

Bernard Cherix architecte

BIM World Munich

**REVERSE ARCHITECTURE**

- architecture inverse -

**openBIM for the renovation of heritage buildings**

Les **ATELIERS** de Renens Switzerland, 28.11.18

### Reverse architecture: openBIM for the renovation of heritage buildings

Buildings are cultural repositories which can be physically experienced. But buildings also store architectural knowledge through drawings executed in order to construct them where different epochs are reflected in the technologies utilised. In a process that stands in opposition to designing new buildings, renovation of heritage buildings starts with reverse architecture. This term was used by R.L. Krikhaar (Amsterdam 1997, ISBN: 0-8186-8013-X) referring to software maintenance, in this paper it is applied to architecture.

A major challenge lies in the frequent lack of documentation or the translation of the respective technology into today's standards as well as the continual upgrading of a digital copy. This paper argues that openBIM -including point cloud- is an important method for the process of renovation and demonstrates how it can be applied. This will be showed in three examples by the author from three phases of digitalisation in the architectural profession.

The first example discusses a classic case of a large-scale ex-industrial heritage complex in Berlin, undergoing transformation in the early 2000's when BIM would be needed, but were not yet fully developed. This represents the beginnings of developing architectural drawings in 3-D as a method of producing plans but sections, elevations and infography would only partly be edited from the model. However it was also the beginnings of software developments which would lead to the production of a "virtual avatar" used for the facility management of buildings.

In the context of the Swiss construction industry and architecture profession, BIM has been slow to advance.

However a norm has been developed, the SIA 2051, and is standard since December 2017. A pioneering example of openBIM-renovation is the 1930 art-déco Bel-Air tower and complex designed by A.Laverrière in Lausanne and completed in 2016 at CCHE architecture. From simple 2D vector drawings of the tower in .DXF format, a comprehensive digital model was produced on standard PCs to which the MEP engineers also contributed 3-D models in .IFC format and coordination of such a complex heritage renovation could be achieved.

The openBIM Bel-Air was a powerful instrument to tests design options to be validated by the head of conservation who followed the renovation of this national monument with particular attention.

Unfortunately no .IFC was required to document the project once the renovation achieved, therefore the full potential of the "virtual avatar" is not being realised.

The third example adopts a further emerging technology in order to simulate the renovation of a heritage building for the Schweizerische Bundesbahnen (SBB) without readable plans. The Vallorbe train station, a 15'000m<sup>3</sup> national monument in Heimatstil designed by Taillens & Dubois in 1913 on the Simplon-Orient Express railway lane, is being used as a test model for an openBIM prototype. Reverse architecture is based on a compilation of point clouds produced by the Yverdon institute of technology (HEIG-VD) documenting the station. Part of the project will be crossing databank of SBB technical devices and the digital model by using open standards (.IFC, .COBie...). The outcome will be applied to similar buildings of the SBB as part of their BIM implementation strategy.

Digital technologies are now available to any architects (in Europe, mostly SME) for the documentation and the planing for transformation of heritage buildings: BIM-renovation. As in many cases transformations occurs only in a part of the building, it's comprehensive documentation on open formats is essential; this "virtual avatar" might therefore be hybrid containing point clouds and digital models. A version tracking of the avatars, form expert validated historic parts over the current state of the building to the transformed parts must be given available to the groupe of mandataries that will be in charge of the next intervention on the building; maybe in ten years time.

Reverse architecture is the first step to extract knowledge in order to achieve integrated design of heritage building. "Virtual avatar" in open formats will ensure its accurate maintenance and development in the long term.

### SPEAKER INFORMATION

M.Arch. Bernard Cherix,  
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Bernard Cherix Architecte

Bernard Cherix is a Swiss architect based in Lausanne (Switzerland) who received his Master in architecture by research (project) from RMIT University, Melbourne (Australia), under Leon van Schaik & Matthias Sauerbruch, also winning of the Australian-European Award Program (DAAD) in 1999 to carry out the research.

Currently working on an openBIM-renovation model to be applied on heritage buildings for the Schweizerische Bundesbahnen (SBB), Bernard taught openBIM at the EPFL to master students in architecture and civil-

engineering from 2016 to 2018.

Within CCHE Architecture he built the openBIM of Switzerland's first sky scraper - the Tour Bel-Air in Lausanne, for its renovation.

At the neighbourhood scale, Bernard has been involved in voluntary collaborations with Pr. Jean-Bernard Racine, in particular regarding resident participation and the development of the newly completed neighbourhood's house in le Desert, Lausanne.

Previously Bernard was guest researcher at the Technical University of Berlin, Prof. Klaus Zillich, and a practising architect for Augustin und Frank Architekten and Max Dudler Architekt, Berlin

He gained his architectural diploma in Geneva in 1992 and his draughtsman's qualification in 1984 in Lausanne.

Ref.:

<https://www.youtube.com/watch?v=EnoGWvZRM24>

# CONTENT

I INTRODUCTION

II STATE OF EXPERTISE

01 I.Z. BERLIN-SCHOENEWEIDE, 2001

02 TOUR BEL-AIR, LAUSANNE, 2016

03 VALLORBE GARE, 2018

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# I INTRODUCTION

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# REVERSE ARCHITECTURE

- architecture inverse -

# BUILDINGS AS CULTURAL REPOSITORIES



INDUSTRIAL CELEBRATION

# STRUCTURAL INNOVATION





# STRUCTURAL INNOVATION



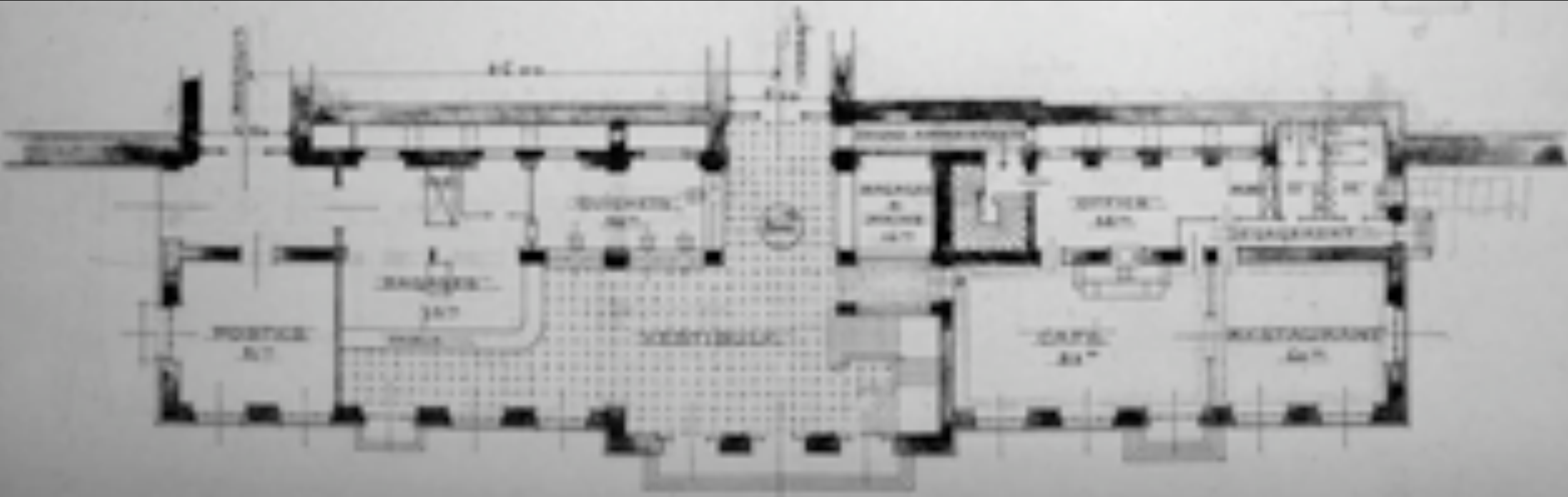




PRESTIGIOUS INTERCONTINENTAL TRAVEL



**RECLAIMING KNOWLEDGE (from drawings)**



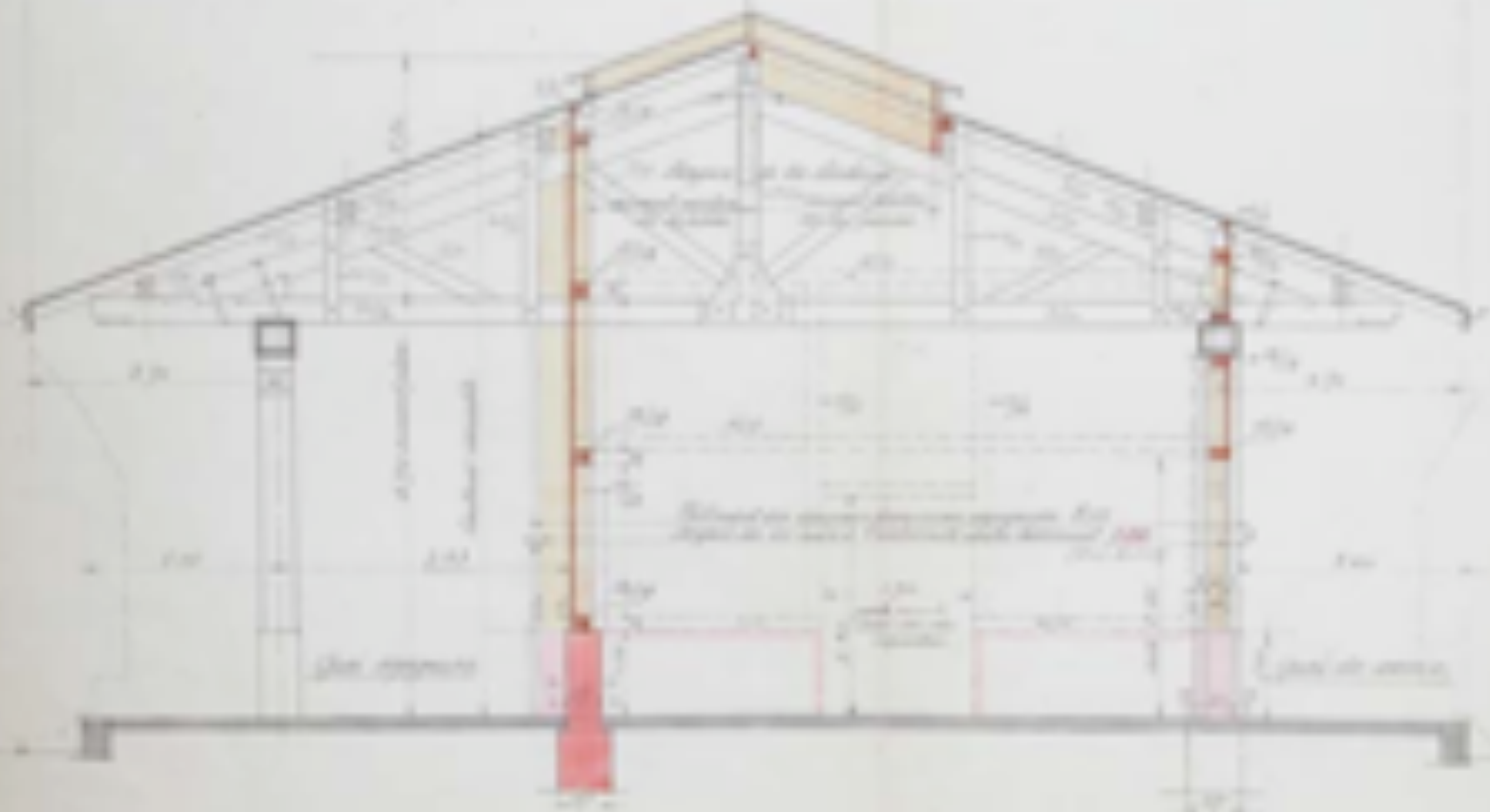
REZ-DE-CHAUSSEE  
COTE COUR

*Plan architectural  
d'un des 21 Nov 1911  
LAUSANNE EXPO 1914  
Fischer et Dubois, arch.*

Echelle de 0.005 m

HISTORIC USE





# CONSTRUCTION & MATERIALS





CULTURE





REVERSE ARCHITECTURE FOR RENOVATION

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## II STATE OF EXPERTISE

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REVERSE ARCHITECTURE  
3 types of architecture, 3 methods





CONTEMPORARY: basic modelling



3D scan

MODERN: reverse architecture- structuralism & rationalism





HISTORIC: advanced reverse architecture



# ADVANCED REVERSE ARCHITECTURE

e.g. Vallorbe Gare digital model LOD 200

volume 16'000 m<sup>3</sup>

surface 5'000 m<sup>2</sup>

2 GIS experts 6 weeks

point clouds 50 Gb

1 architect 15 weeks

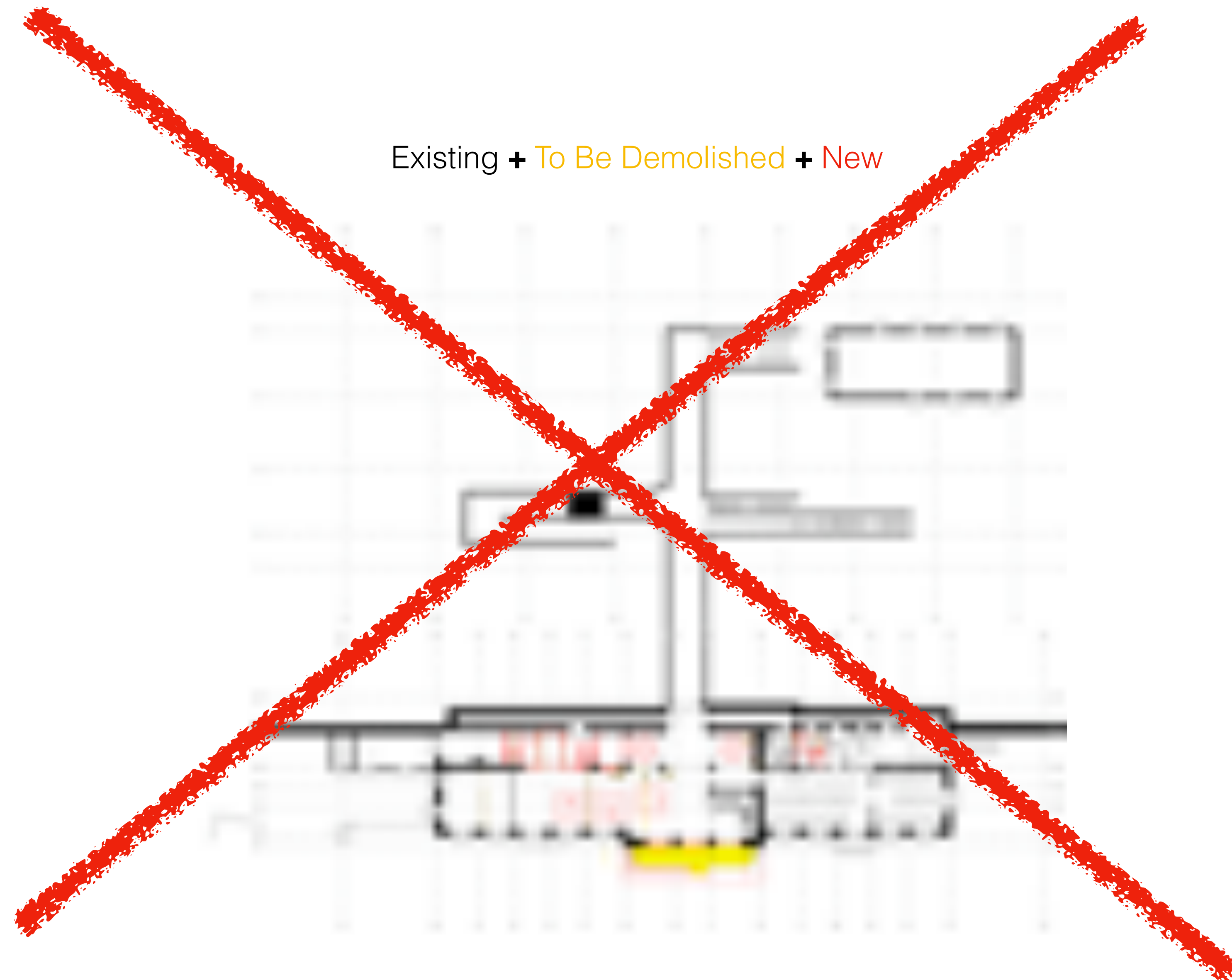
openBIM-RENOVATION  
recommendation for model delivery

Existing + To Be Demolished + New



1 MODEL = 3 renovation categories

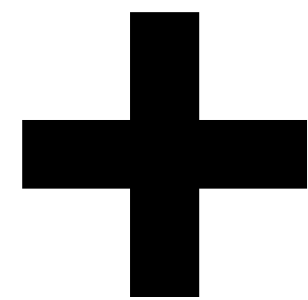
Existing + To Be Demolished + New



DESIGN PROCESS CORRUPTS « EXISTING »

building prior to changes

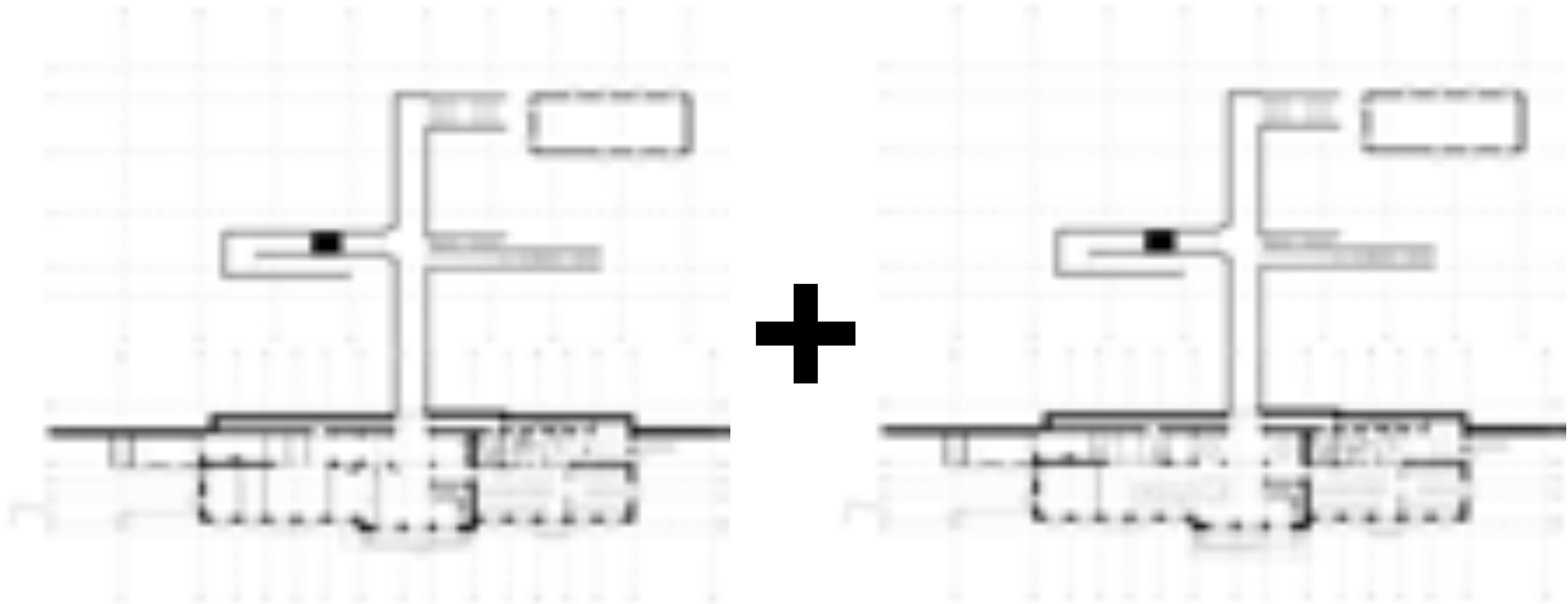
building after changes



POINT CLOUD + DIGITAL MODEL

building prior to changes

building after changes



2 MODELS > cp. with analytical software

openBIM-RENOVATION  
current enquiries

# 1. BIM + LINKED-DATA

re-use of .IFC in 40Y for further planning

Q.: method and data permanence ?

Cp. reclaim of .IFC 2 (Berlin-Schöneweide project) & SBB databank issue



## 2. REVERSE ARCHITECTURE BEYOND EXISTING

model of original building for national monuments

Ref. experience with conservation authorities in the Bel-air project

Q.: funding?

