DEPARTMENT OF BUILDING

UNIVERSITI TEKNOLOGI MARA

(PERAK)

FABRICATION AND INSTALLATION OF STEEL TRUSS

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(PERAK)

DECEMBER 2018

It is recommended that this practical training report provided

by

Mohammad Firdaus bin Mohd Ismail
2016458476

entitled

Fabrication and Installation of Steel Truss

be accepted in partial fulfillment of the requirements for obtaining the Diploma In Building.

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STUDENT'S DECLARATION

I hereby declare that this report is my own work, except for extract and summaries for which the original references are stated herein, prepared during a practical training session that I underwent at PI Brilliant Sdn Bhd for a duration of 14 weeks starting from 3 September 2018 and ended on 7 December 2018. It is submitted as one of the prerequisite requirements of DBG307 and accepted as a partial fulfillment of the requirements for obtaining the Diploma in Building.

Name : Mohammad Firdaus bin Mohd Ismail

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Date : 18/12/18

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I would like also like to extend my deepest appreciation to the lecturers who are directly involved during my training stint. To Encik Zulkifli Bin Abd. Halim, Supervising Lecturer, En Muhammad Naim bin Mahyuddin, Practical Training Coordinator, Cik Norazizah Talkis, Practical Training Coordinator and Dr. Dzulkarnaen bin Ismail, Programme Coordinator. I value the time, effort, encouragement and ideas that they have contributed towards the successful completion of my training, this report and the valuable knowledge that have been shared over the last few semesters.
Last but not least, my special thanks to my beloved parents for their sacrifices over the years.
Thank you so much.

ABSTRACT

Roof trusses are important to bridge the space above a room and to support the roof of a building. This report was conducted for the building construction of steel truss for 2 storey link houses at Antara Gapi, Selangor. The objective of this report is to identify the method of steel truss construction. The focus was on how the steel truss were constructed and fabricated. It also determines the equipment used for installation and fabrication of steel truss on this site. The methods used to complete this report requires observation on the work carried on this site and interview sessions with related individuals. Main findings were the steel truss were easier to use and more economic also the construction procedure is easier compared to the wood truss. In conclusion this report contains the work of installation and fabrication of steel truss that are made according to the specification and the steel truss were found out to be used commonly in modern building because of its advantages such as easier to install, more economy and less defects that lead to long-term life span.

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CHAPTER 1.0

INTRODUCTION

A truss is a structural framework in which loads are resisted primarily by axial forces in the individual members. Trusses are commonly used in buildings to support roofs, floors and other internal components such as services and suspended ceilings. They are generally more economical than standard steel beams over relatively large spans. (Davison, 2012)

Buick Davison added in his book Steel Designers' Manual, trusses can offer extremely efficient structural solutions in terms of material use. Howewer, it is noteworthy that any potential savings to the overall steel weight by using a greater number of relatively small members may, as is often the case, substantially increase fabrication and long-term maintenance costs.

The definition of "truss" can be extended to include not only the ordinary planar (primarily two-dimensional) steel trusses, but also systems such as folded trusses, space frames, and geodesic domes (Underwood, 2007)

For building, the principal early applications of trusses were in achieving the basic gable-form roof, with two opposed sloping flat sides meeting at the ridge at the top and forming to draining edges (eaves) at their opposite bottom sides . A horizontal tie across this building at the eave level held the two edges from thrusting outward and thus formed a single triangle truss, with two compression members (the rafters) and one tension member (the horizontal tile). (Ambrose, 1994)

Truss structures constitute a special class of structures in which individual straight members are connected at joints. The members are assumed to be connected to the joints in a manner that permit rotation, and thereby it follows from equilibrium considerations, to be detailed in the following, that the individual structural members act as bars, i.e. structural members that can only carry an axial force in either tension or compression. Often the joints do not really permit free rotation, and the assumption of a truss structure then is an approximation. (Krenk, 2013)

Steel roof trusses are triangulated plane frames which carry purlins to which the roof coverings can be fixed. Steel is stronger than timber and will not spread fire over its surface and for these reasons it is often preferred to timber for medium and long span roofs. The rafters are restrained from spreading by being connected securely at their feet by a tie member. Struts and ties are provided within the basic triangle to give adequate bracing. (Chudley, 2008)

