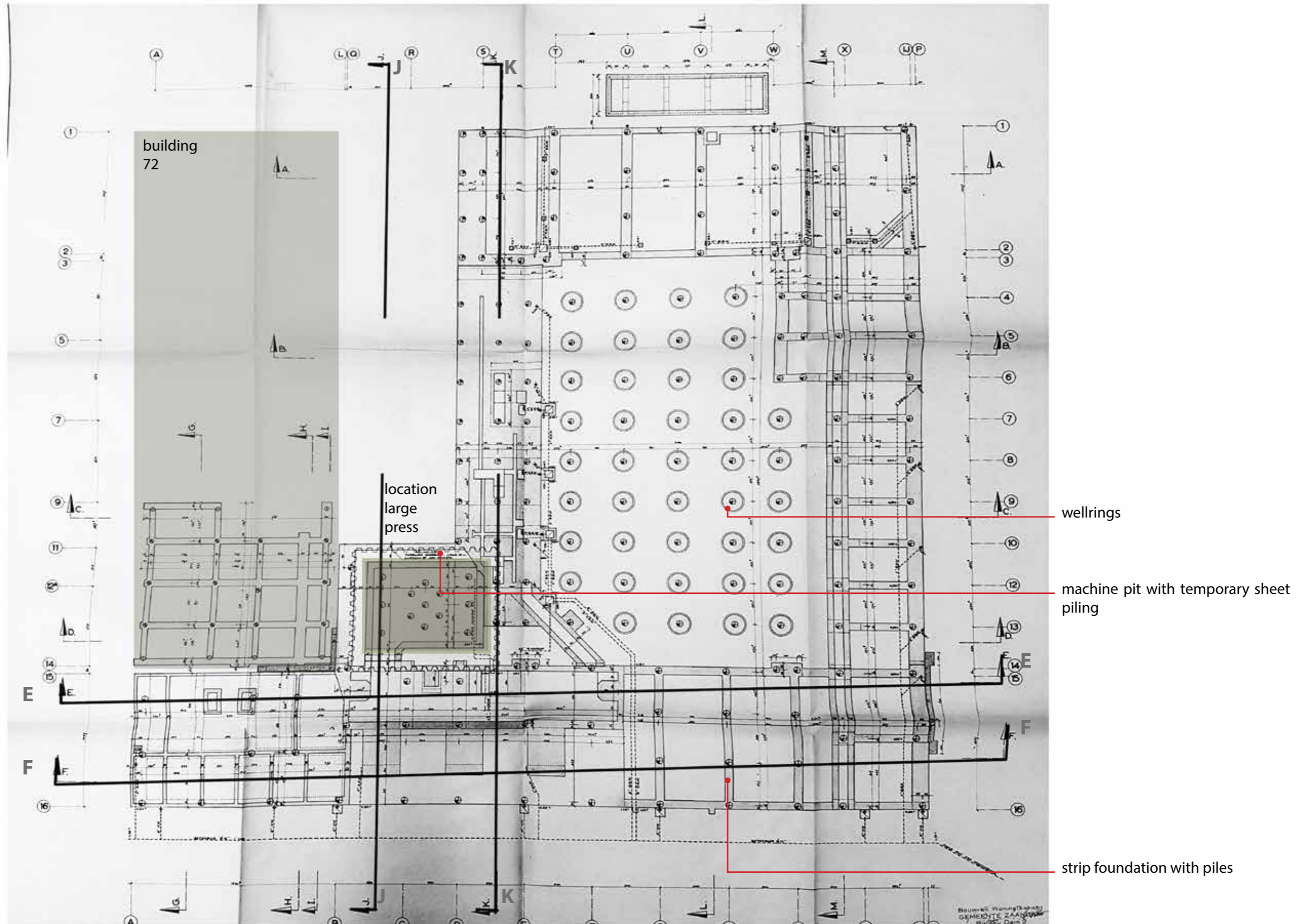


Fig. 9.5.1 foundation drawing building 436 (Archief Zaanstad)