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# 01 BERLIN-SCHOENEWEIDE

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2001, M.Arch. at RMIT University





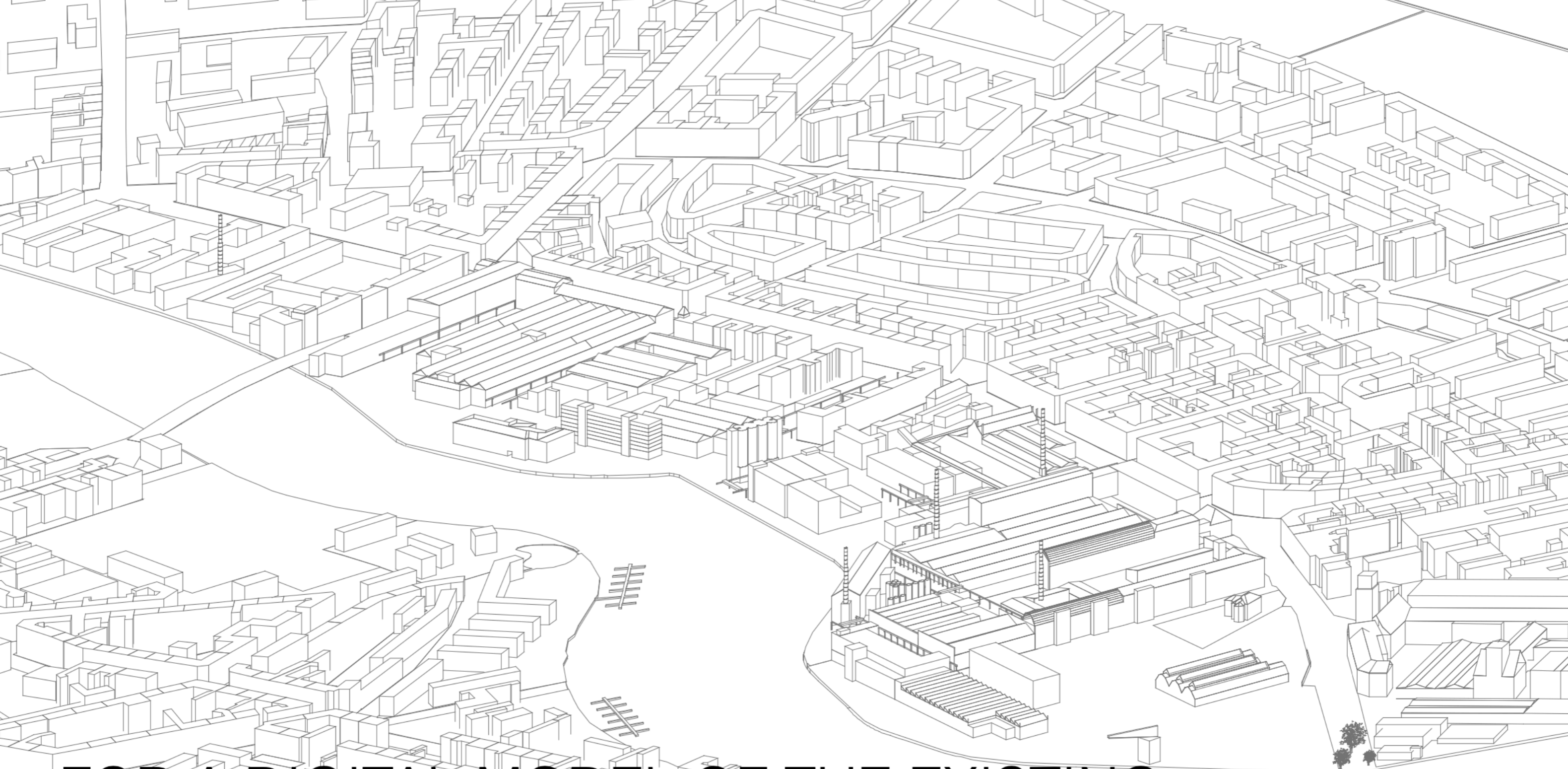
SITE FROM « CADASTRAL BITMAP »



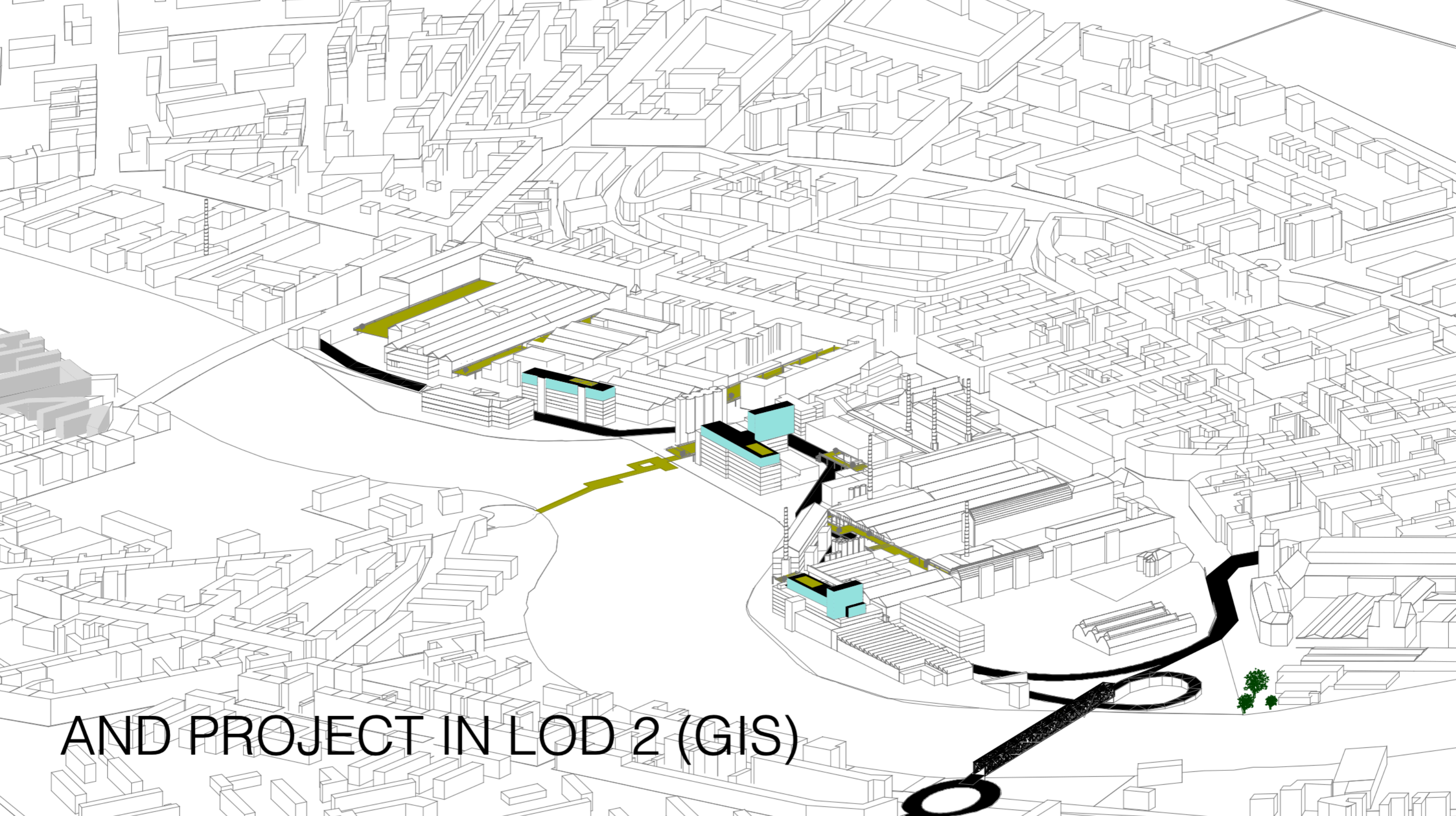


... AND PHOTOGRAPHS

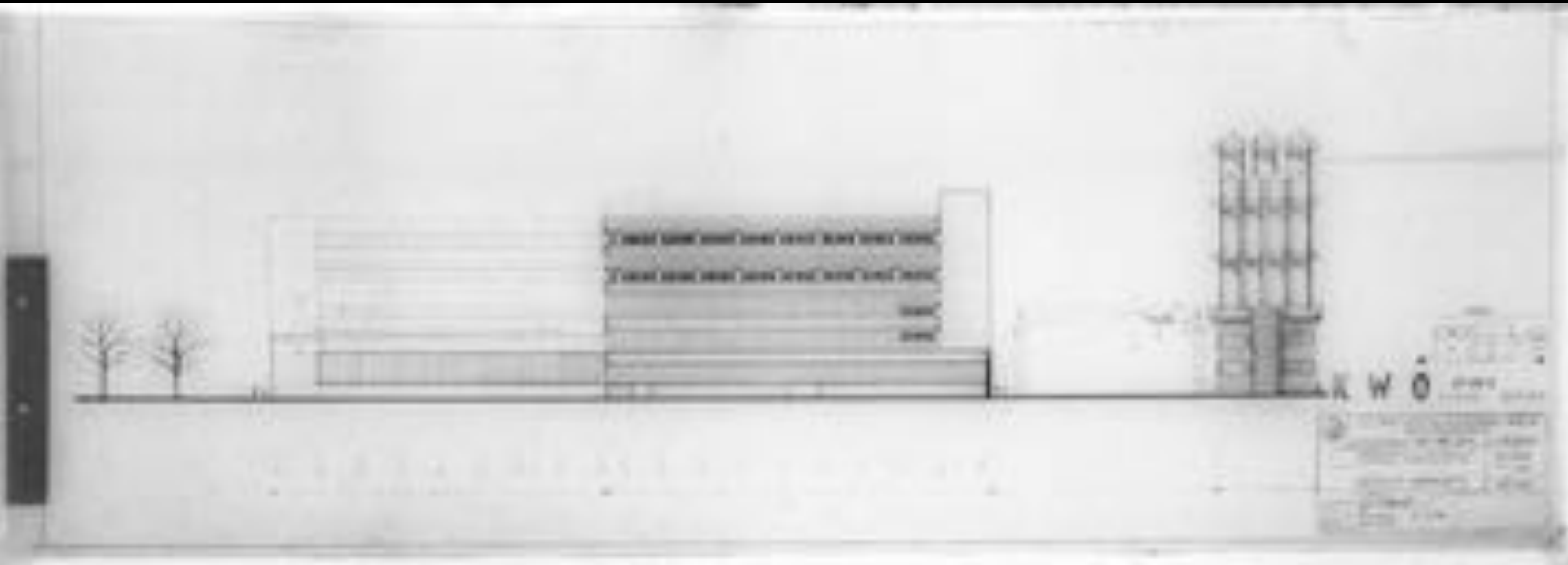




FOR A DIGITAL MODEL OF THE EXISTING



AND PROJECT IN LOD 2 (GIS)



ARCHITECTURE: FROM BITMAP





1<sup>st</sup> DIGITAL PLANS vectors -no section-



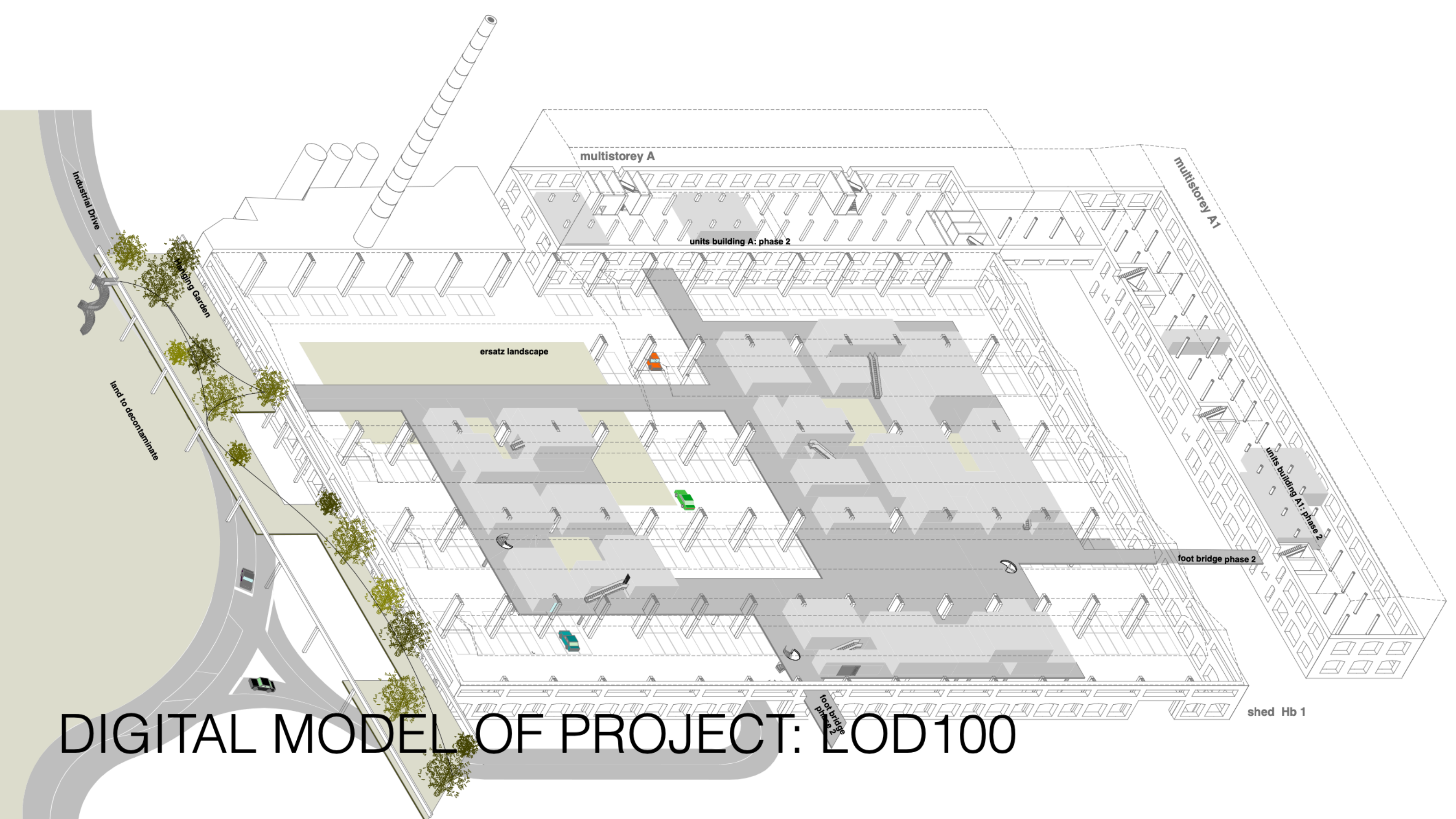
3<sup>rd</sup> DIMENSION FROM PHOTOGRAPHS





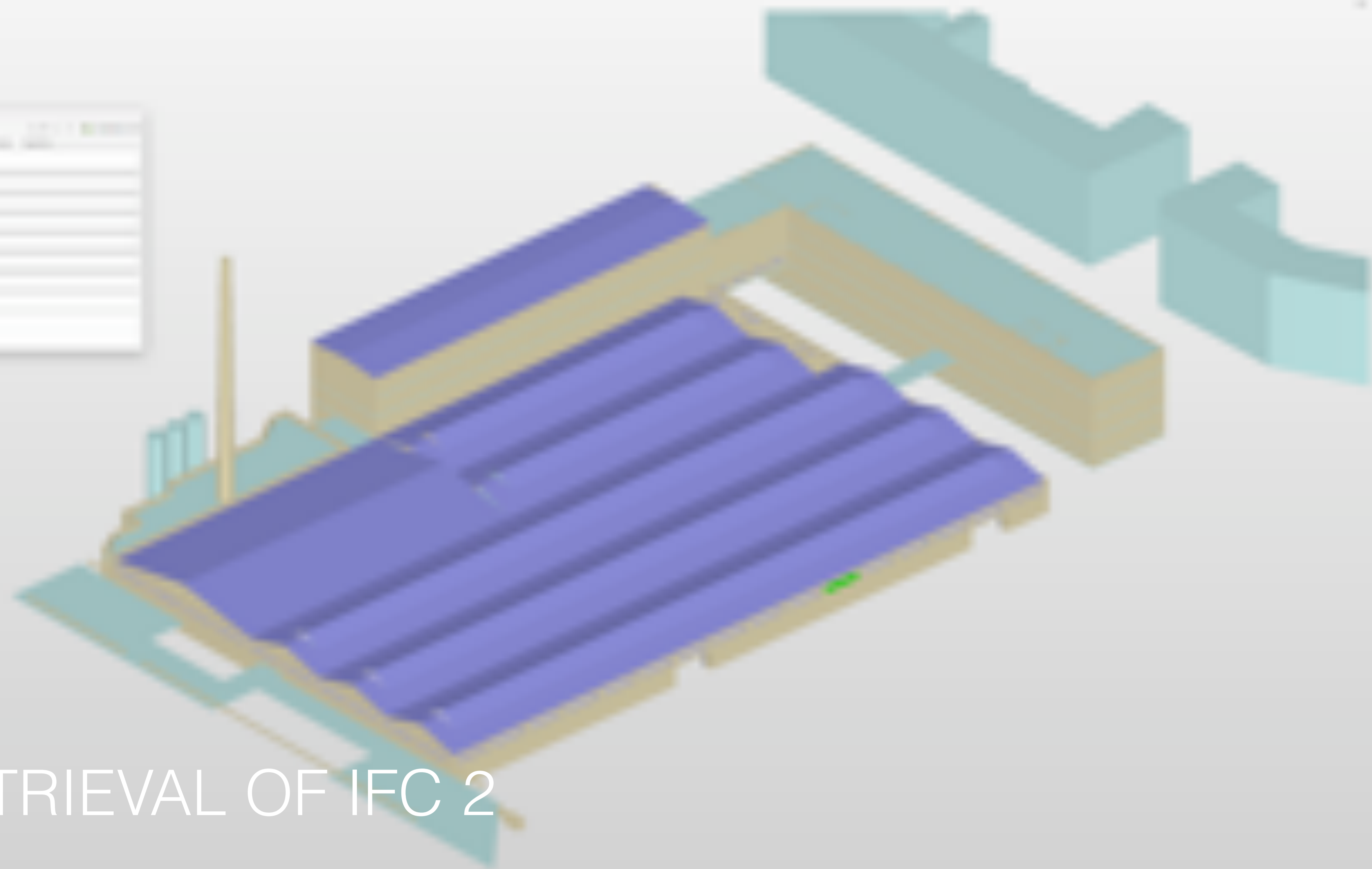
> PROJECT (work spaces for micro-companies)





# DIGITAL MODEL OF PROJECT: LOD100

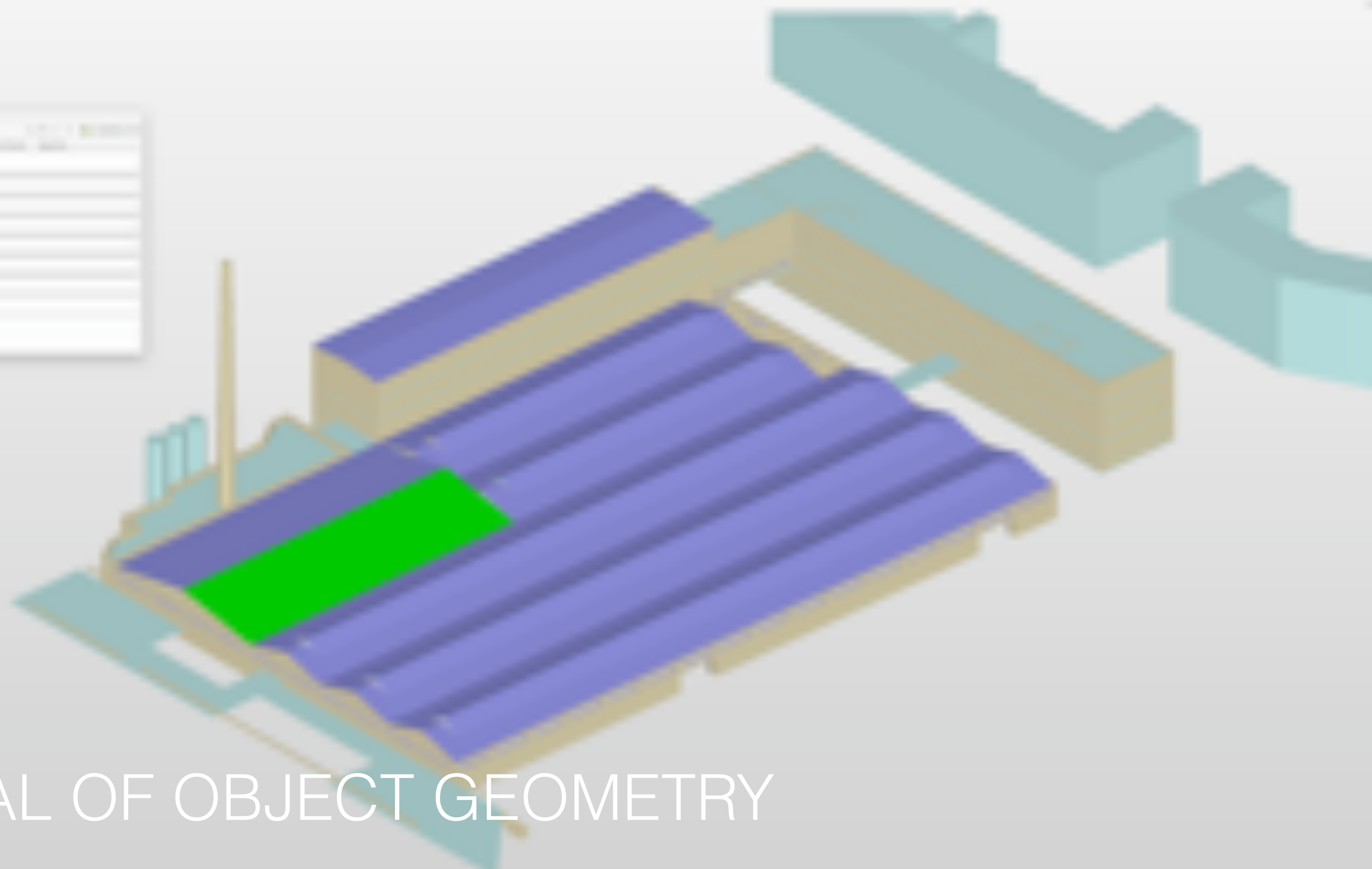
Item	Quantity	Unit	Material
1	100	m <sup>2</sup>	Concrete
2	50	m <sup>3</sup>	Rebar
3	200	m	Steel
4	150	m <sup>2</sup>	Brick
5	80	m <sup>3</sup>	Gravel
6	120	m <sup>2</sup>	Insulation
7	30	m <sup>3</sup>	Concrete
8	10	m <sup>3</sup>	Gravel
9	5	m <sup>3</sup>	Concrete
10	2	m <sup>3</sup>	Gravel