Trusses are pin-jointed and triangulated assemblies of simple struts stressed in either tension or compression. Truss bending moments are resolved into tension and compression forces in the bottom and top chords. Shear forces are resolved into tension and compression forces in the diagonal and vertical members. Trusses use material more economically and are more efficient in spanning long distances than solid beams but are relatively expensive to fabricate because of the number of connections and the complexity of the joints. They become more economical when used as primary structural members supporting secondary trusses or beams. (Ching, 2014)

1.1 Background and Scope of Study

The study was carried out on the 'Projek Membina dan Menyiapkan 154 Unit Rumah Link 2 Tingkat (22'x 65') Dan Sebuah Pencawang Elektrik Dua Ruang' which was located in Antara Gapi, Hulu Selangor, Selangor. The study focuses only on the fabrication and installation method of steel truss and to determine the machineries and equipments involved in the fabrication and installation of steel truss.

1.2 Objectives

1.2.1 Aim

The aim is to report on the building construction of the steel truss at Antara Gapi, Selangor.

1.2.2 Objective

- To study the fabrication and installation method of steel truss.
- To identify the equipment and machineries used for fabricating and installing the steel truss.

1.3 Methods of Study

1.1.1 Primary Data

i. Interview

Interview session with the project staff at the Antara Gapi site, who are in charge for roof construction. They are Miss Norarizan, the engineer, Mr. Lim, the site supervisor and one skilled worker.

ii. Observation

Observation was done on the roof fabrication and installation work at the Antara Gapi site during the practical period. All the information was collected from what was done at this site with guidance from the supervisor. All the fabrication and installation works were recorded by using a smart phone and jotted in the note book.

iii. Document review

Review the method statement for the roof trusses prepared by the suppliers. Collecting data from the documents and review the roof structure, roof layout and connection detail drawings for the roof with guidance and explanation from the supervisor.

1.1.2 Secondary Data

The main reason for a literature review is enable a study and to get information regarding the building construction specifically on roof trusses, the material used and how its construction through relevant books, articles and thesis at the National Library and at UiTM Seri Iskandar Library in Perak.

CHAPTER 2.0

COMPANY BACKGROUND

2.1 Introduction of Company

PI Brilliant Berhad formerly known as PKNS Infra Berhad was established in 1993. PI Brilliant Berhad is registered as a Class A Contractor in the G7 Category with the Construction Industry Development Board (CIDB). It has also obtained the ISO 9001:2008 and OSHAS MS 1722:2011.

For years, the company has been competititve from the perspective of its finances and capability in the construction sector. Today, the activities of the company are in the construction field, property development and engineering services. With its broad experience, the company has proved its expertise particularly in the conventional and turnkey sector for commercial, housing and private and government institutions development valued at over RM1 billion.

2.2 Company Profile

Company Name	: PI Brilliant Berhad
Address	: 77 & 78 Jalan Teknologi 3/9, Bistari D'Kota, PJU5, Kota Damansara, 47810 Petaling Jaya, Selangor Darul Ehsan.
Telephone	:
Fax	:
E-mail	: general@pibrilliant.com.my
Website	: http://www.pibrilliant.com.my
Main Business	: Property Development, Engineering Services and Construction
Authorized Capital	: RM 10,000,000.00
Paid-Up Capital	: RM 6,000,000.00
Shareholders	: Perbadanan Kemajuan Negeri Selangor (PKNS) - 85% Staff PKNS & PIBG - 15%
Bank	: **1. CIMB Bank Berhad** Lot 27, 29 & 31, Jalan 52/2, 46200 Petaling Jaya. **2. Bank Islam Berhad** Tingkat Bawah & Satu, No. 2 & 4, Jalan 14/22, 46000 Petaling Jaya **3. Arab-Malaysia Bank Berhad** Menara Dion, Jln. Sultan Ismail, 50250 Kuala Lumpur.
Board of Directors	: 1. Puan Hajah Noraida Binti Haji Mohd Yusof 2. Puan Hajah Norita Binti Mohd. Sidek 3. Tuan Haji Md. Kamarzaman Bin Md. Rais

