Construction design for a renovation project with the use of Tekla Structures

Peltosaari Residential Project

HAMK
UNIVERSITY OF APPLIED SCIENCES

Bachelor's thesis

Construction Engineering

Visamäki, spring, 2015

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ABSTRACT

VISAMÄKI
Degree Programme in Construction Engineering
Steel Construction

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Subject of Bachelor's thesis	BIM Construction design for a renovation project with the use of Tekla Structures	

ABSTRACT

The purpose of this thesis was to examine the applicability of Tekla Structures to renovation projects and to make observations on the performance of the software and produce useful information about learning to use it. The materials generated with the program are for the benefit of the Peltosaari Renovation Project in Riihimäki.

The thesis consisted of making a virtual model of a commercial building's frame and parts of its facade and using it to generate more modern alternatives to the 30-year-old construction plans from which it was made. Additionally the model was used to make suggestions for the addition of a second floor on top of the old frame. These facade components along with the suggested expansions were used to generate quantity surveys and demolition and construction schedules. Throughout the project, observations were made on Tekla's features and its user assistance materials.

As a result of the thesis it was concluded that Tekla Structures can be practical for such renovation projects, even though many of its tools could not find application and some of its study materials can undergo improvements. This is because the materials the program generated satisfy the initial requirements and provide many new opportunities for the further steps of the project.

Keywords BIM, renovation, design, Tekla.

Pages 20 p. + appendices 40 p.

CONTENTS

1 INTRODUCTION

With the increasing demand for sustainability in today's society, more particularly in the construction industry, renovation plays an ever larger role. The goal of this bachelor's thesis is to add to the database of knowledge of renovation and the construction industry as a whole in order to optimise the planning stage for projects. This is a stage which involves a significant amount of Building Information Modelling (BIM) in current construction processes.

There are many BIM platforms in use today, each with its merits and setbacks. This thesis more specifically explores Tekla Structures, due to its success in Finland and abroad, by using the student version of the program for the benefit of an actual renovation project.

The thesis introduces the making of a virtual model of an aged building in order to assist its potential future renovation and draw conclusions from the process and its results. Additionally, it examines the renovation possibilities, performance and use of the software and provides insights into learning to use Tekla, which can be useful to students and teachers alike.

This is done through observations on the use of Tekla for such a project and on the tools of the software and their many applications. The program is used to generate data on the building and to make suggestions for its expansion for the use of potential renovators.

The building is part of the Peltosaari Renovation Project in Riihimäki. It is a one-storey commercial building and the goal of the project managers is to replace the facade and add an additional floor, which might serve as a residential area for old people, students and people looking for affordable accommodation.

2 TEKLA IN THE CONSTRUCTION INDUSTRY

Tekla is a company founded in 1966 in Finland that provides services in two business areas: Building & Construction and Energy & Public Administration. Their services are most widely used in Finland but they have offices in more than twenty countries, a worldwide partner network, and customers in over 100 countries. The company employs around 600 people (Figure 1). They became part of Trimble Navigation Ltd. in 2011. (Tekla Corporation, 2015 b)

Trimble is a leading provider of advanced location-based solutions that maximize productivity and enhance profitability. The company integrates its positioning expertise in GPS, laser, optical and inertial technologies with application software, wireless communications, and services to provide complete commercial solutions. Trimble serves a variety of industries including agriculture, engineering and construction, transportation and wireless communications infrastructure. The

Company's portfolio of over 1,000 patents is the basis for the broadest positioning solutions portfolio in the industry. Their global headquarters are in Sunnyvale, California. (Trimble Navigation Limited, 2015).

Tekla Structures is used for a wide range of tasks by many companies in the construction industry around the world. Examples of such companies are the North American company Barton Malow which uses Tekla software while working on the Karn/Weadock Power Plant project among others (Tekla Corporation, 2015 a).

Wayne Brothers Incorporated, one of the most progressive and technology-savvy commercial concrete contractors in the Southeast USA, has been using Tekla software since its adoption in 2012 to successfully increase their production efficiency especially thanks to Tekla’s reinforced concrete design capabilities (Tekla Corporation, 2015 c).

Other notable companies, which are among the leaders in their respective sectors of operation, include Sweco (Finland), Fort Polska Sp. z o.o. (Poland), Siltanylund Oy and Destia Oy (Finland), Arup (Singapore), Hurks delphi engineering (Belgium), VTCO Investment Ltd., Co. (Vietnam). (Tekla Corporation, 2014 c).

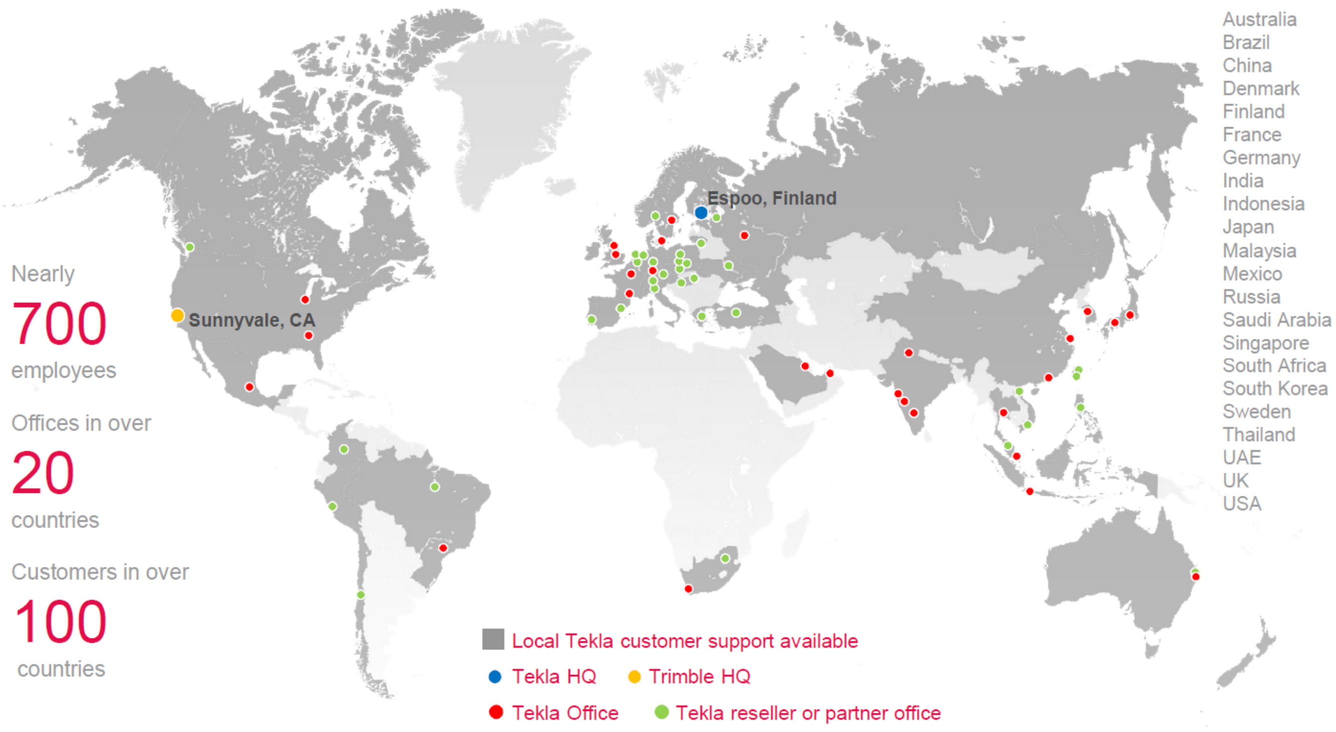

Figure 1 Tekla Global Network (Raikaa, e-mail 6.3.2015)

3 PELTOSAARI RENOVATION PROJECT

Peltosaari is a large scale renovation project, which, ever since 2010, aims at renewing the Peltosaari suburban area and making it more attractive. This is done in order to benefit the local economy and improve the quality of the region, which is situated next to the main train station of Riihimäki and gives the first impression of the town to the station's arrivals (Figure 2). The project representative is Ilaro Seitsonen. (Väkevä-Harjula, 2012).

Over 50% of the city-owned rental houses are located in Peltosaari. The area was built up during the 1970-1990s and has an excellent location opposite the Riihimäki railway station. Despite that it has accumulated socio-economical problems. The rental houses need renovation and the rate of unemployment reached 27-33% by the year 2009. (Väkevä-Harjula, 2012).

The targets of the project are stated as follows (Väkevä-Harjula, 2012):

• Image and reputation of the area will be improved
•"the new general plan" will connect Peltosaari to the city of Riihimäki
• Safe and attractive area
• Eco-efficient, energy-efficient
• Specially made for young professionals, families with children, students and senior citizens as well as singles
• Active inhabitants taking care of their houses and environment

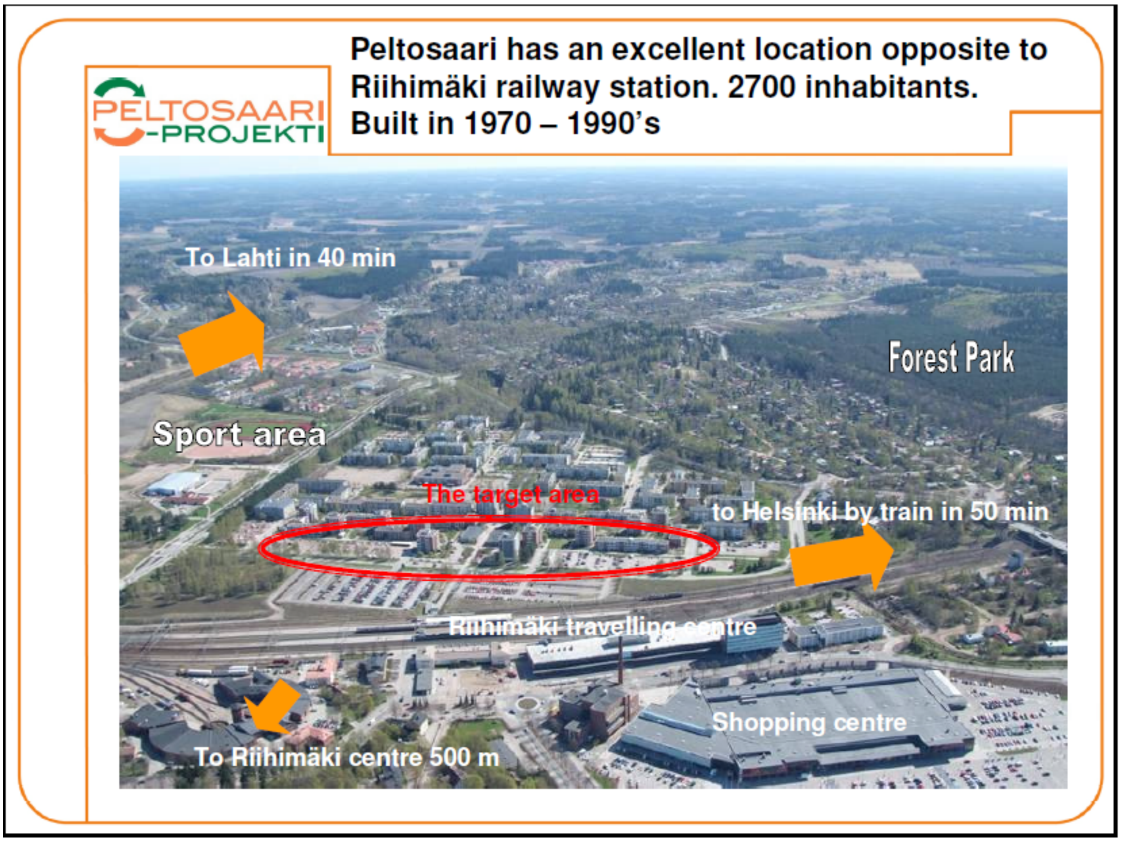

Figure 2 Aerial picture of Peltosaari (Väkevä-Harjula, 2012)

3.1 Building information

The building is a one storey commercial building, which is used for public venues, e.g. shops, restaurants, stores. The frame of the building is of reinforced concrete and a portion of the outer walls is made out of composite concrete and insulation and a portion out of glass panels (Figure 3).

Figure 3 Outside appearance of the building

The building is in need of renovation structurally and aesthetically as are others in the neighbourhood.

In Table 1 below are listed the construction specifications of the building.

Table 1 Construction Specifications

BUILDING:		
Area: Peltosaari	District: 2022	Plot no 11
Village	Mode / stat	RNo
Address: Telluskatu, Riihimaki		
The quality of the building: Commercial Building		Fire Class: C
building permit applicant:		
Rak.tsto A. Puolimatka Ltd c / c Peltosaari service center		
designer:		
Rakennustoimisto A. Puolimatka Ltd Planned Forssa		

I FOUNDATION 1. Basic northern quality (rock, gravel, sand, silt, clay, etc.) 2. Foundation type (reinforced concrete. Sole piling, etc.) 3. Stone pedestal structure (from the outer surface to the inner surface)	1 Clay 2. Reinforced concrete piles and hard bottom reinforced concrete blocks 3 Sandwich panel: - 6o mm concrete ÷ 125 mm min. hard insulation + 8o min concrete
II WALLS 4. External wall constructions 5. Interior walls (quality and thickness) a) Load-bearing walls b) Limiting the walls and soundproofing c) Other walls	4.Facades: a) Sandwich-panels: 60mm concrete+125mm mineral wool+ 80mm concrete b) 2 piece thermal glass 5. a) and b) clean cloth. masonry brick
III ROOF 6. Roof coatings and slope 7. Substructure	6. 3-layered blanket flat roof 7. NILCON-roof elements
IV SUSPENDED CEILINGS 8. Building (hangers and surface material) 9. Place of use	8 Boarding 9 Restaurant

V INTERMEDIATE FLOORS Structural Settlement of the floor surface (quality and thickness of material) 10. Roof and the k-value	10. Nilcon- roof elements

11. Intermediate floors 12. Ground floor 13. Basement floor	11. – 12. – 13. Hollow core slab
VI HUMIDITY, WATER AND WATER PRESSURE INSULATION 14. Basement floor 15. Basement ceiling 16. Basic Walls 17. Under drains etc.	 14. Necessary items 2-layered. insulating paint or plastic moisture barrier 15. - 16. - 17. 150 mm brick drain
VII VENTILATION 18. The system, chimney structure, etc.	 18. Mechanical removal Horrmit sheet + necessary fire protection mineral wool
VIII HEATING METHOD 19. Chimneys, building materials, artificial way, etc.	 19. Electric heating
IX GENERAL PUBLIC SAFETY 20. Category, location size, etc.	 20. -
X OTHER INFORMATION For example, new building materials and building methods use etc. Fire protection equipment	

3.2 Desired Changes

The municipality staff wishes to salvage the frame of the old building, therefore the general idea is to replace the facade entirely and, if possible, to erect an extra floor on top of the frame, which can be used for cheap accommodation for students, old people, etc.

4 BUILDING MODEL

Since the facade of the building will be torn down the model only needs to have the reinforced concrete frame. Additionally, there are suggestions for the frame of the extra floor.

The concrete outer walls were also added in order to be used to calculate the amount of time it would take for them to be demolished and the amount of waste they will produce.

After the frame and the portions of the facade were done, suggestions for future additions in the building were made. The suggestions include an example steel frame for the extra floor and side staircases.

These are then used to calculate material quantities and generate a construction schedule.

4.1 Old building plans

The old plans do not provide thorough information on all components of the building and where they do it is often presented in ways which prove hard to decipher and slight mistakes can be found in some parts.

4.1.1 Faults in drawings

In the example in Figure 4 the drawing is not a scaled down representation of the components and when it is recreated with the given dimensions there are slight differences and irregularities.

This drawing provides information for all corner pads of the building, whether they are next to a 390 mm width strip footing or a 350mm one. For this example the 350 mm wide strip footing is used.

The red lines represent the drawing, made with the given dimensions. The dimensions for the sides of the triangle are missing. There are only enough dimensions to draw the right angle at its supposed place. The rest of the triangle is drawn by eye using the lines of the drawing. Therefore, the line on the left, which doesn't fit with the original, is put there according to the given dimensions and not by eye. Only its length is not defined and has to be improvised.

On the right side it can be seen that the corner, indicated with thicker lines, goes beyond the edge of the footing and the position of the hypotenuse, even though in the original drawing it is clearly behind the edge.

When the drawing is drawn with the strip footing width of 390 mm, the corner rests exactly on the hypotenuse of the triangle.

When the model was drawn using this drawing, it was adjusted so that the corner does not protrude.

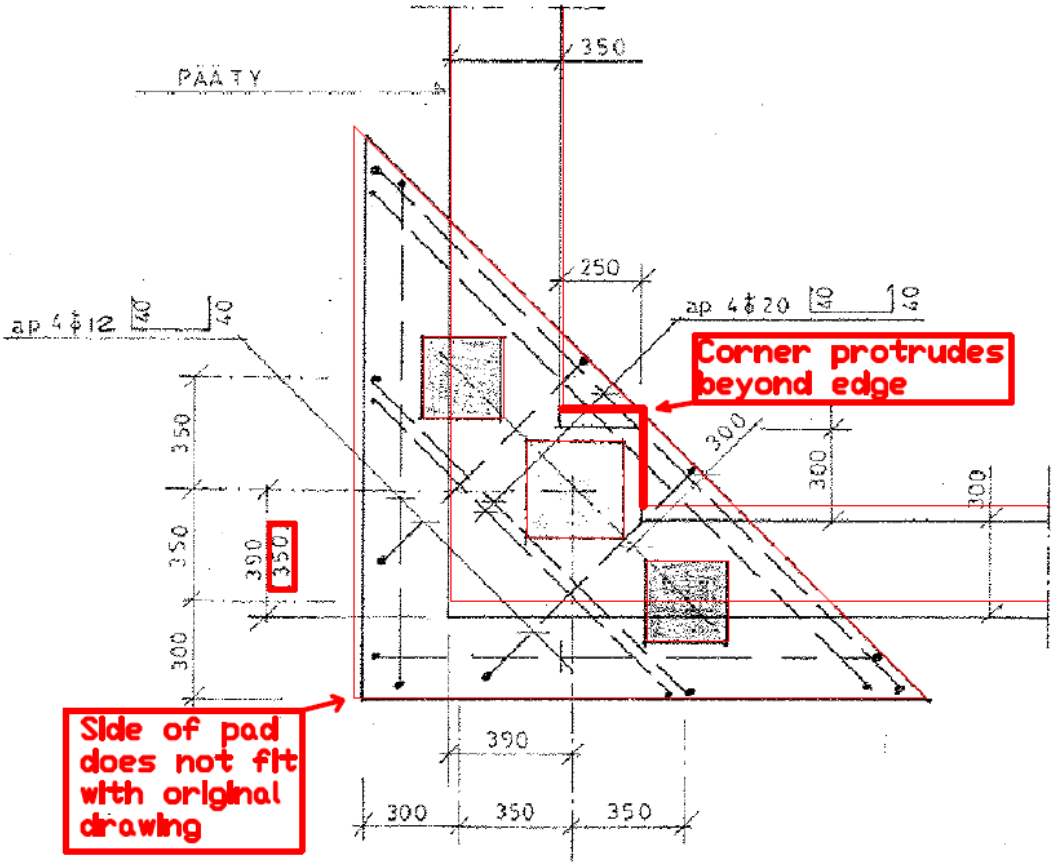

Figure 4 Corner pad footings

It is assumed that these mistakes have been faced during the construction of the building and dealt with on the spot. That is why they are fixed in ways in which the building's constructors might fix them during the construction process in order for the model to provide a more accurate representation of the finished building.

4.1.2 Missing information

Apart from mistakes the model also suffers from insufficient information. There is a lack of dimensions for the arrangement of some parts of the reinforcement and some reinforced concrete elements completely lack reinforcement information.

In such cases the reinforcement of similar elements is used and in the cases of no dimensions they are positioned based on how they appear in the drawings.

In Table 2 there is a list of parts which lack some information with short descriptions of what is missing. These parts can be traced in the old construction plans given in Appendix 1.

Table 2 Missing information

Part	Missing Information
Piles	Lengths and reinforcement dimensions
Pad footings under beams P2, P1a, b, e	No spacing for some of the reinforcement and no dimensions for the sides of some of the footings
Strip footings at the width of the building	No reinforcement information

If more information is attained in the future it can be used to improve the model by the project planners.

4.2 Modelling process

The modelling process of the frame of the building was the most challenging part of the project. This is due to the fact that the building's old design is incompatible with many of Tekla's features.

Tekla possesses many tools to ease and speed up the design process. But when reconstructing this already existing plan many of these tools cannot be used, which leaves the designer with mainly using the basics and having to personally detail the components instead of, for example, using the component catalogue.

The significance of this is easily seen when it is considered that it took dozens of hours of work to adjust the old concrete frame to be as true to reality as possible and less than two hours to generate and adjust the steel frame on top, which is a new addition.

4.2.1 First model

An initial test model was made from drawings provided at the start of the project. These drawings proved insufficient for any credible information to be drawn from the model and so they were discarded along with the model made from them as soon as more accurate ones become available.

This early model helped for the preparation and provided practical experience for the use of Tekla Structures in the incoming work, even though it was not used for the final product.

4.2.2 Second model

After receiving more extensive and accurate plans of the structure the second model was started. This model is used throughout the rest of the project. It posed a significant challenge to make it true to the original plans for several reasons.

Firstly, due to the fact that the structure was designed in the 1970s, the information in the plans does not entirely correspond to modern engineering practices. In many cases the materials used are not named as they are presently, which necessitates additional research in order to find their modern equivalents in the Tekla catalogues. Additionally, the design of the reinforcement proved a significant challenge, partly due to the fact that the reinforcement of some parts was only given in calculation sheets, written by hand (Figure 5).

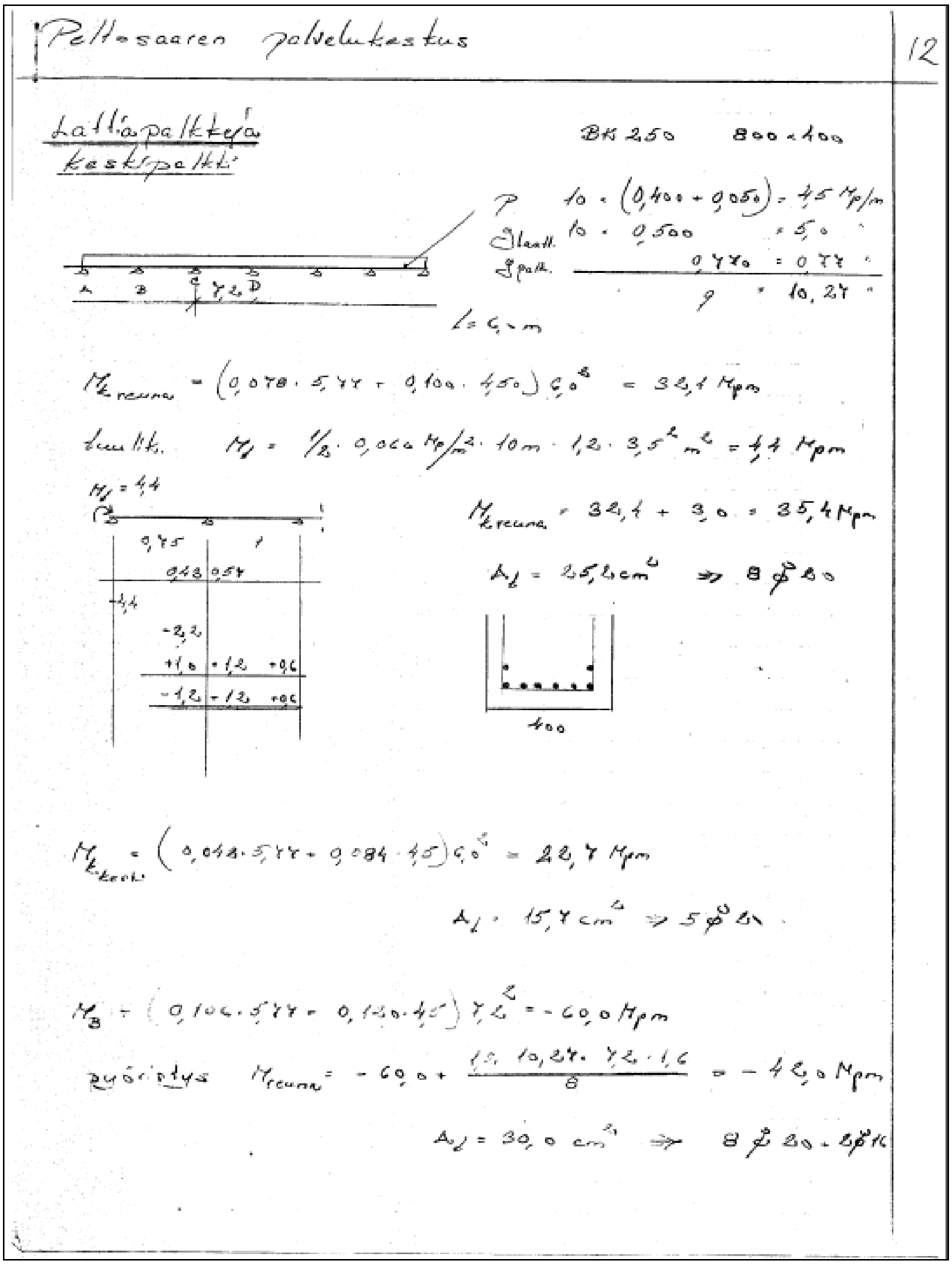

Figure 5 Part of the calculation sheets

Tekla possesses an extensive array of ready reinforcement options, which can be used to almost instantly design the reinforcement of complex objects (Figure 6), but due to the nature of this project these options could not be used.