2018: RETRIEVAL OF IFC 2

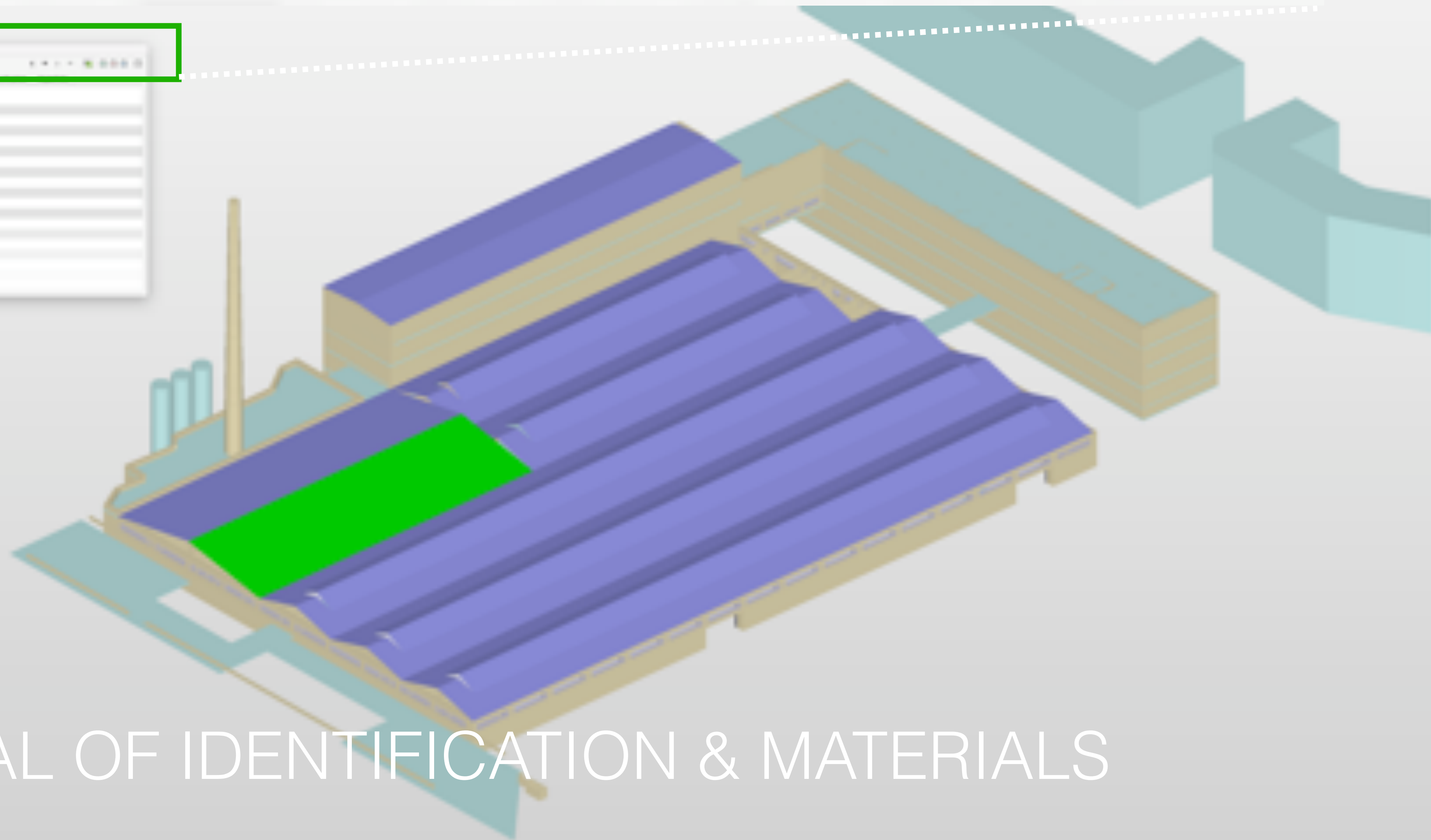


Object ID	Object Name	Material	Color	Dimensions (mm)
1	Block A	Aluminum	Blue	100x50x20
2	Block B	Steel	Yellow	150x75x30
3	Block C	Plastic	Light Blue	200x100x40
4	Block D	Wood	Green	80x40x15
5	Block E	Aluminum	Blue	120x60x25
6	Block F	Steel	Yellow	180x90x35
7	Block G	Plastic	Light Blue	250x120x50
8	Block H	Wood	Green	90x45x18
9	Block I	Aluminum	Blue	110x55x22
10	Block J	Steel	Yellow	160x80x32



RETRIEVAL OF OBJECT GEOMETRY

ID	Name
1000001	Concrete
1000002	Steel
1000003	Wood
1000004	Brick
1000005	Insulation
1000006	Roofing
1000007	Windows
1000008	Doors
1000009	Paint
1000010	Lighting

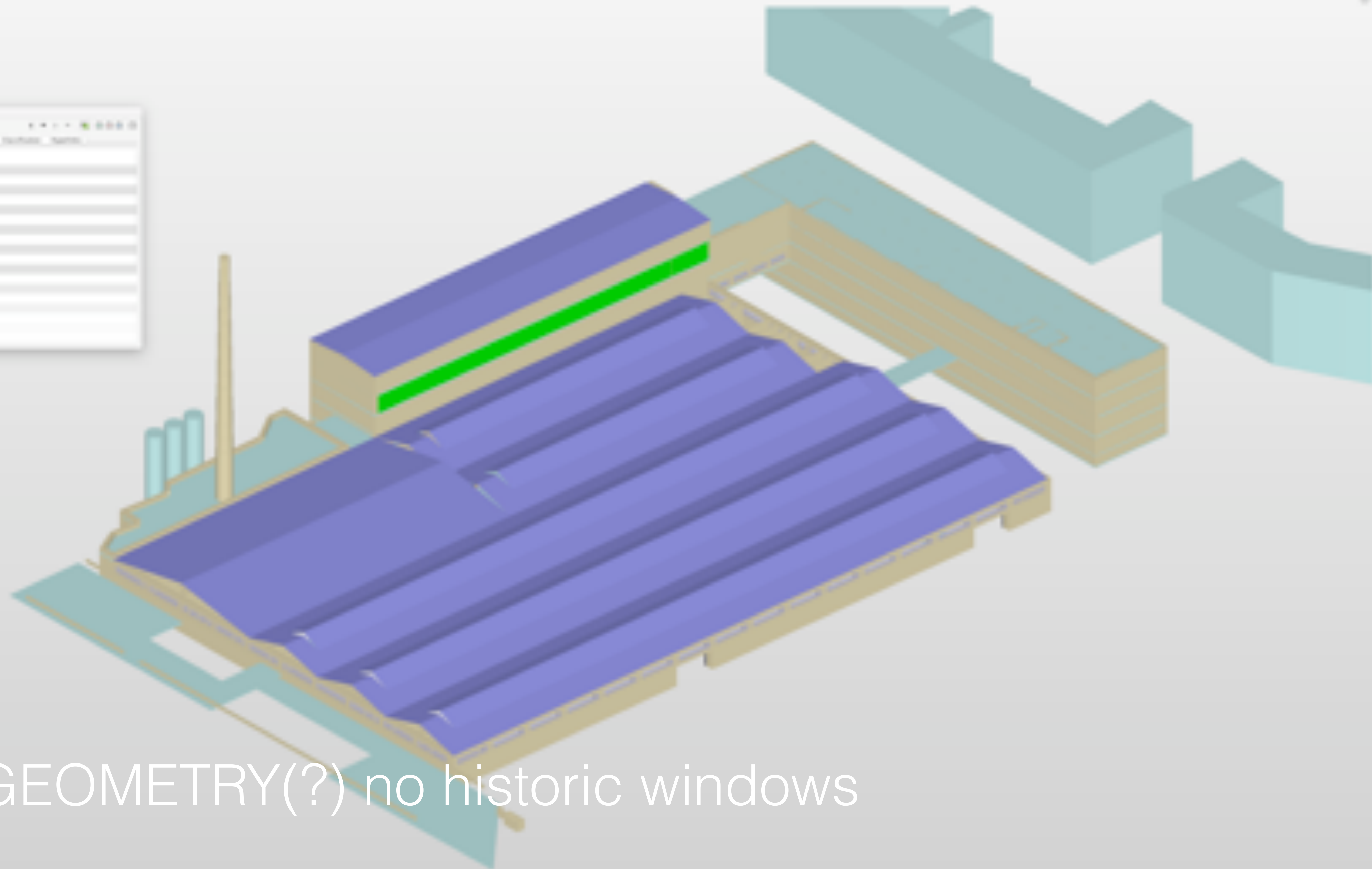


RETRIEVAL OF IDENTIFICATION & MATERIALS





Layer	Material	Thickness
1	Concrete	150
2	Concrete	150
3	Concrete	150
4	Concrete	150
5	Concrete	150
6	Concrete	150
7	Concrete	150
8	Concrete	150
9	Concrete	150
10	Concrete	150
11	Concrete	150
12	Concrete	150
13	Concrete	150
14	Concrete	150
15	Concrete	150
16	Concrete	150
17	Concrete	150
18	Concrete	150
19	Concrete	150
20	Concrete	150



MISSING GEOMETRY(?) no historic windows



# IFC4: POSSIBLE RETRIEVAL OF GEOMETRY IN 2060 (STATEMENT)

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# 02 TOUR BEL-AIR, LAUSANNE

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2016, ARCHITECT AT CCHE

# 1<sup>st</sup> SWISS SKYSCRAPER

Alphonse Laverrière architecte







FROM 2D DOCUMENTATION (.dxf) TO ...





... DIGITAL MODEL



FOR openBIM RENOVATION



& DESIGN ALTERNATIVES



# 1. MATERIALITY

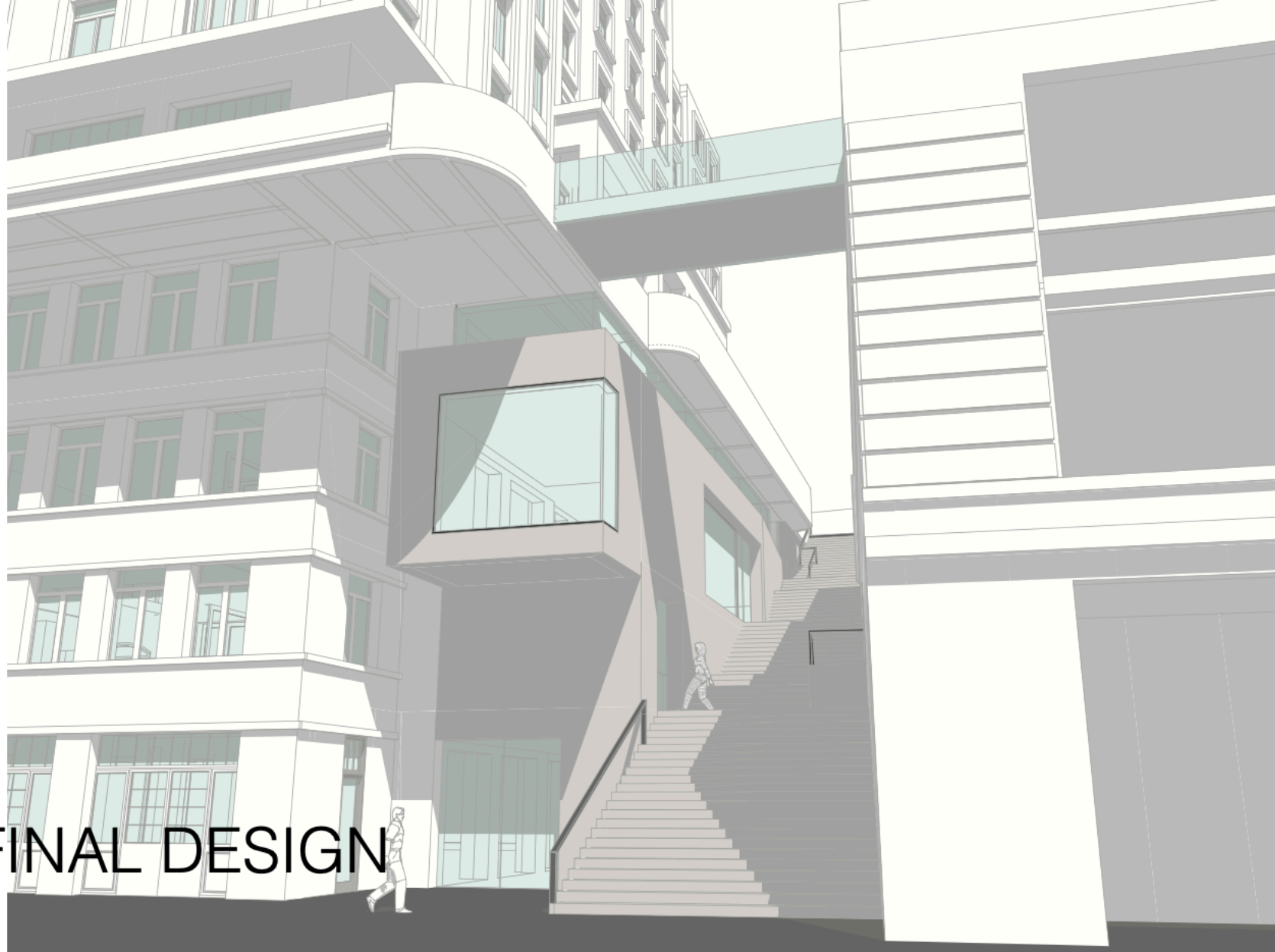


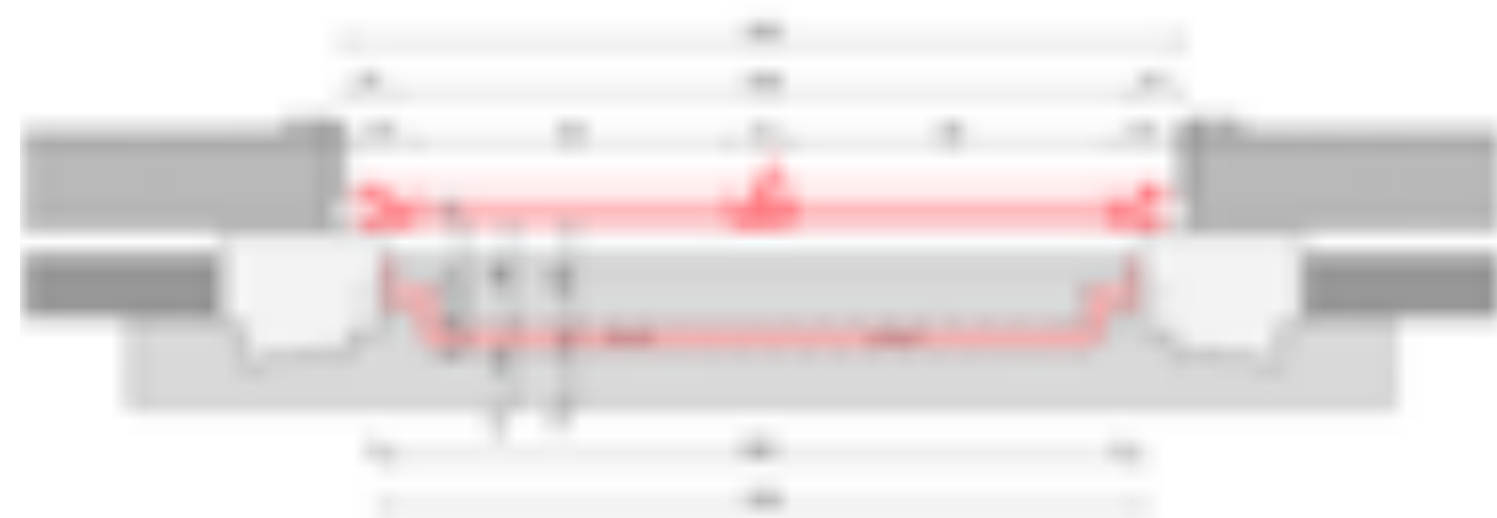
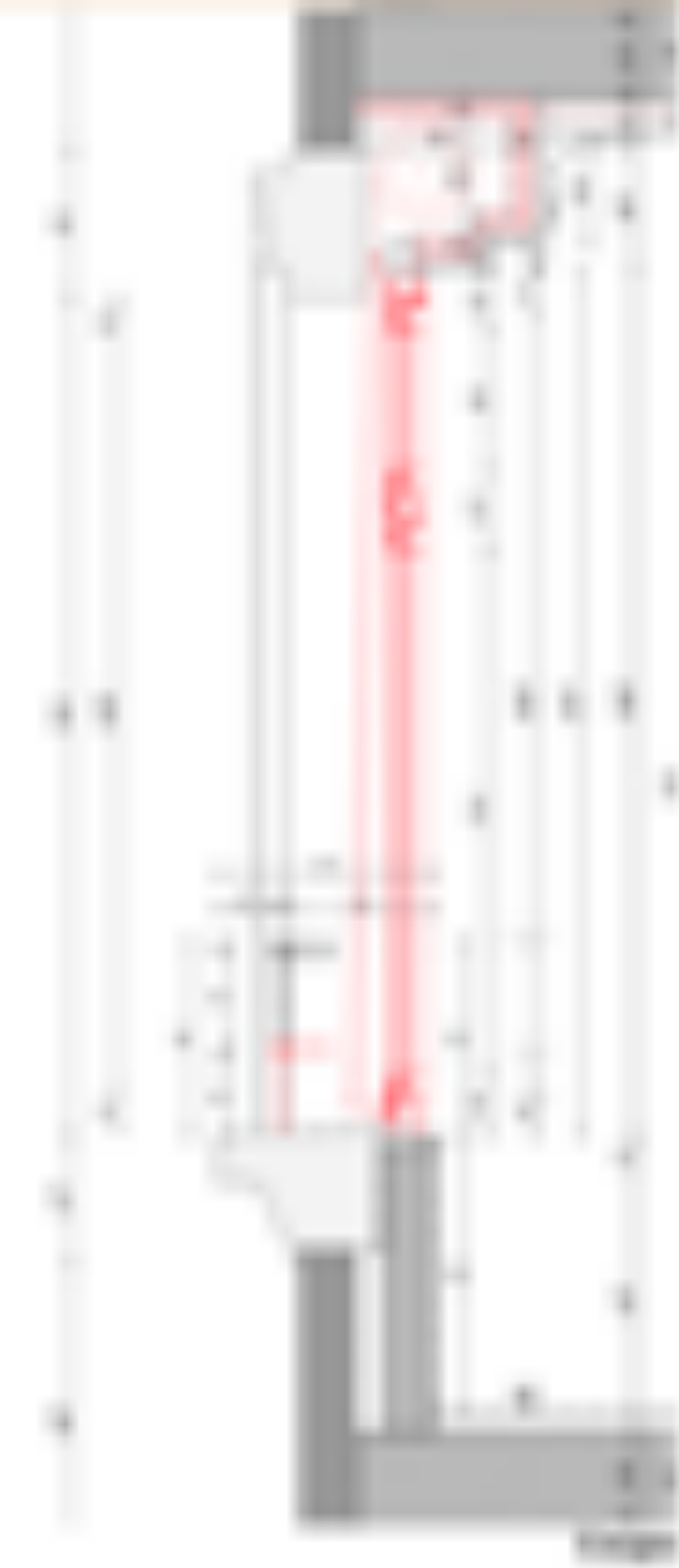
## 23. GEOMETRY