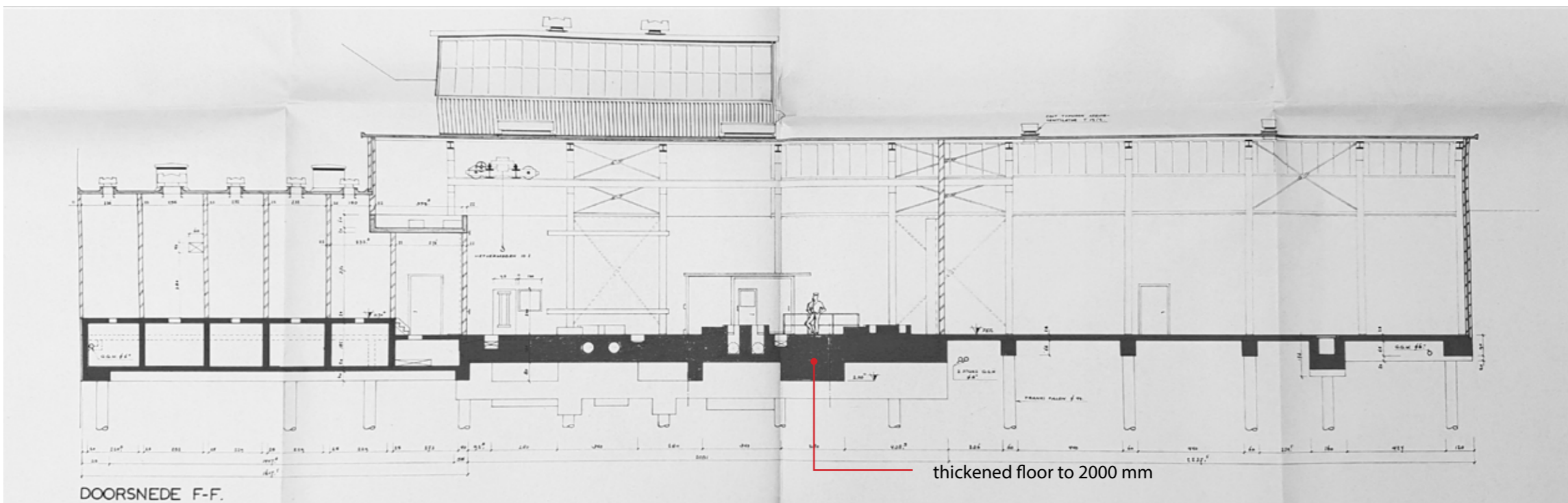
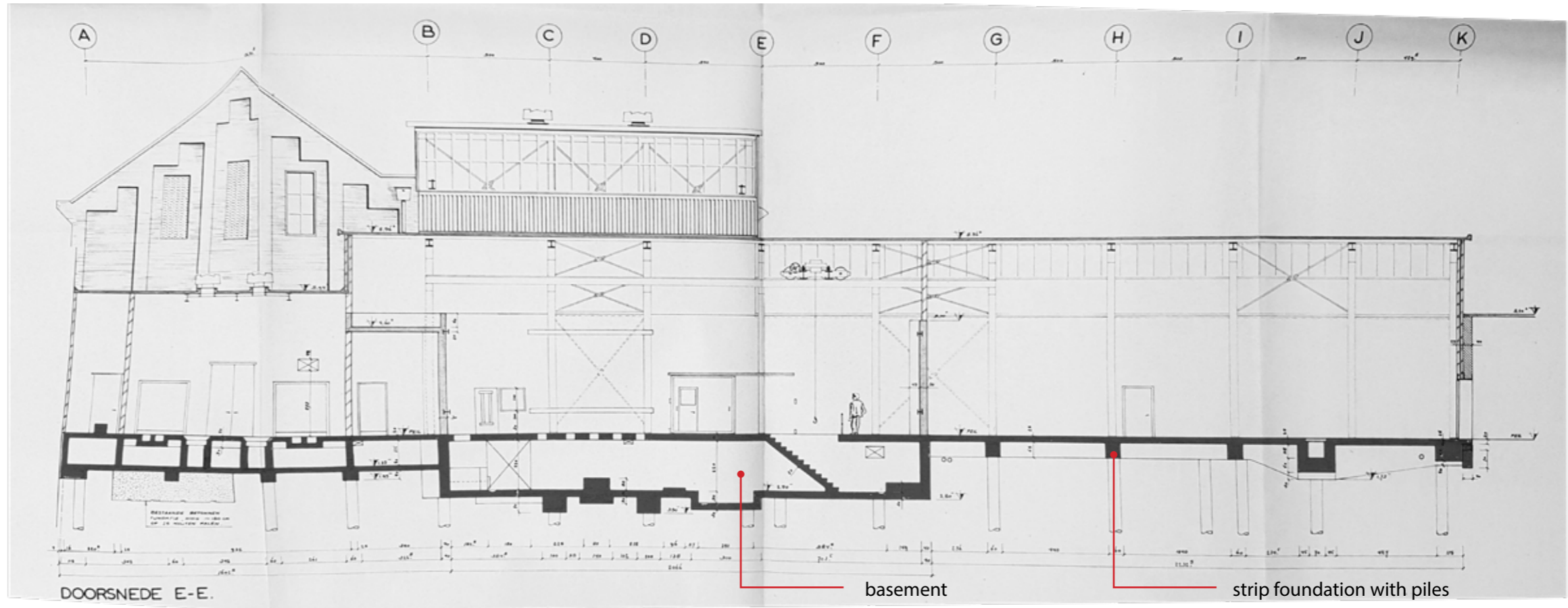


Fig. 9.5.2 sections E-E ad F-F building 436 (Archief Zaanstad)