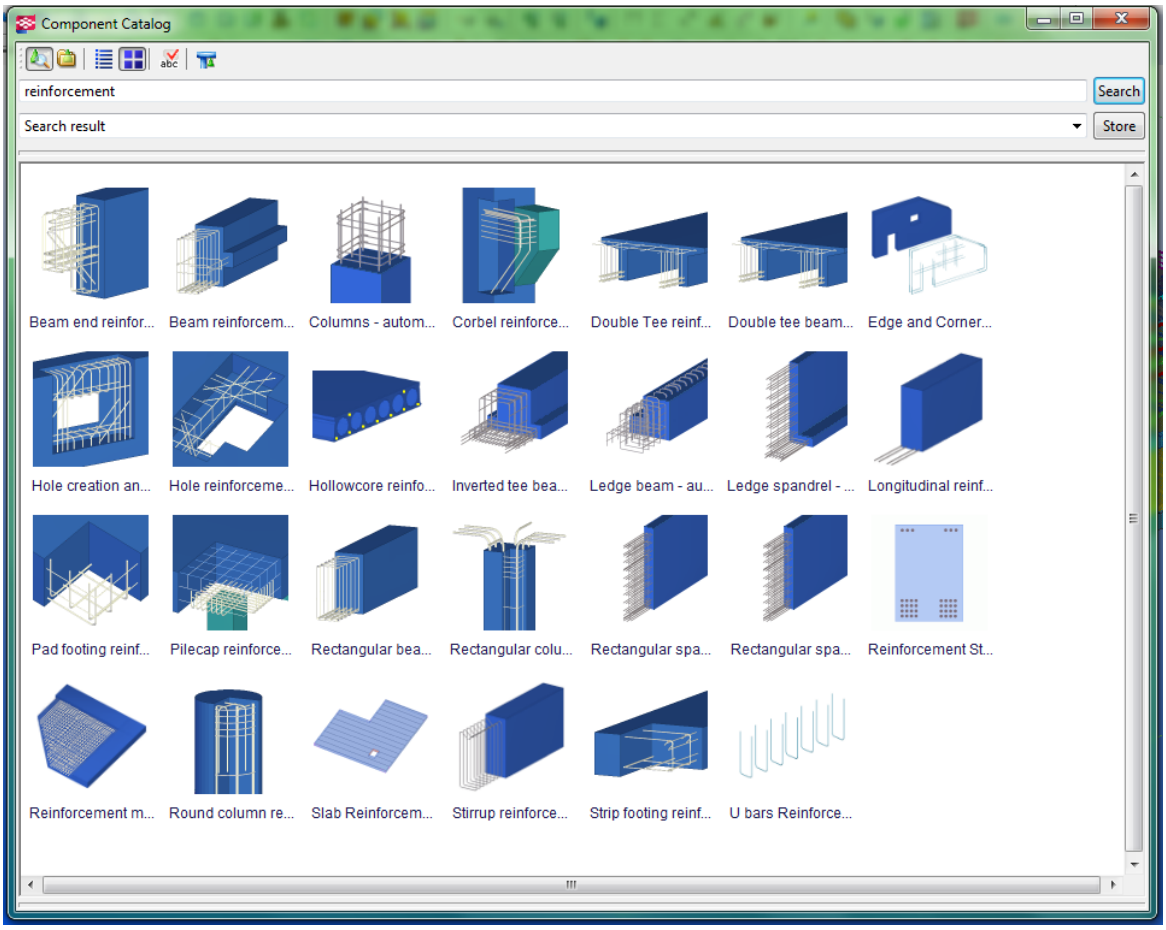

Figure 6 Tekla component catalogue

Instead, custom reinforcement was made by the designer that would be as true as possible to the one in the structural plans and therefore to the actual building. This process encompasses a large amount of time and effort due to the fact that all the components of the reinforcement are designed in separate groups, mainly with the use of the “Reinforcing bar shape catalogue” feature (Figures 7 and 8).

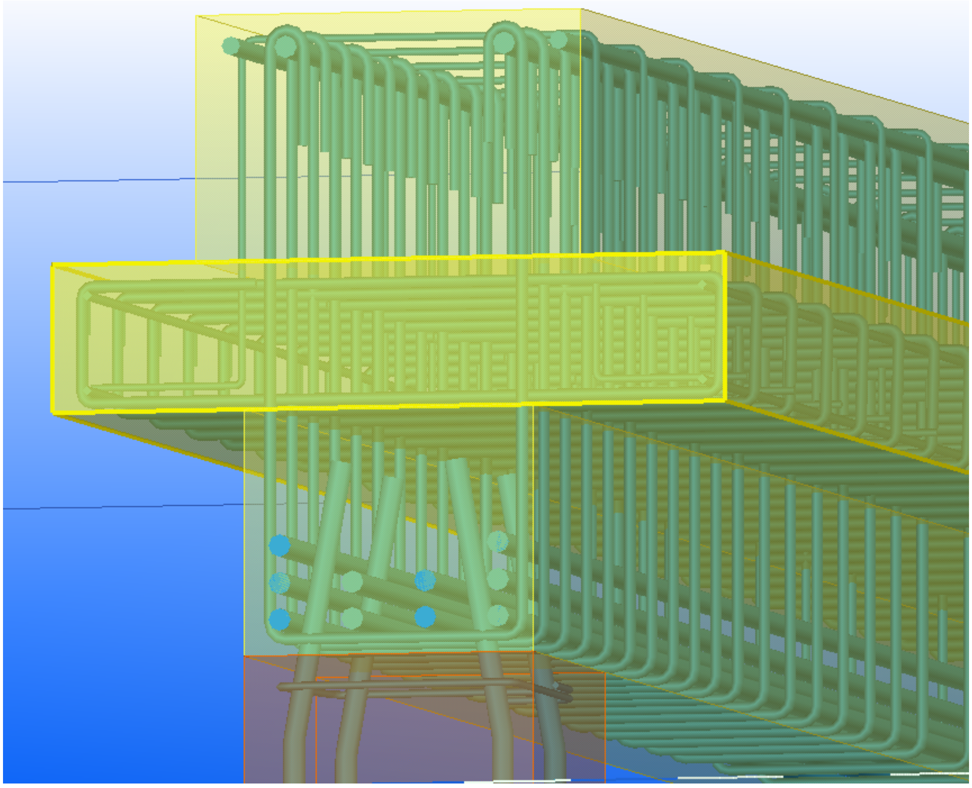

Figure 7 Custom made reinforcement

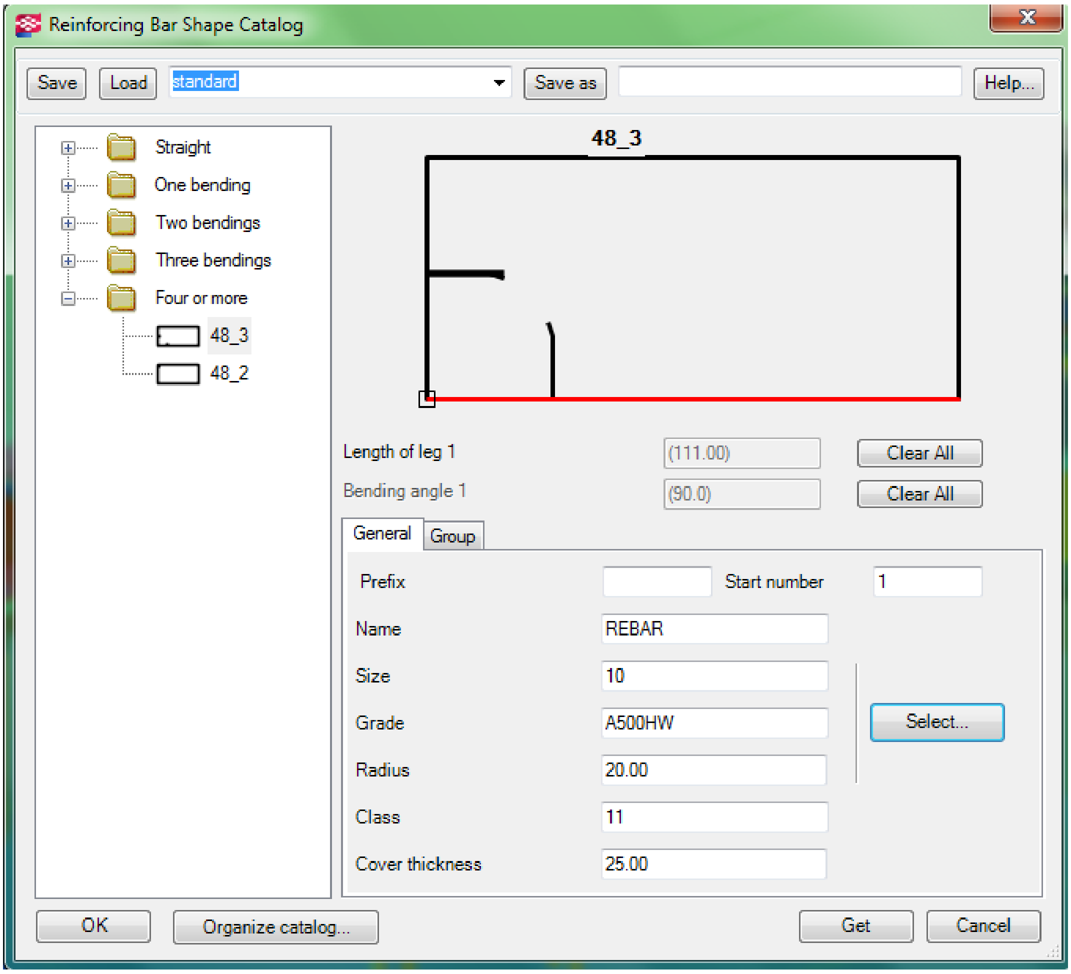

Figure 8 Reinforcing bar shape catalogue

The accuracy is needed so that this model could be used to realistically portray the current state of the building if exported to a structural analysis program made by any future project planners. Another reason is that it must provide accurate information on the structure's frame so that it can be used to replace the outdated structural plans which the building currently has. Different views of the finished model can be seen in Appendix 3.

4.3 Extra models

Finally, the finished model was divided into two almost identical Tekla models - one in which the frame and staircases have been separated into individual components and one that has them as whole pieces. This was done, because when used to make the construction schedule they were each recognized as one whole piece by the software and it was desired that it calculates the assembly time with a component per time speed of work. Therefore, it would not count all their separate components in its calculations. So a separate model was made where the function "explode component" was used on them and it essentially made each of their parts individual, which allows for them to be selected and edited separately.

This has also been useful for generating reports from them, such as the quantity survey.

4.4 Exporting the model to Tekla BIMsight

After it was finished the model was exported to Tekla BIMsight, where it can be easily viewed and used for collaboration between different parties involved in the project who can upload their works with Tekla or other software,merge them with it and check for clashes and other problems (Figure 9).

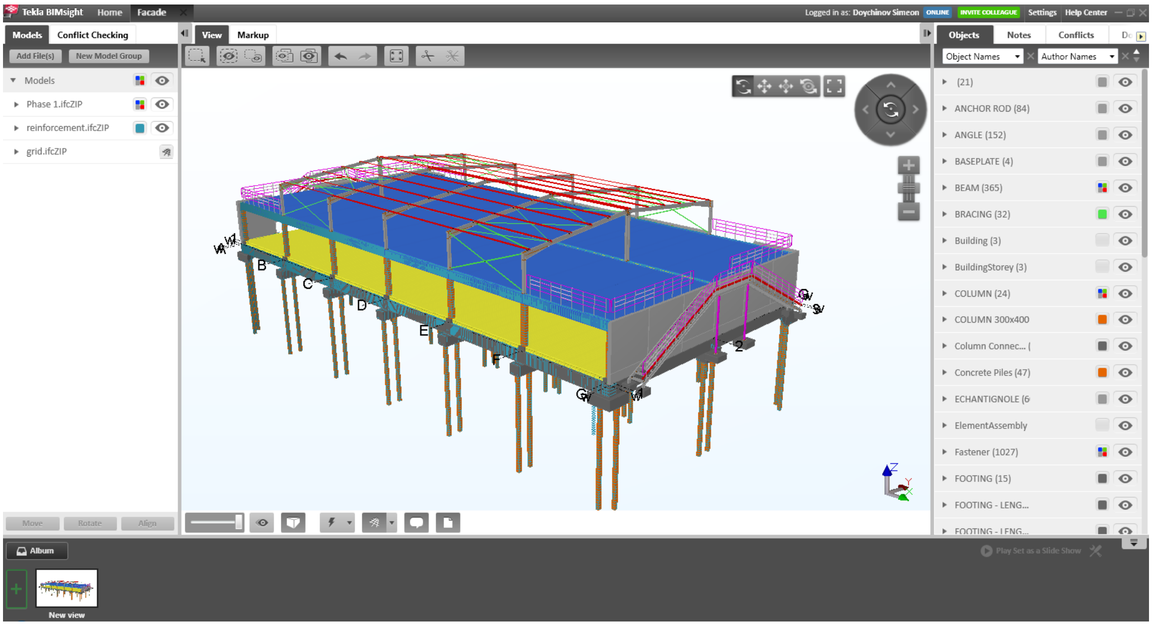

Figure 9 Model in Tekla BIMsight

4.5 Linking Tekla to structural analysis software

The Analysis model cannot be properly exported to structural analysis software, due to the need of support software for Tekla. This support software is an add-on which links Tekla with the analysis software. (Tekla Corporation, 2015 a)

The problem is that in order to download these “links” a person needs a Tekla extranet account and that can only be made if that person is involved with a company, which has purchased Tekla’s product and its support material. Because of this, people with only a student account, as the author of this report, can only download the student version of the program and different environments.

The only option left is to export the model itself as a file, which a structural analysis software can open and adjust so that it can be used there. There are several file formats to which Tekla can export.

These conclusions were reached after researching the Tekla manuals and website information but the most concluding example is the information provided by a company representative:

“Extranet is intended for customers on maintenance.
For students we cannot provide access to extranet...” (Raikaa, Extranet access request, Doychinov, Simeon, 2014, November 6).

This is a limitation to this survey and generally for studying to use Tekla to its full potential and due to it any possibilities to use the program in this way are presently unavailable for such a research.

4.5.1 Exporting the model

The alternative method for Tekla models to be transferred to structural analysis software such as Autodesk Robot and SAP2000 consists of exporting the model in a different file format, which can then in turn be imported by the analysis software.

When the model is exported as an .IFC file and afterwards that file is opened with Audotesk Robot it is not initially usable as can be seen in Figure 10. Most of the elements are not connected to each other and many of them are inconveniently misplaced.

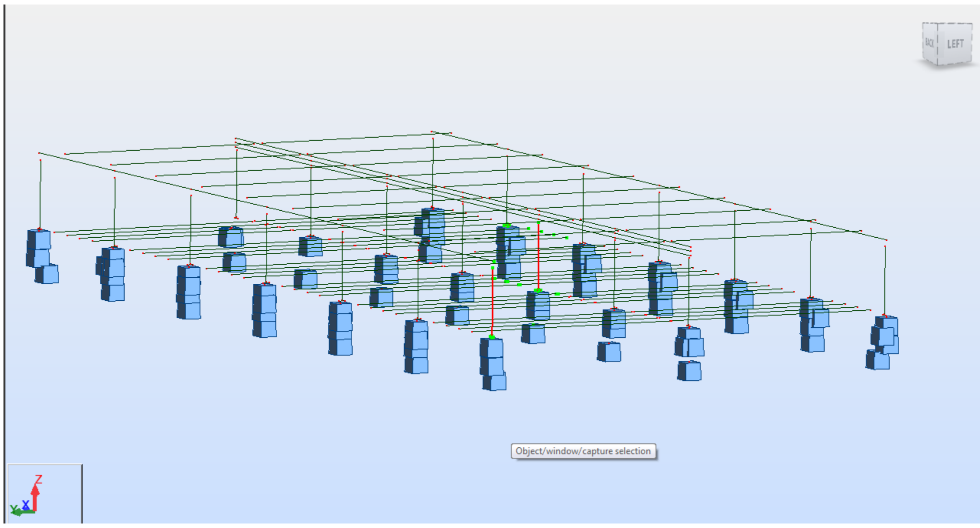

Figure 10 Model opened as an .IFC file in Autodesk Robot

Fixing the resulting model in Robot presents as much effort as making it from scratch if not more, which would deviate drastically from the theme of this research, i.e. exploring the uses of a Tekla model, and therefore is deemed impractical.

Other attempts to export the model in such a way ended in similar misfortune (Figure 11). Due to this the method was abandoned.

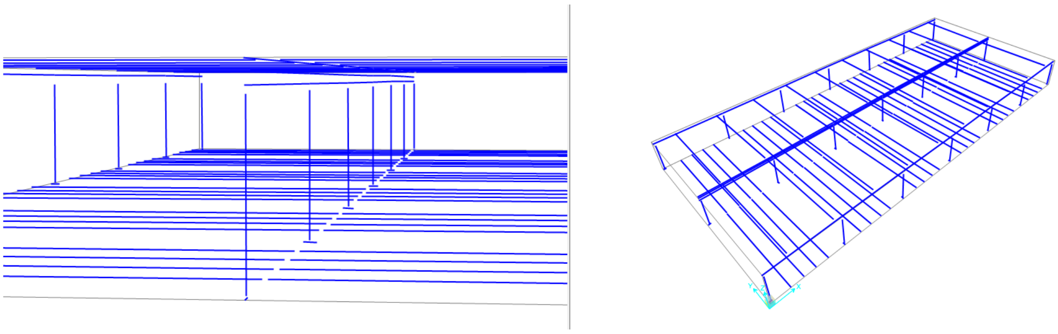

Figure 11 Model opened as an .IFC file in SAP2000

5 DATA GENERATED FROM THE MODEL

The most immediate need of this project is to have better, more modern construction plans. Although these can be generated by Tekla in an unlimited variety, at this point there are no extra requirements and so they have been made mostly as improved versions of the old ones with some extra information.

Additionally, the model was used to generate a time schedule for the demolition of the concrete parts of the facade and the erection of the second floor frame, drawings of the frame and a bill of quantities for all of these elements.

5.1 Time schedule

The time schedule is represented in the form of a Gant Chart and provides the demolition time of the concrete parts of the old facade and the erection time of the added suggestions.

Taken together these processes could take fewer than five months to complete. By hiring a larger workforce this time could even be halved.

It should be noted that this is not the end of the renovation but only the preparation of the frame of the building. The rest of the time schedule can be added when the rest of the building is designed.

This information is hypothetical and can be easily adjusted with the program to meet the contractor’s work speed, free days and any other new conditions that are needed.

This information could be used to significantly ease the initial feasibility reports before the start of work (Figure 12).

RootScenario

	Task Name	Task Type	Planned Production Rate	Planned Start D...	Actual Start D...	Planned Duration	Planned End Date	Actual End D...	Percentage Complet...
1	Concrete Facade Demolition	Concrete Facade Demolition	200.00 kg/h	27/02/2015 08:00		52.06 d	12/05/2015 08:26		0 %
2	**Pad Footing - Moulding**	**PERUSTUSTYÖT**		**12/05/2015 08:...**		**0.74 d**	**12/05/2015 14:30**		**0 %**
3	Pad Footing - Moulding	Anturan muotitus	5.25 m2/h	12/05/2015 08:26		0.71 d	12/05/2015 14:14		0 %
4	Pad Footing - Concreting	Anturan betonointi	10.88 m3/h	12/05/2015 14:14		0.04 d	12/05/2015 14:30		0 %
5	Erection of Stairs & Railings	Teräspalkin asennus	1.63 pcs/h	13/05/2015 08:15		48.90 d	20/07/2015 15:32		0 %
6	Erection of Steel Frame	Teräspilarin asennus (hitaus)	1.00 pcs/h	12/05/2015 08:26		37.87 d	02/07/2015 15:26		0 %

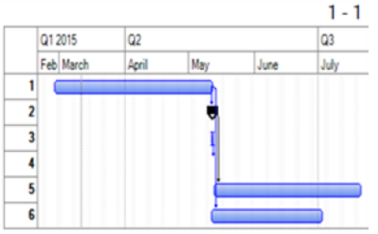

Figure 12 Tekla generated Gantt Chart

5.2 Drawings

The drawings generated by Tekla provide all the information on the original building plans with fixed inaccuracies and added clarity and some information on the suggestions for the second floor frame all of which can be seen in Appendix 2.

The drawings for this new frame are less thorough, since at this point it is mostly a suggestion and its 3-D representation is the most functional at this stage. It is more useful to calculate its costs, and if Tekla is linked with a structural analysis program, to test its feasibility.

5.3 Quantity survey

The model can be used to generate a bill of quantities for the whole frame but since the intention so far is to replace the facade and add an extra floor, only the quantities of these are generated.

The quantities of the frame components can be used for the waste management after the demolition and the quantities of the suggested steel frame can be used to calculate the material cost of such an extension.

The full quantity survey can be seen in Appendix 4.

6 SUGGESTIONS FOR EXPANSION OF THE BUILDING

The steel frame is designed on top of the old concrete frame of the building (Figure 13). It covers most of the roof with some space left for balconies. For the most part it was automatically generated by Tekla with the designer choosing the dimensions, materials, etc. It can be easily adjusted further to fit additional needs (Figure 14).

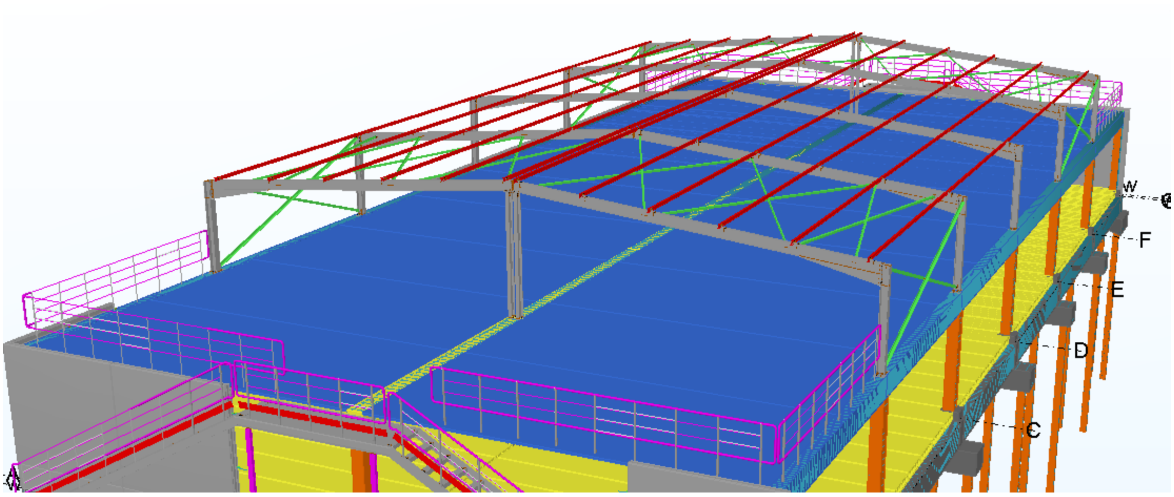

Figure 13 BIMsight view of the Steel Frame

A steel frame was chosen for the second floor expansion, since it is light weight and fast to assemble. Additionally, it could be an economic solution, depending on its shape and complexity.

In this example the frame is of simple and widely used type, which means it would be easier to find experienced workers for its construction and consequently the risks of errors, accidents and extra costs are lower. Therefore, if the project planners have a small budget, this or a similar type of steel frame would be a suitable solution.