# 40. FINAL DESIGN





HISTORIC REFERENCE > COMPLIANCE



# DESIGN TEST

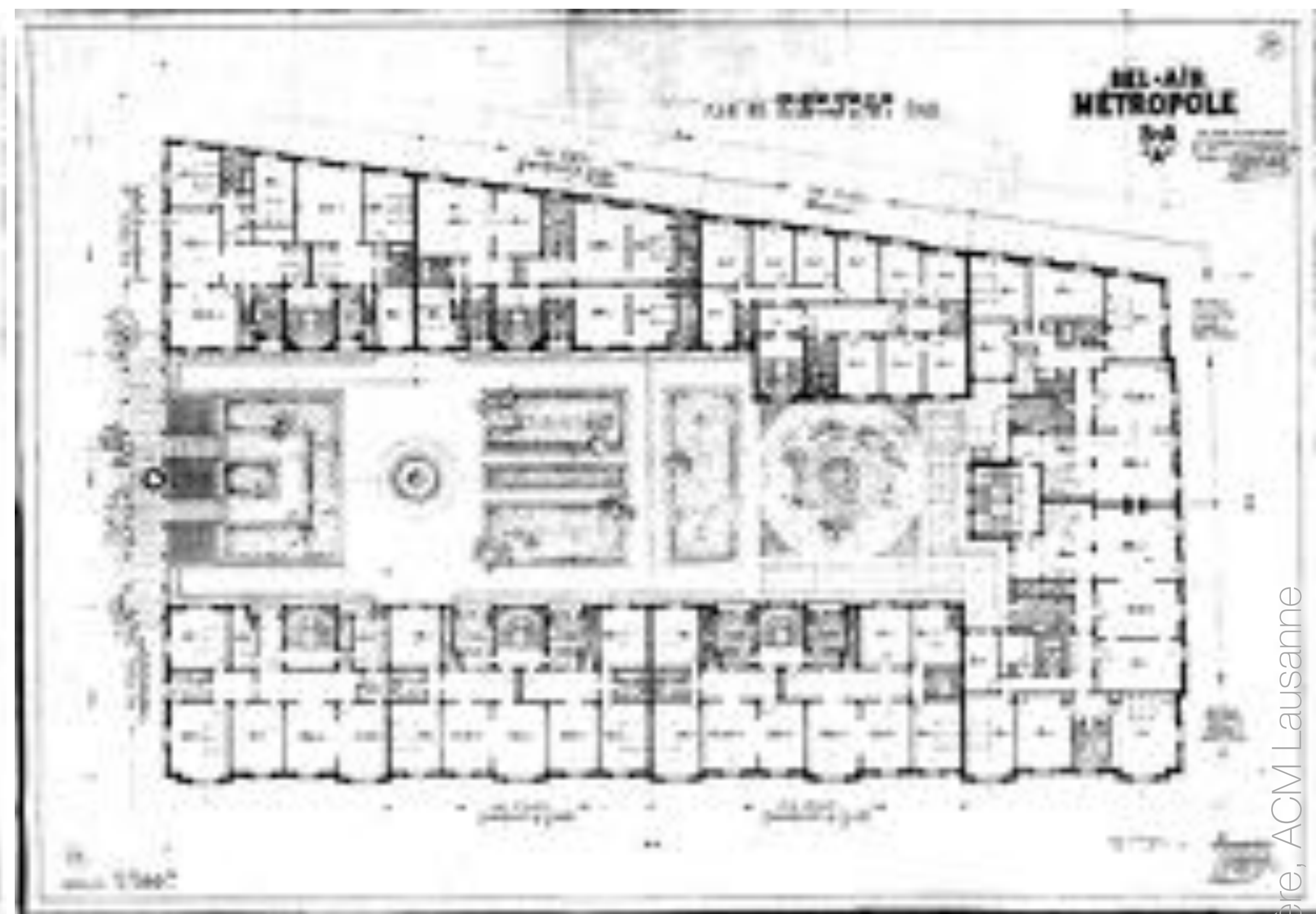
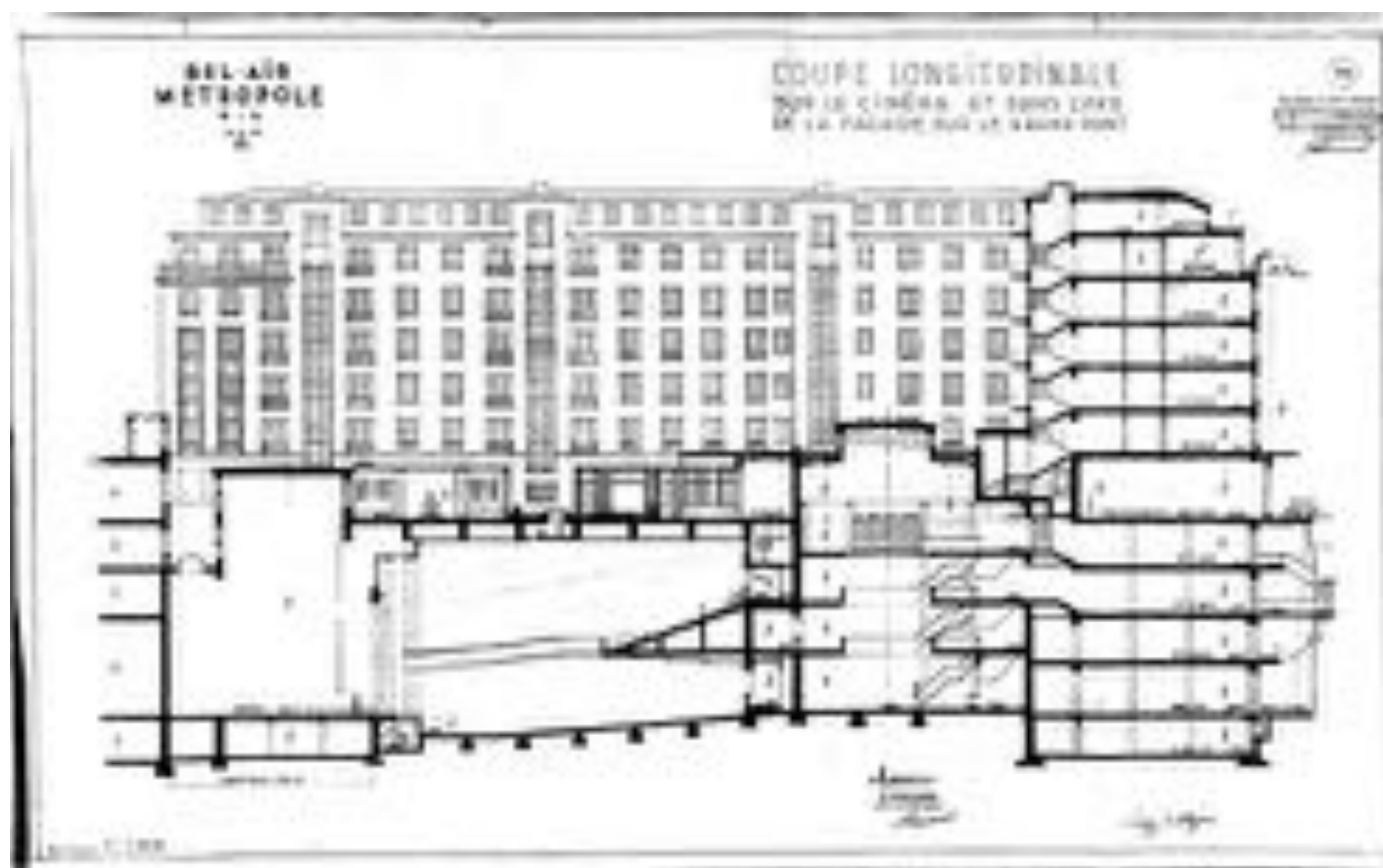




# DESIGN TEST







cp. MODELING THE ORIGINAL BUILDING

TO MANAGE CHANGE







e.g. LATE DESIGN : light for the redundant entrance

MODEL OF THE ORIGINAL BUILDING  
TO UNDERSTAND HISTORIC SPACES & USES



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# 03 VALLORBE GARE

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2018,  **SBB CFF FFS** PILOT PROJECT