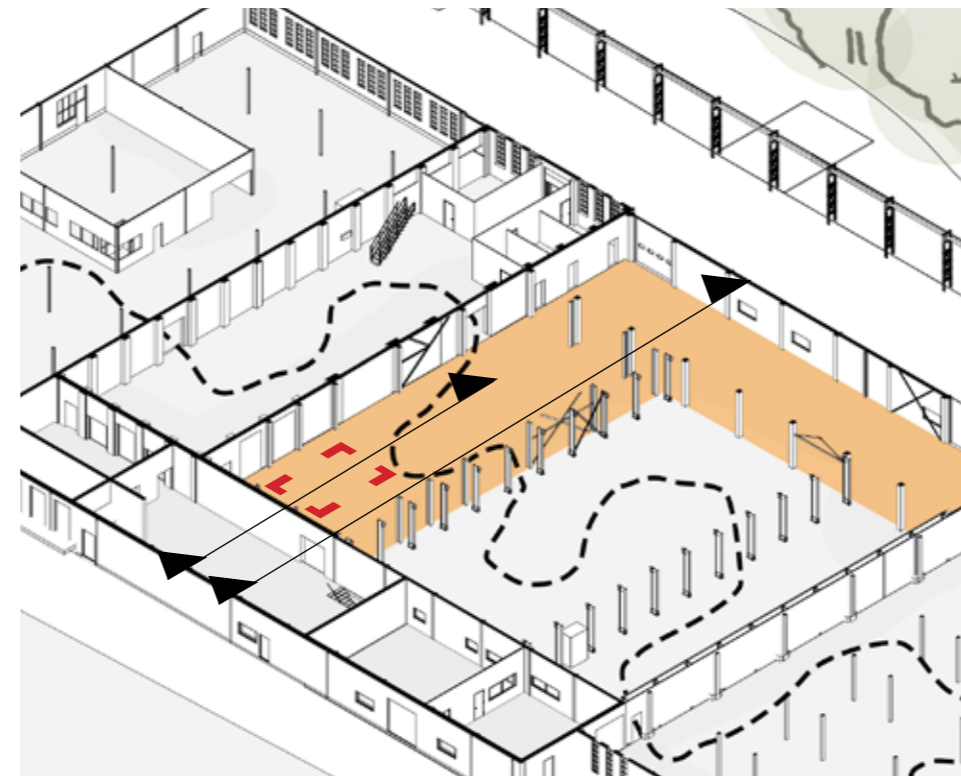
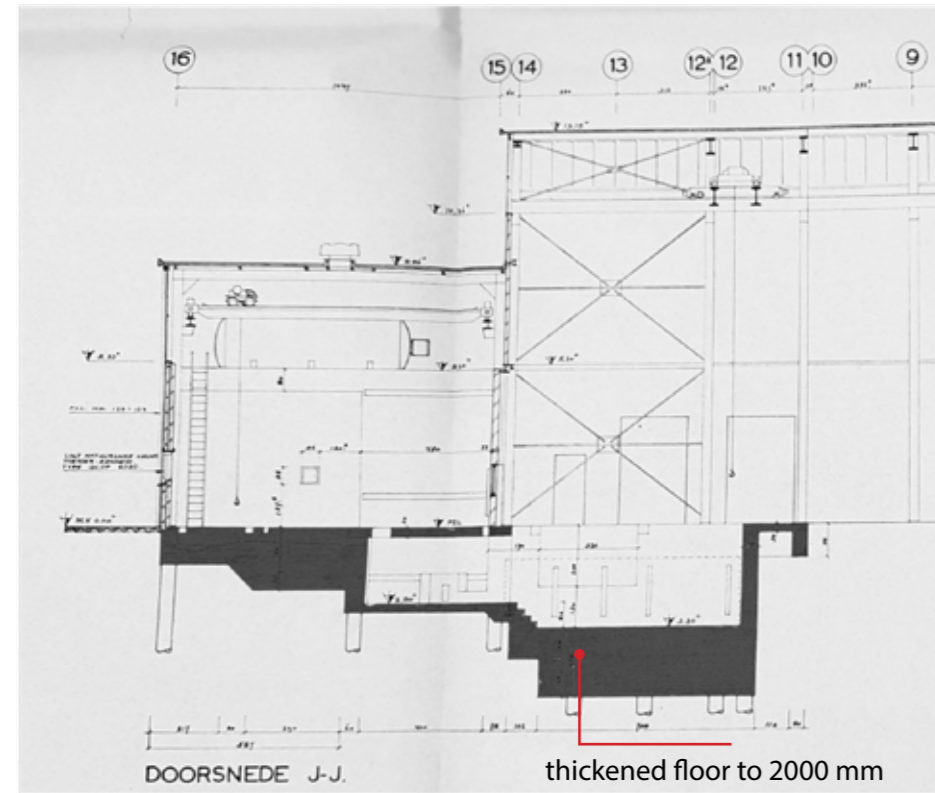
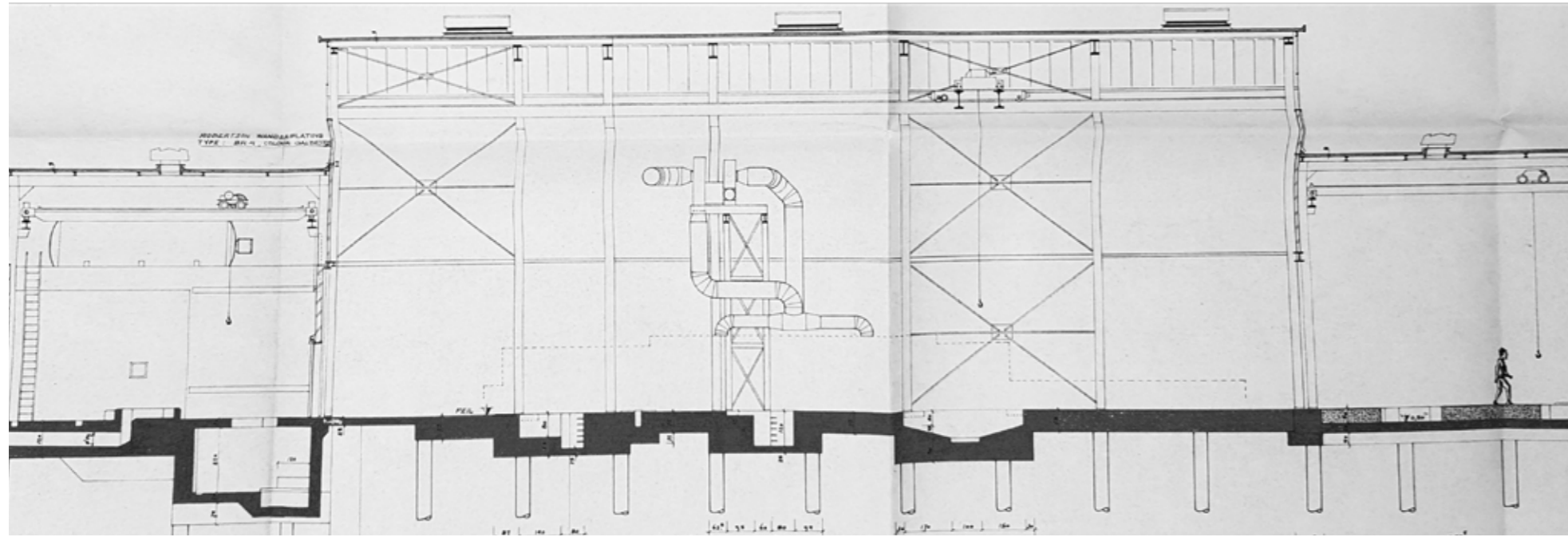