2.3 Organization Chart

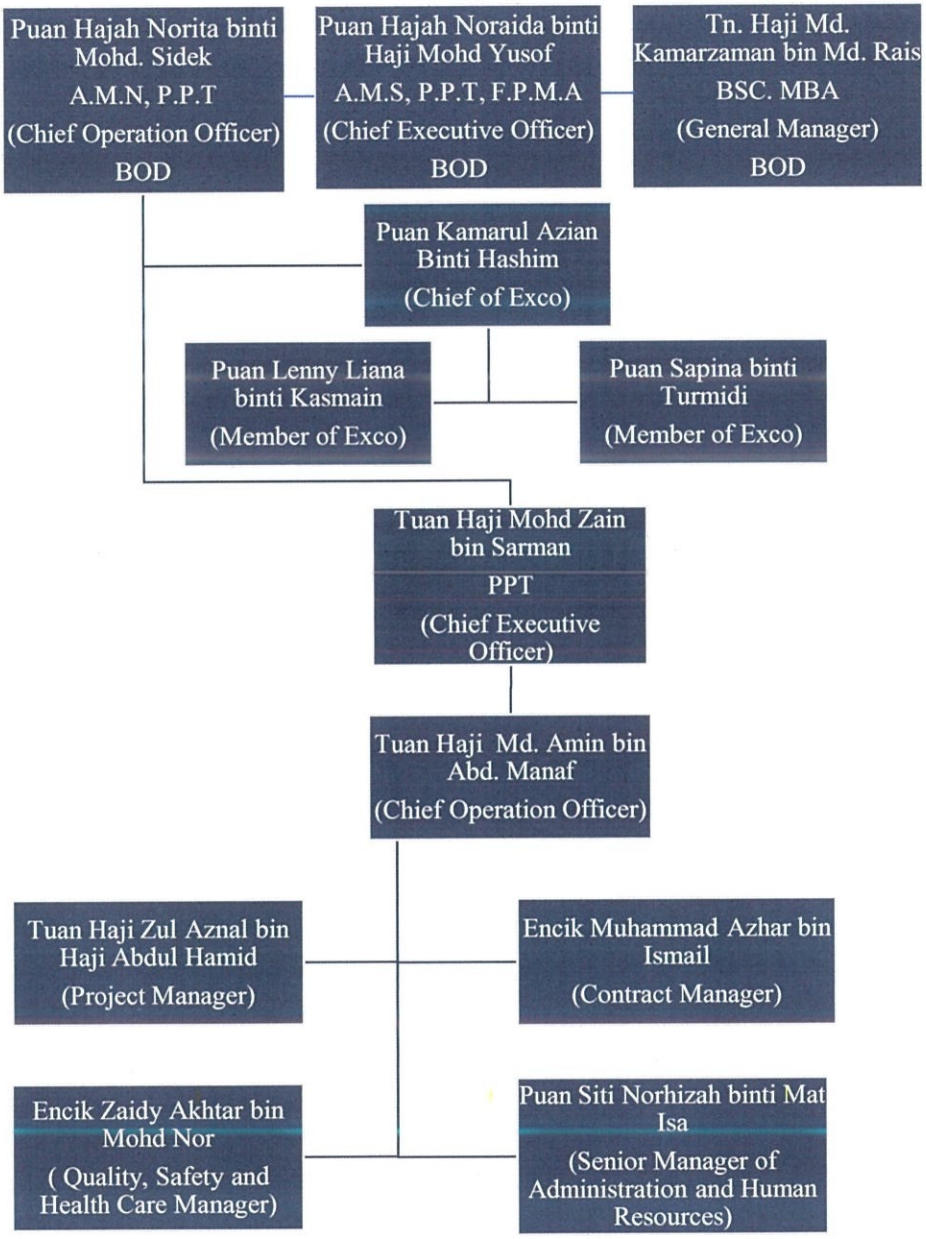


Figure 2.1 Overall PI Brilliant Berhad organization chart

Source: PI Brilliant Company Profile

2.4 List of Projects

2.4.1 Completed Projects

Table 2.1: List of PI Brilliant Completed Project

No.	Project Name	Location	Completed Date
1.	Build and Complete 64 Units Double Storey Link House, Antara Gapi	Section 2B, Antara Gapi, Hulu Selangor District, Selangor Darul Ehsan	27th May 2012
2.	Build and Complete 15 Units Banglo House, Kuala Selangor	Plot 3, Fasa 2, Jalan Kemajuan, Kuala Selangor, Selangor Darul Ehsan.	3rd July 2012
3.	Build and Complete 1422 Units Semi-D Single Storey House, Bukit Botak, Bandar Baru, Selayang	Bandar Baru Selayang, Mukim Batu, Daerah Gombak, Selangor Darul Ehsan.	21st July 2012