VALLORBE





COMPLEX WITH CUSTOMS



**SIMPLON-ORIENT-EXPRESS**



GRANDE BRETAGNE . FRANCE . SUISSE . ITALIE  
SERBIE . CROATIE . SLOVENIE . BULGARIE  
ROUMANIE . GRÈCE . TURQUIE . SYRIE



**LIGNE DU SIMPLON**

*la plus directe  
et la plus pittoresque!*

EDMUND  
PARIS  
FRIEDBURG  
LAUSANNE  
GENÈVE  
MILANO  
ROMA  
ATHÈNES  
LE CAIRE



FIFTEEN ORIGINALS TO BE KEPT AT THE ARCHIVE



NON-EXPLOITABLE DOCUMENTATION





# USE OF LASER- & PHOTOGRAMMETRY

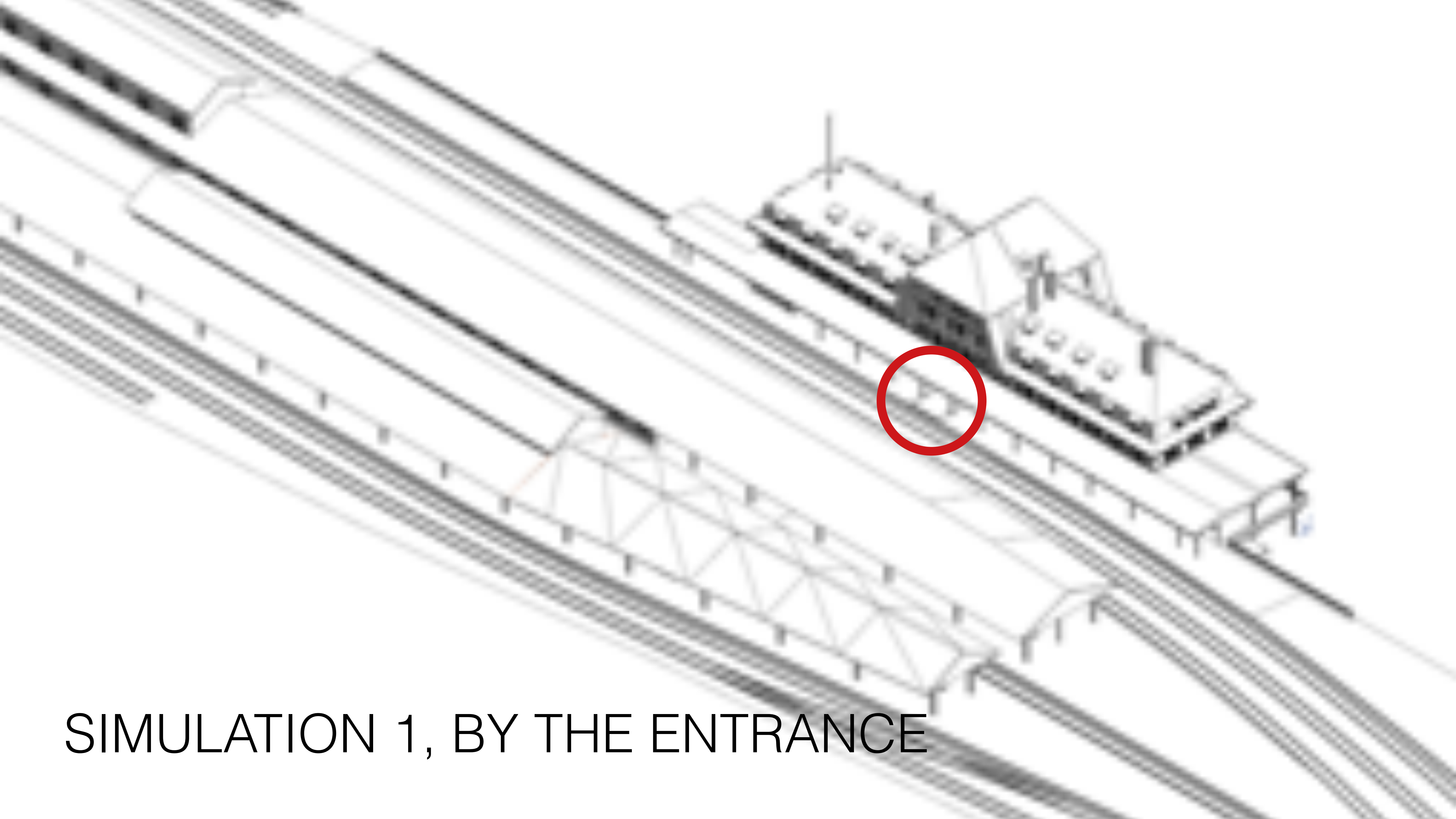




AIM OF PILOT PROJECT : LOD 300 with simulation of renovation

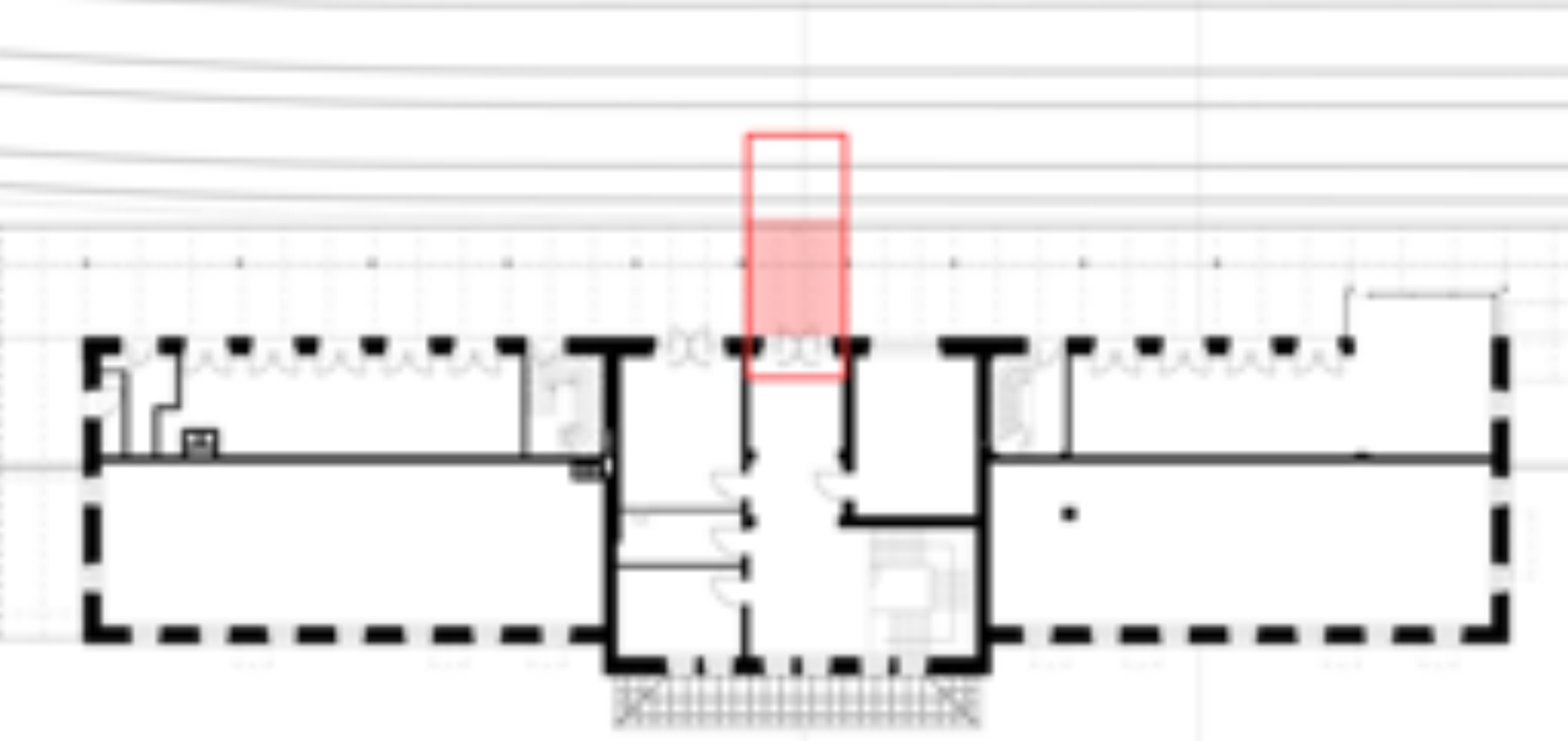


SBB ENQUIRY I : geometry  
e.g. stepless access to trains

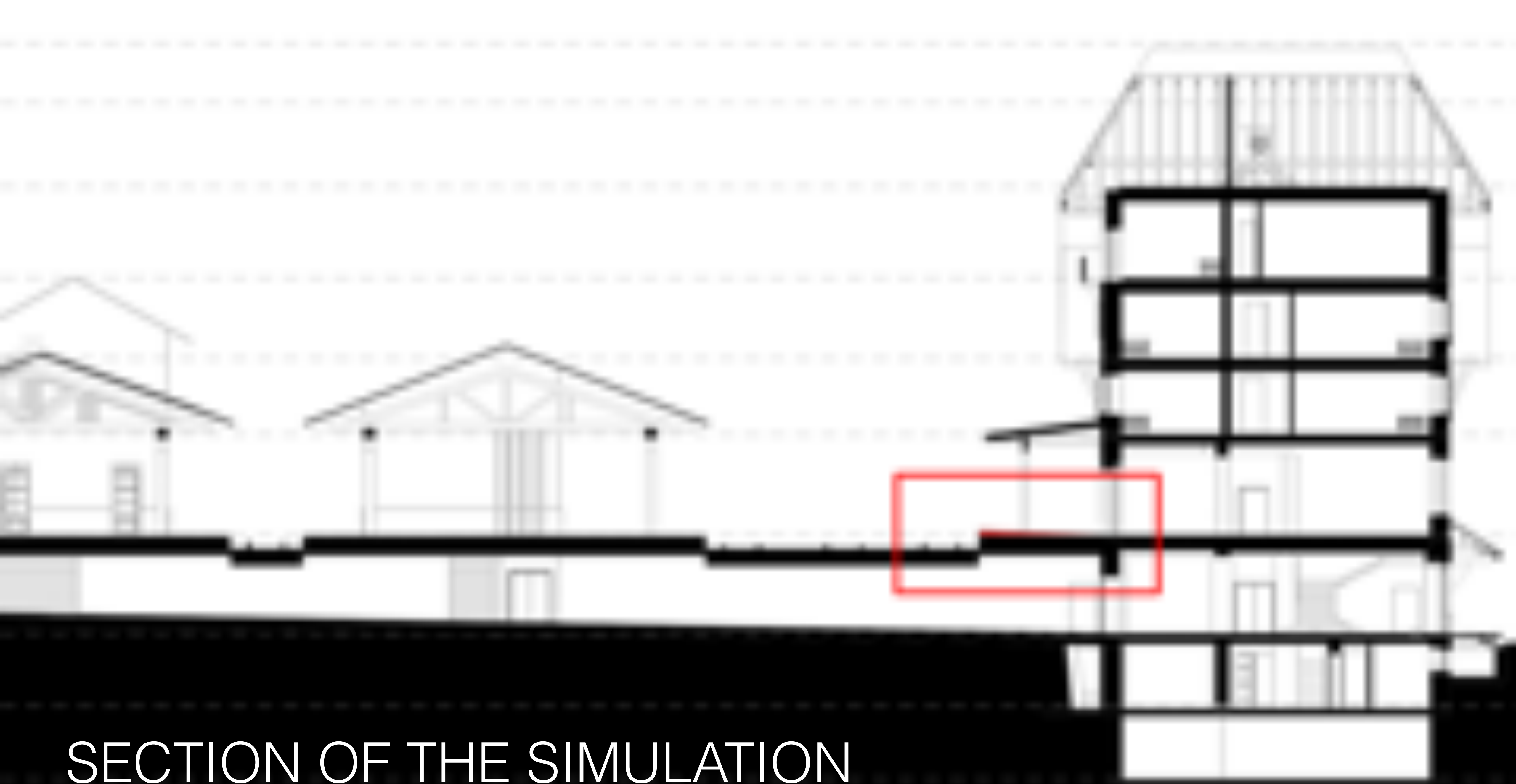


SIMULATION 1, BY THE ENTRANCE



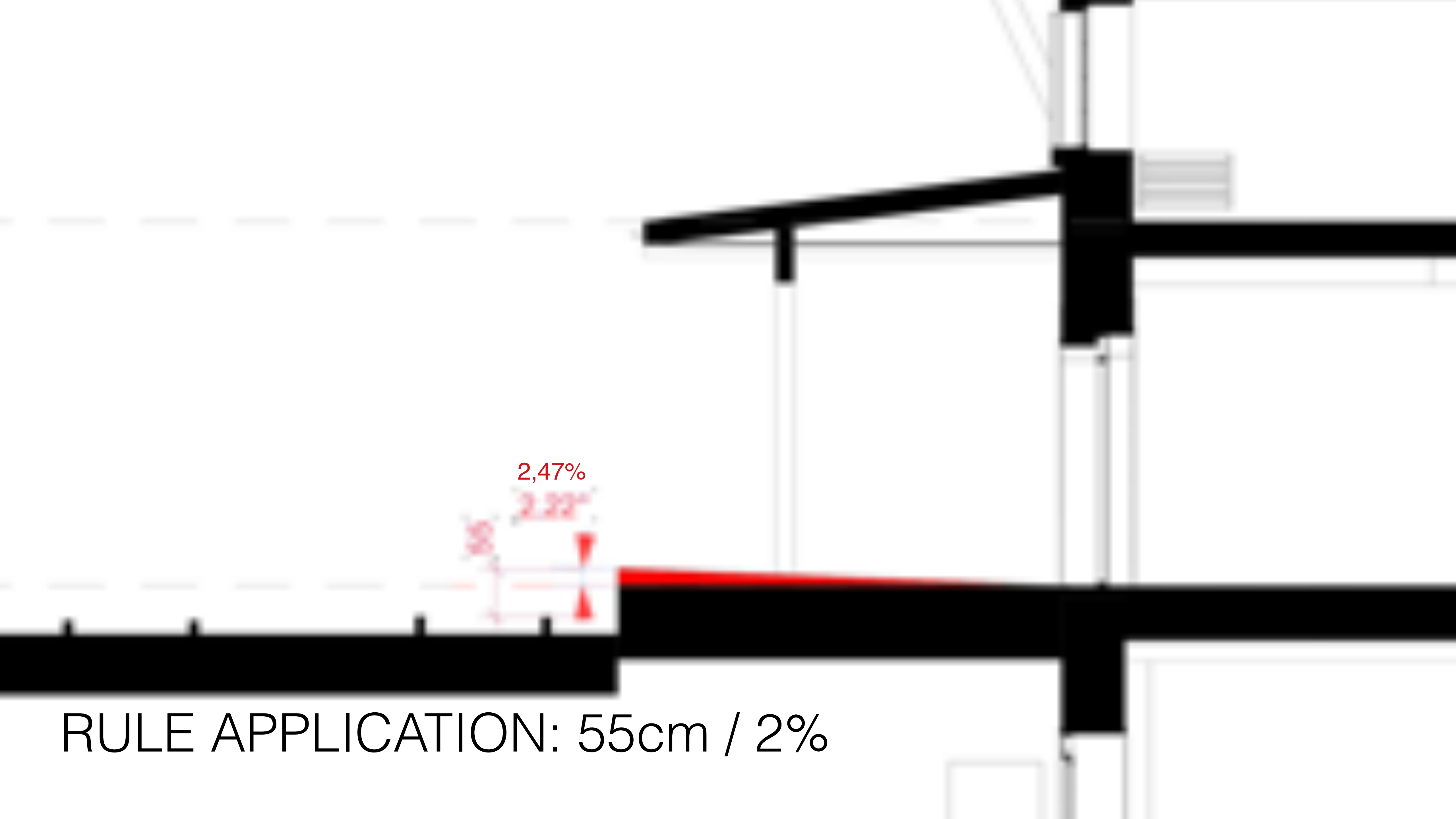


ZONE OF THE SIMULATION



SECTION OF THE SIMULATION



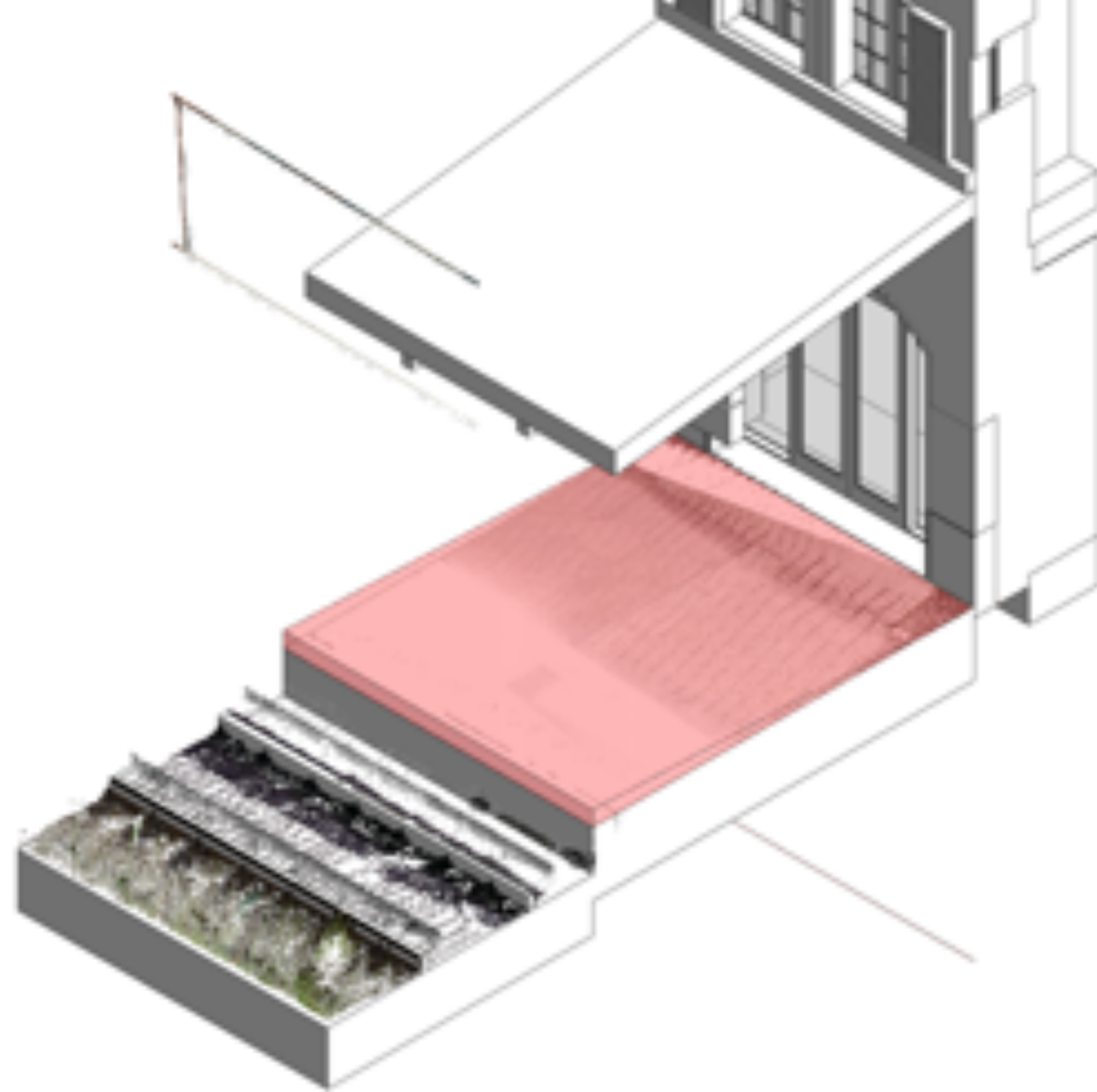


2,47%

2,32°

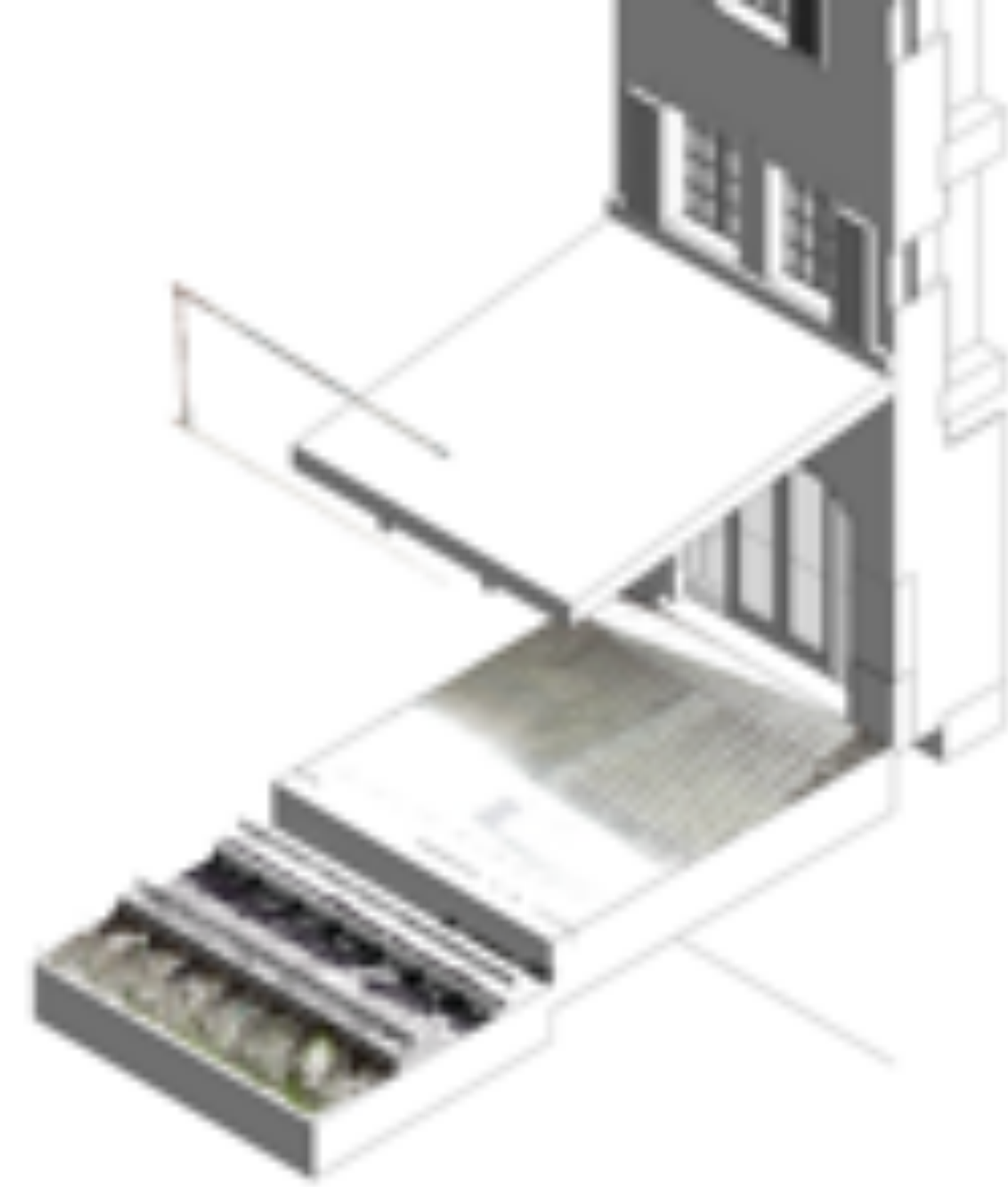
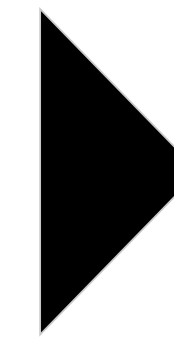
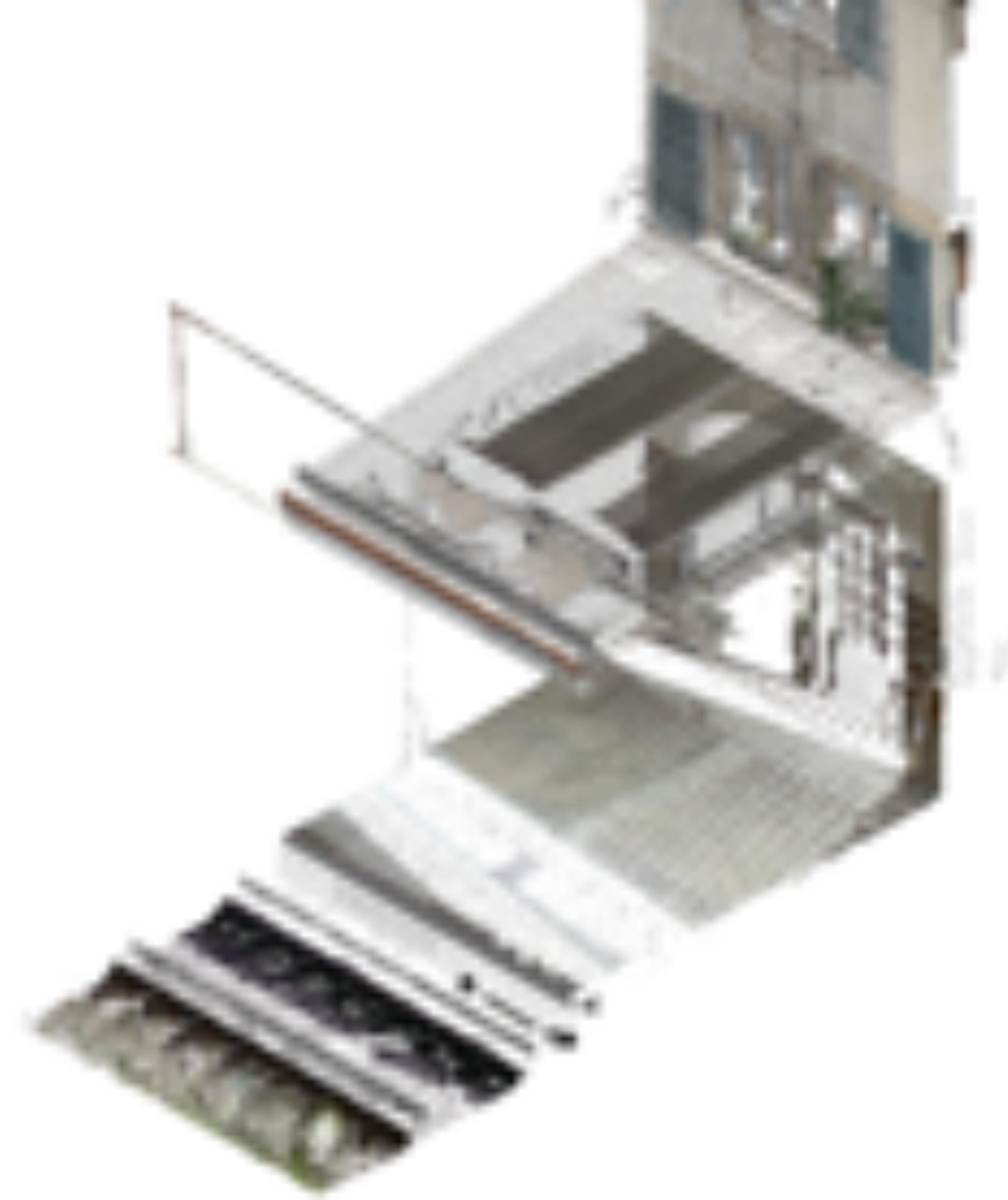
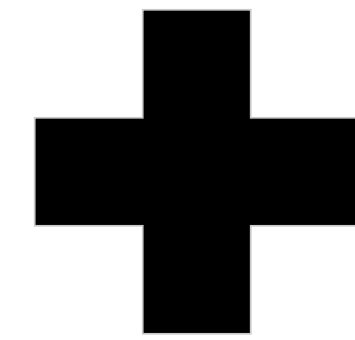
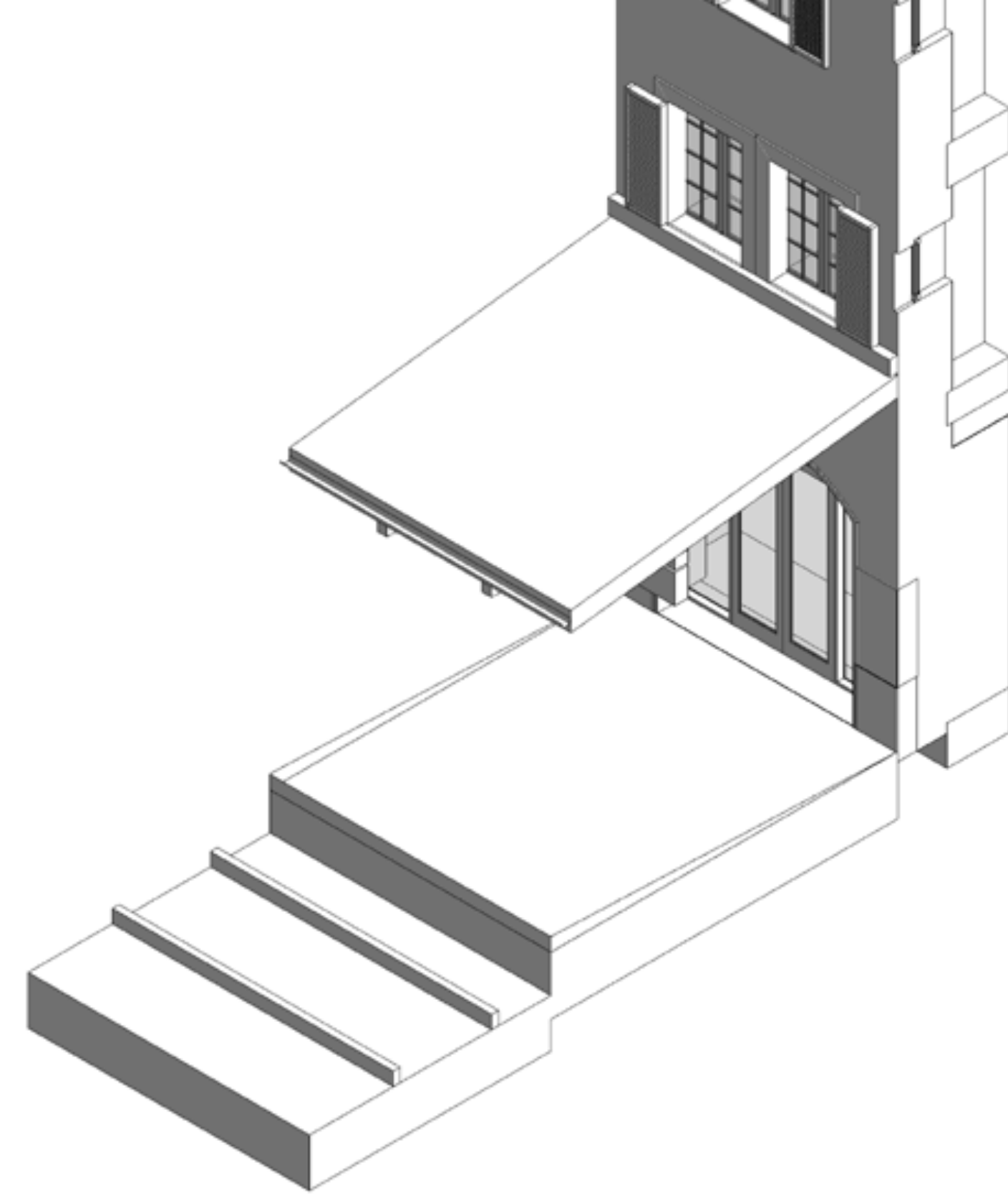
8

RULE APPLICATION: 55cm / 2%



POINT CLOUD + MODIFICATION





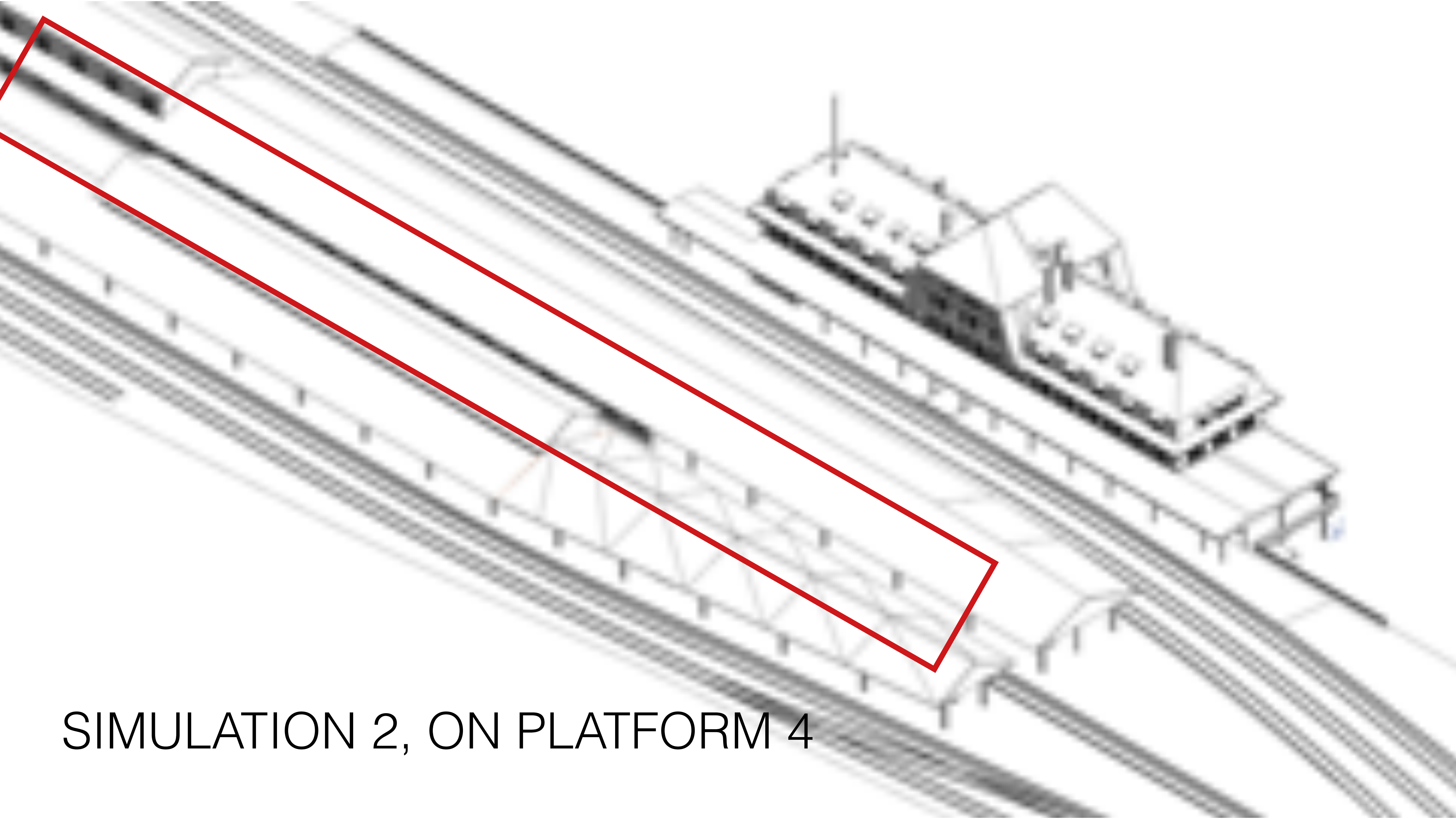
digital model architecture

point cloud from GIS expert

both superimposed

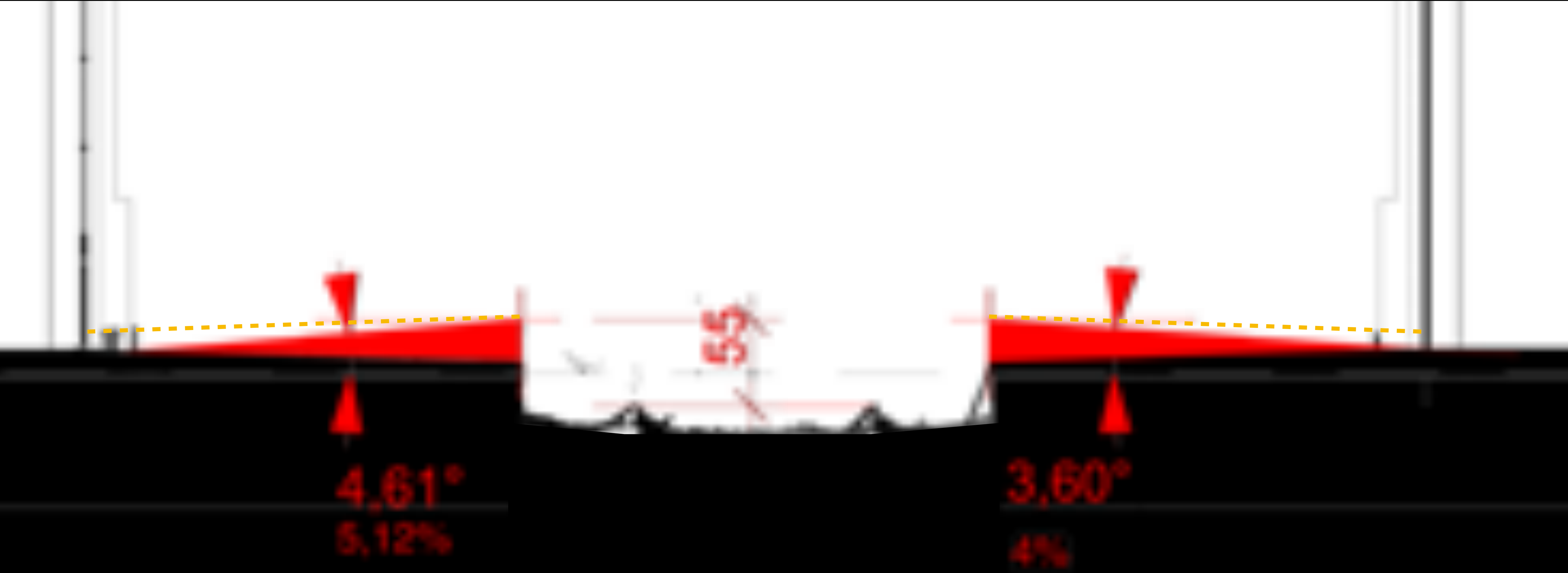
MODEL + 3D SCAN = 1cm planning precision