Fig. 9.5.3 sections J-J and K-K building 436, here the largest press of Europe was located. (Archive Zaanstad)

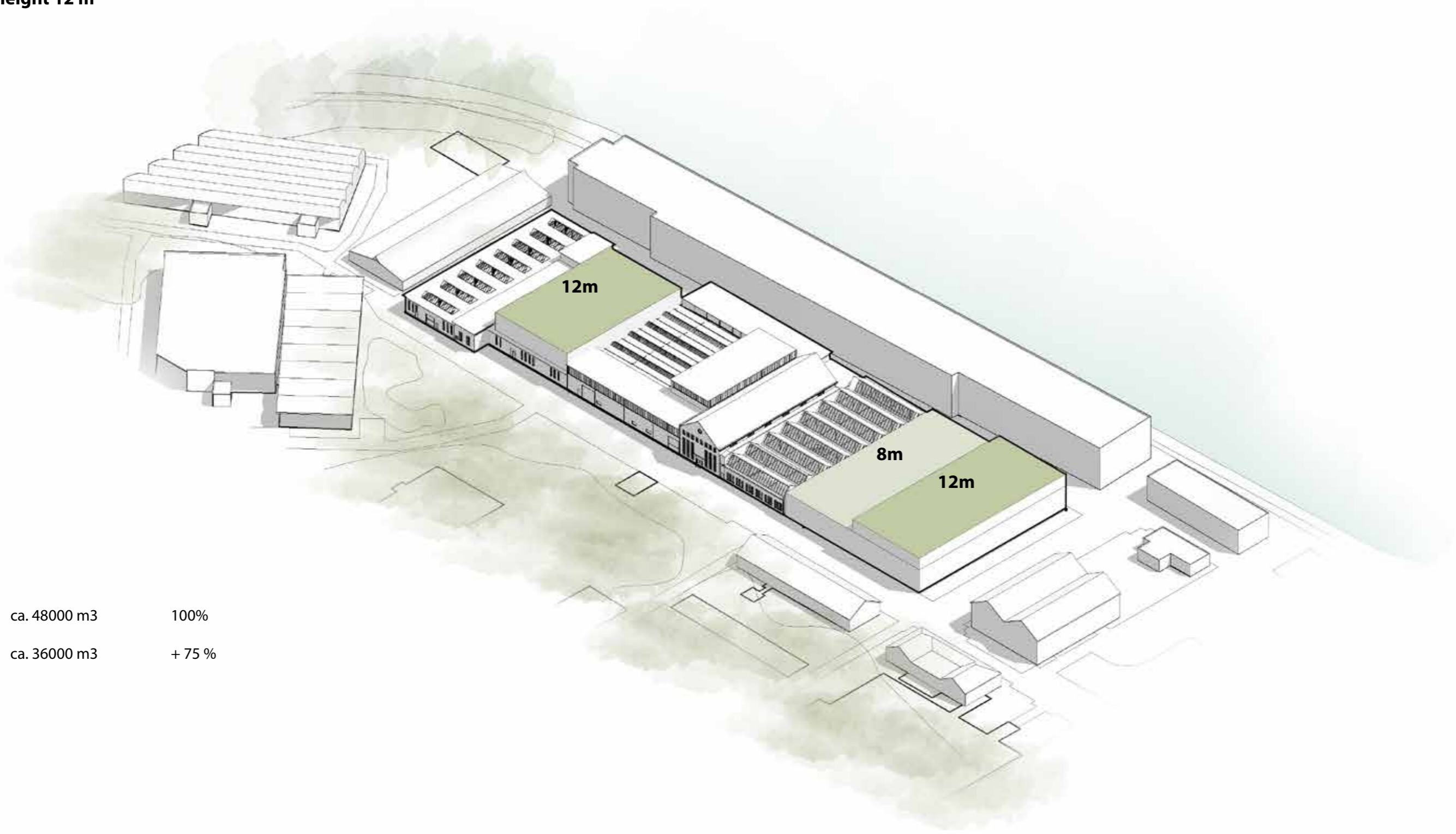
Fig. 9.5.4 location large press (by author)