Source: PI Brilliants Berhad (2018)

2.4.2 Projects in Progress

Table 2.2: List of PI Brilliant Project in Progress

No.	Project Name	Location	Start Date	Completed Date
1.	Build and Complete 154 Units Double Storey Link House, Antara Gapi	Section 5B, Antara Gapi, Bandar Sungai Chik, Hulu Selangor, Selangor Darul Ehsan	3rd August 2017	1st August 2019
2.	Build and Complete 159 Units Double Storey Link House & 4 Units Double Storey Semi-D House	Fasa 4A Bandar Sultan Suleiman, Mukim Kapar, Daerah Klang, Selangor Darul Ehsan.	3rd April 2018	3rd August 2020
3.	Completing Infrastucture & Earthwork	Fasa 7, Laman 1, Bernam Jaya, Hulu Selangor, Selangor Darul Ehsan.	27th September 2018	26th December 2019

Source: PI Brilliant Berhad (2018)

CHAPTER 3.0

CASE STUDY

3.1 Introduction to Case Study

The project seen in the case study during the practical training session was 'Projek Membina dan Menyiapkan 154 Unit Rumah Link 2 Tingkat (22'x65') Dan Sebuah Pencawang Elektrik Dua Ruang, Di atas Sebahagian PT8 HS(D) 39404, Seksyen 5B, Antara Gapi, Bandar Sungai Chik, Daerah Hulu Selangor, Selangor Darul Ehsan'. This project started on the 3rd of August 2017 and expected to finish on the 1st of August 2019. The duration of the project is 104 weeks. This project cost RM 40,007,815.49 million.

This project comprise of 18 blocks of double storey link houses and a substation. A block has 9 to 10 units. The size of the houses are 22'x 65' which consist of 4 bedrooms and 2 bathrooms. The project site at Antara Gapi, Hulu Selangor, Selangor, very strategic since it is close to another housing area, 2 minutes to the shop, 3 minutes to the main road Rawang-Ipoh, 10 minutes to the NSK Rawang Supermarket and 5 minutes to access the Rawang Bypass which took 15 minutes to reach Kuala Lumpur by car. There is a primary school which is Sekolah Kebangsaan Antara Gapi around 3 minutes away.

The client of this project is Perbadanan Kemajuan Negeri Selangor (PKNS) and the consultants involved in this project are Bahagian Arkitek PKNS as the architect, HML Consultancy Sdn. Bhd as the civil and structure consultant, Perunding ZEQ as the quantity surveyor, Perunding Bersatu as the mechanical and electrical consultant and Unit Lanskap PKNS as the landscape architect. The contractor appointed for this project is PI Brilliant Berhad and two sub-contractors, KCH Sdn Bhd and KG Balai Sdn Bhd.

For this case study, the focus is on the fabrication and installation of steel trusses. The steel truss is chosen for this site to speed the work progress since it is much easier to install, more economic and can save more time.

Table 3.1: List of Consultants

Client	Perbadanan Kemajuan Negeri Selangor (PKNS)	Bangunan Ibu Pejabat PKNS, No. 2, Jalan Indah 14/8 Seksyen 14, 40000 Shah Alam, Selangor Darul Ehsan. Tel:
Architect	Bahagian Arkitek PKNS	Bangunan Ibu Pejabat PKNS, No. 2, Jalan Indah 14/8 Seksyen 14, 40000 Shah Alam, Selangor Darul Ehsan. Tel:
Civil & Structure Engineering	HML Consultancy Sdn. Bhd.	No. 67, 1st Floor, Jalan SS15/4C, 47500 Subang Jaya, Selangor Tel:
Mechanical & Electrical Engineer	Perunding Bersatu	10-G, Jalan SS 15/4C, SS 15, 47500 Subang Jaya, Selangor Tel:
Landscape Architect	Unit Lanskap PKNS	Bangunan Ibu Pejabat PKNS, No. 2, Jalan Indah 14/8 Seksyen 14, 40000 Shah Alam, Selangor Darul Ehsan. Tel:
Quantity Surveyor	Perunding ZEQ	No. 10, Jalan Kosas 1/5, Taman Kosas, 68000 Ampang, Selangor Tel:
Contractor	PI Brilliant Berhad	77 & 78, Jalan Teknologi 3/9, Bistari D'Kota PJU 5, Kota Damansara, 47810 Petaling Jaya, Selangor Tel:

Source: PI Brillliant Berhad (2018)

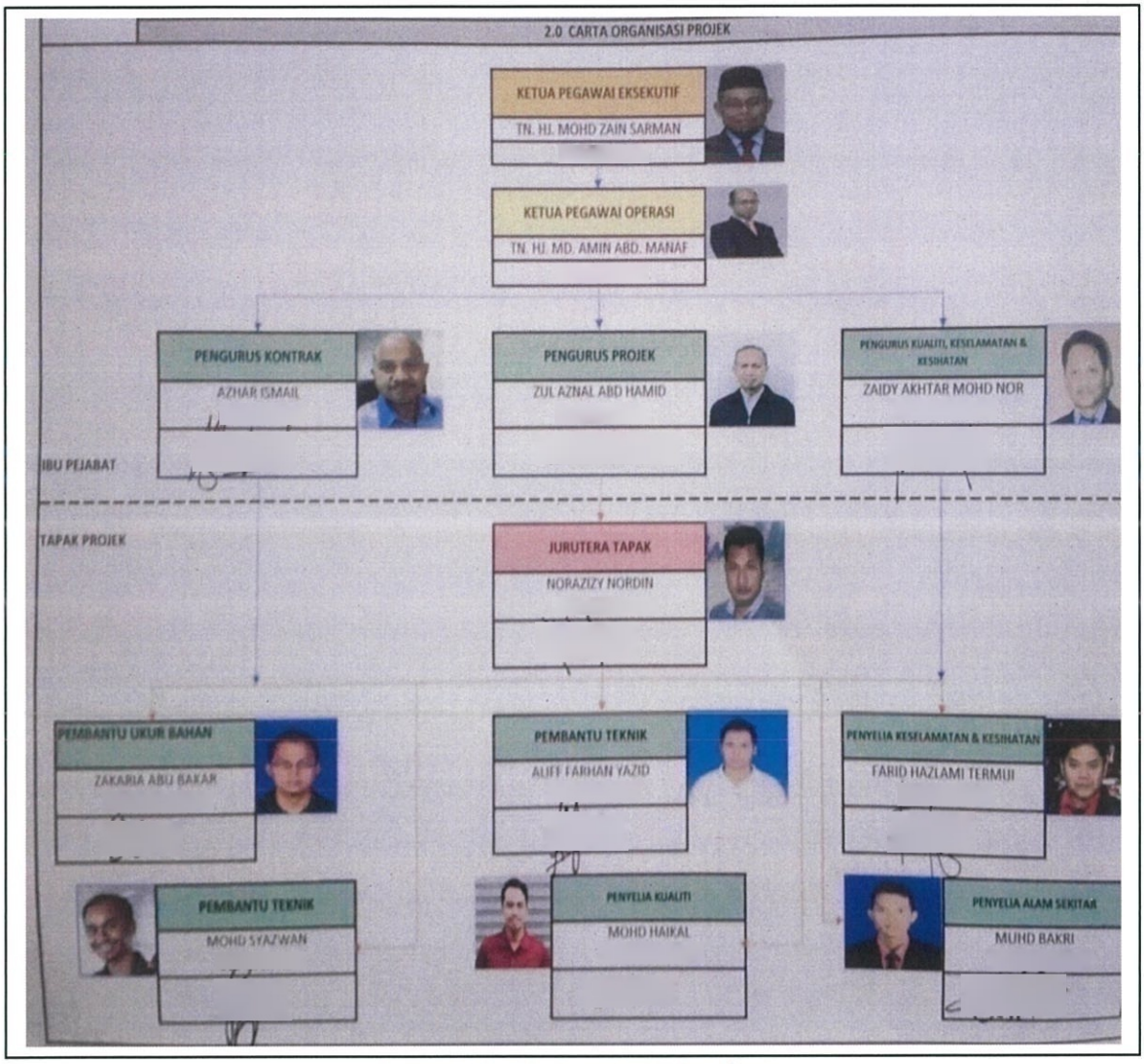


Figure 3.1: On site organization chart

Figure 3.2: Map of site location

3.2 Method of Fabrication and Installation of Steel Truss

Nowadays buildings commonly use steel roof truss instead of timber roof truss. This is because steel truss can save more time and do not carry any of the issues of timber truss such as shrinkage and gaps at the joints. Steel truss can be fabricated to the standard specification or custom made by using computer-aided engineering. The steel truss can be used even in the poor weather and that can save more time. Steel truss also will not warp, shrink or change. Steel truss also have a long life span and can carry heavy loads.