SIMULATION 2, ON PLATFORM 4





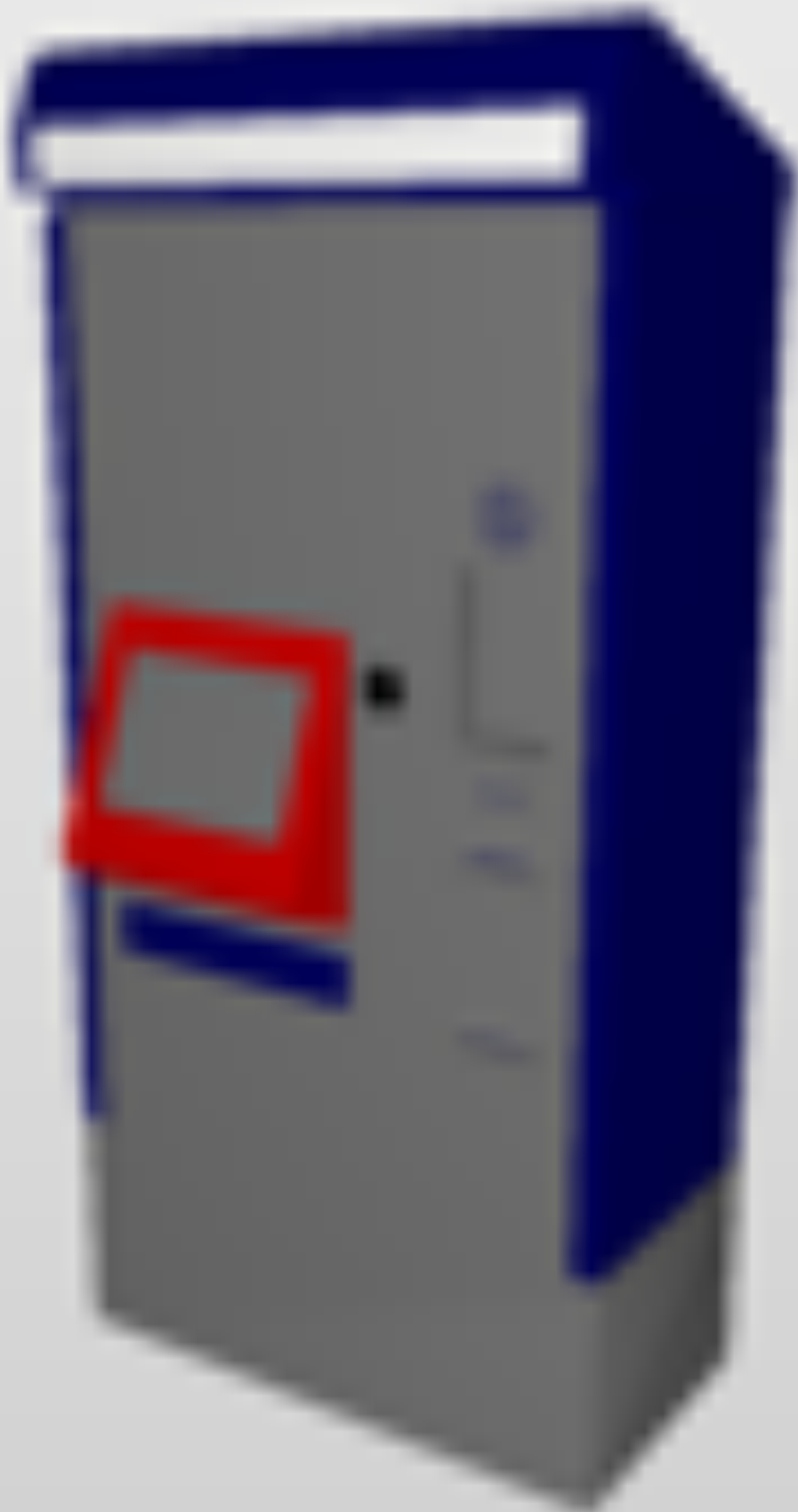
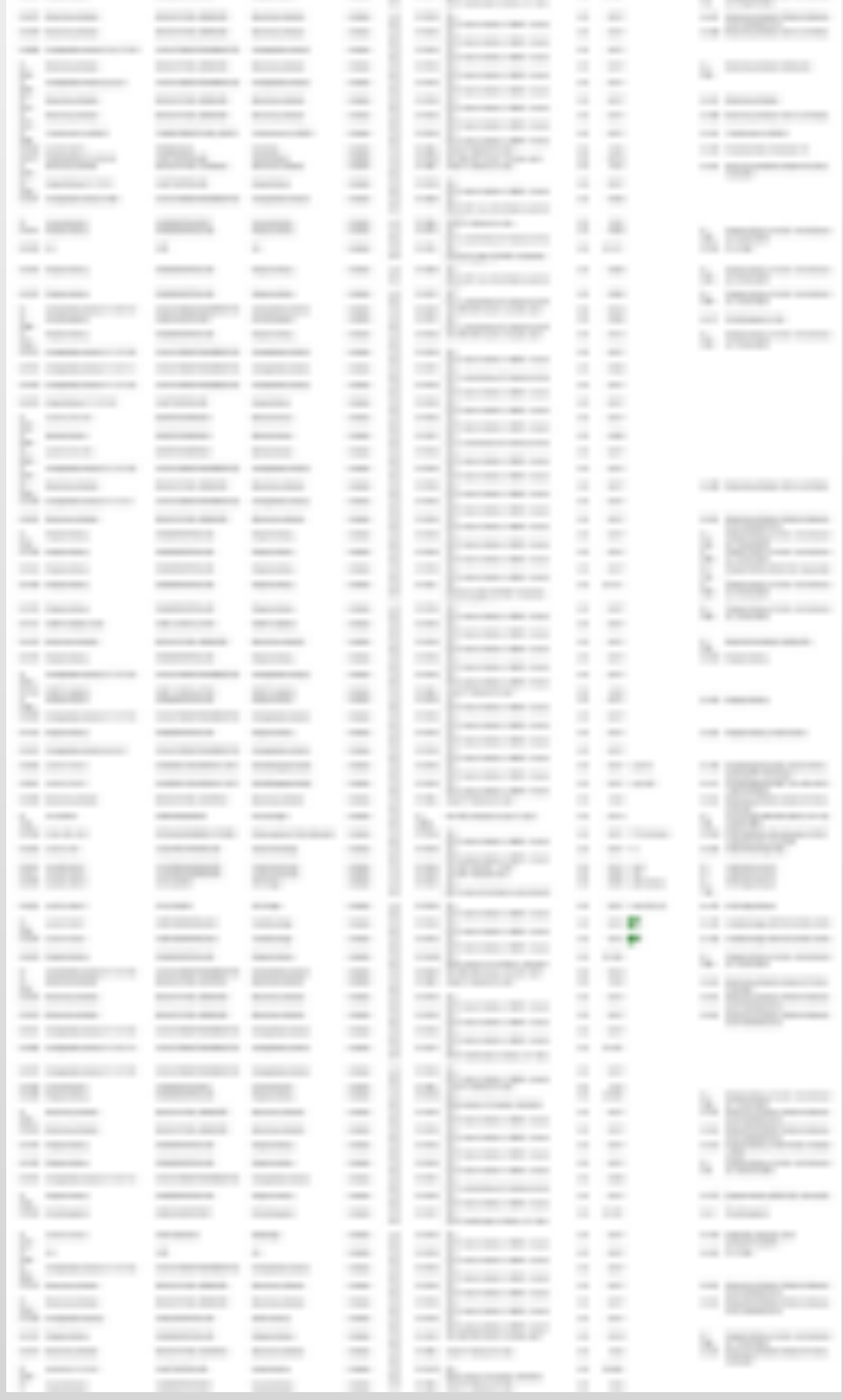
CONFLICT : HISTORIC DOORS vs 2% RAMP

SBB ENQUIRY II : databank  
crossing with digital model

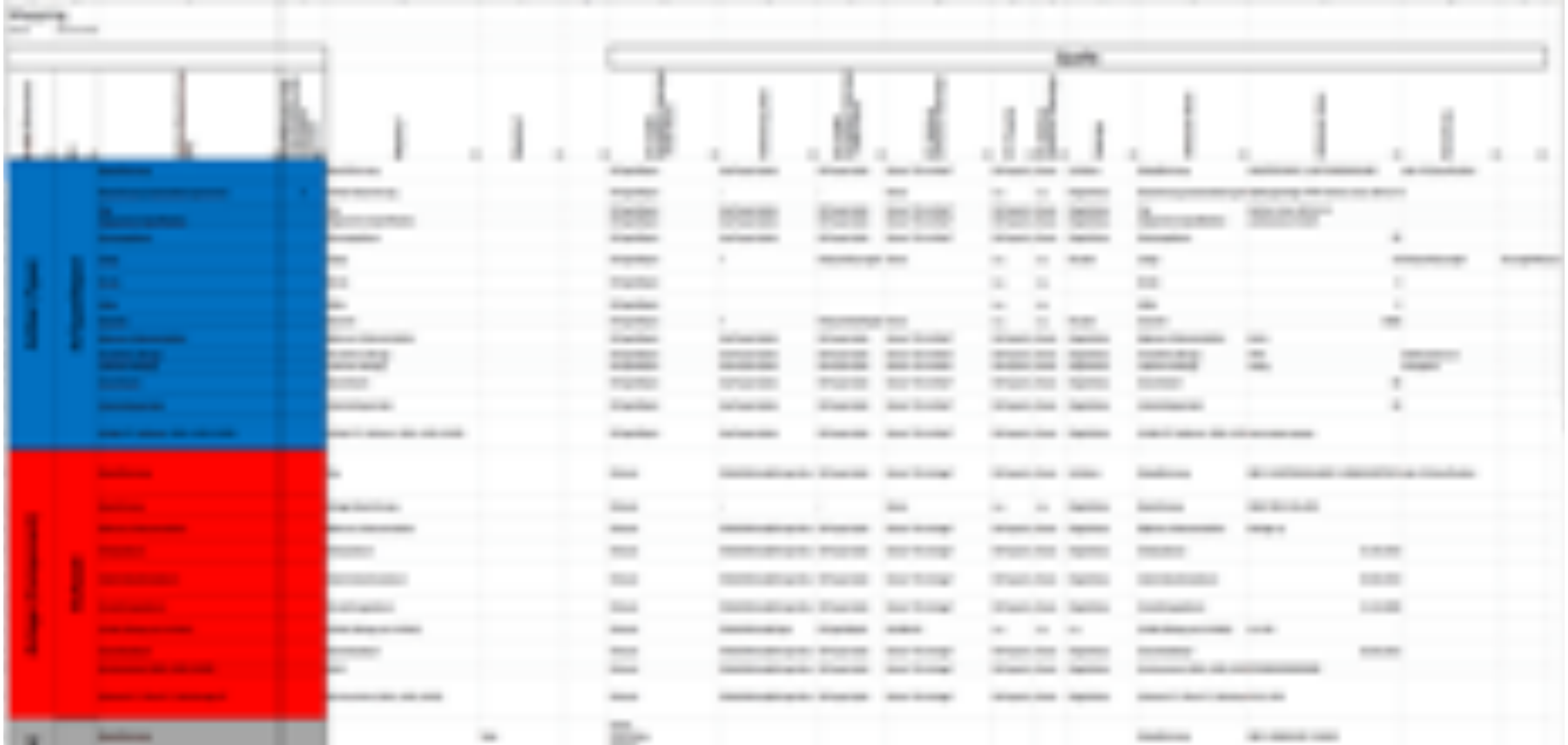




IO-1Q06	VAL-ZAM-04	PERRONANZEIGER	Perronanzeiger	In Betrieb	I-AT-KUF	ST-2WMA	VAL-PD02, Marquise de quai 2, Quai 2	200	46.143		AL-AWL	Perronanzeiger BMG MIS (AEG) LCD 4 doppelseitig ZAM4
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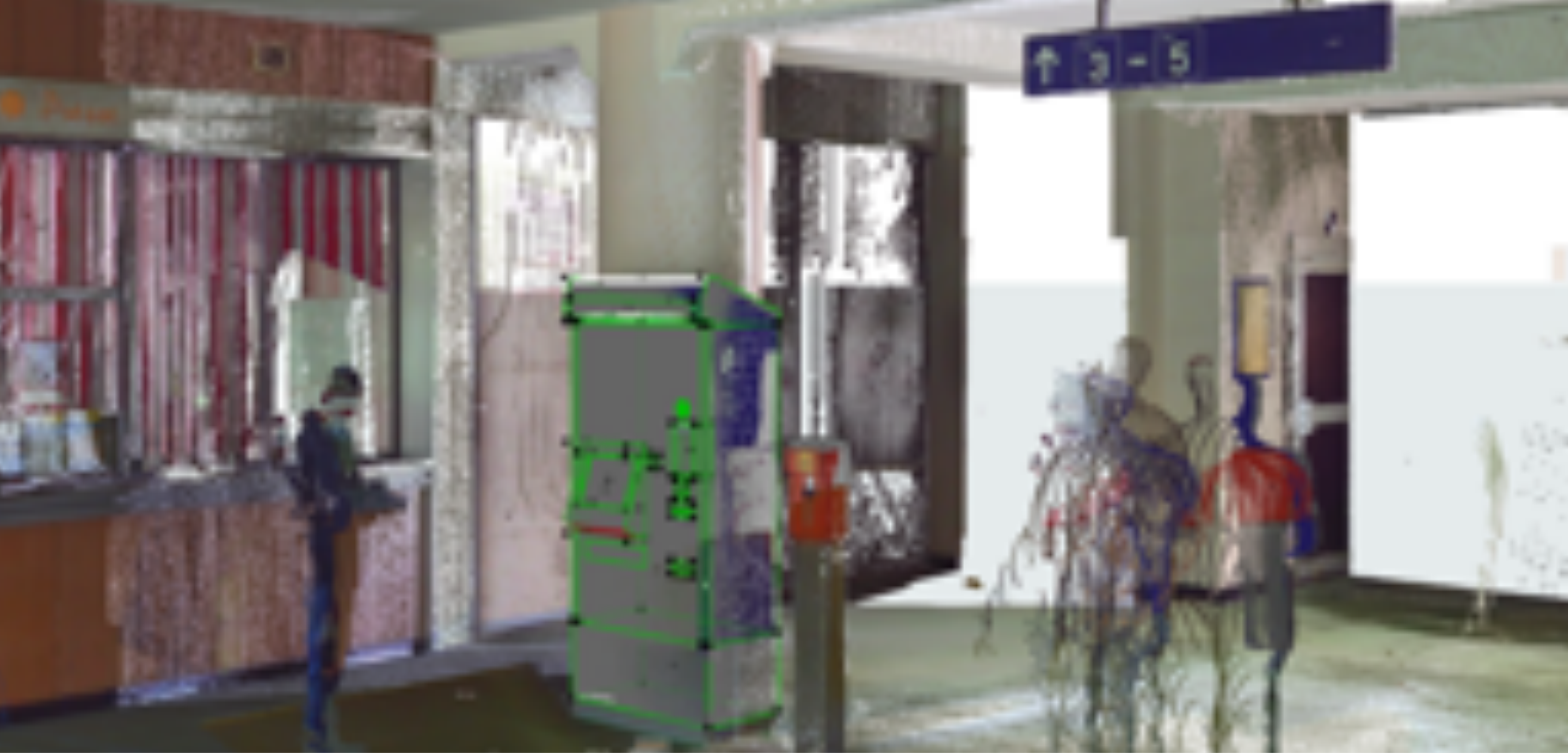


EACH TRAIN STATION = hundreds of items



EACH ITEM = large volumes of data





1 WAY OF CROSSING : georeferenced objects ...

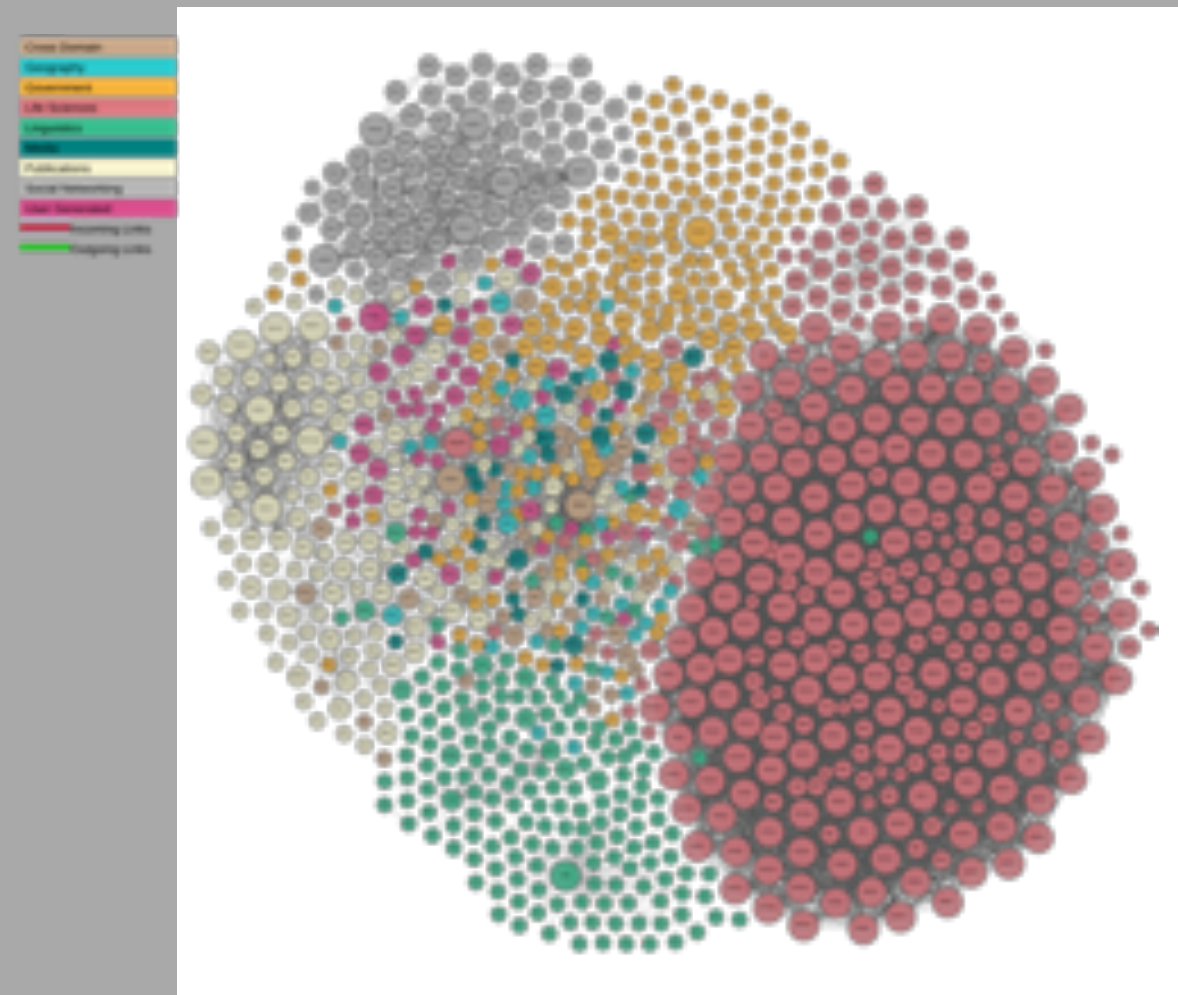




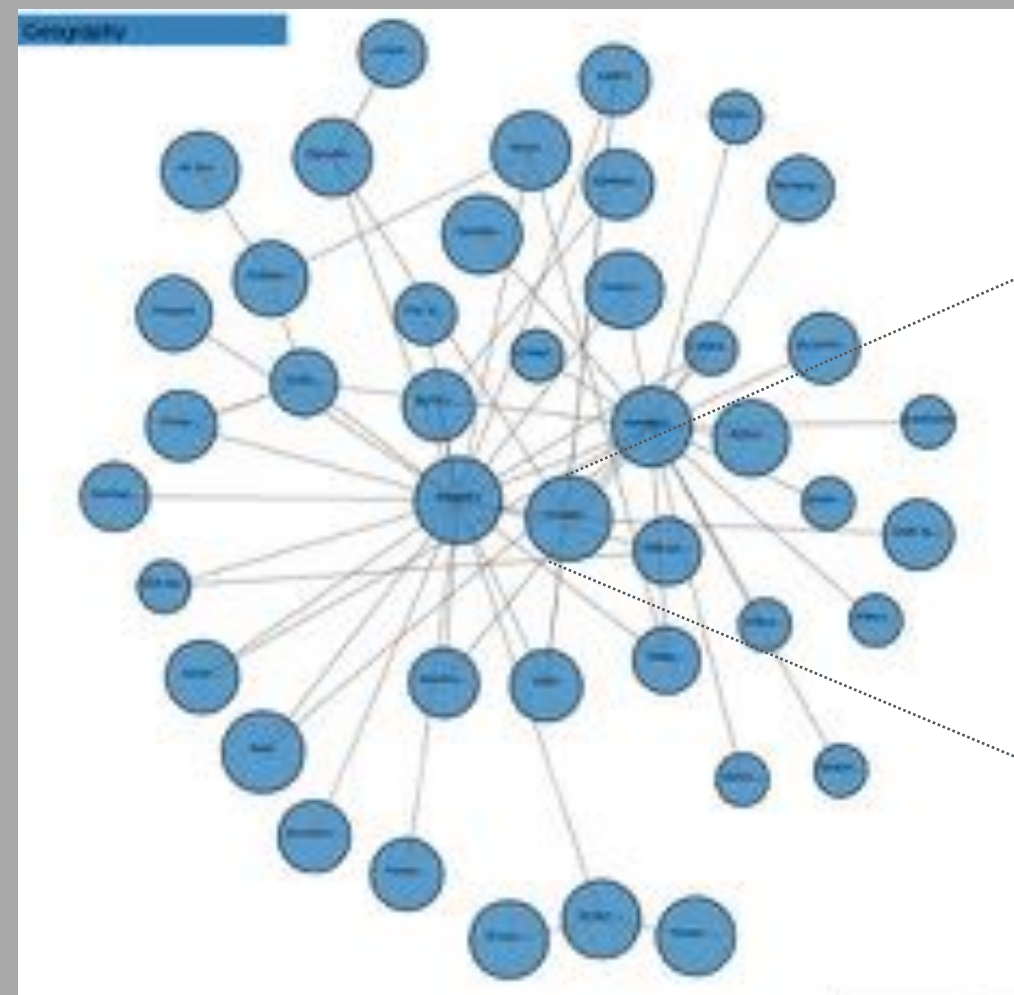
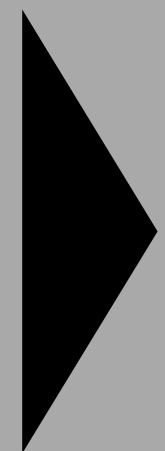
... WITHIN GEOREFERENCED MODEL