Fig. 9.5.5 photo of the large pit (Rene Ros op Fortificatie Forum.nl)

Drawing made by authors

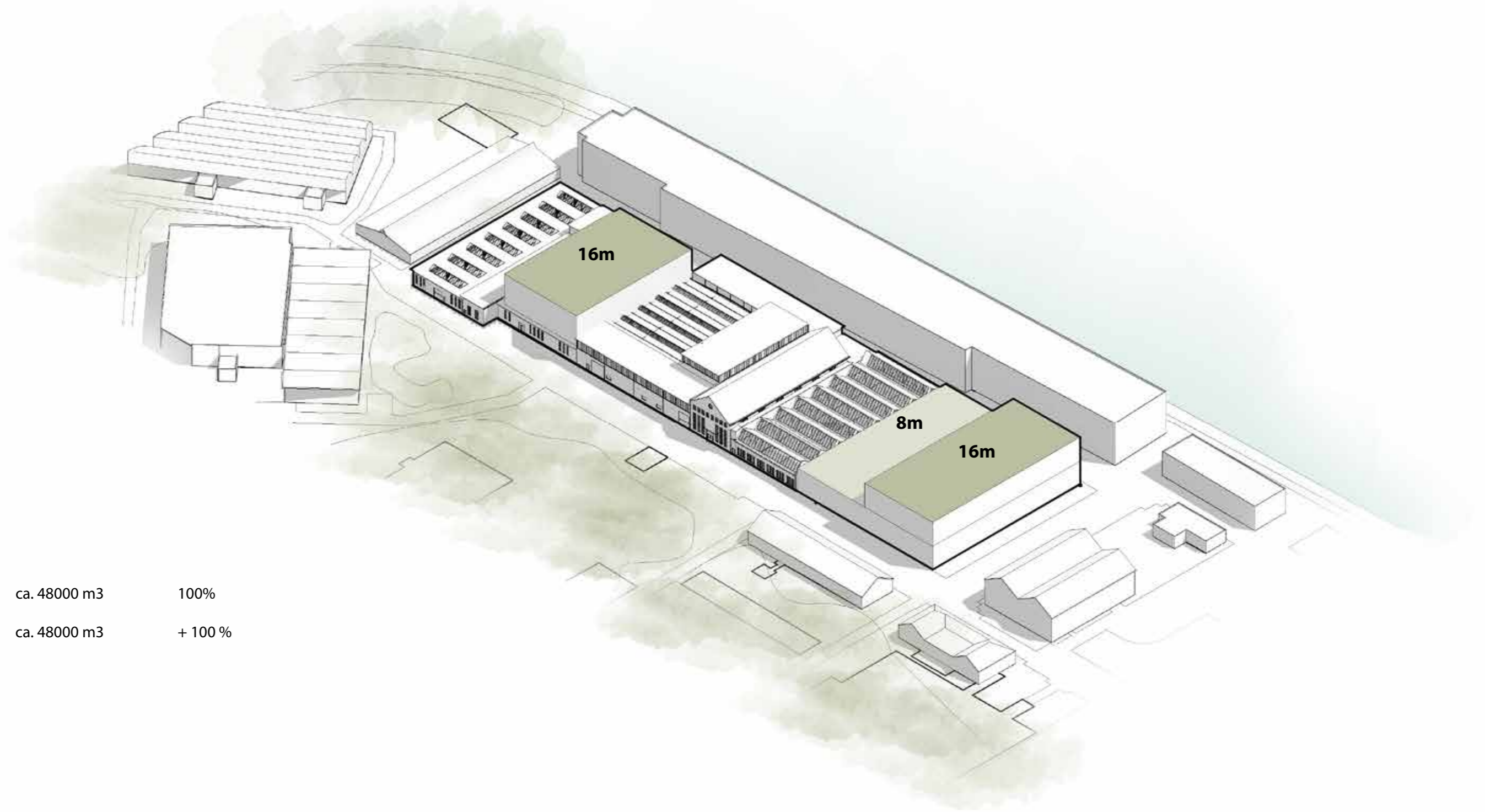
9.6 M³ STUDY

+ 75 % mass
maximum height 12 m



existing	ca. 48000 m ³	100%
added	ca. 36000 m ³	+ 75 %