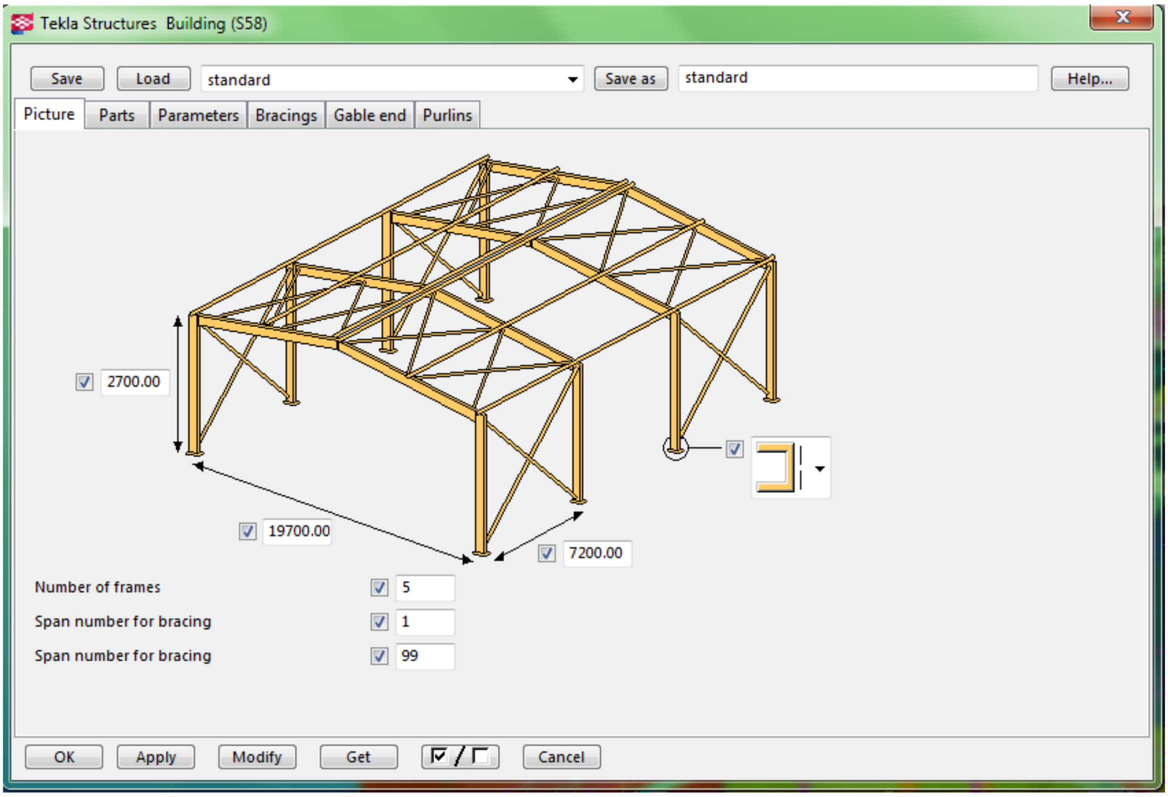

Figure 14 Steel Frame Component Settings

Furthermore, suggestions are made of exterior steel staircases and railings (Figure 14). These have also been chosen from the component catalogue and can easily be adjusted as a whole, without having to change the settings of too many components separately.

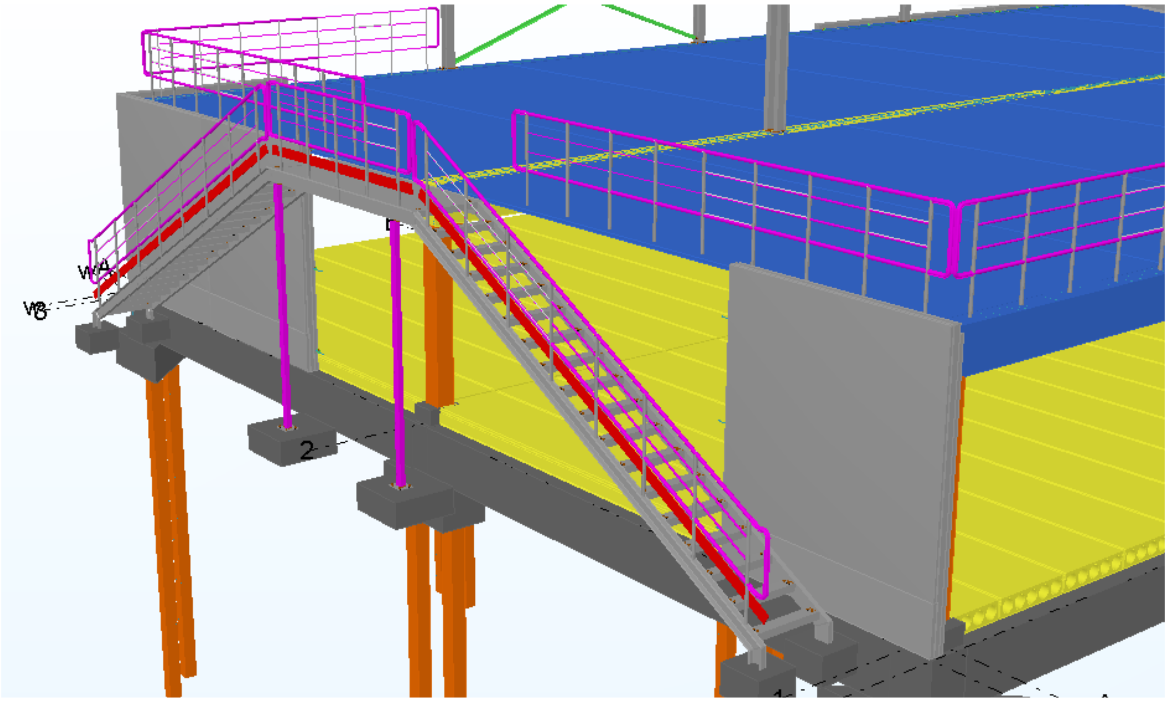

Figure 15 BIMsight view of the Staircases and Railings

Even if at a later stage the steel frame, staircases and railings are changed for economic, aesthetic or other reasons, they can still serve the purpose of presenting the idea of such a method of expansion and provide approximate information on its costs and how it would look. That way the project planners can more easily reach a decision on how to proceed with the project.

7 CONCLUSIONS

Due to the available information online and the free student versions of the program, Tekla Structures provides plenty of material for anyone interested in learning how to use it. Thanks to this, studying the software can be relatively fast and easy.

Despite all this there is still room for improvement. Not all of the features are available for a private study. The additional materials needed for linking the program to structural analysis software are unavailable to people with merely student accounts and there is no specific information explaining this. Because of that the program cannot be studied in its full potential and many users, who are attempting to do so, end up spending a lot of unnecessary time researching the methods for it before discovering their limitations.

Additionally, many of the program’s tools, which speed up the design process of new constructions, are ineffective when used for recreating already predesigned ones like the one in this report. This significantly slowed down the process. But due to the information generated by the model, the work in other parts of the project can be eased and sped up and the number of risks can be reduced.

Because the software can be used to design constructions of virtually all sizes and combine them with other designer’s work it improves the speed, communication and quality of the work in all stages of projects. That is why big names in the construction industry in Finland and abroad use it for large and intricate undertakings.

But Tekla is mostly limited to the large construction companies, due to its high price. Because of that, small projects, like the one described in this report, often do not get to benefit from the software the way it is intemded.

Thanks to it the commercial building has new and detailed drawings and the possibility to generate an unlimited range of others, depending on the demand. Additionally, the model has a steel frame second floor, whose construction time and material quantities have been calculated. This provides the basis for the creation of a feasibility report and gives the opportunity for testing the idea with structural analysis software. Furthermore, the model has been uploaded to Tekla BIMsight were other parties can view it and add their input. All of these benefits are well worth the effort even with the challenges that the design process presents.

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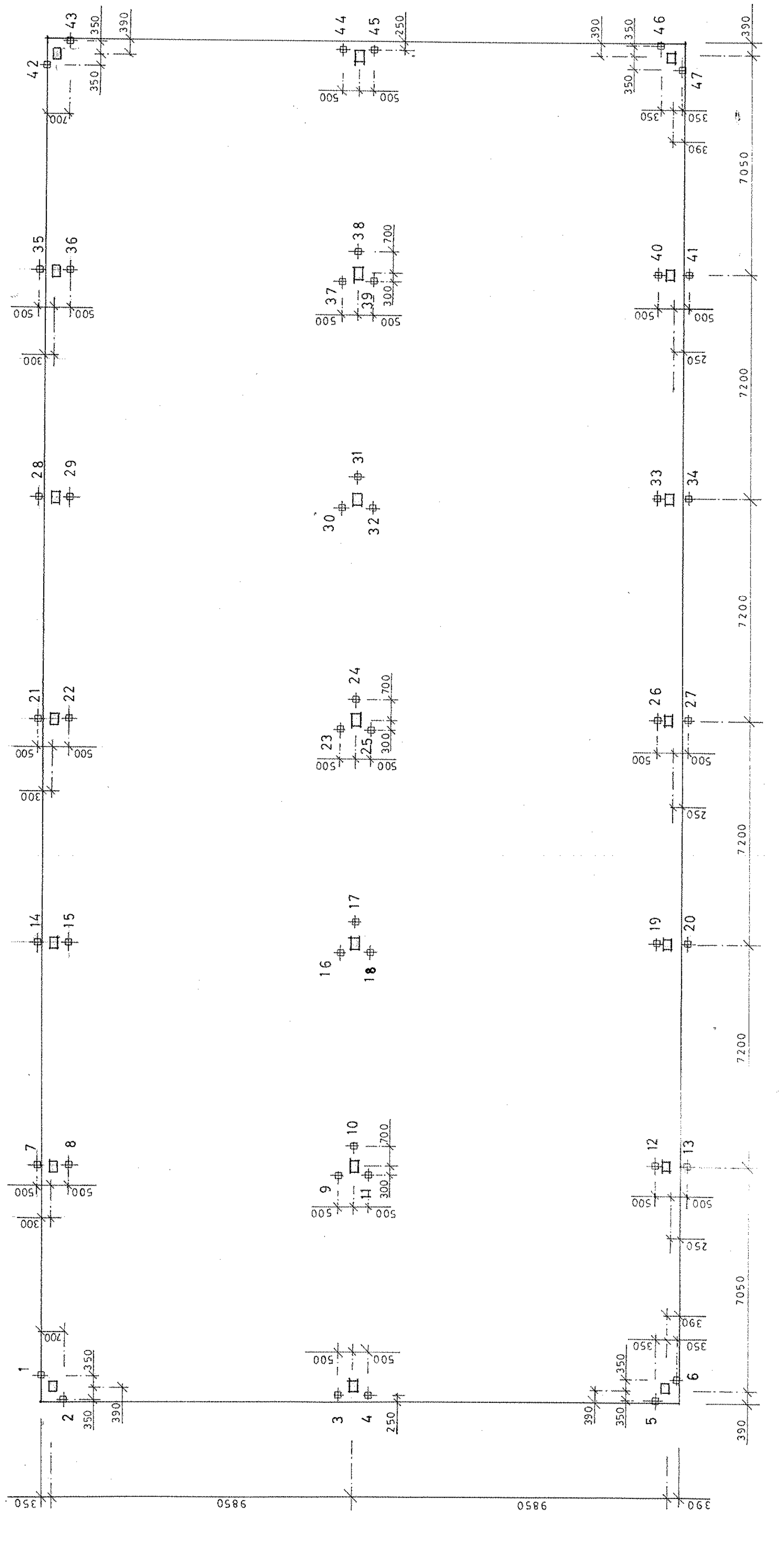
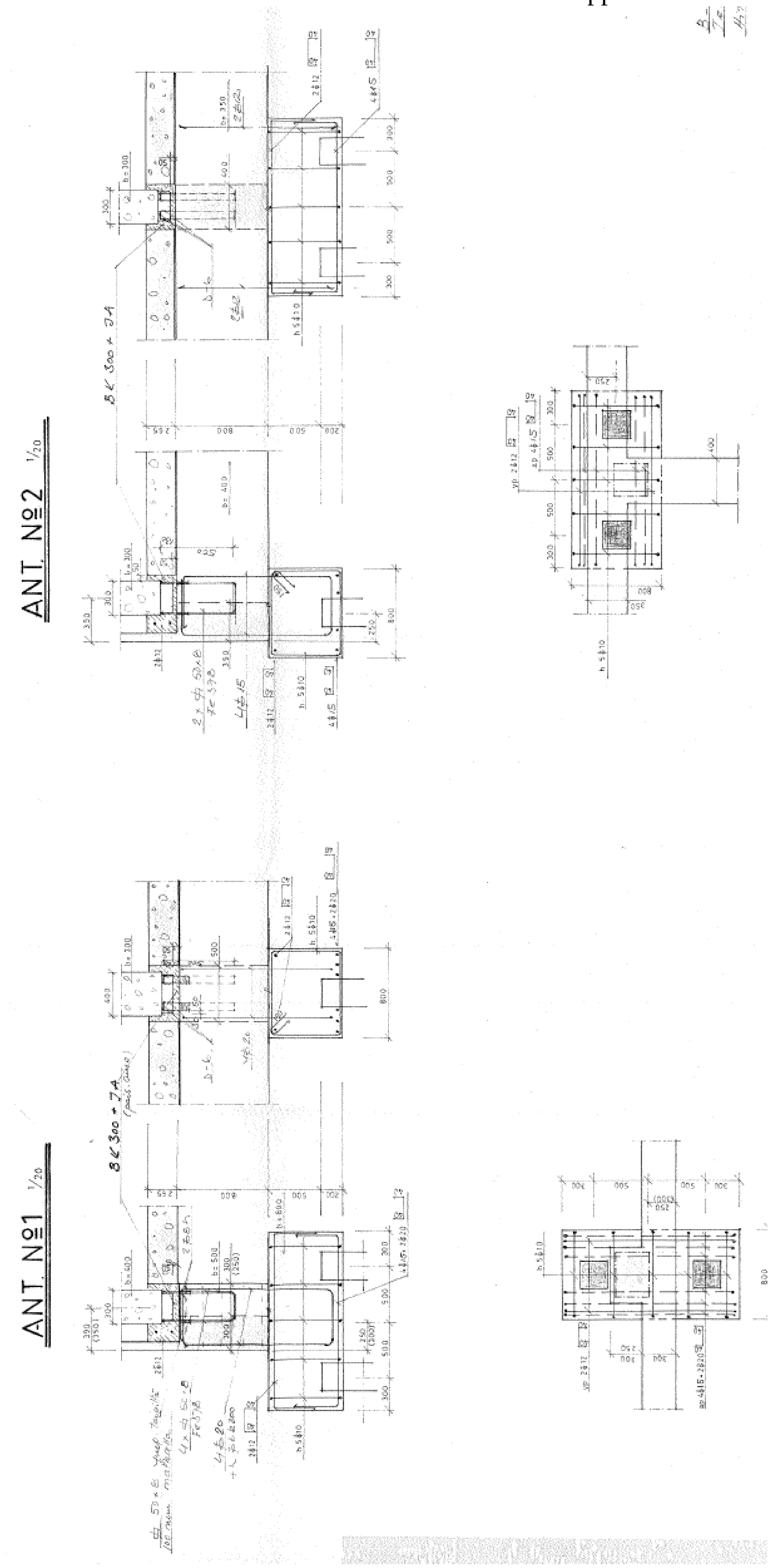
Appendix 1/1
Old Construction Drawings



Appendix 1/2



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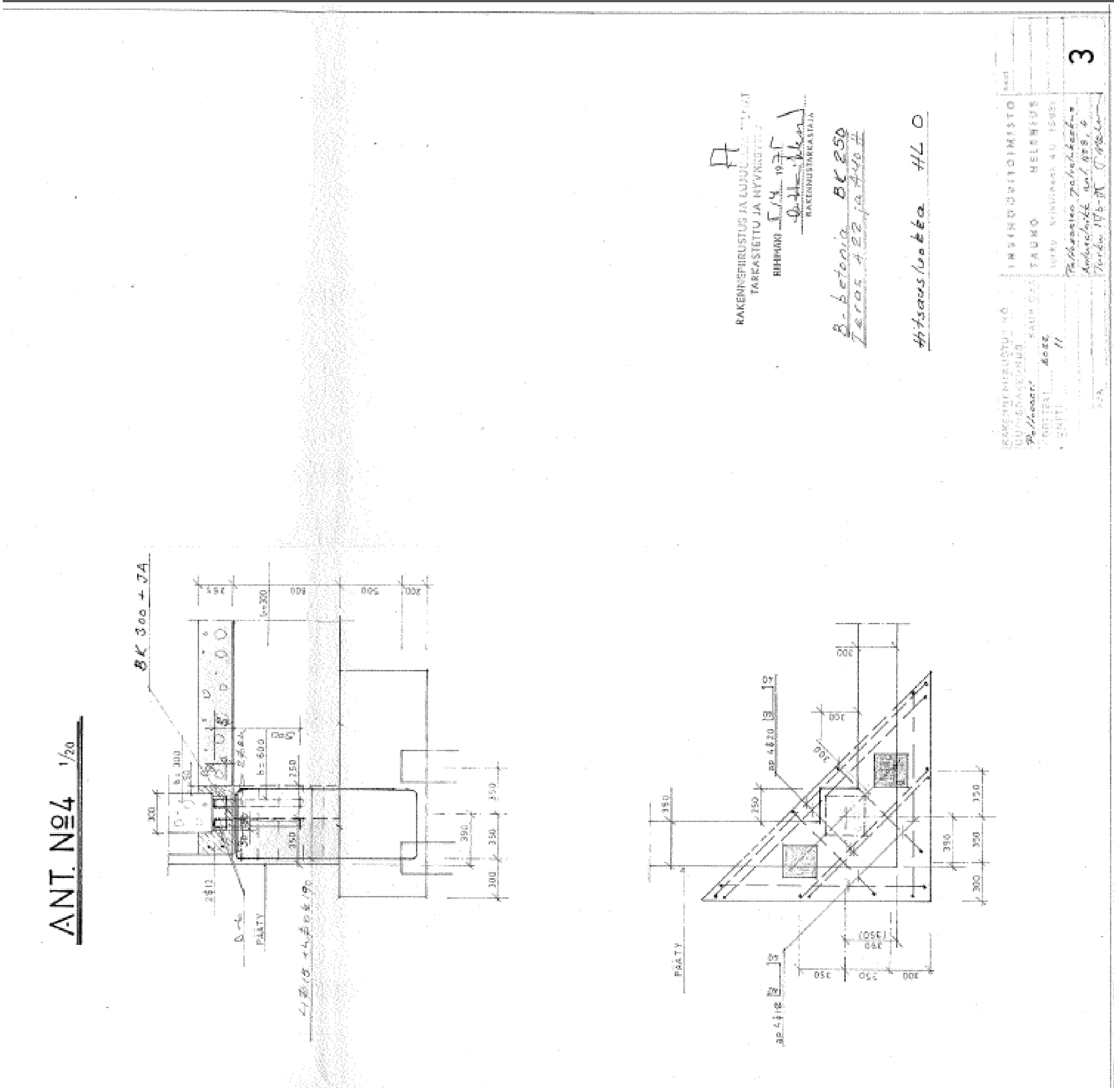

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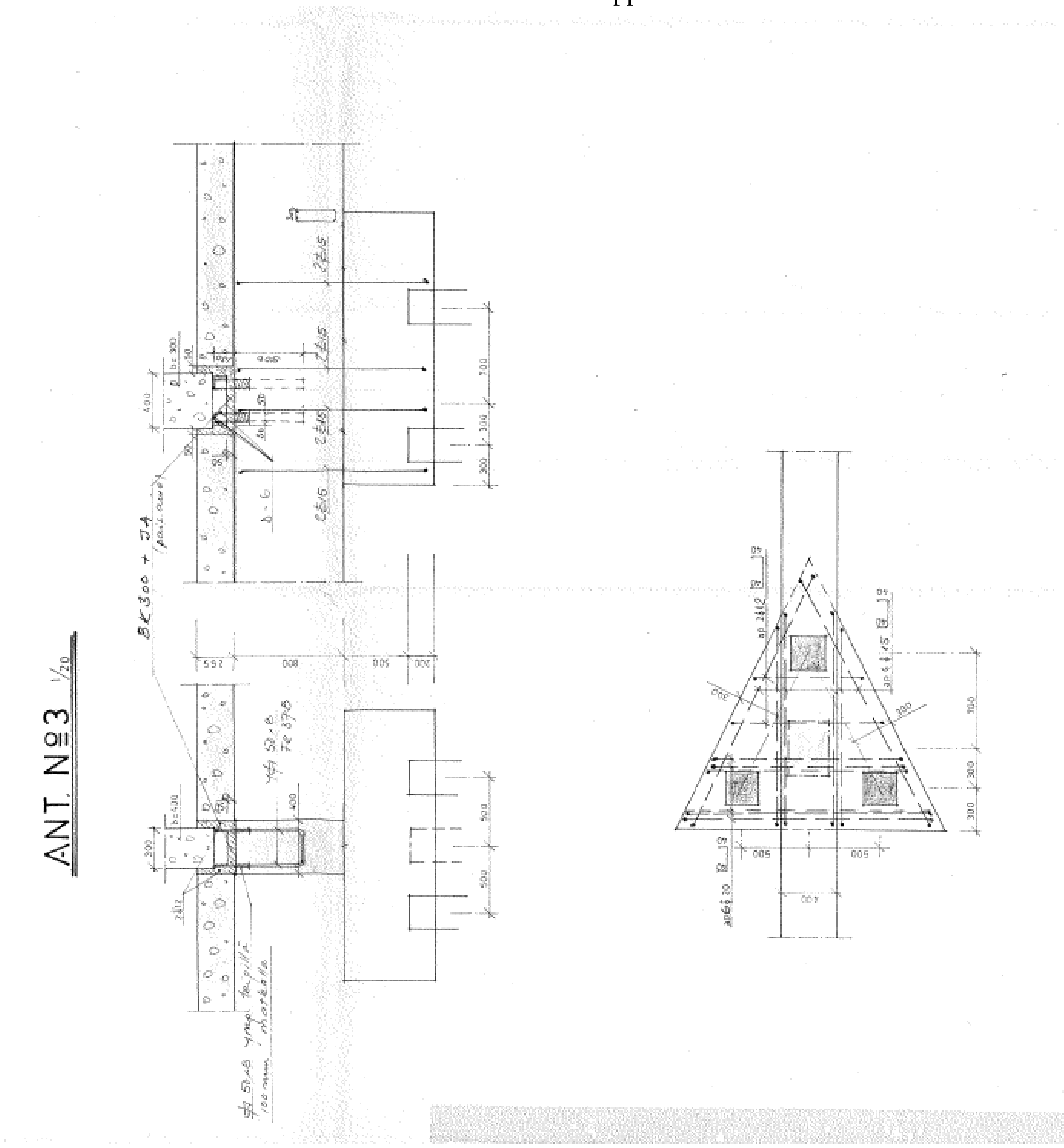
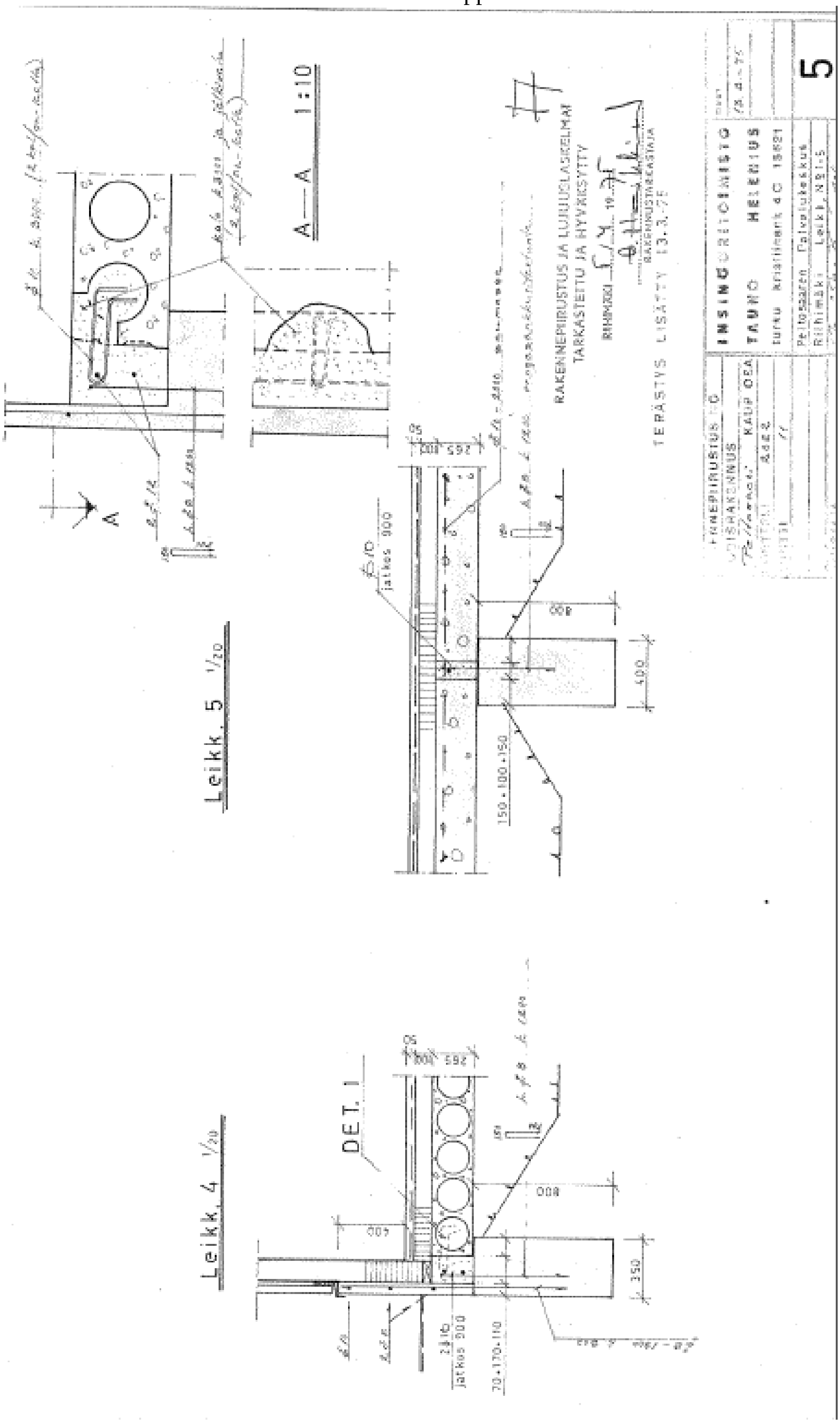
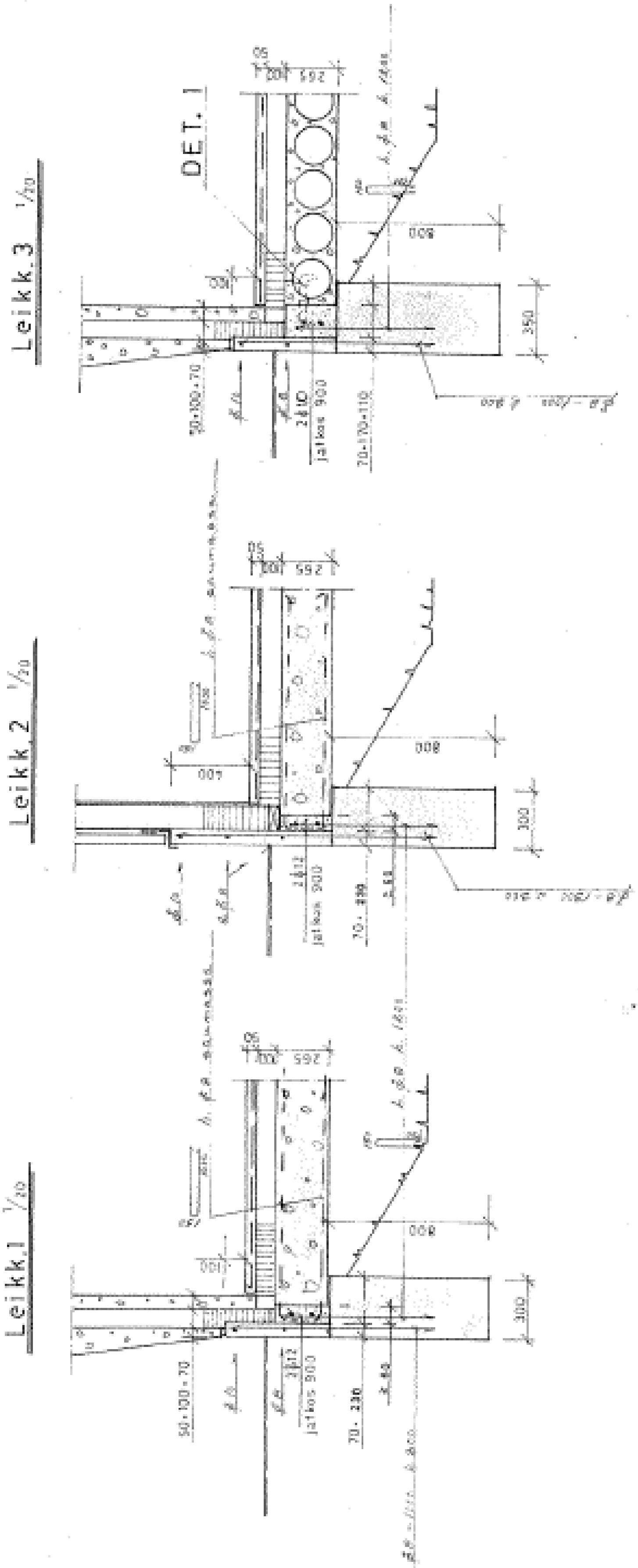