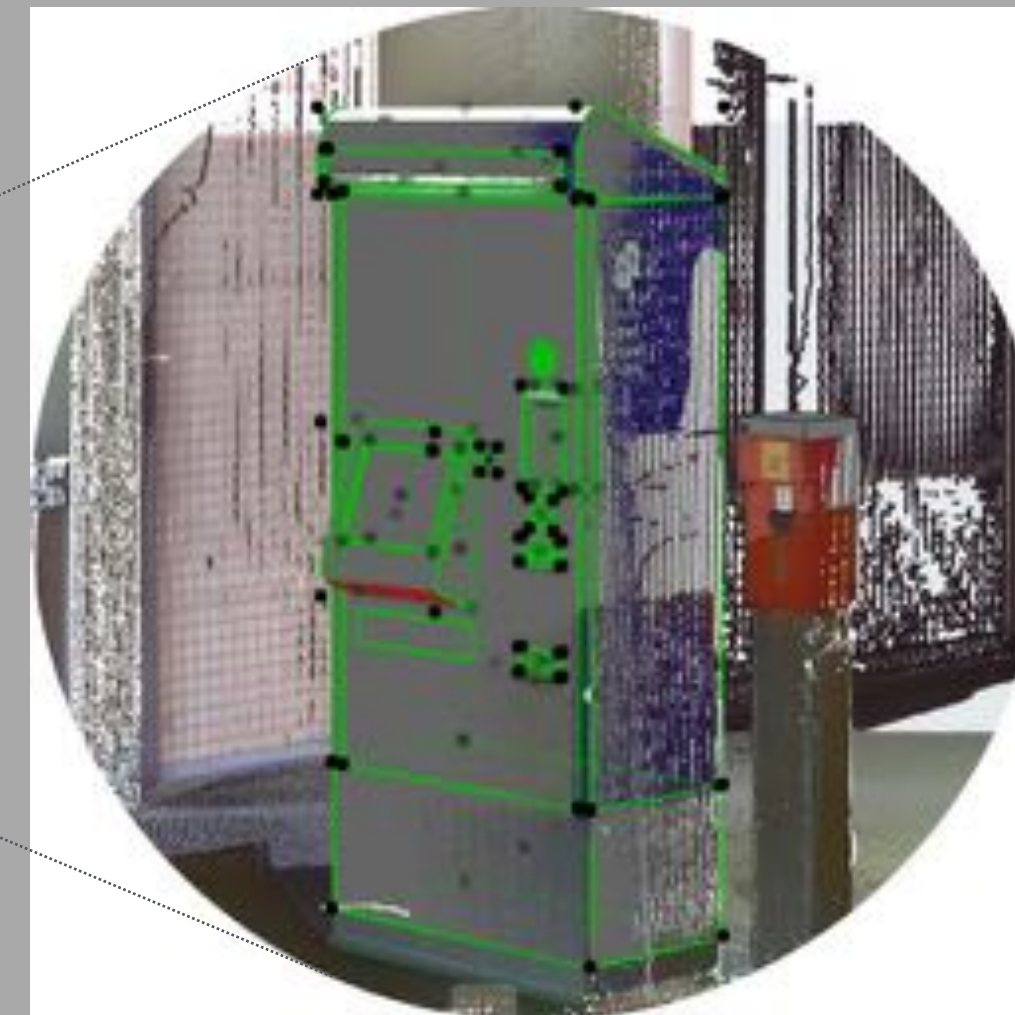


**interdisciplinary dataset**



**disciplinary dataset**

e.g. SBB technical device databank



**building and object geometry**

points & mesh with georeferencing

WAITING FOR BIM-linked data...

MODELING IN THE CLOUD (of geomatics)



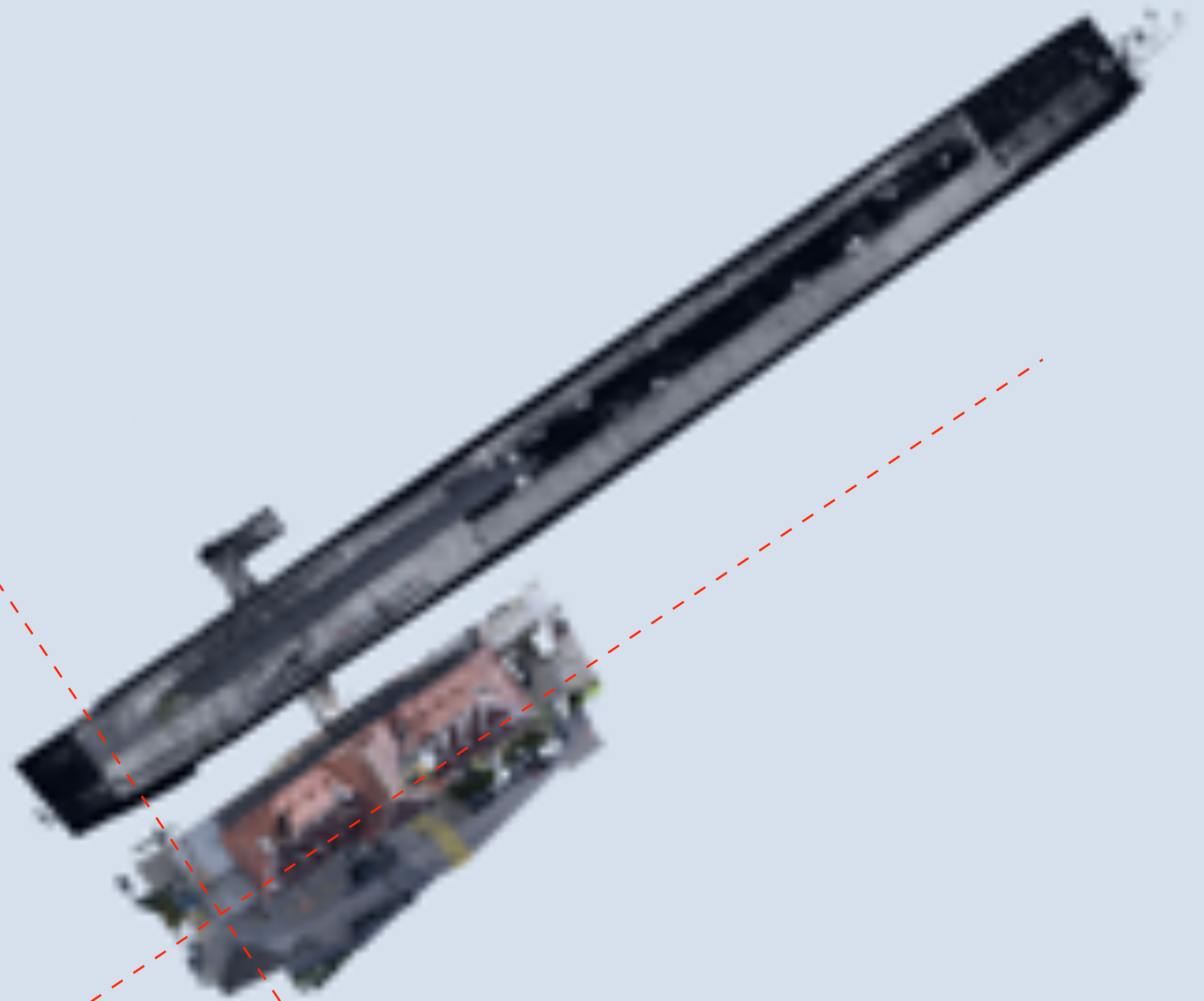
Swiss coordinate system : MN 95

x = 2'734'684.1

y = 491'549.30

z = 802.872

Nor 324.82°



GEOREFERENCED 3D SCAN



CLOUD COMPILATION OF 50 Gb







GARE C.F.F.