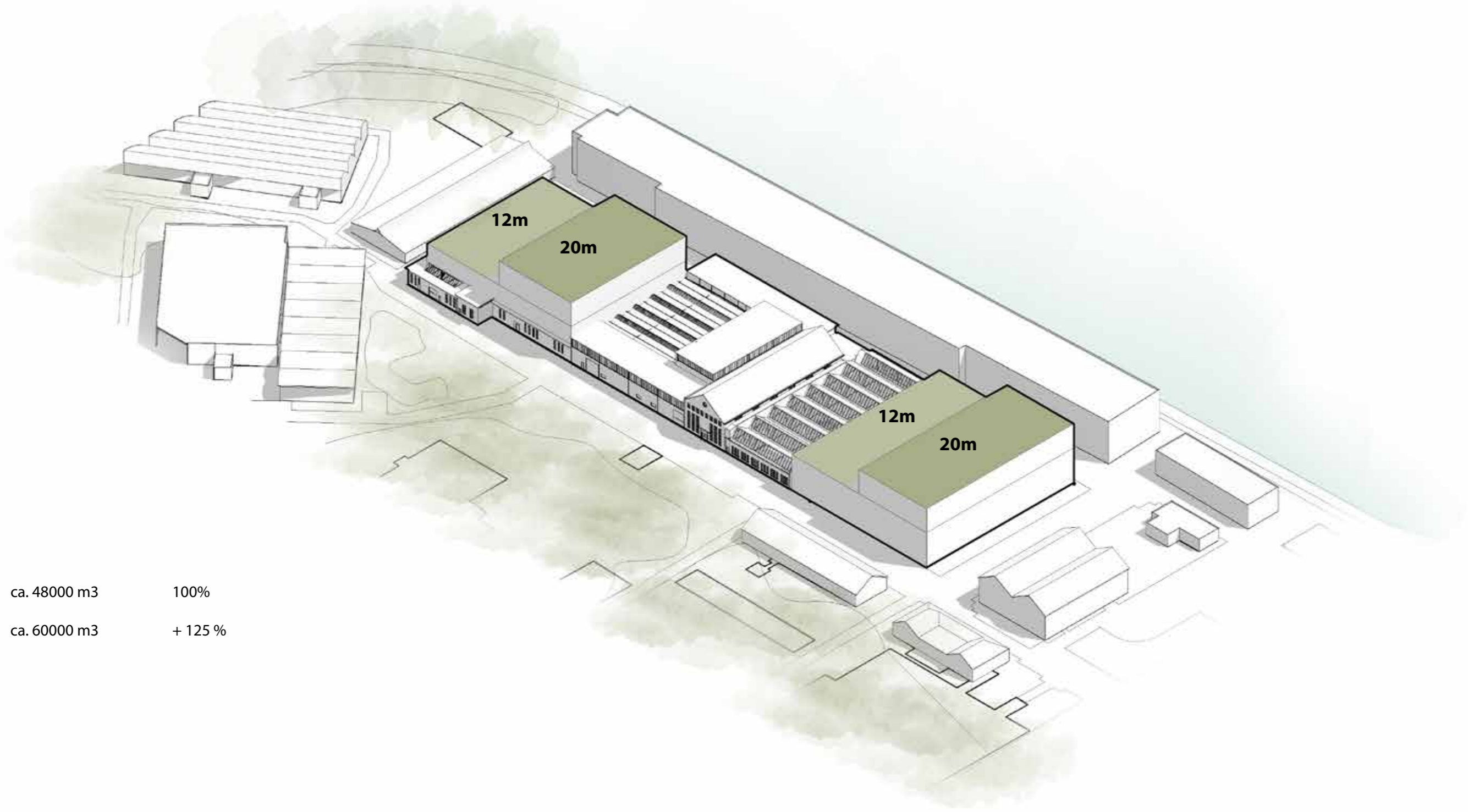
+ 100 % mass
maximum height 16 m



existing	ca. 48000 m ³	100%
added	ca. 48000 m ³	+ 100 %

Drawing made by authors

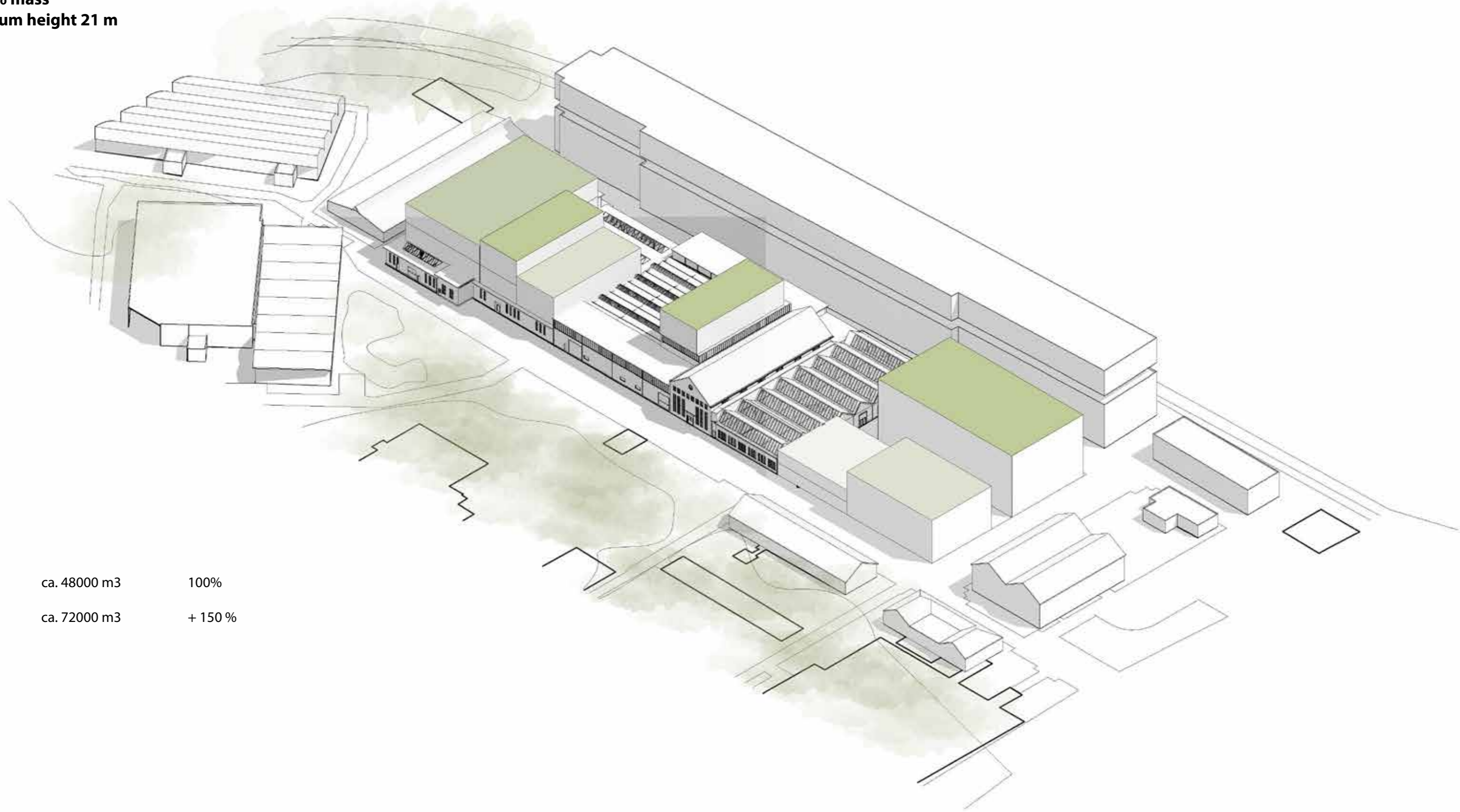
+ 125 % mass