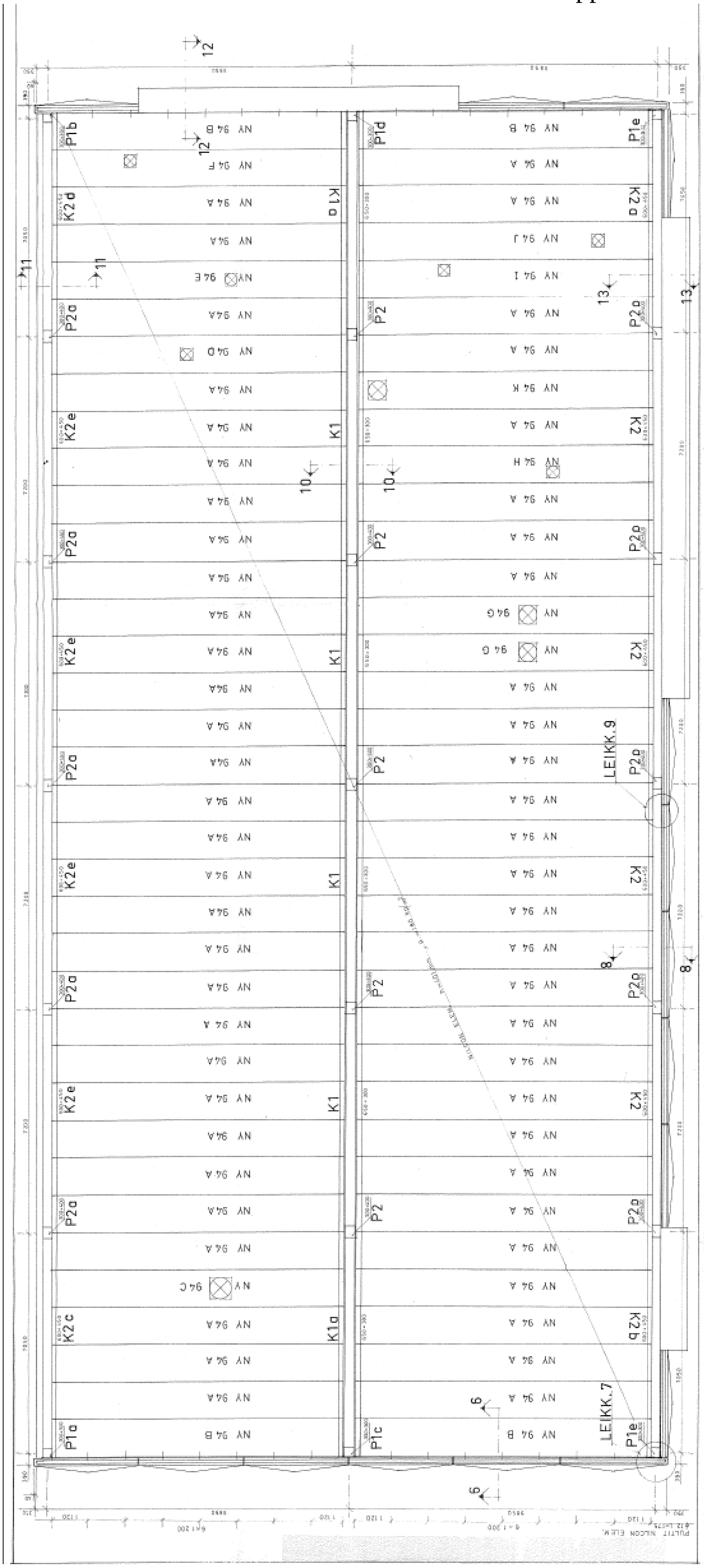
Appendix 1/5


DET. 1 1:10
A—A 1:10
Leikk. 5 1/20
Leikk. 4 1/20
DET. 1
RAKENNEPIIRUSTUS JA LUJUUSLASKELMAT
TARKASTETTU JA HYVÄKSYTTY
TERÄSTYS
INSINÖÖRITOIMISTO
TAUNO HELENIUS
5

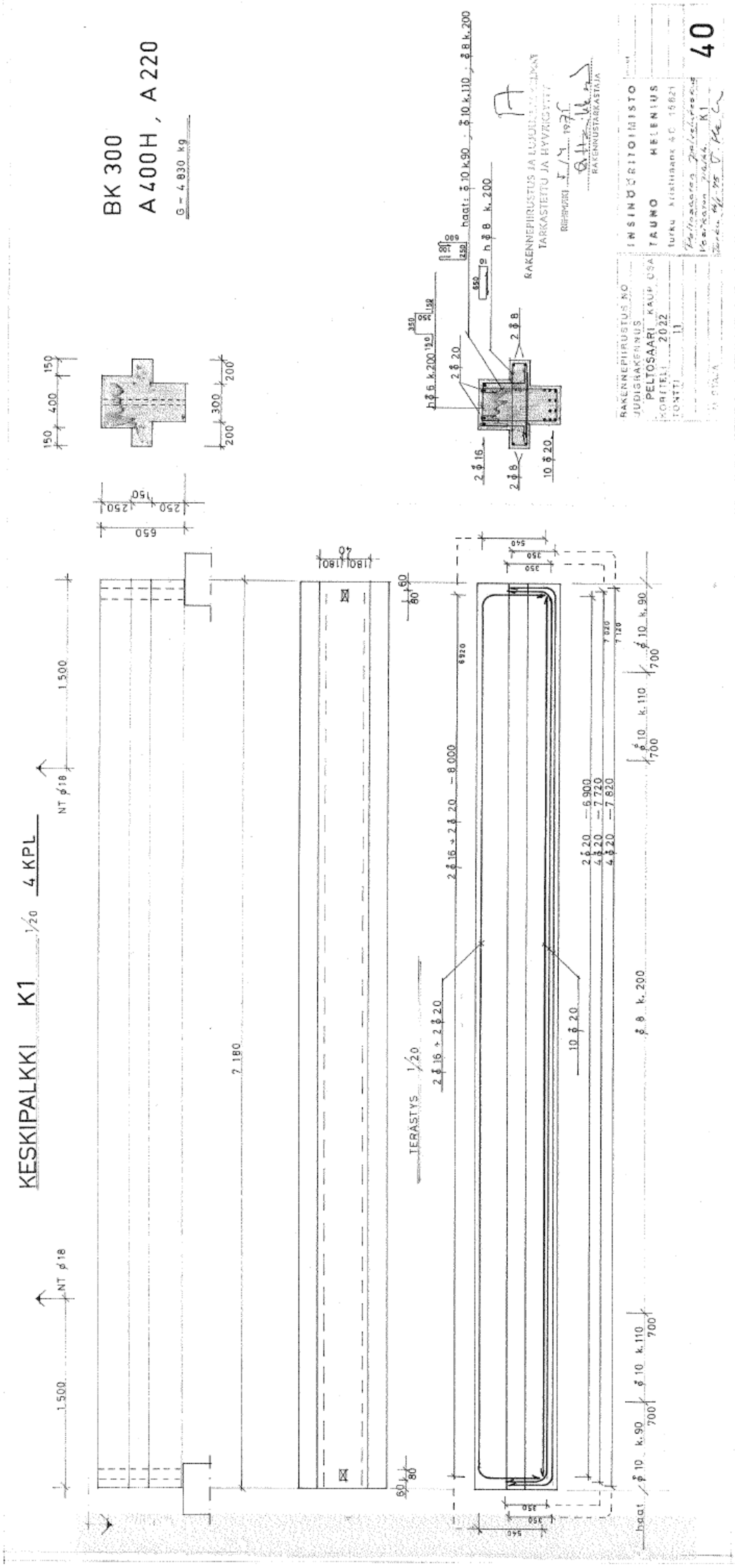
Appendix 1/6



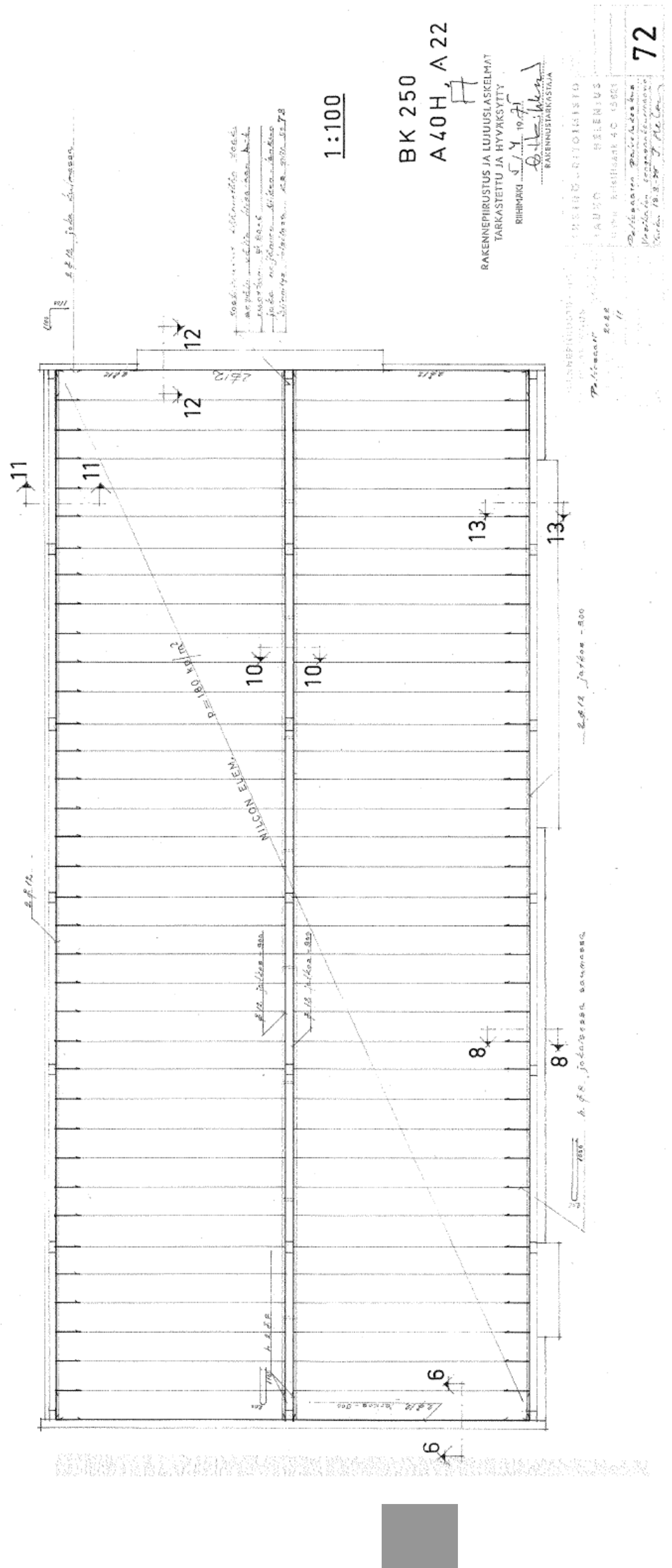
Appendix 1/7

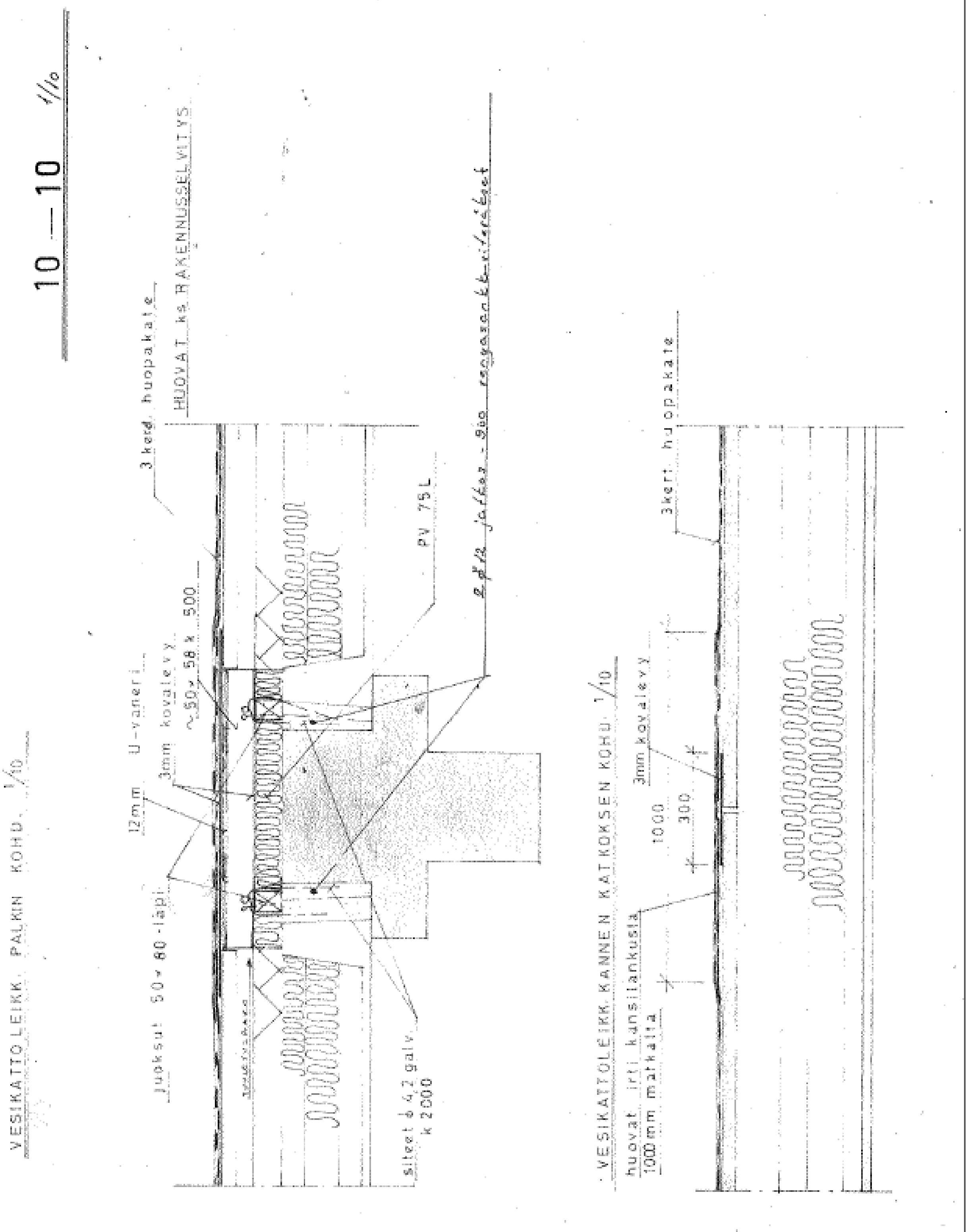

P1b
P1d
P1e
K2d
K1a
K2a
P2a
P2
P2b
K2e
K1
K2
LEIKK.9
K2c
K1a
K2b
LEIKK.7
P1a
P1c
P1e

Appendix 1/8



Appendix1/9


1:100
BK 250
A 40H, A 22
RAKENNEPIIRUSTUS JA LUJUUSLASKELMAT
TARKASTETTU JA HYVÄKSYTTY
RIIHIMÄKI
RAKENNUSTARKASTAJA
72
MILCON ELEM.
p = 180 kp/m²
12
11
13
10
8
6


10 — 10
1/10
VESIKATTOLEIKK. PALKIN KOHD. 1/10
3 kerd. huopakate
HUOVAT ks RAKENNUSSELVITYS
U-vaneri
3mm kovalevy
12mm
juoksut 50×80-läpi
PV 75L
siteet ⌀4,2 galv.
k 2000
VESIKATTOLEIKK. KANNEN KATKOKSEN KOHD. 1/10
3kert. huopakate
3mm kovalevy
1000
300
huovat irti kansilankusta
1000mm matkalta

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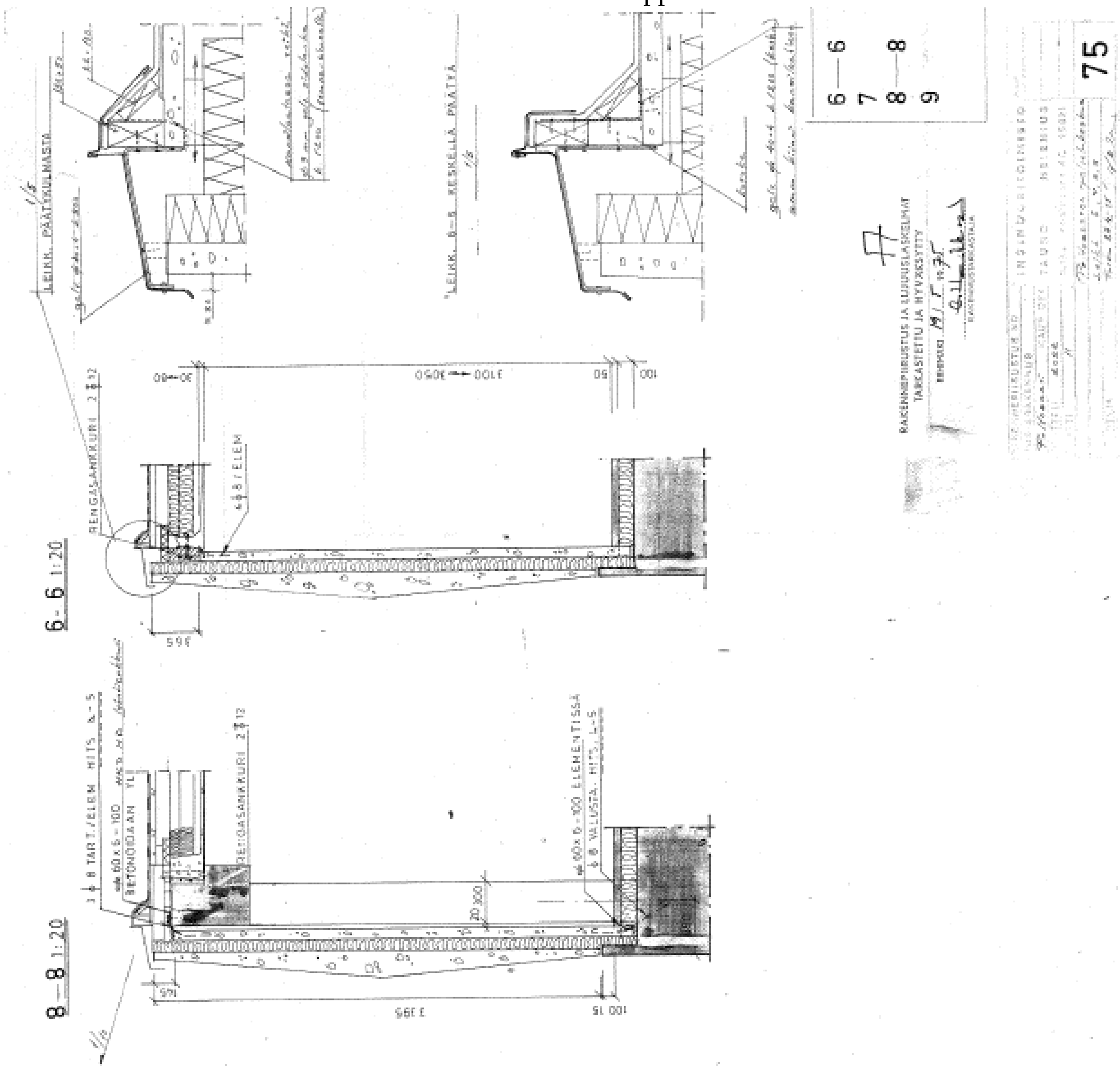