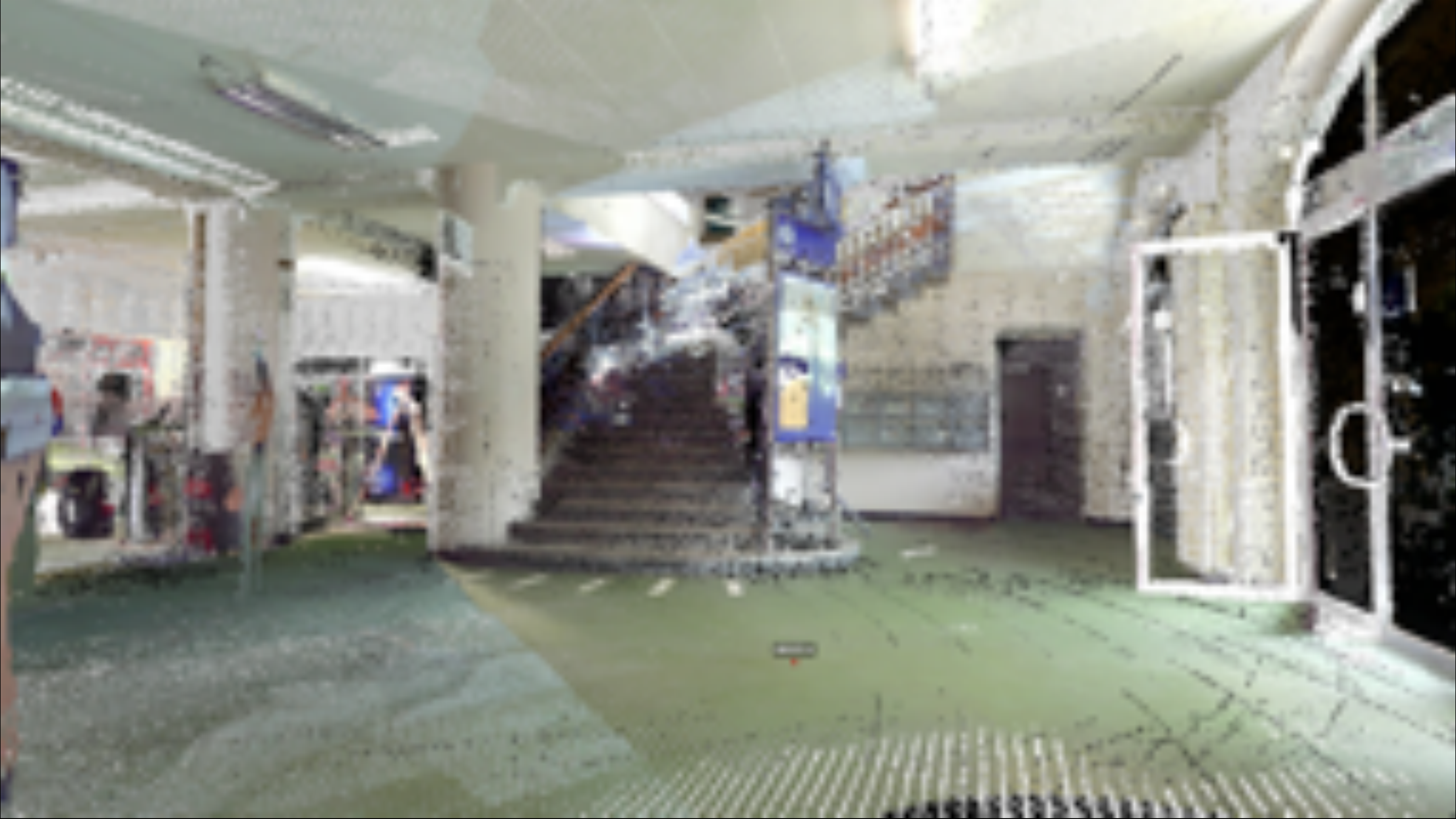








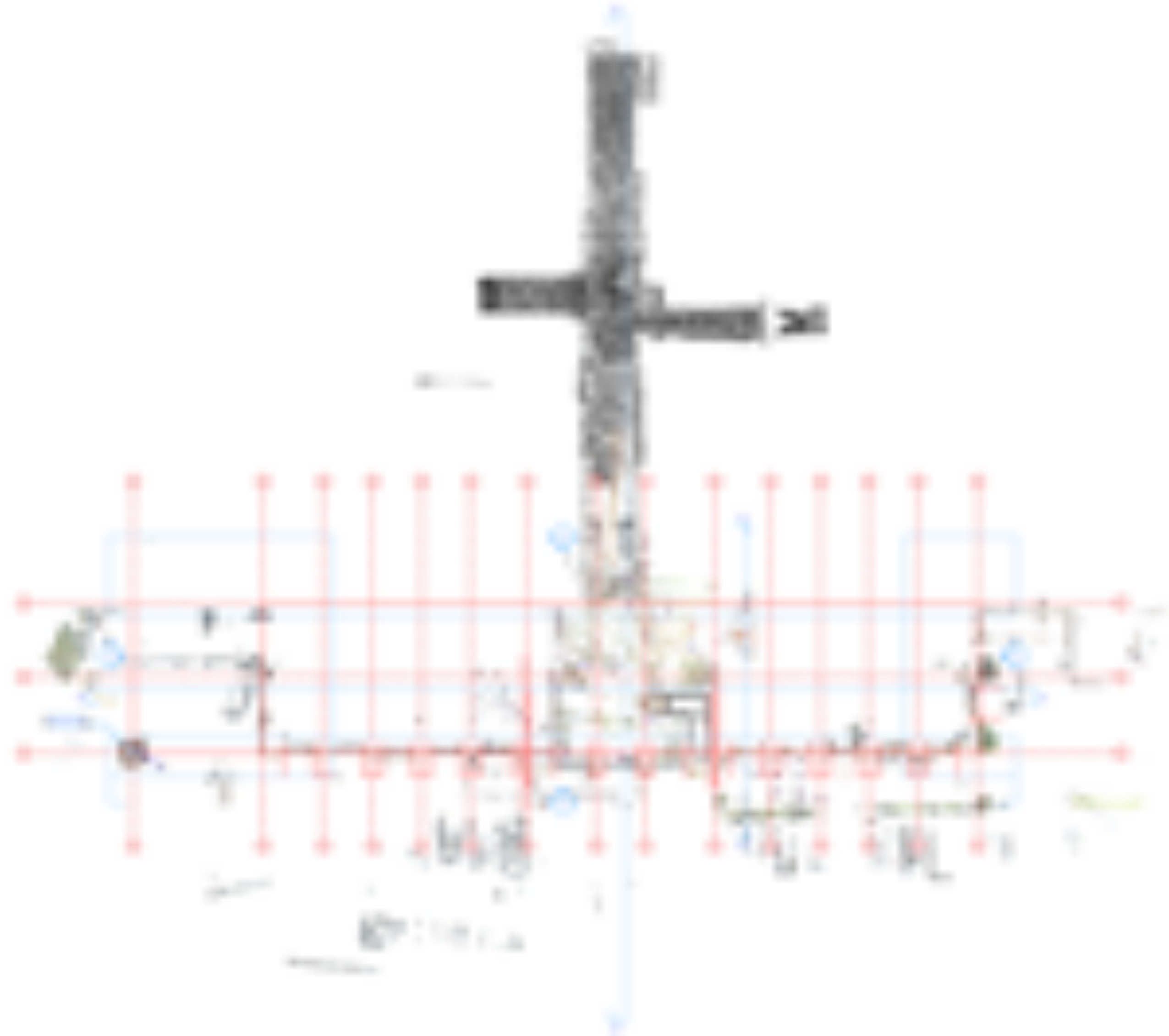




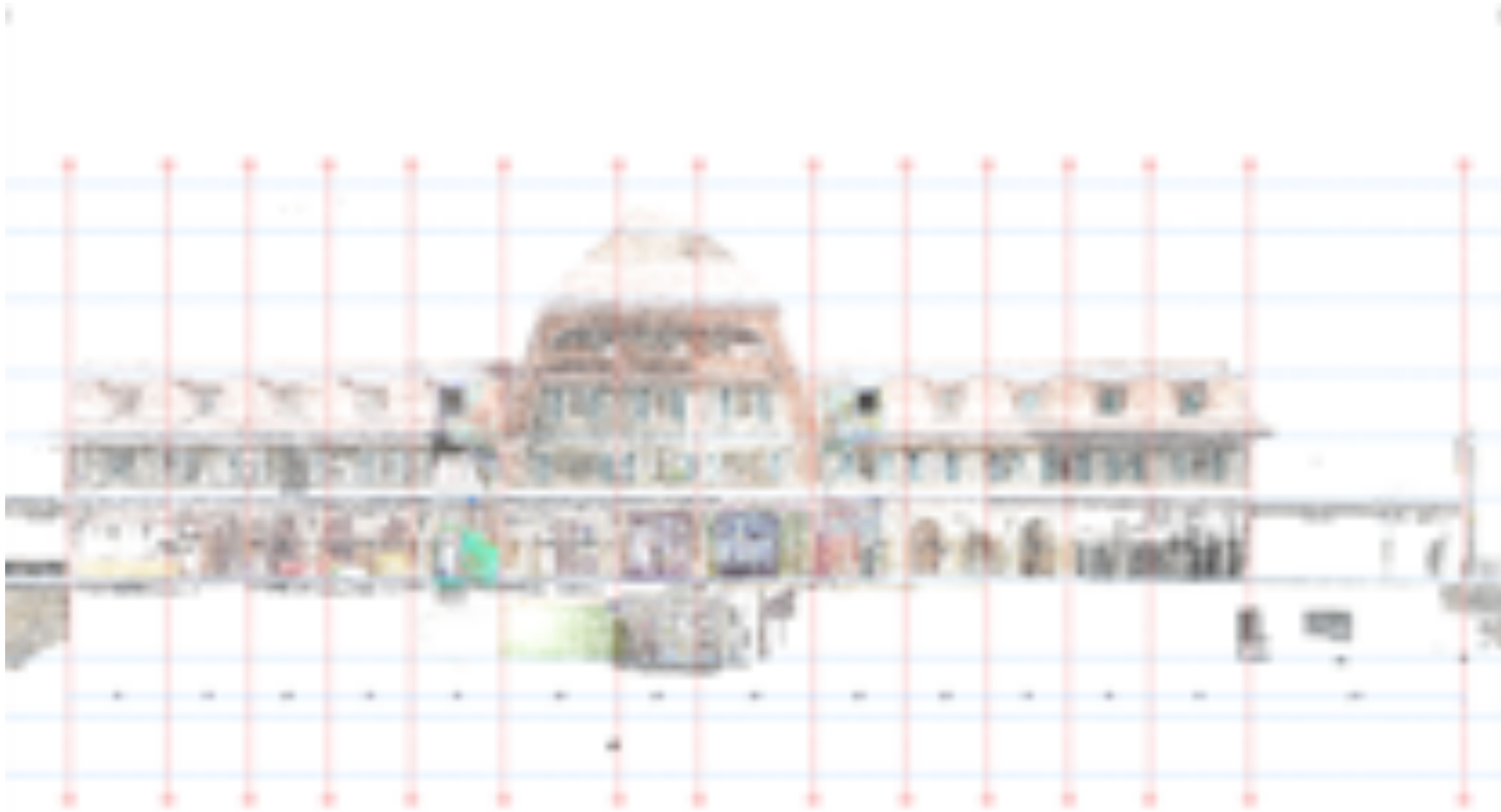






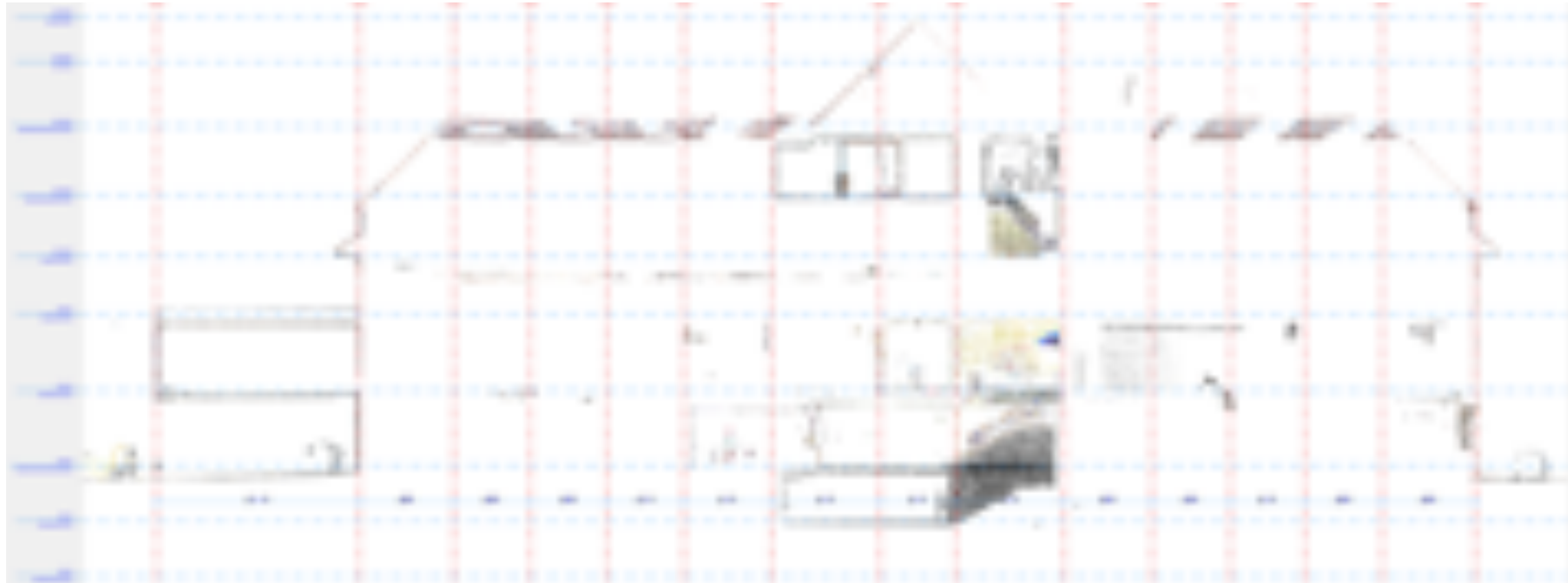


IMPORT AND TRANSLATION INTO CAD



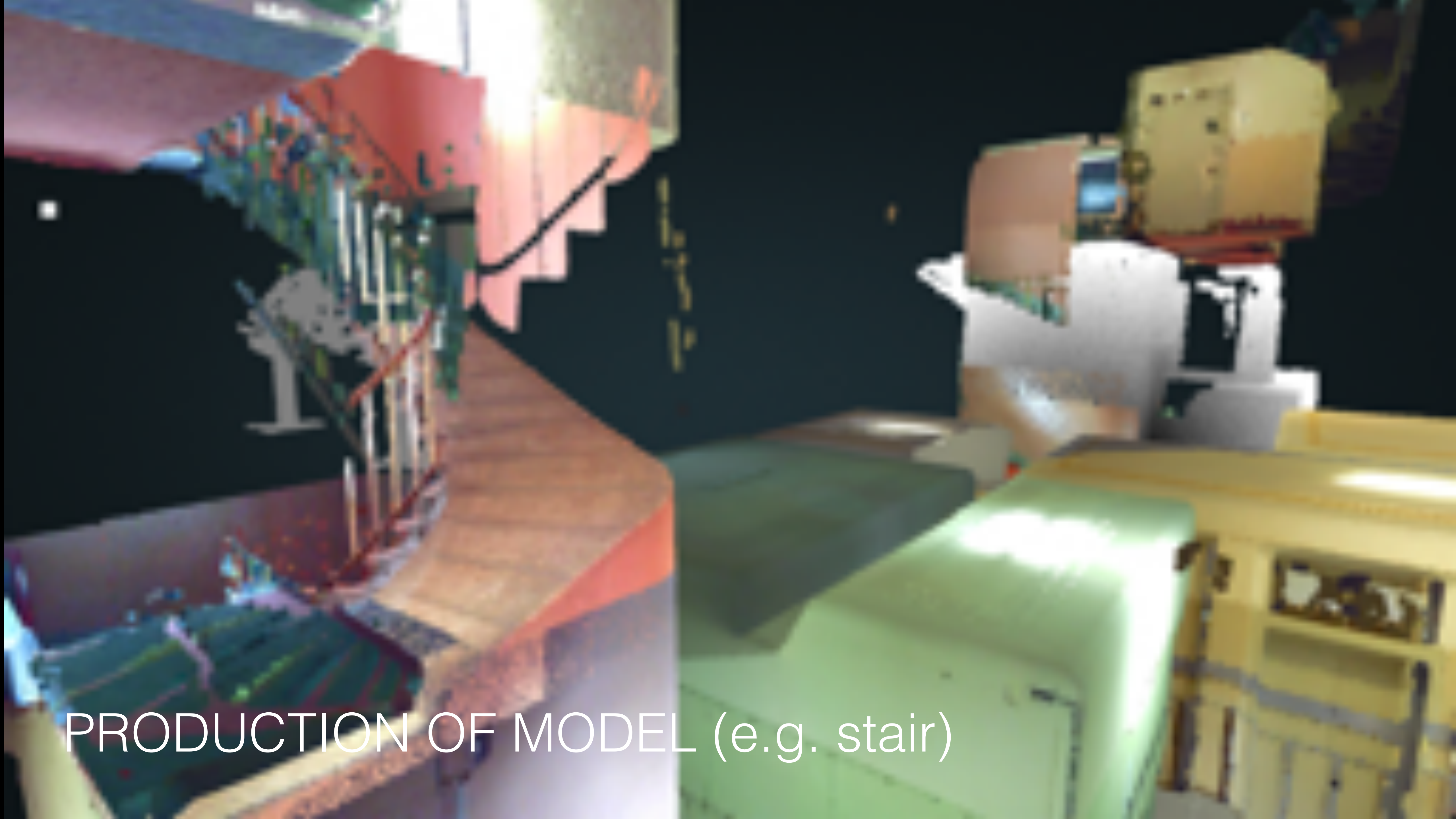
STRUCTURAL ANALYSIS





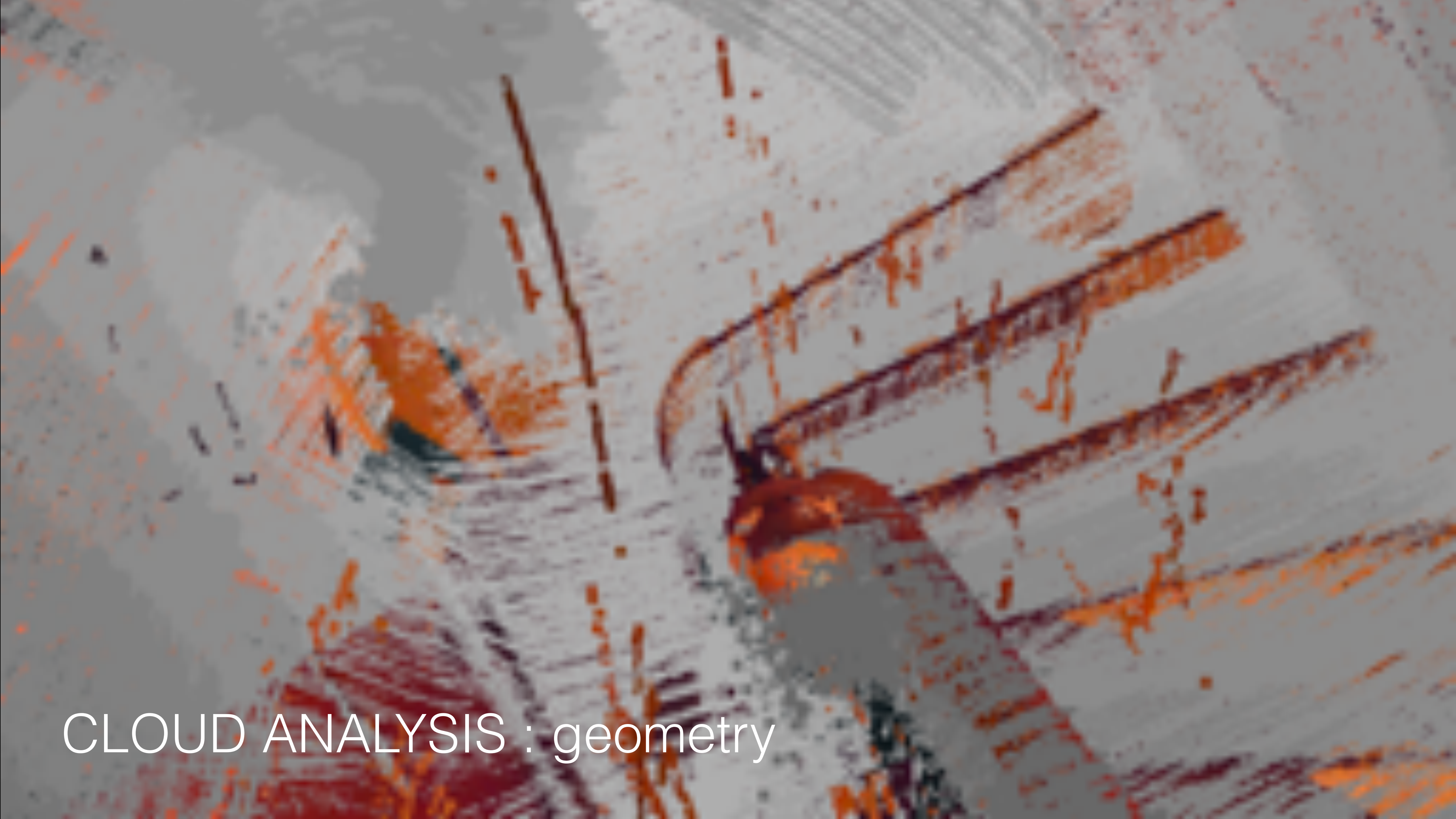
DEFINITION OF LEVELS





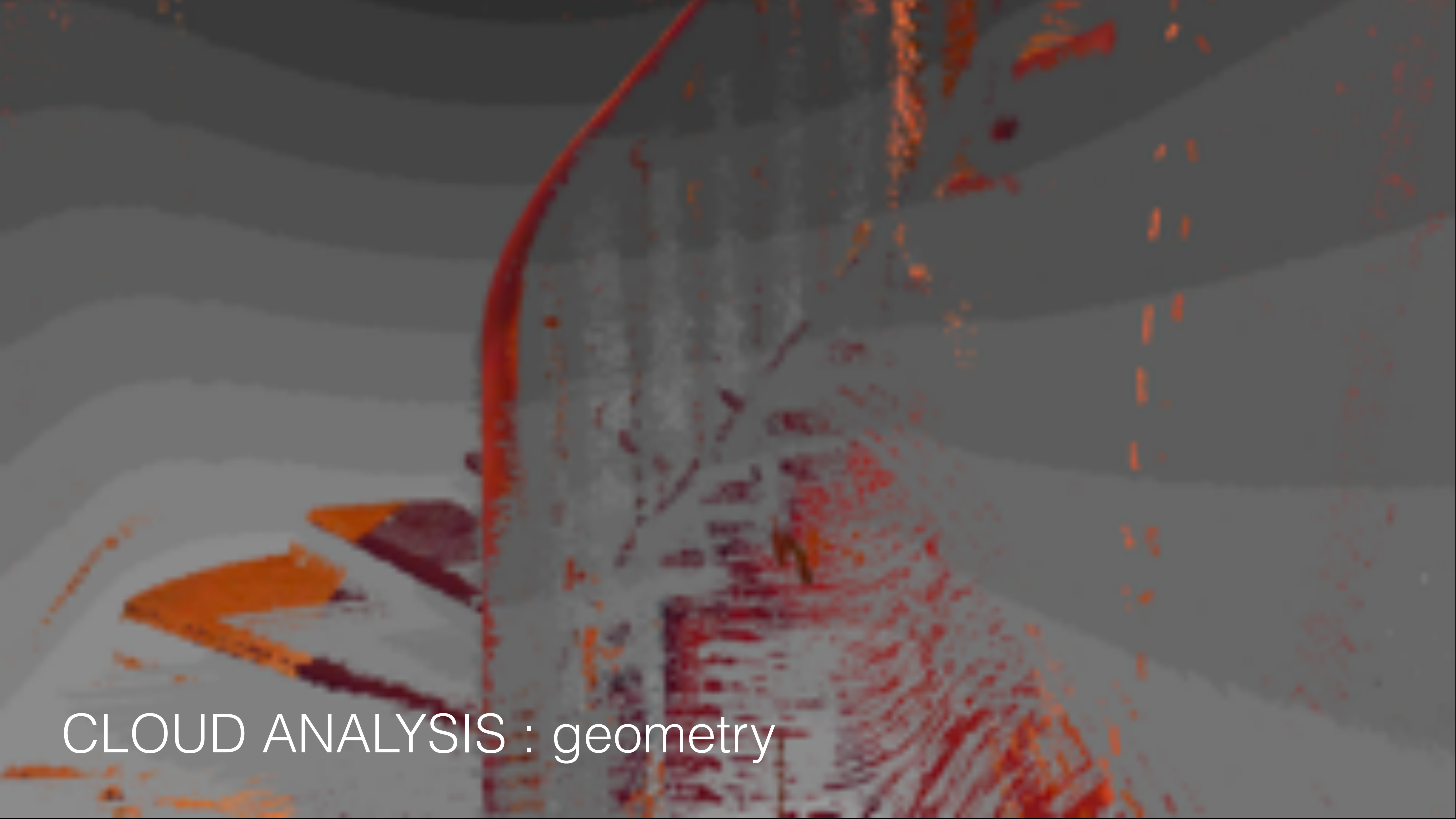
PRODUCTION OF MODEL (e.g. stair)





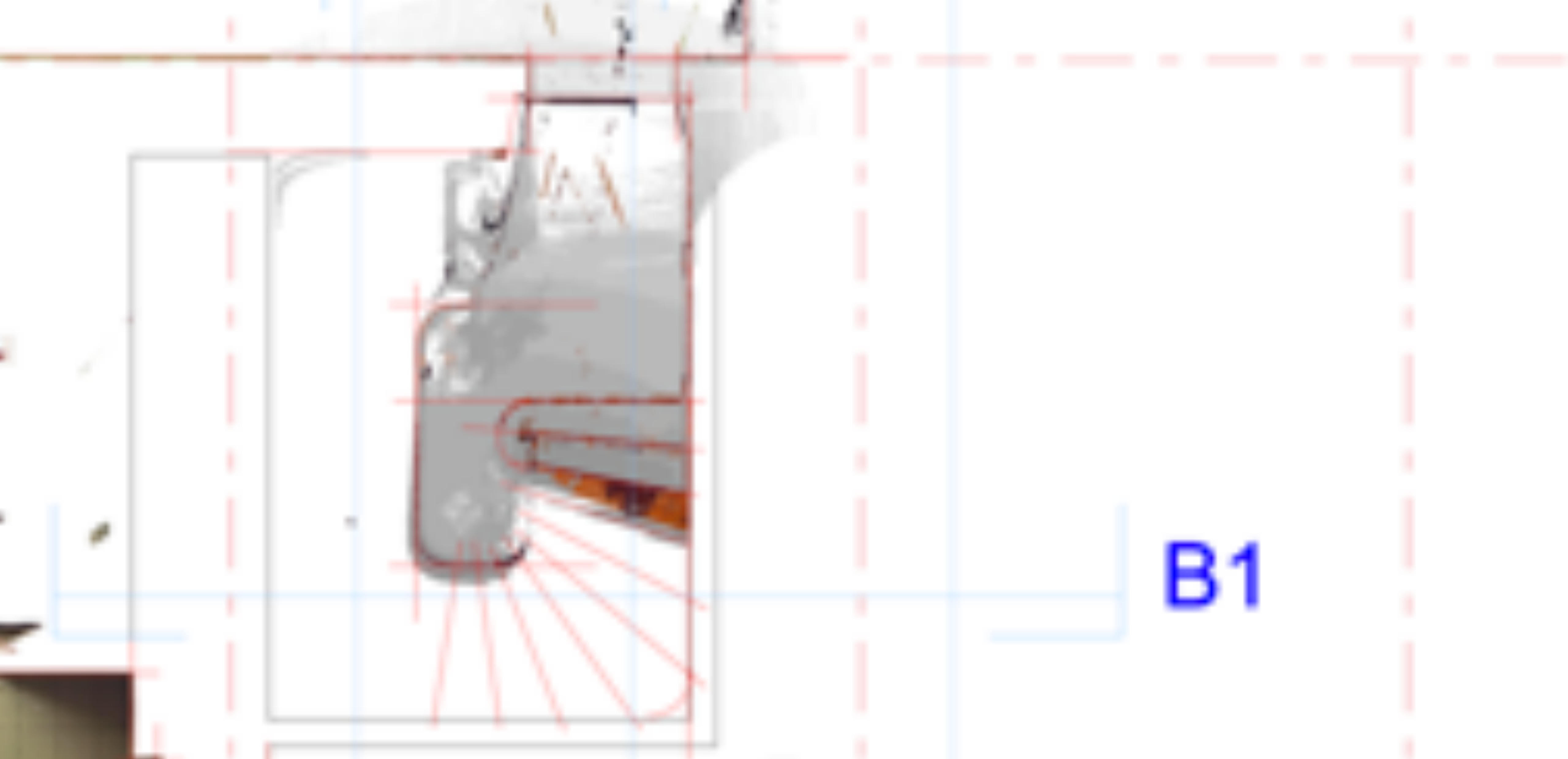
CLOUD ANALYSIS : geometry





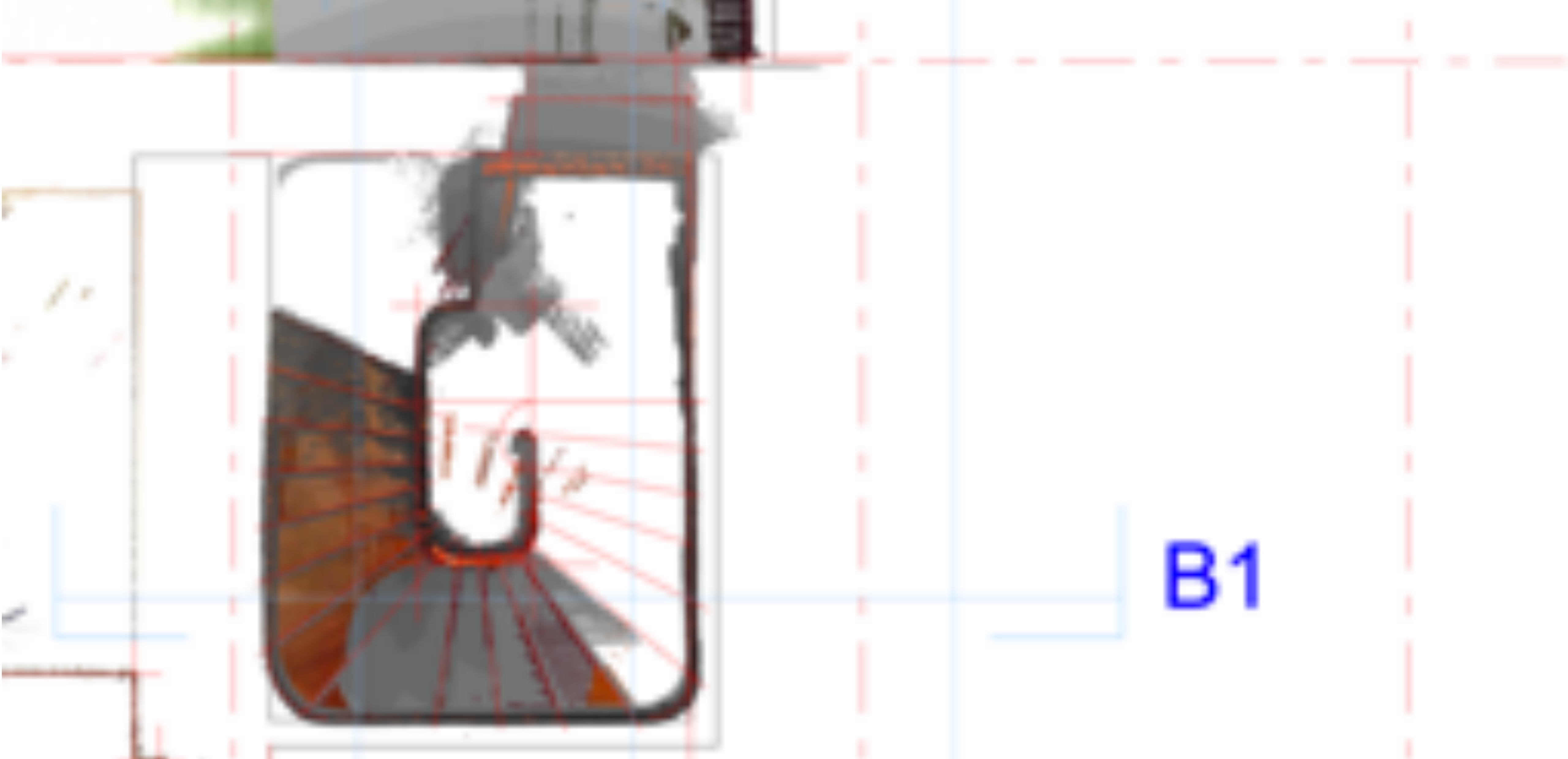
CLOUD ANALYSIS : geometry





**B1**

PRODUCTION STEP BY STEP...



... CAD WITH A.I. + « HISTORIC ADJUSTMENT »





REVERSE ARCHITECTURE -with stairs-





DANKE



Bernard Cherix architecte

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Les ATELIERS de Renens Switzerland, 28.11.18