maximum height 20 m



existing	ca. 48000 m ³	100%
added	ca. 60000 m ³	+ 125 %

Drawing made by authors

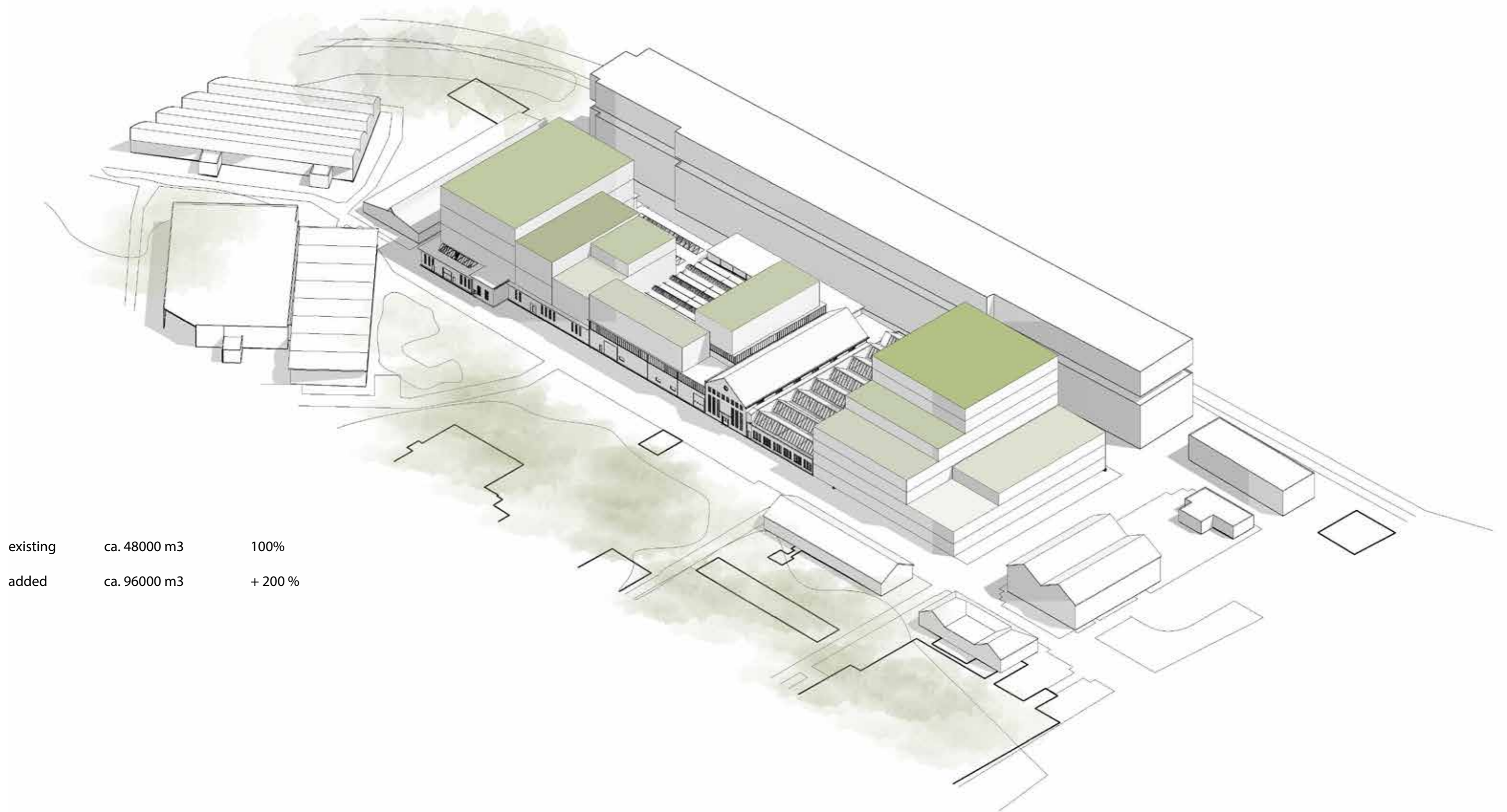
+ 150 % mass
maximum height 21 m



existing	ca. 48000 m3	100%
added	ca. 72000 m3	+ 150 %