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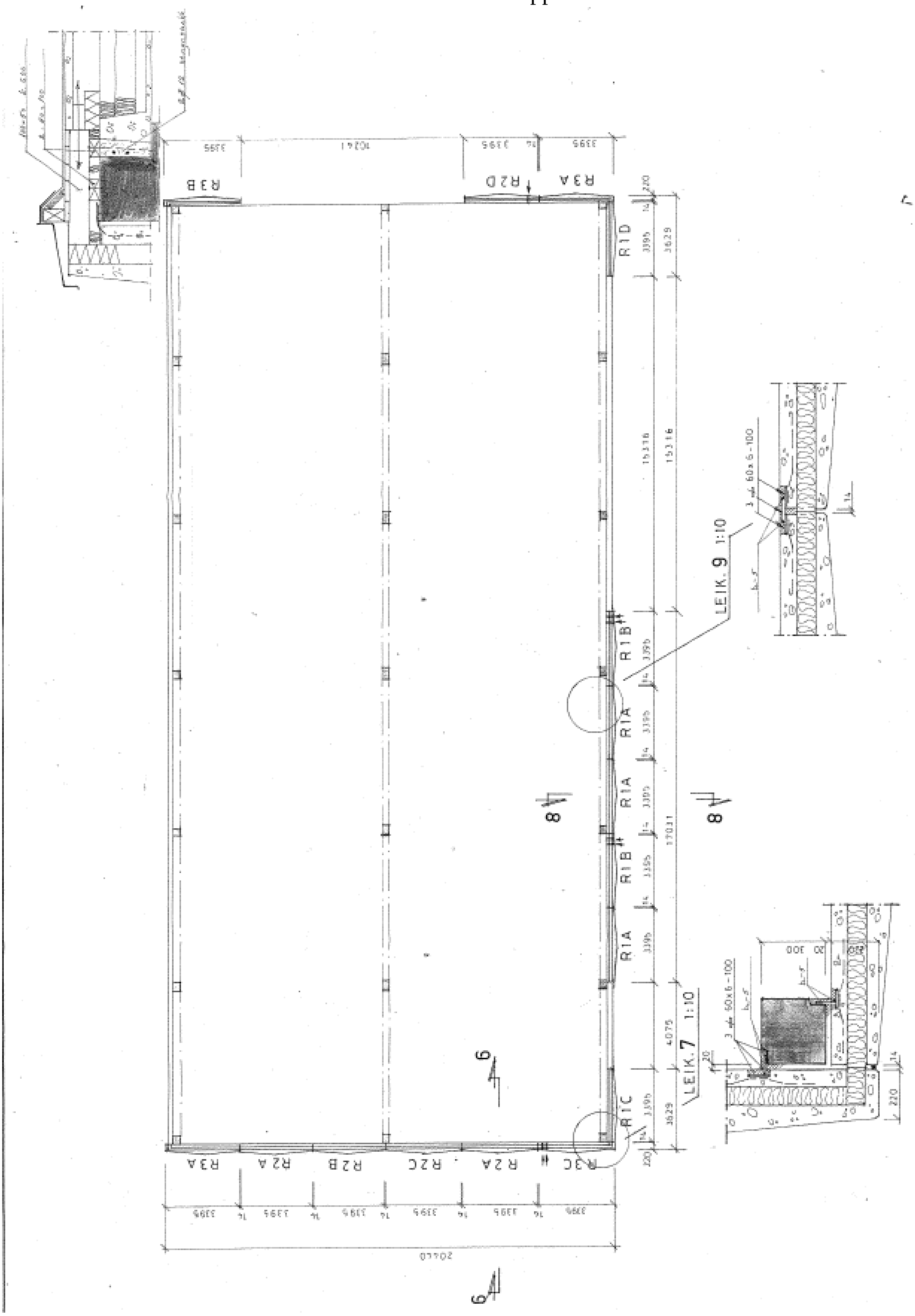
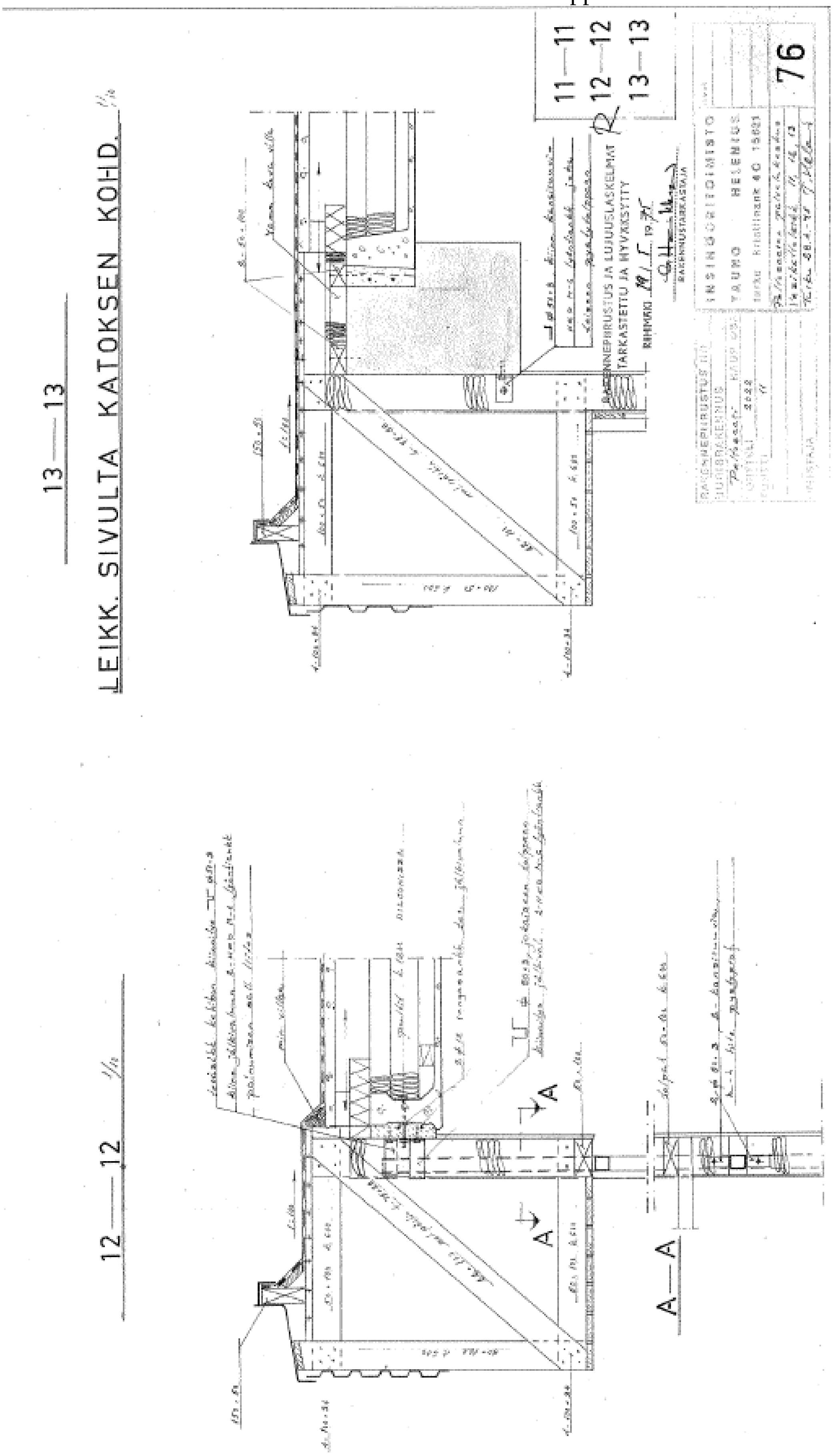
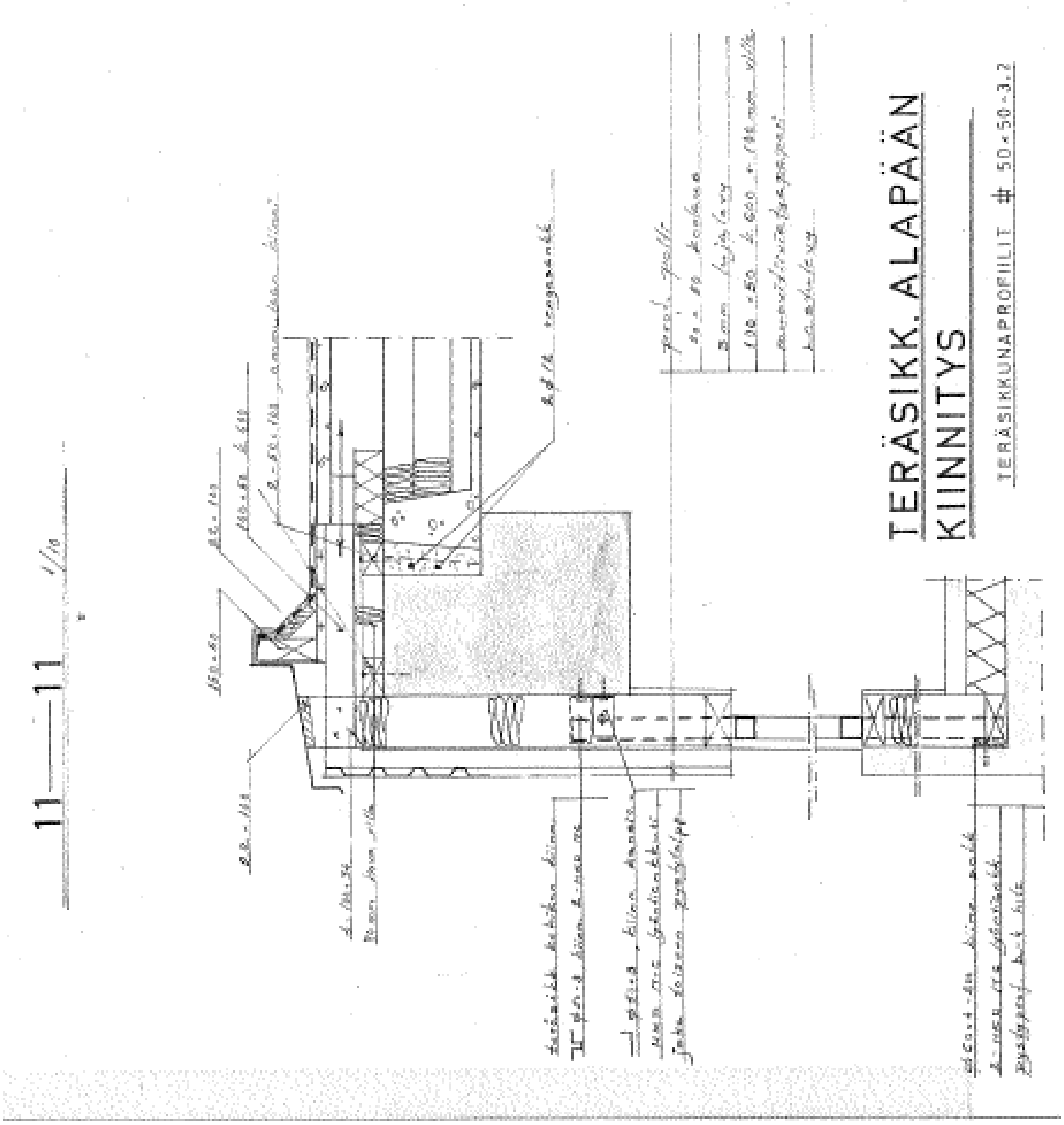
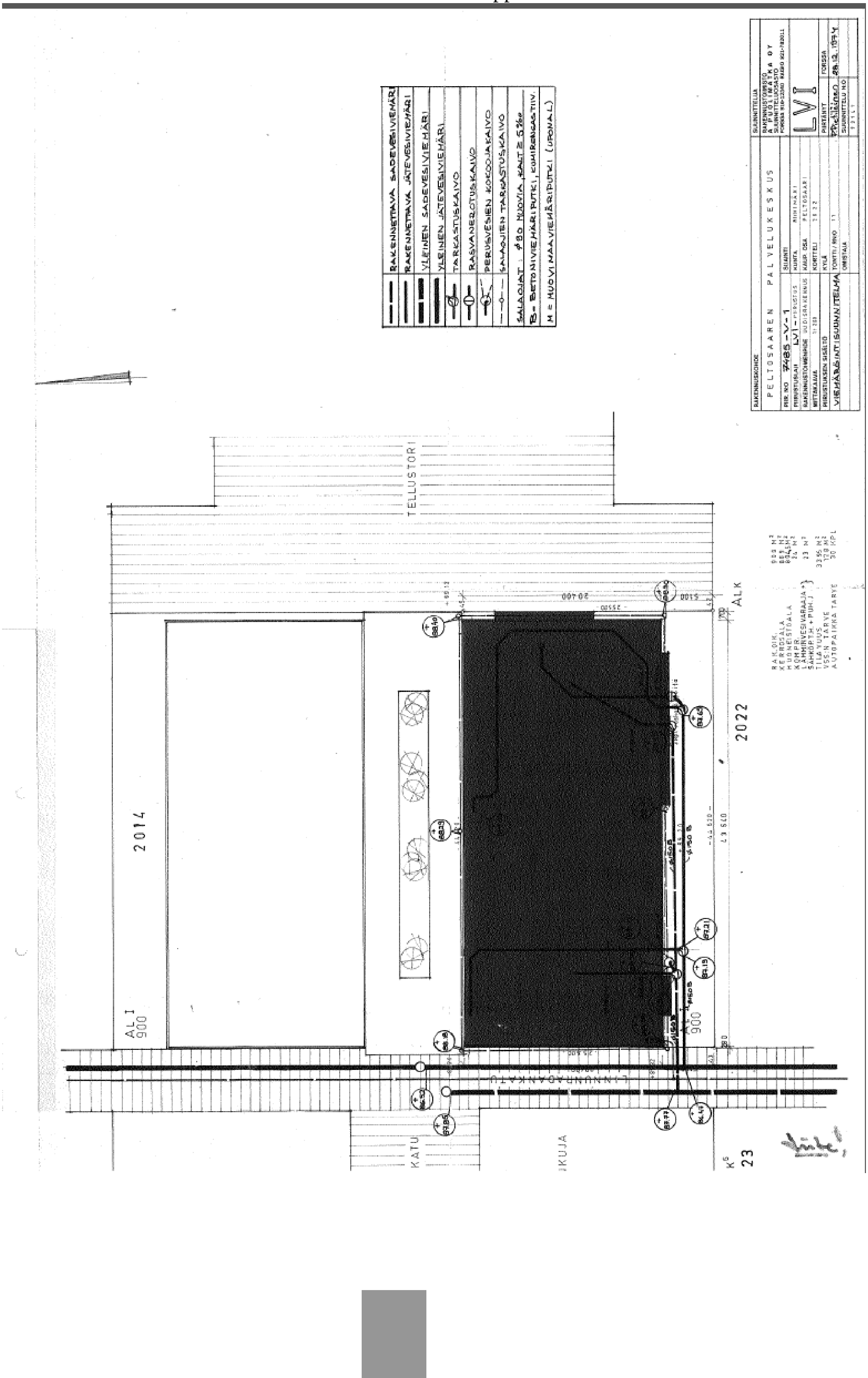
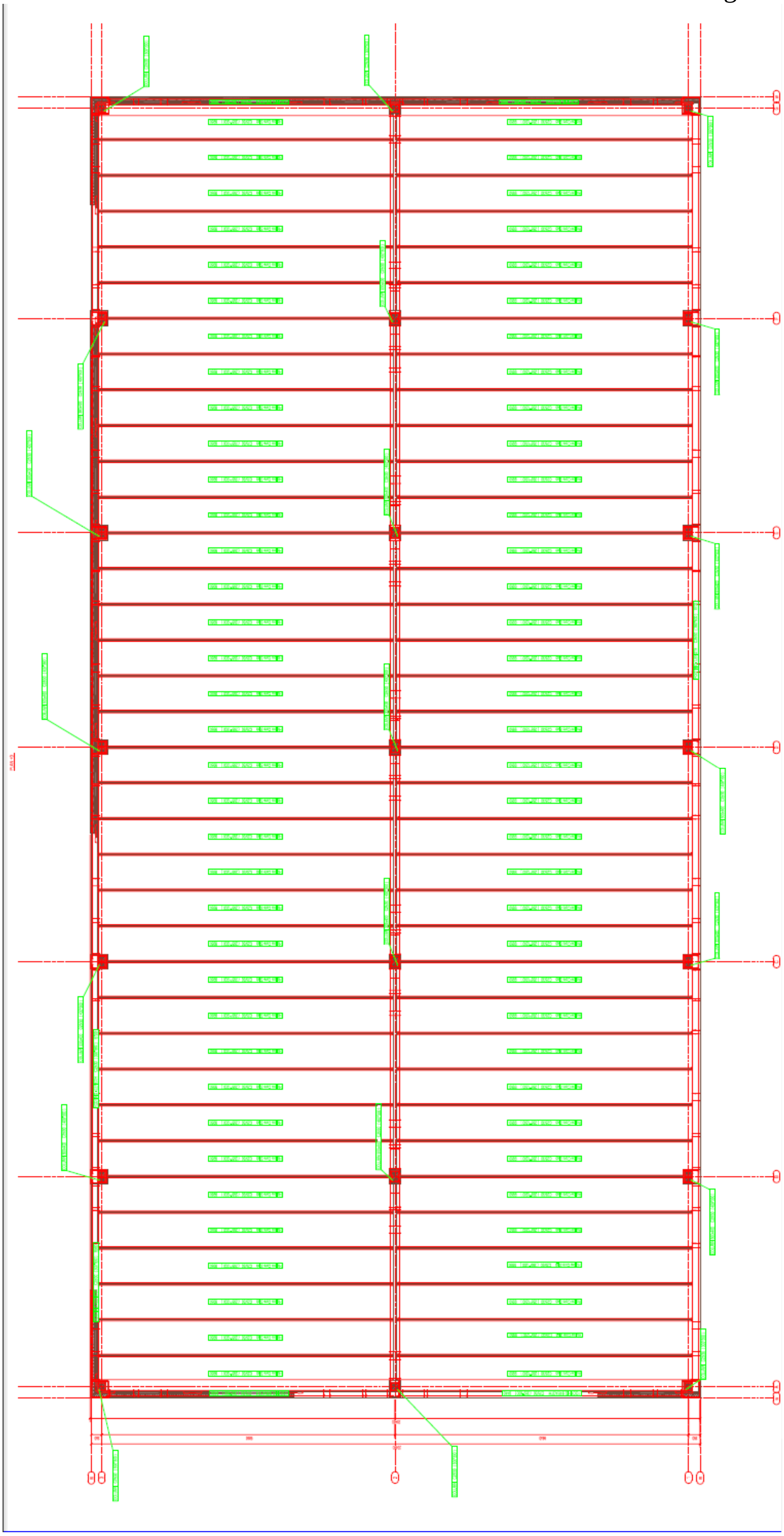



13 — 13
LEIKK. SIVULTA KATOKSEN KOHD.
12 — 12
A — A
11 — 11
12 — 12
13 — 13
RAKENNEPIIRUSTUS JA LUJUUSLASKELMAT
TARKASTETTU JA HYVÄKSYTTY
INSINÖÖRITOIMISTO
TAUNO HELENIUS
76

Appendix 1/14




RAKENNETTAVA SADEVESIVIEMÄRI
RAKENNETTAVA JÄTEVESIVIEMÄRI
YLEINEN SADEVESIVIEMÄRI
YLEINEN JÄTEVESIVIEMÄRI
TARKASTUSKAIVO
RASVANEROTUSKAIVO
PERUSVESIEN KOKOOJAKAIVO
SALAOJIEN TARKASTUSKAIVO
LVI
TELLUSTORI
2014
2022



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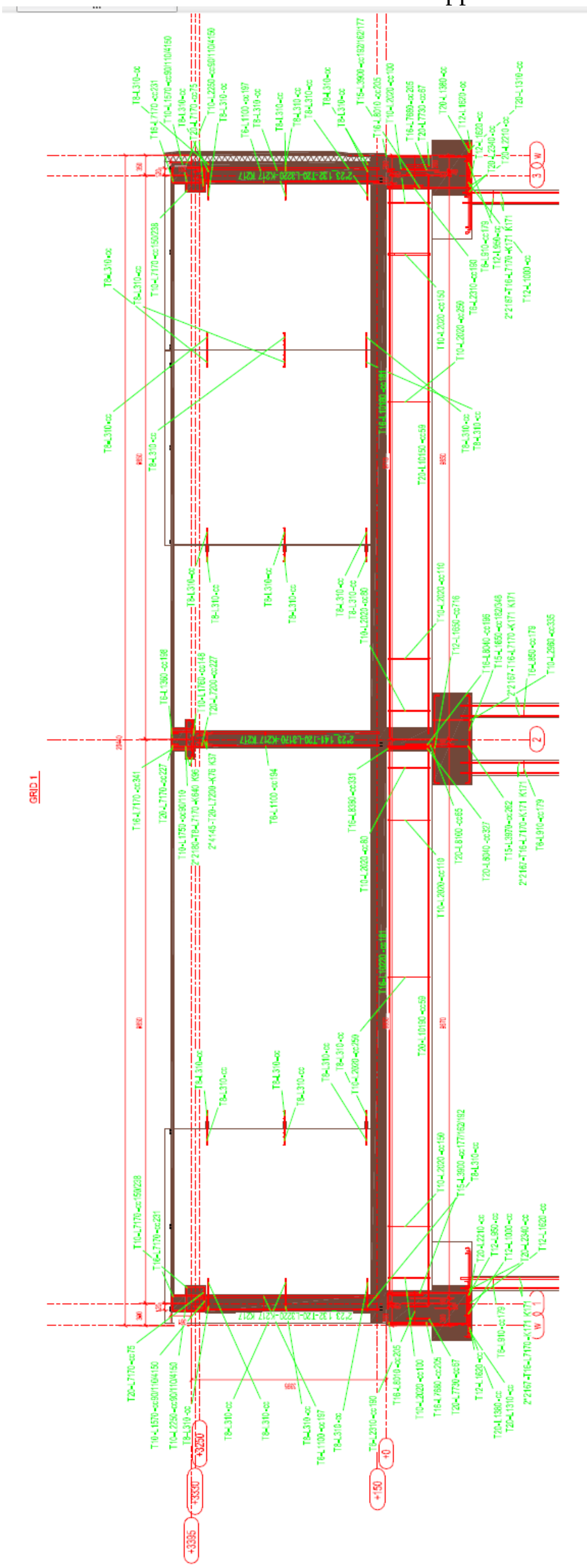

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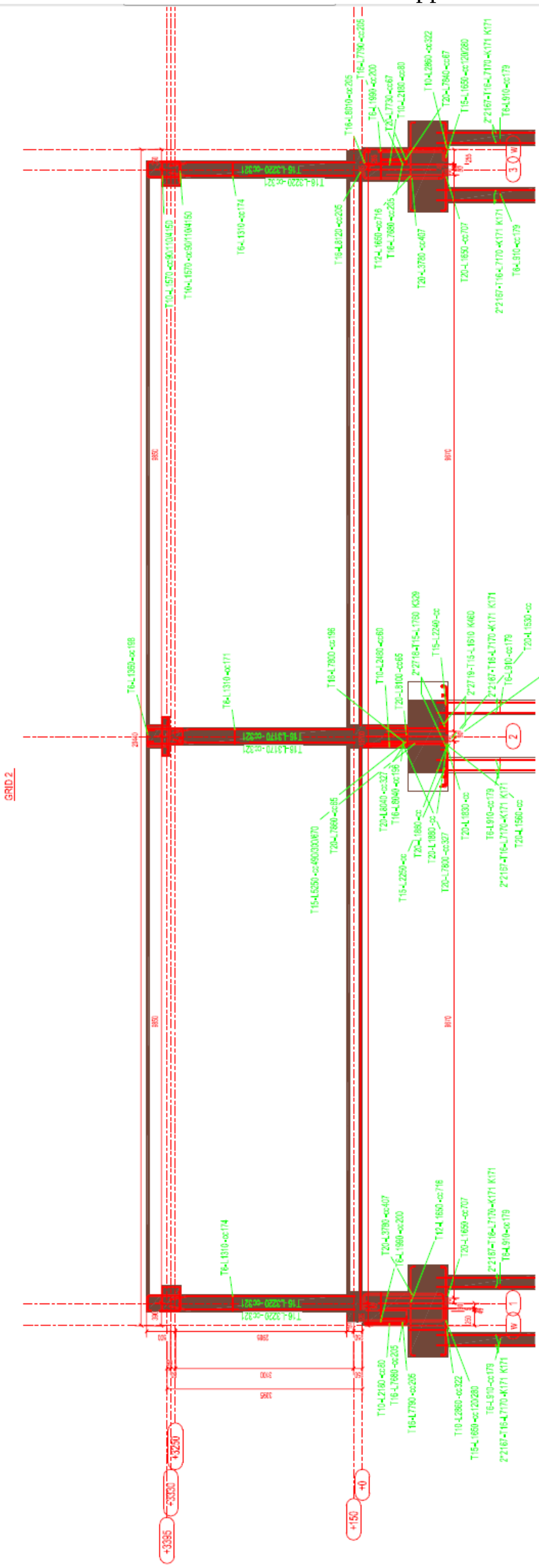

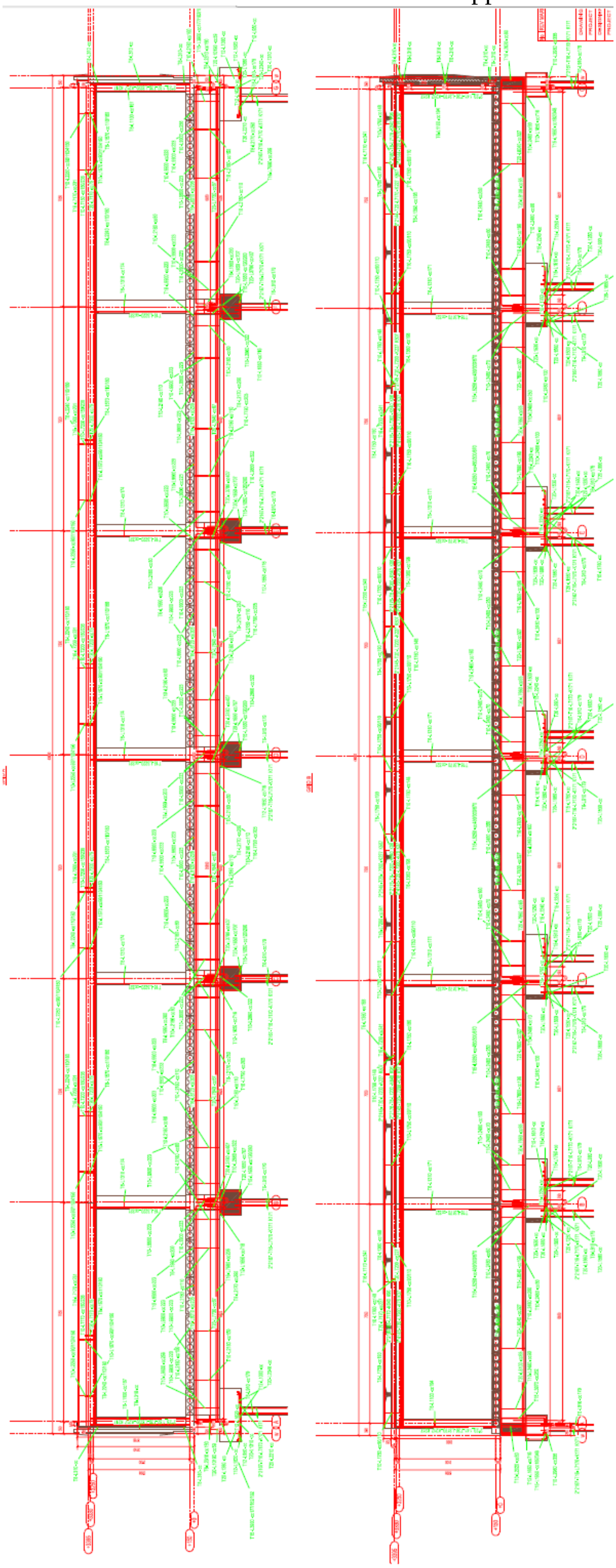

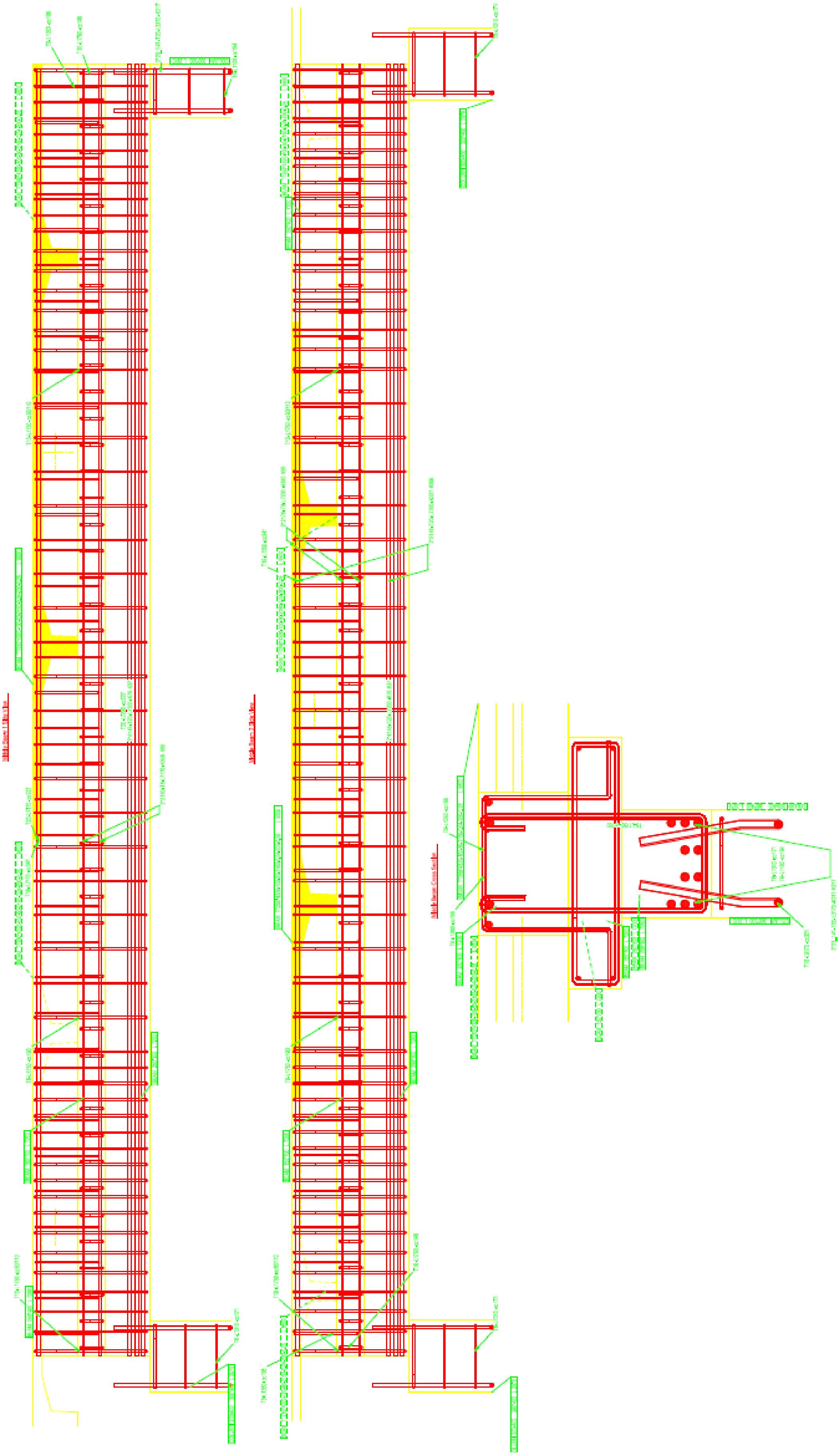

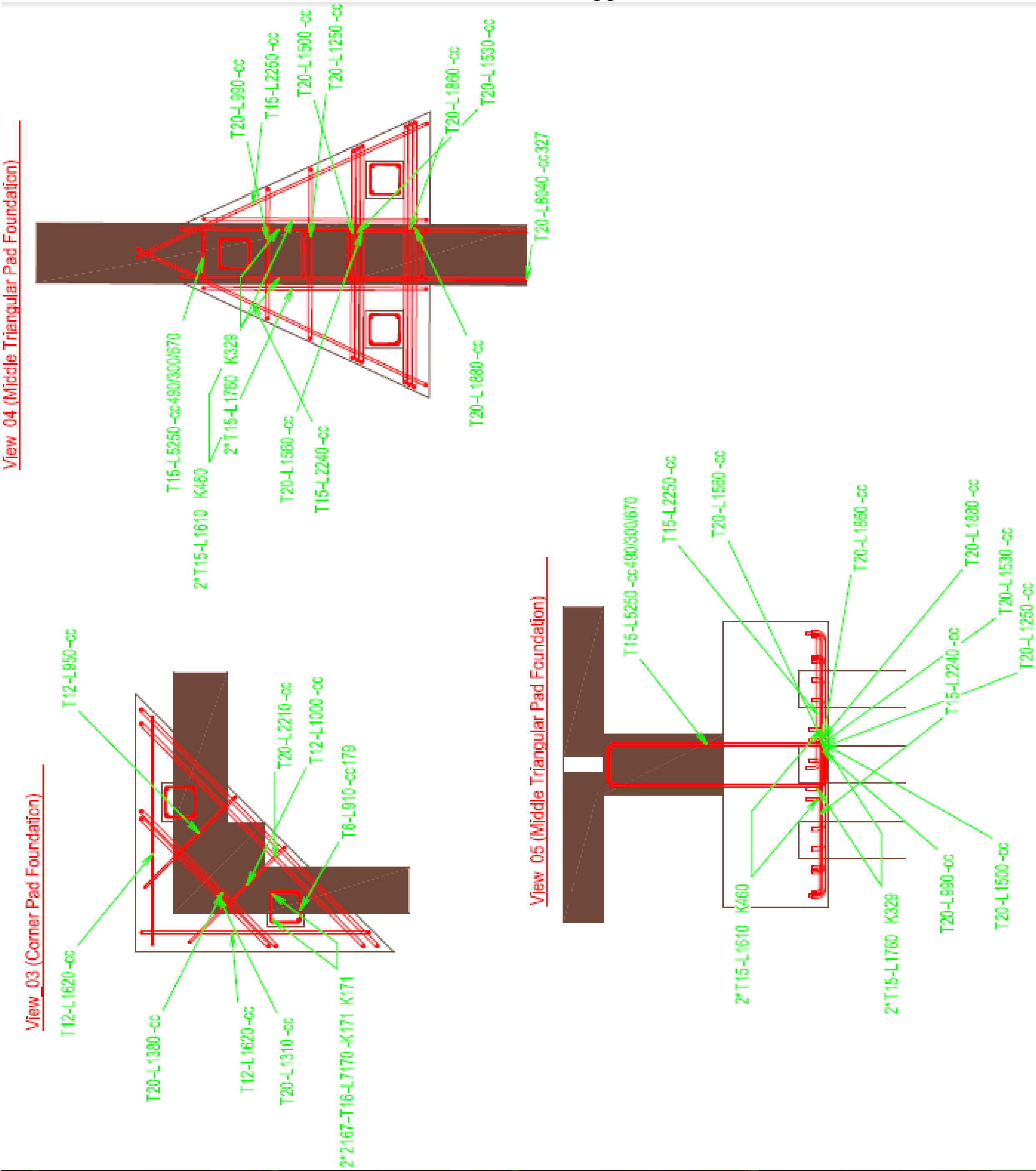
View 04 (Middle Triangular Pad Foundation)
T20-L990-cc
T15-L2250-cc
T20-L1500-cc
T20-L1250-cc
T20-L1860-cc
T20-L1530-cc
T20-L6040-cc327
T15-L5250-cc490/300/670
2*T15-L1610 K460
2*T15-L1760 K329
T20-L1560-cc
T15-L2240-cc
T20-L1880-cc
View 03 (Corner Pad Foundation)
T12-L950-cc
T20-L2210-cc
T12-L1000-cc
T6-L910-cc179
T12-L1620-cc
T20-L1380-cc
T12-L1620-cc
T20-L1310-cc
View 05 (Middle Triangular Pad Foundation)
T15-L5250-cc490/300/670
T15-L2250-cc
T20-L1560-cc
T20-L1860-cc
T20-L1880-cc
T20-L1530-cc
T20-L1250-cc
T15-L2240-cc
2*T15-L1610 K460
2*T15-L1760 K329
T20-L990-cc
T20-L1500-cc

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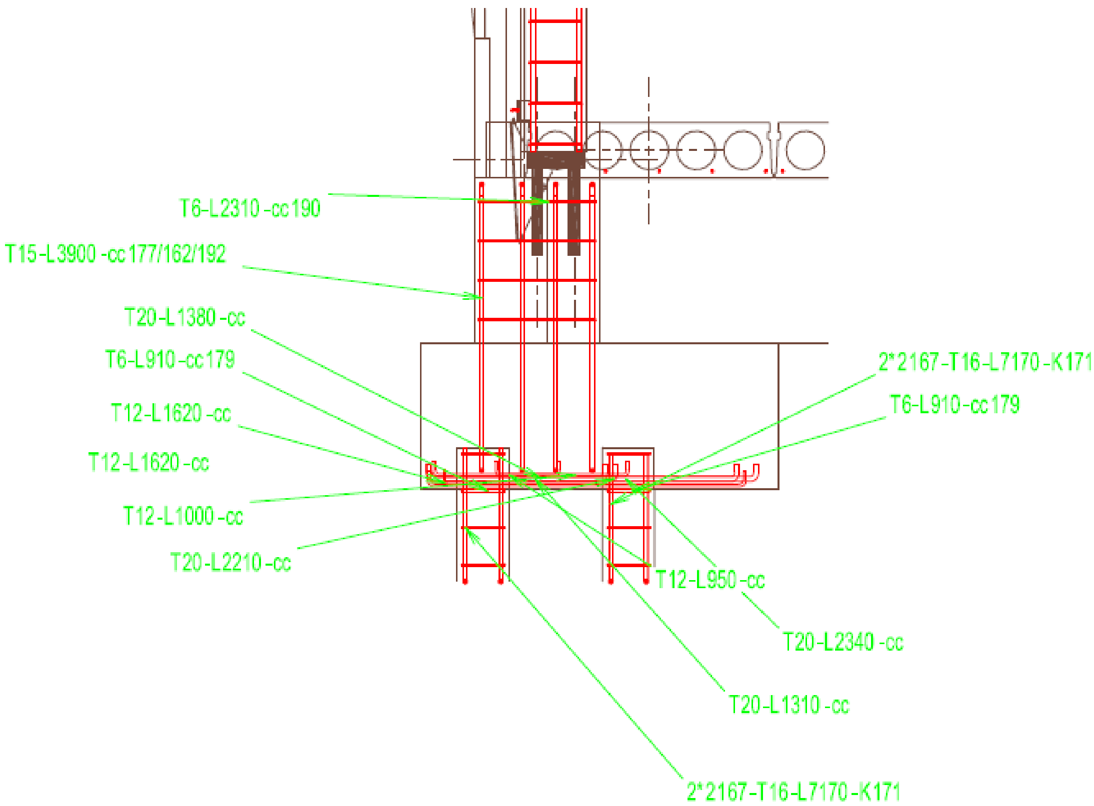
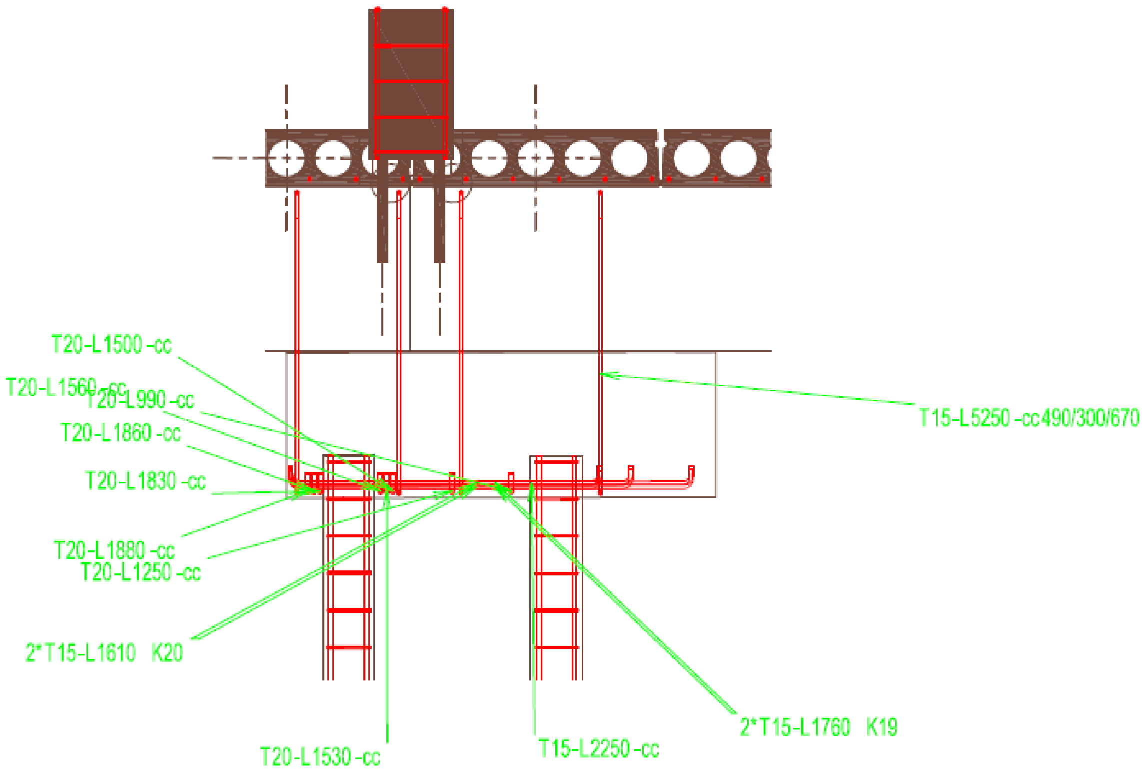
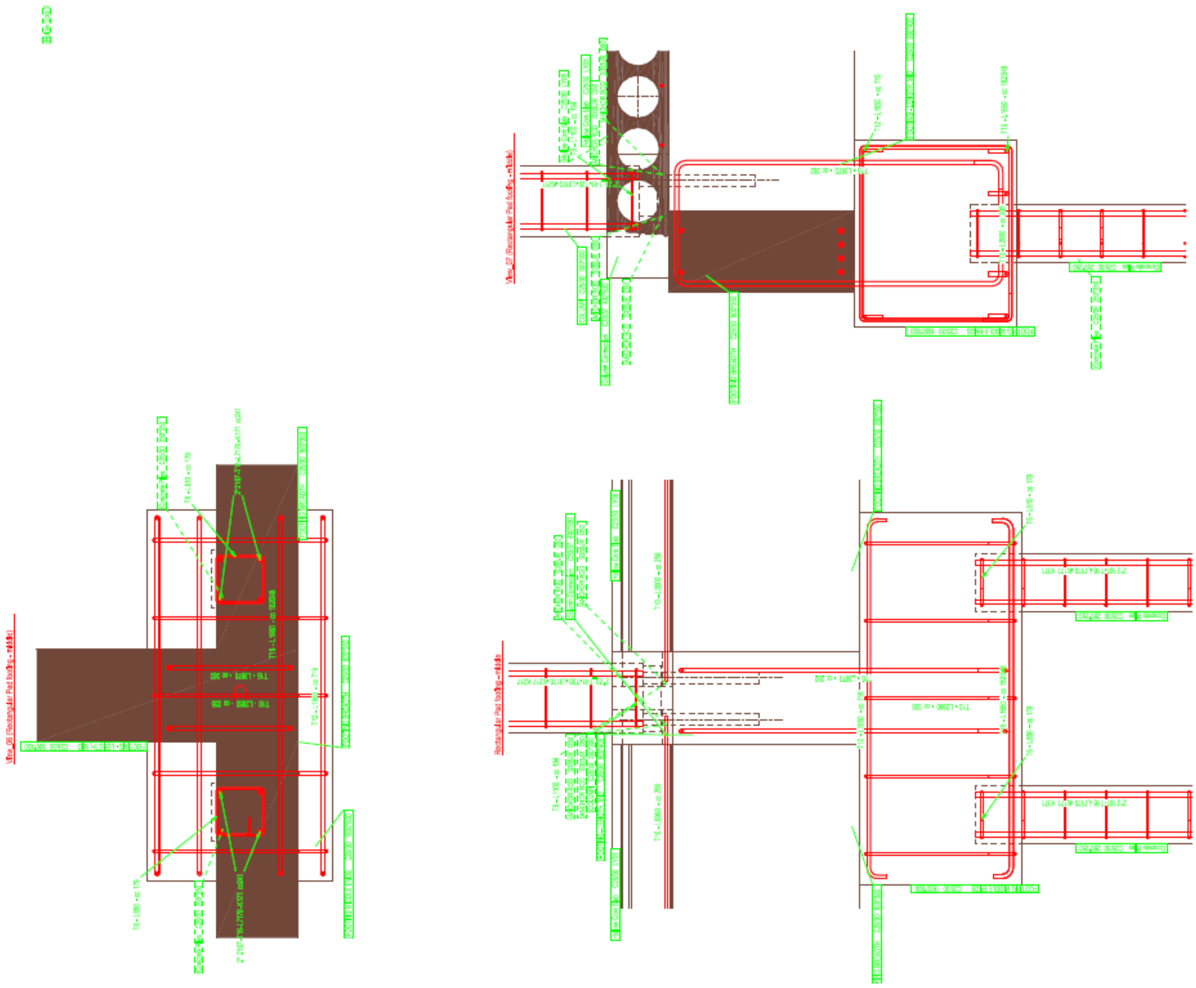
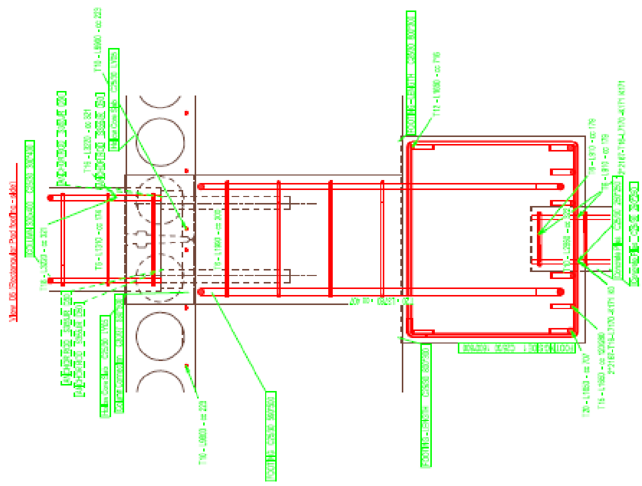
Corner Pad Foundation

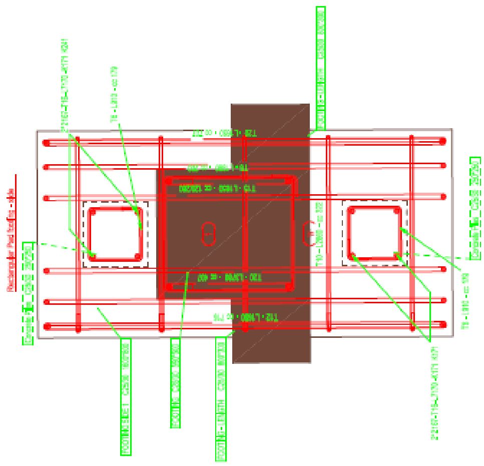


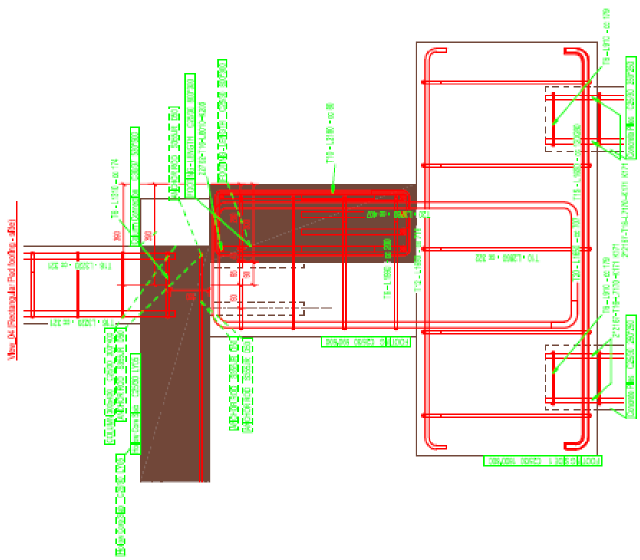
Middle Triangular Pad Foundation











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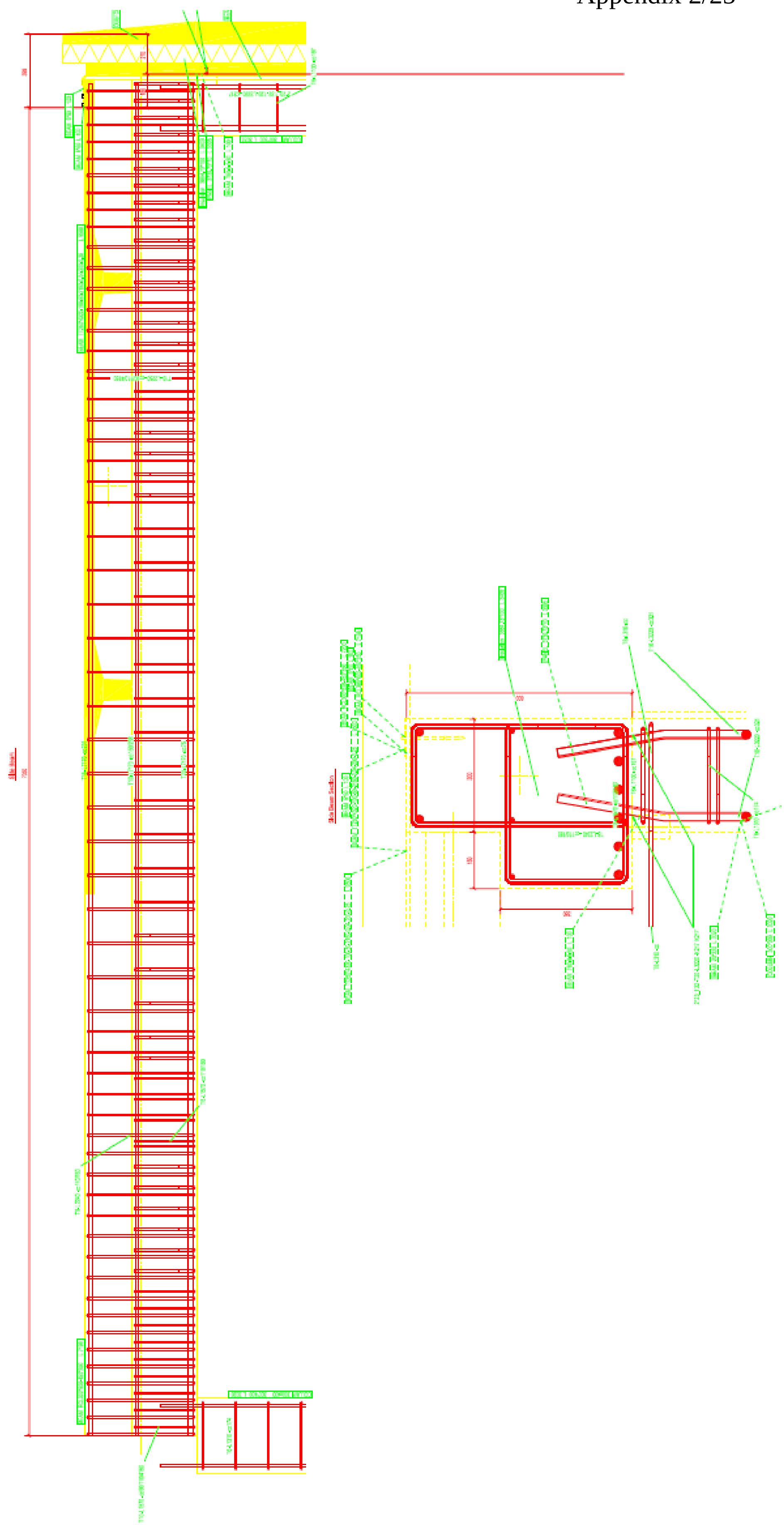