Drawing made by authors

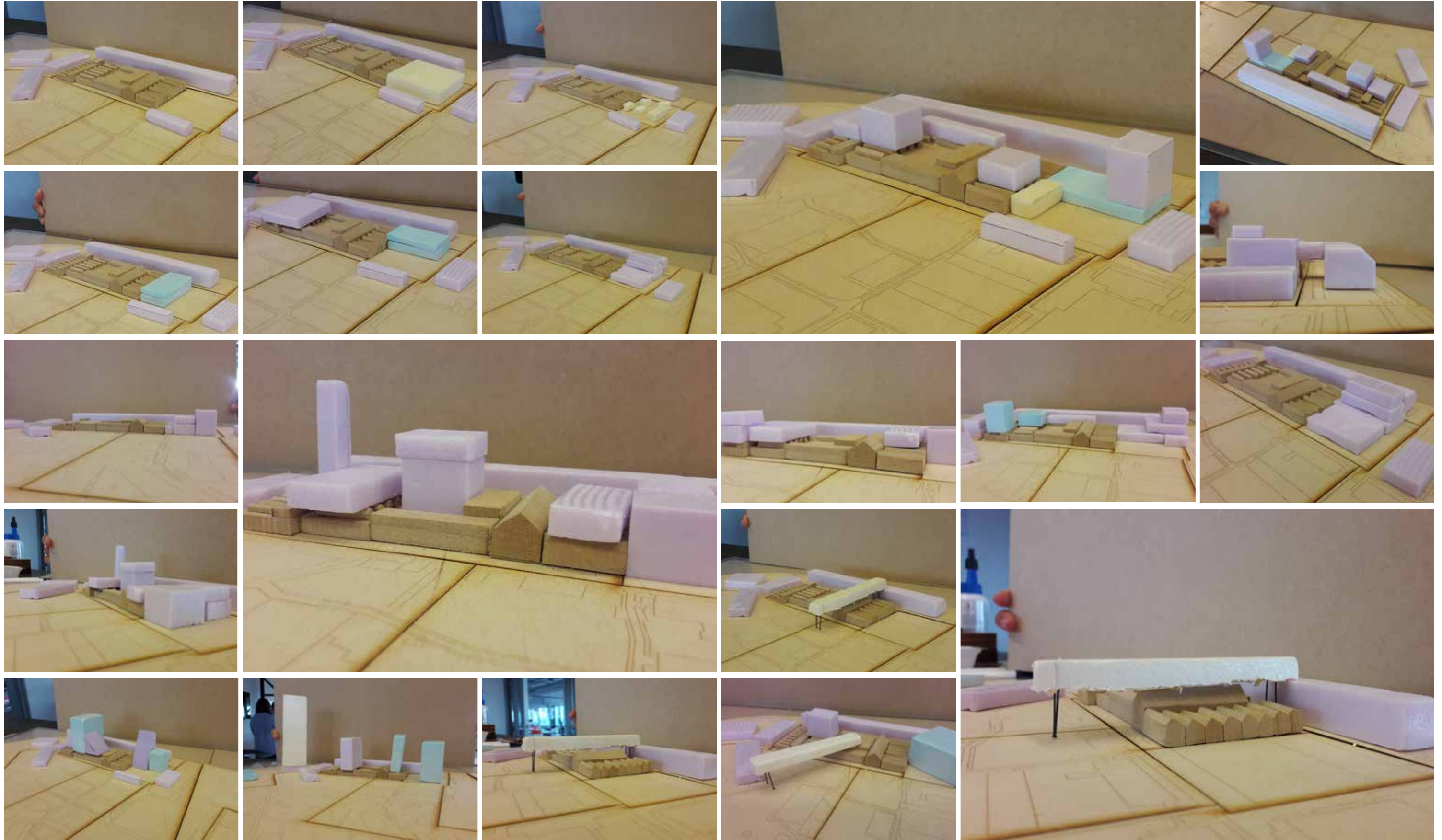
+ 200 % mass
maximum height 28 m



existing	ca. 48000 m ³	100%
added	ca. 96000 m ³	+ 200 %

Drawing made by authors

9.7 FORM STUDY



All pictures made authors