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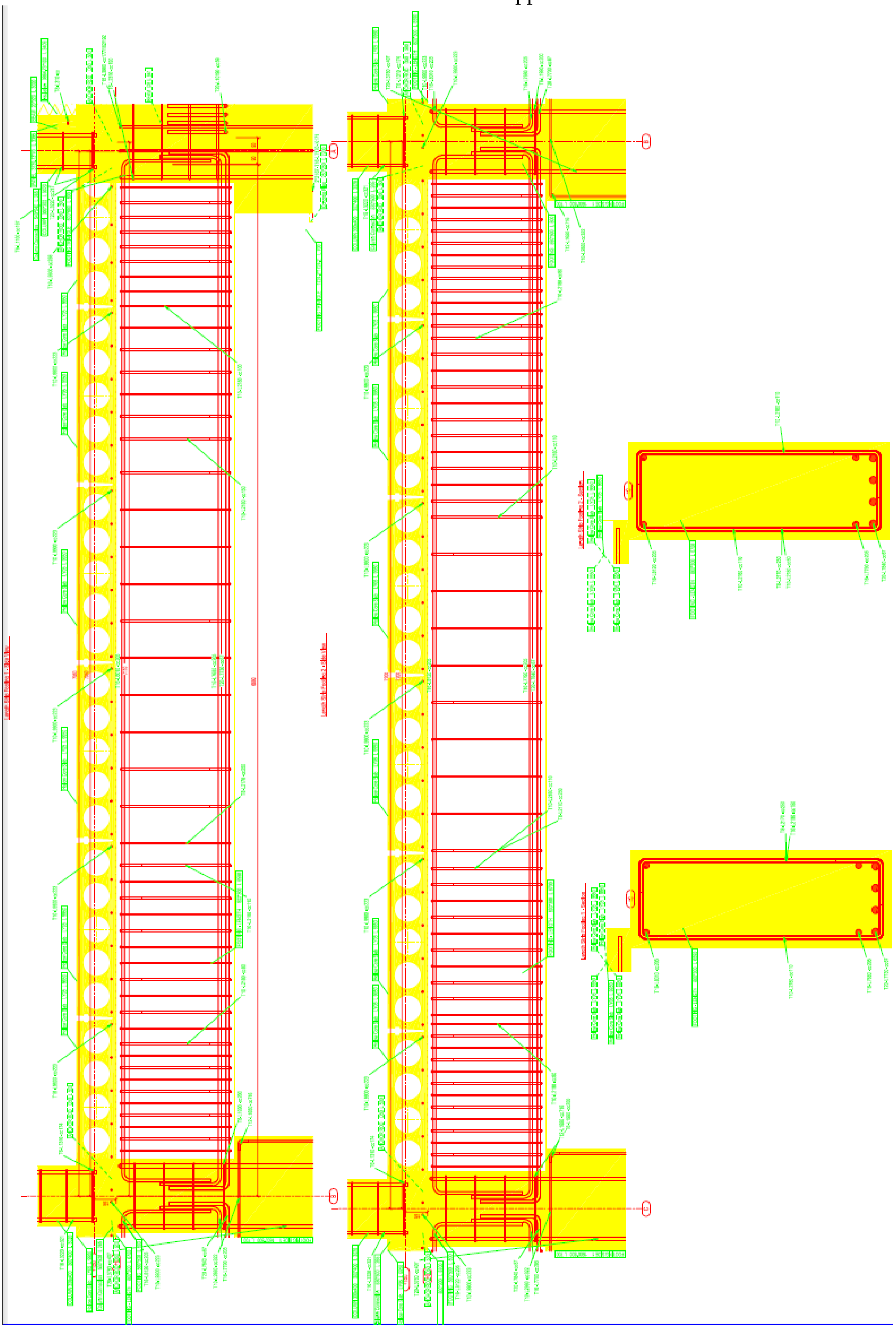

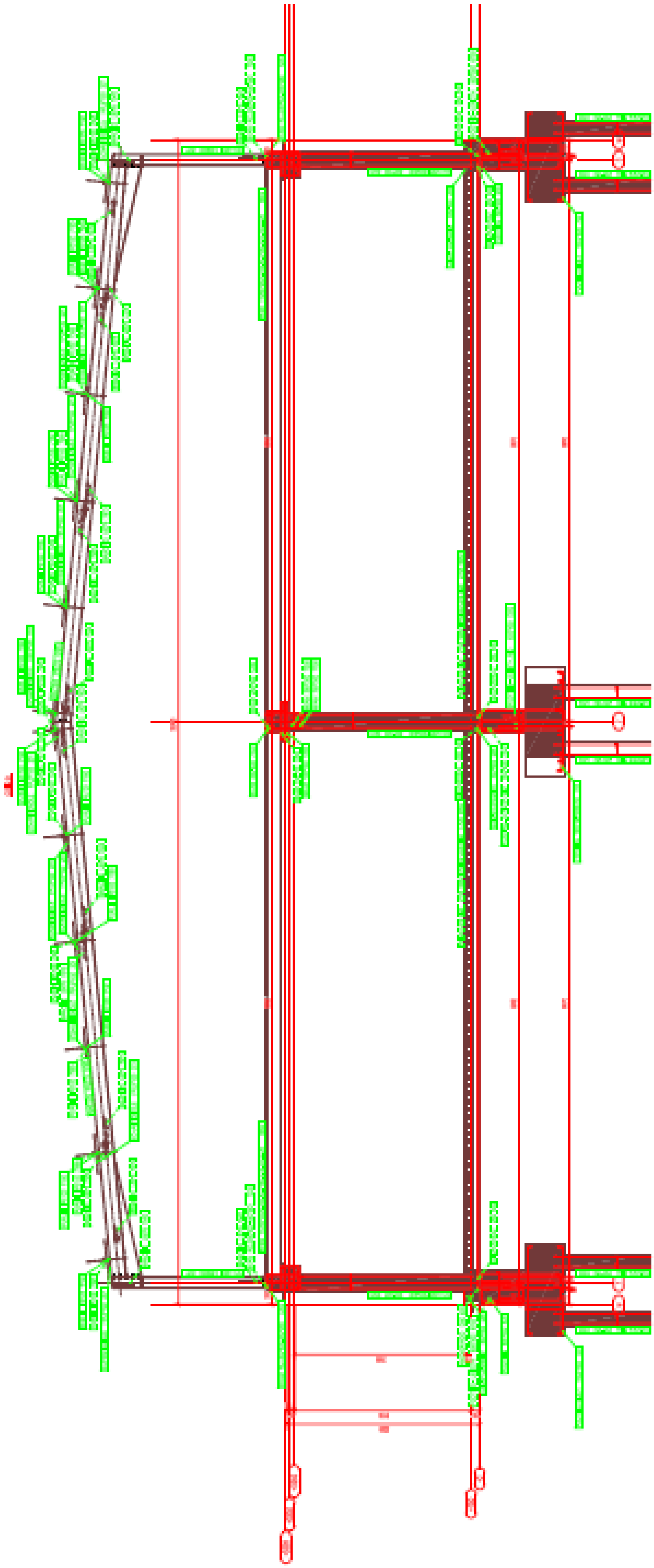

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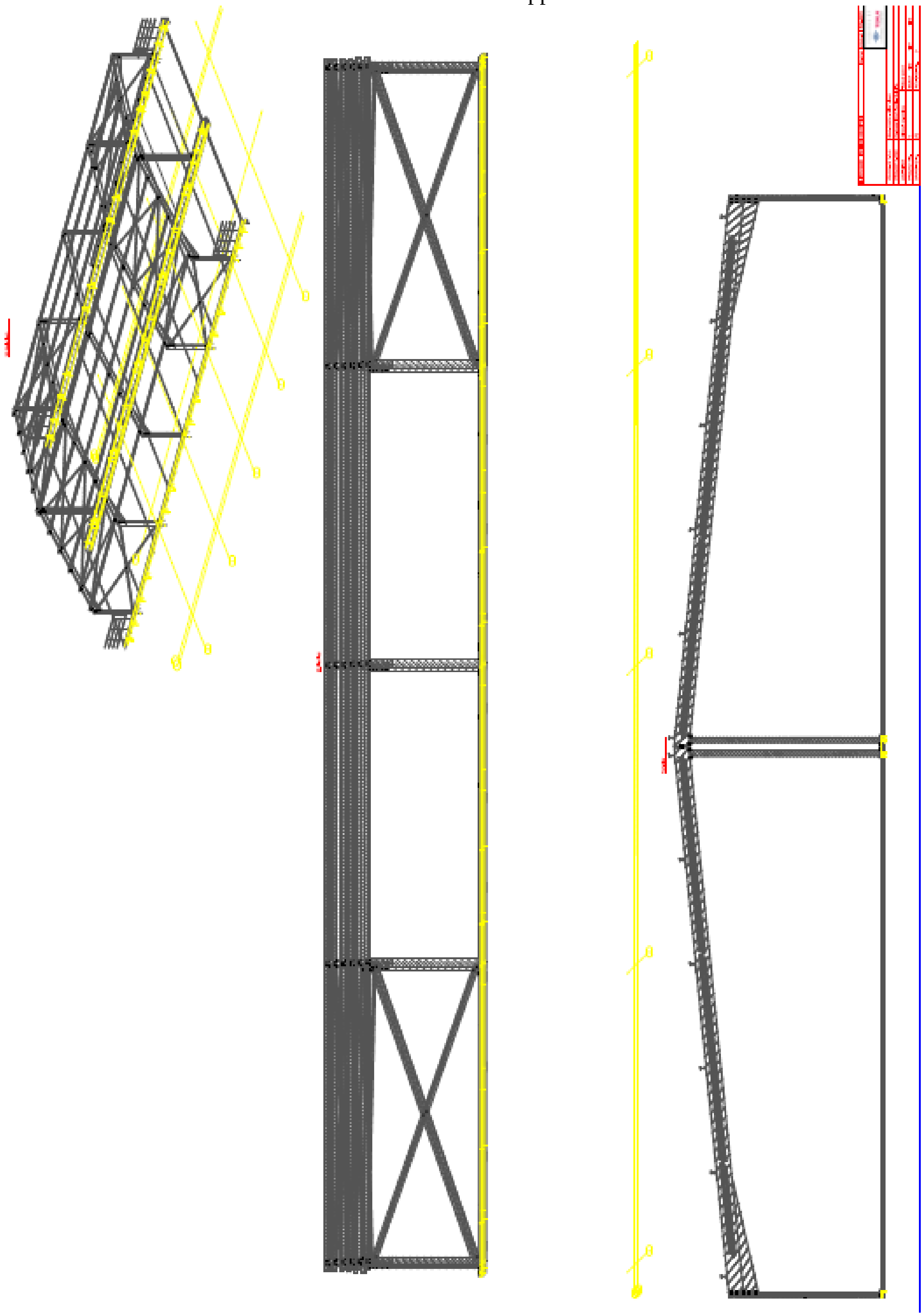

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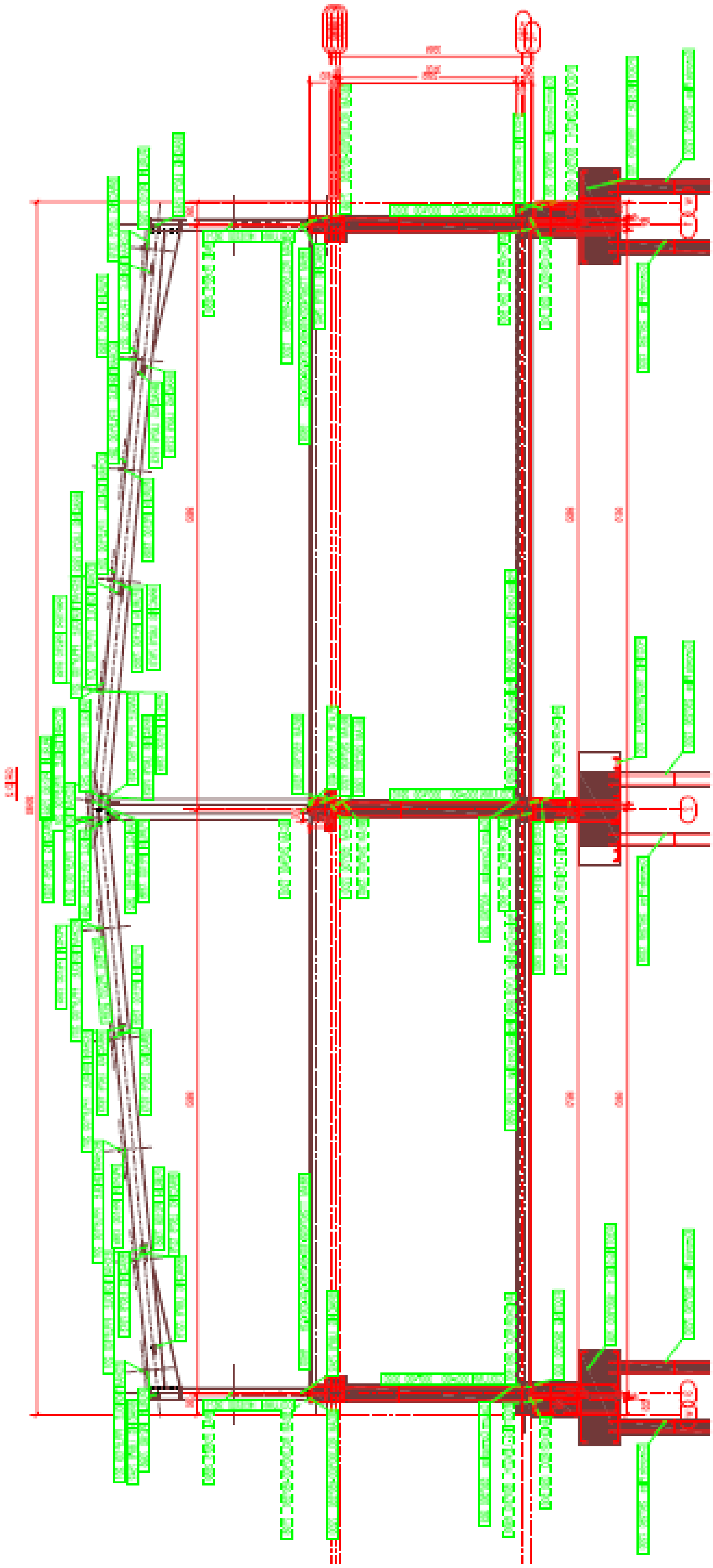

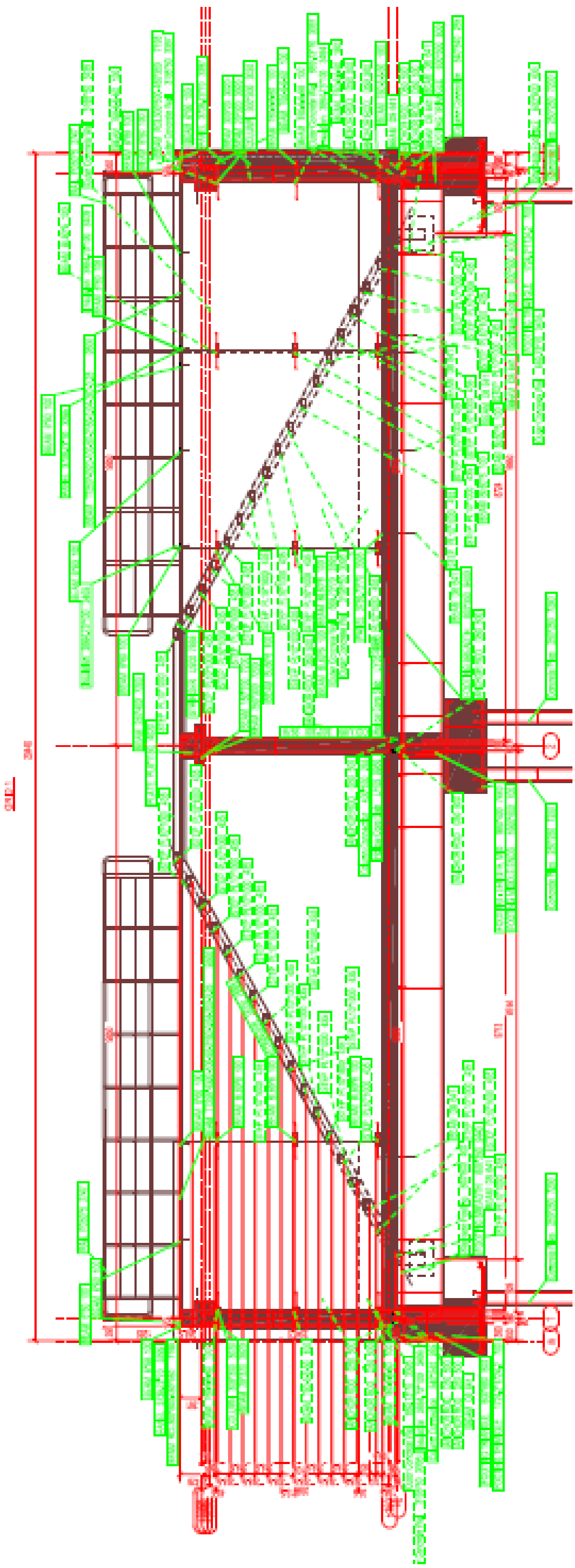

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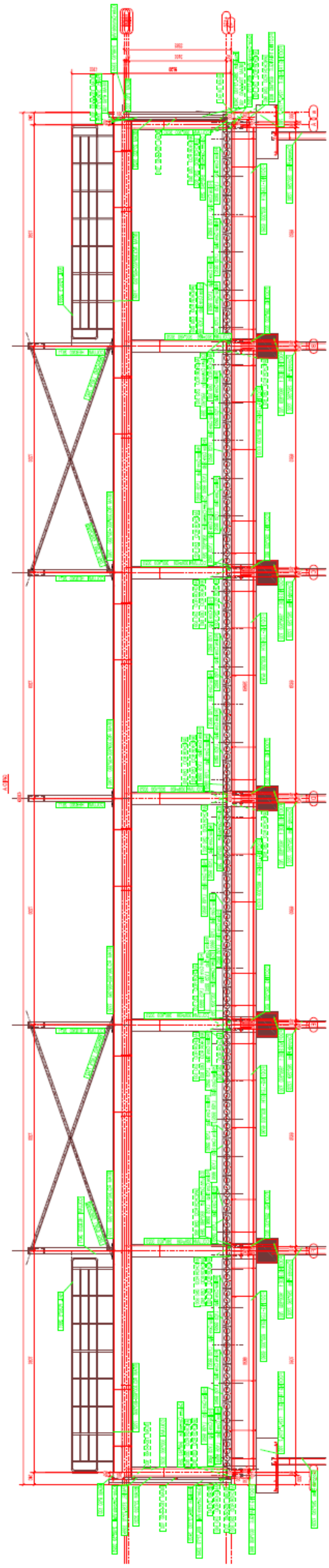

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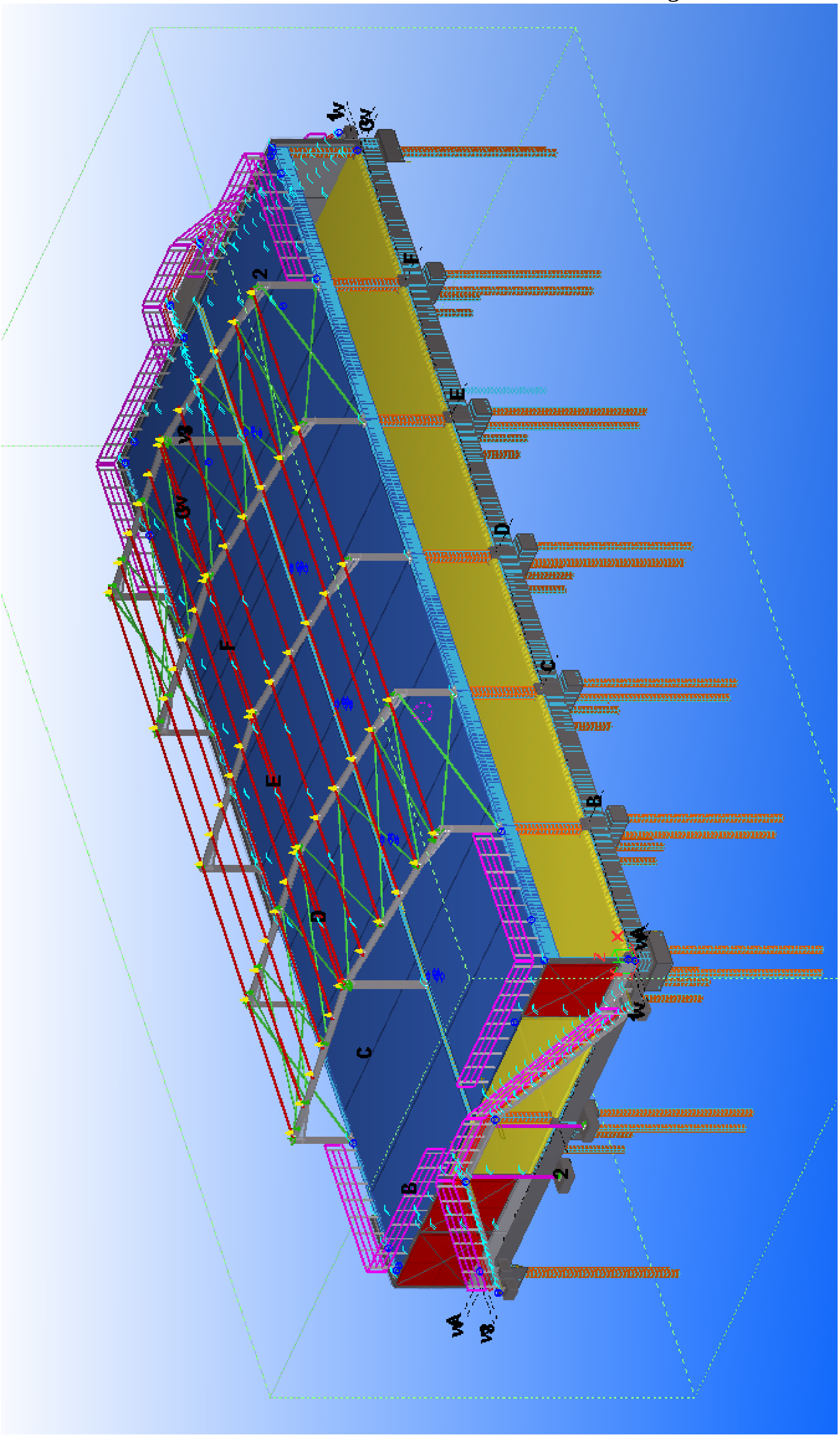
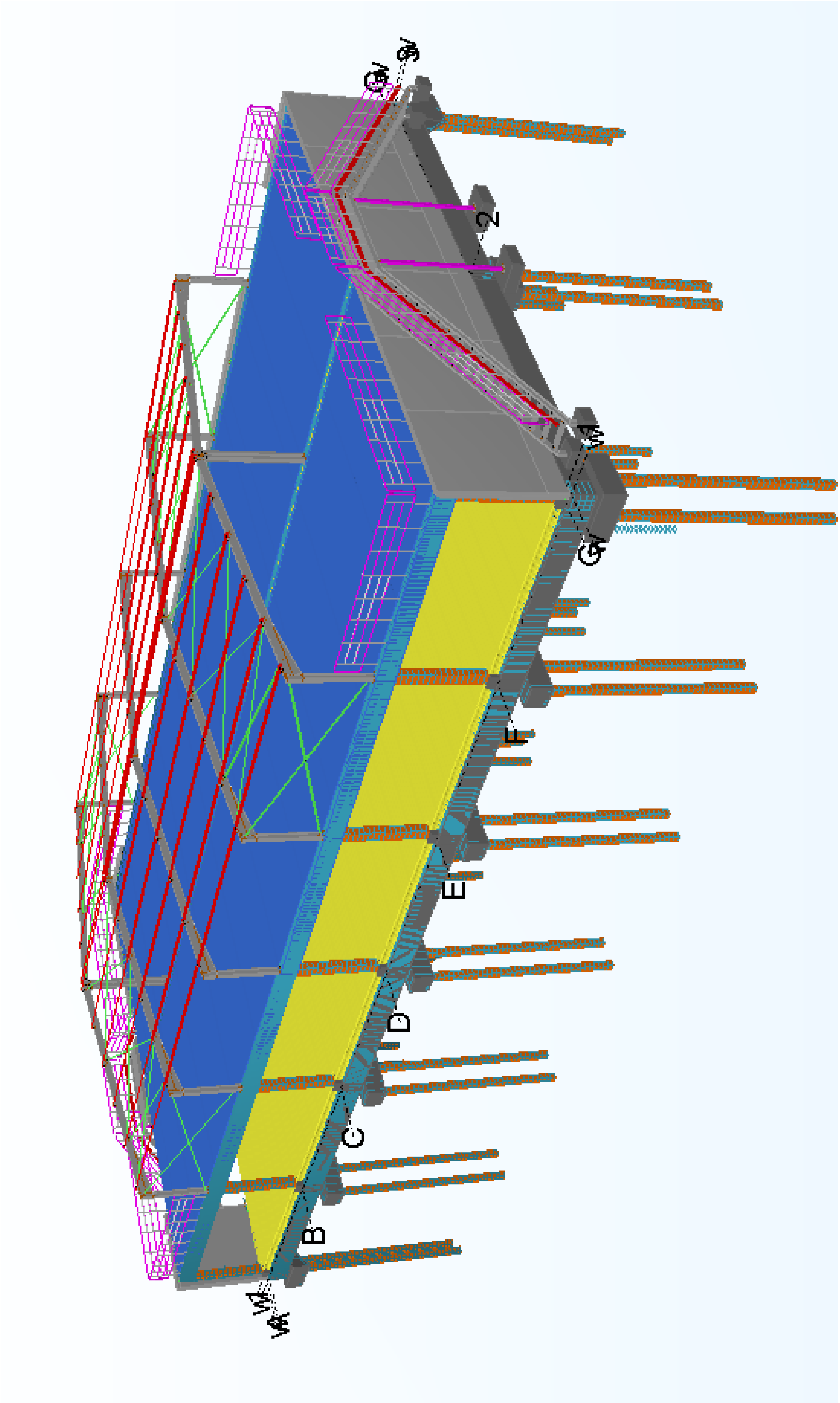
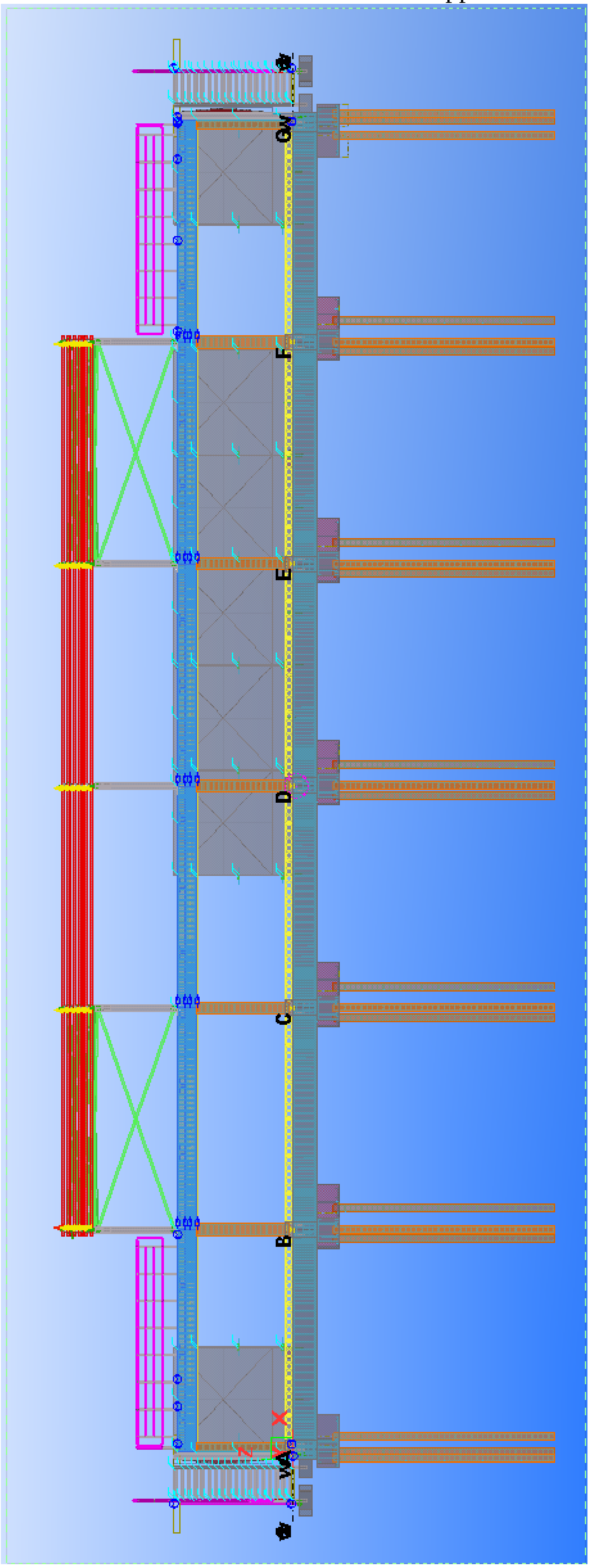
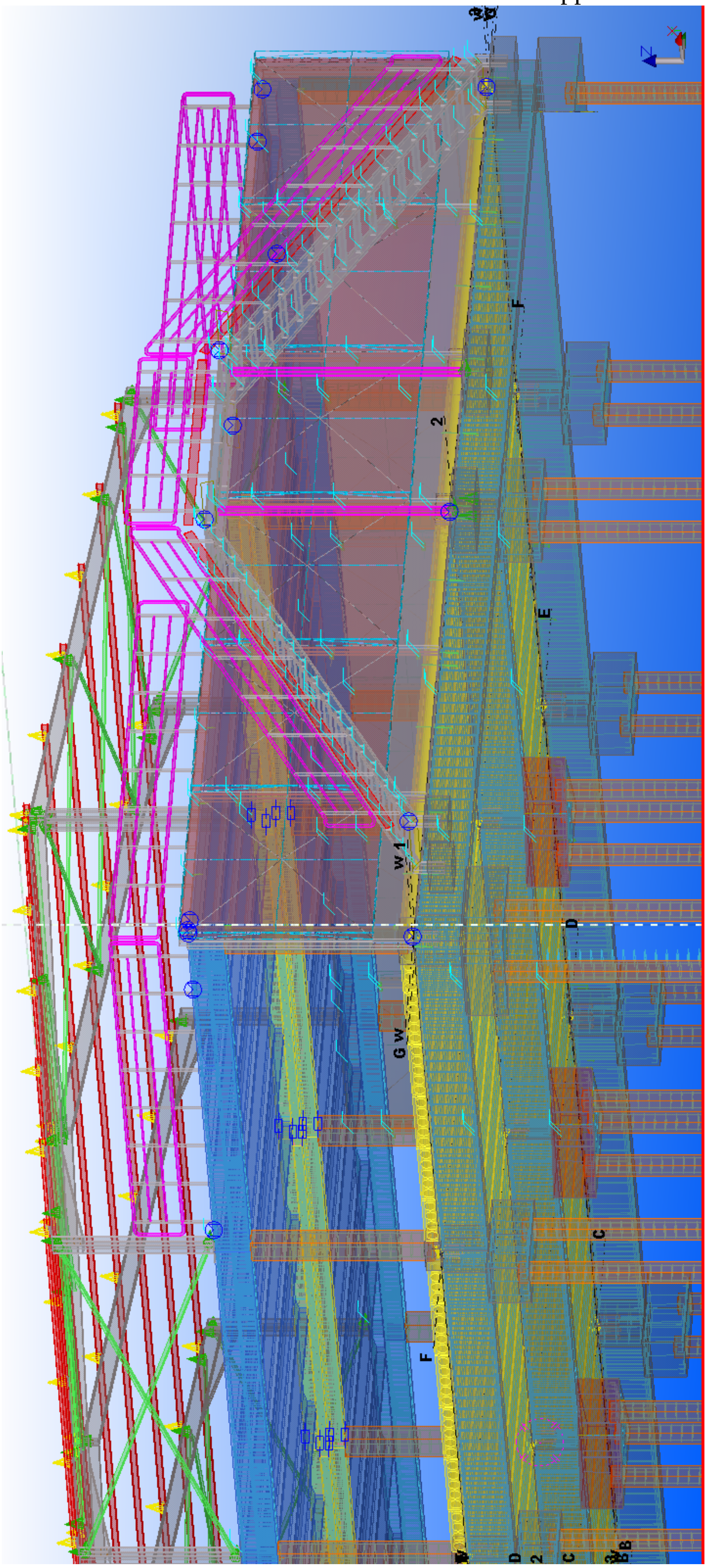
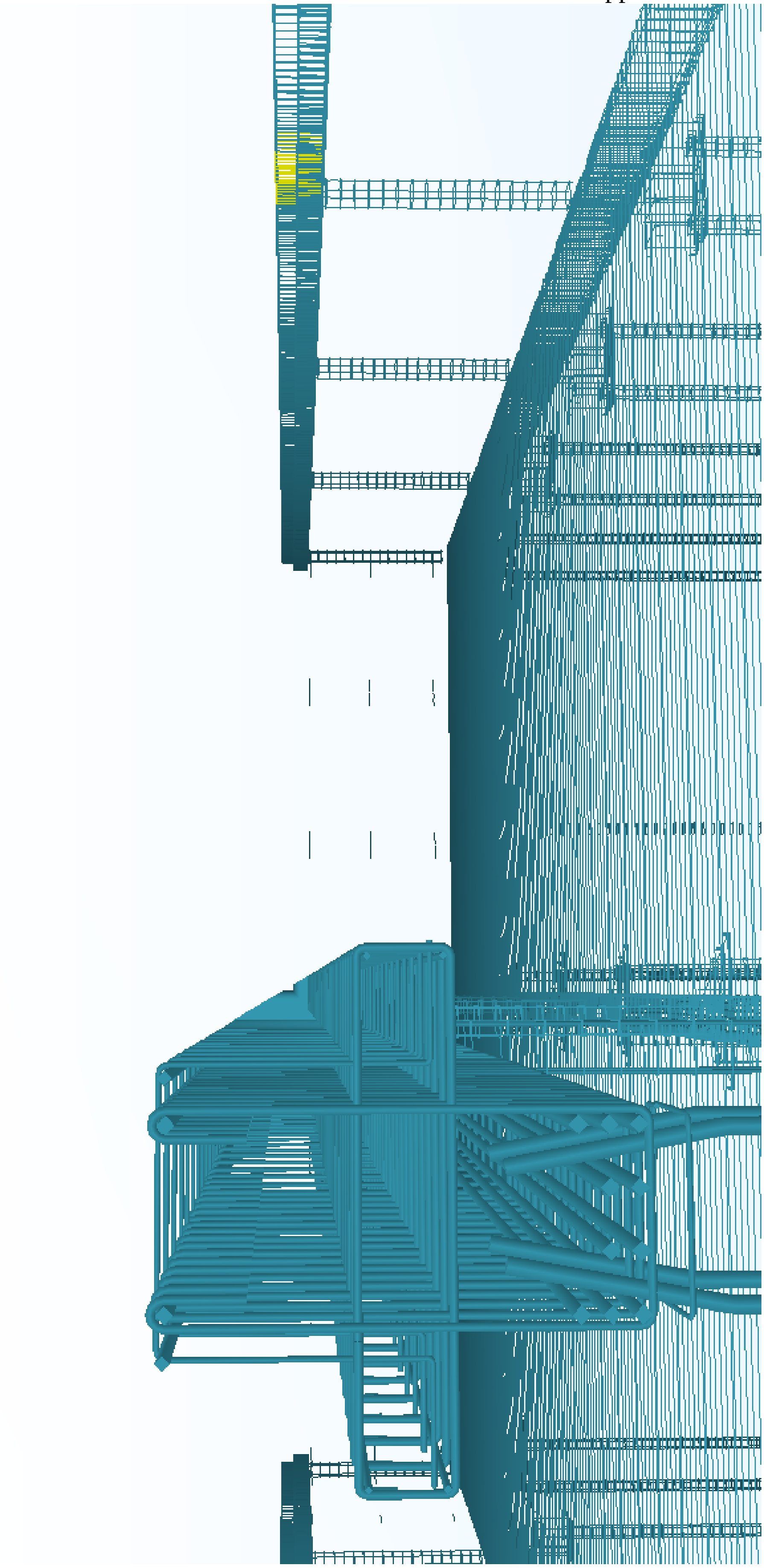
3-D views of the model in Tekla Structures and BIMsight

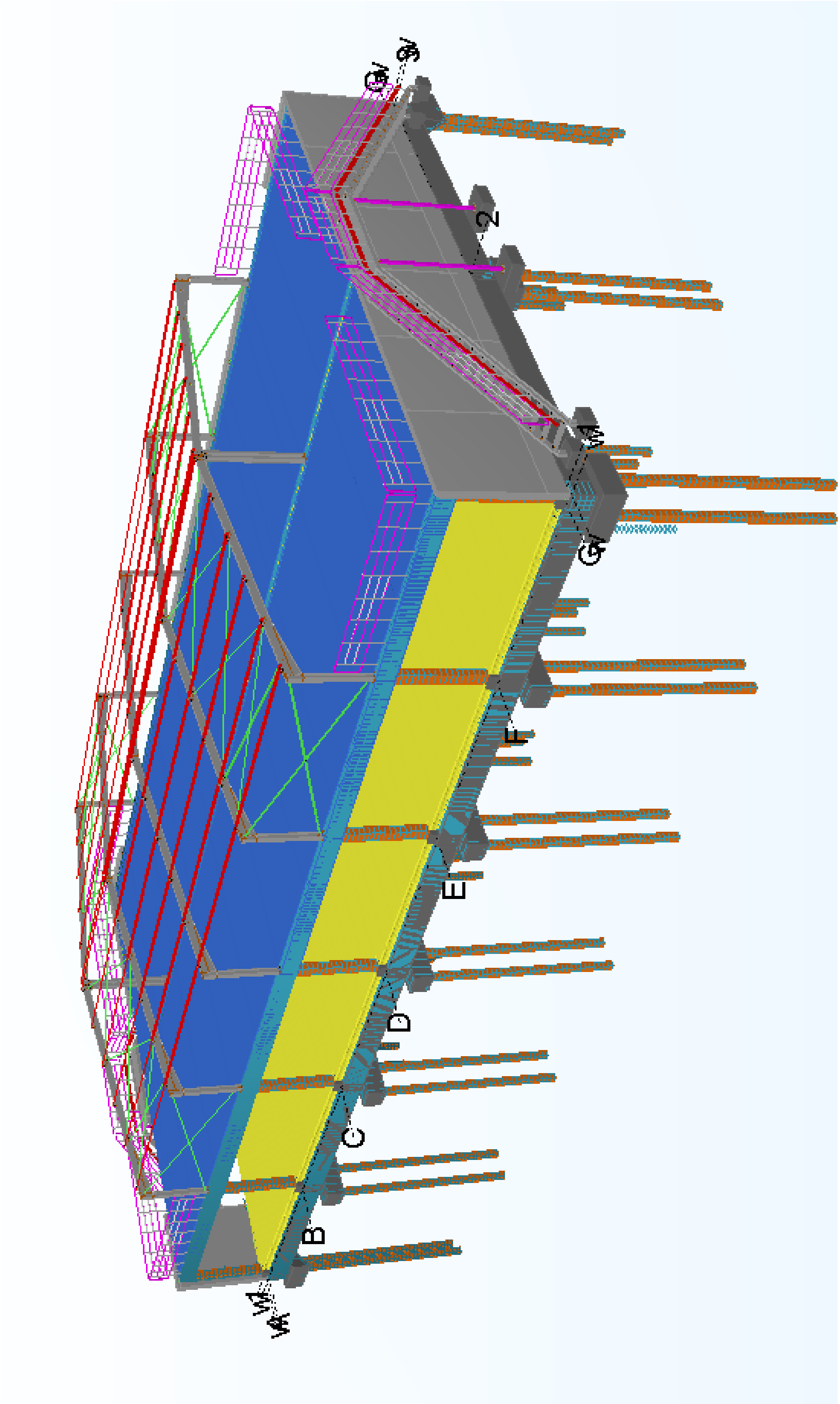


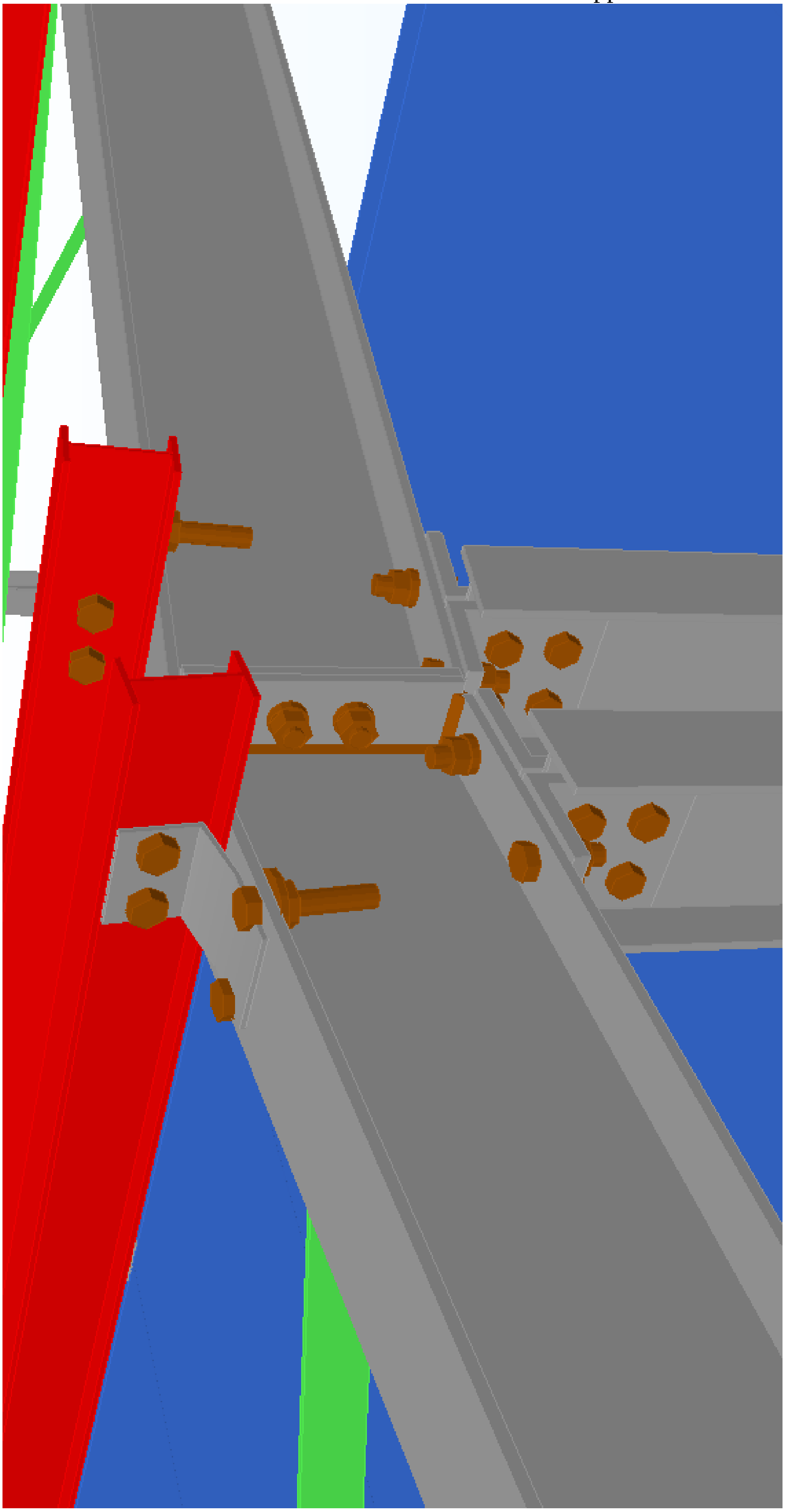

B
C
D
E
F
2


F
E
D
C
B






2
F
E
D
C
B



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Quantity survey report of the steel frame and concrete walls

Tekla Structures									
Date:	;28.03.	2015							
Profile		;Material	NUM	Length [mm];	Length sum;	Weight [kg];	Weight sum;	Area [m2];	Area sum;
6*60		;S235JR	2	100;	200;	0.3;	0.6;	0.01;	0.03;
Sub total, 6*60				;	200;	;	0.6;	;	0.03;
BLL80*80*10		;S235JR	144	125;	18000;	1.5;	212.0;	0.04;	6.19;
Sub total, BLL80*8	0*10			;	18000;	;	212.0;	;	6.19;
HEB200		;S550J2H	10	2671;	26709;	163.7;	1637.1;	3.07;	30.74;
Sub total, HEB200				;	26709;	;	1637.1;	;	30.74;
HFRHS120*80*6.0		;S550J2H	4	3855;	15420;	67.2;	268.7;	1.48;	5.94;
Sub total, HFRHS12	0*80*6.0			;	15420;	;	268.7;	;	5.94;
IPE100		;S550J2H	24	7190;	172560;	58.1;	1395.2;	2.88;	69.02;
IPE100		;S550J2H	24	7395;	177480;	59.8;	1435.0;	2.96;	70.99;
Sub total, IPE100				;	350040;	;	2830.2;	;	140.02;
IPE200		;S550J2H	4	3372;	13486;	75.4;	301.7;	2.59;	10.36;
Sub total, IPE200				;	13486;	;	301.7;	;	10.36;
IPE270		;S550J2H	10	9795;	97955;	352.9;	3529.5;	10.20;	101.97;
Sub total, IPE270				;	97955;	;	3529.5;	;	101.97;
L60*6		;S550J2H	8	7279;	58231;	39.5;	315.9;	1.70;	13.57;
L60*6		;S550J2H	8	7923;	63384;	43.0;	343.8;	1.85;	14.77;
L60*6		;S550J2H	8	7973;	63781;	43.2;	346.0;	1.86;	14.86;
Sub total, L60*6				;	185396;	;	1005.7;	;	43.20;
L80*8		;S550J2H	8	7542;	60336;	72.8;	582.6;	2.35;	18.76;
Sub total, L80*8				;	60336;	;	582.6;	;	18.76;
PL6*1150		;S550J2H	2	4020;	8040;	217.7;	435.5;	9.31;	18.62;
Sub total, PL6*115	0			;	8040;	;	435.5;	;	18.62;
PL10*1000		;S235JR	72	435;	31320;	34.1;	2458.6;	0.90;	64.71;
Sub total, PL10*10	0			;	31320;	;	2458.6;	;	64.71;
PL15*300		;S550J2H	1	400;	400;	14.1;	14.1;	0.26;	0.26;
PL15*300		;S550J2H	10	500;	5000;	17.7;	176.6;	0.32;	3.24;
Sub total, PL15*30	0			;	5400;	;	190.8;	;	3.50;
U200		;S235JR	6	518;	3106;	13.1;	78.5;	0.34;	2.05;
U200		;S235JR	8	2010;	16080;	50.8;	406.5;	1.33;	10.63;
U200		;S235JR	8	7888;	63106;	199.4;	1595.1;	5.21;	41.71;
Sub total, U200				;	82291;	;	2080.1;	;	54.39;
Total:		;		;	;	;	15532.9;	;	498.42;

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TEKLA STRUCTURES MATERIAL LIST FOR CONTRACT

No:1 Page: 1

TITLE: Peltosaari Commercia Date: 30.03.2015

Size	Grade	Qty.	Length(mm)	Area(m^2)	Weight(kg)
669.73*70	C25/30	1	3435	5.4	403.4
669.73*70	C25/30	1	3397	5.1	382.2
669.73*70	C25/30	1	3395	5.3	399.0
669.73*70	C25/30	13	3395	5.1	382.0
			54362	82.4	6150.4
3195*50	C25/30	1	3435	23.8	2683.8
3195*50	C25/30	1	3397	22.4	2604.0
3195*50	C25/30	1	3395	23.5	2668.5
3195*50	C25/30	13	3395	22.4	2603.3
			54362	360.8	41799.0
3739.73*70	C25/30	4	3395	26.4	2133.0
3739.73*70	C25/30	4	3395	26.2	2117.0
3739.73*70	C25/30	1	3397	26.2	2118.2
3739.73*70	C25/30	1	3285	25.6	2063.9
3739.73*70	C25/30	1	3245	25.1	2029.4
			37087	287.3	23211.4
3864.73*100	Insulat	7	3409	27.8	126.7
3864.73*100	Insulat	6	3409	27.8	127.2
3864.73*100	Insulat	1	3494	28.5	130.0
3864.73*100	Insulat	1	3492	28.5	129.8
3864.73*100	Insulat	1	3352	27.3	124.6
			54655	445.4	2034.3
BL60*6	S235JR	27	100	0.0	0.3
			2700	0.4	7.6

Total: 73202.8 kg