The material properties used for the steel truss component (Chords and Webs) to incorporate 0.75mm thickness only. The components are manufactured in accordance with BS5950-5:1998-D Steel Sheet Hot Dipped Zinc Coated or Aluminium/Zinc Coated. The truss battens are made from 0.45mm thick. The design code are:

- BS5950 Structural Use of Steelwork : Part 1 : 1985 Code of Practice for Design in Simple & Continuous Construction,
- BS5950 Structural Use of Steelwork : Part 5 : 1998 Code of Practice for Design of Cold Form Thin Gauge Sections
- BS 6399 : Part 1 : 1984 Code of Practice for Dead 8: Superimposed Load.

Figure 3.3: Steel truss template

First of all, the steel truss template is created according to the drawing specifications to ensure the subsequent trusses have the same configuration and slope. The steel truss is fabricated from 6 metres length C7575 channel sections from material of high-tensile steel of thickness 0.75mm and the yield strength of 550 Mpa. The channel sections are measured using the measuring tape to the right dimension according to the drawing specifications for every part and marked with a pen marker. After that, all the channel sections are cut to the length of subsequent trusses in the right measurement by using a disc cutter and angle grinder.

Figure 3.4: Workers are measuring and marking the length required on the steel truss

Then, the inverted stools are built to align the truss members. The inverted stools are built around the template trusses as shown below in the figure 3.5. The subsequent parts are assembled over the truss template and the workers would fasten up the members together with bolt screws using the electric drill machine.

Figure 3.5: Workers are fasten the subsequent members

After completing the fabrication of trusses, the subsequent trusses are then moved from the template stack and transported to the worksite and sorted bundle by bundle. Then, the bundles are lifted by the mobile crane to the top of roof beams for installation. Before installing the subsequent roof truss to the roof beam, the workers measured and mark the right position of each subsequent trusses at the front and back of the house.

Figure 3.6: Mobile crane lifting up the bundle of truss to the roof beam

The bundle of subsequent trusses are arranged to the right position. After all the subsequent trusses have arranged to the right position, the 'L' bracket are installed to the subsequent truss on the roof beam by using bolt to hold it down to the roof beam. The 'L' bracket are installed at the both sides of the roof beam which is in the front and back of the house.

Figure 3.7: 'L' Bracket installed to the roof beam and truss

Then, all the subsequent trusses are braced together at the front and back of the house according to the required specifications. After that, the workers started to install and fasten up the battens on the trusses using the bolt screws. The workers then install the foil paper and proceed to lay the roof tile.

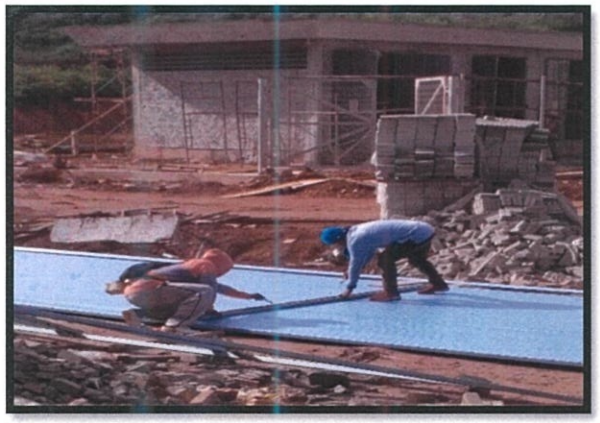
Figure 3.8: Foil paper and battens finished fixed

3.3 Method Statement Form

3.3.1 Fabrication Method Statement Form

Date : 18/10/18 - 1/11/18

NO	OPERATION	SEQUENTIAL DIAGRAM	MACHINERY & PLANT	LABOUR	EQUIPMENT	DURATION
1.	Creating a truss template.	 *Figure 3.9: Trusses template*	- Drill Gun - Rotary disk cutter	- 1 Skilled workers - 3 Semi-skilled workers	- Steel truss c-sections - Bolt screw - Measuring tape - Pen marker	2 Days

2.	Unloading steel truss long channel sections steel truss at the worksite	 *Figure 3.10: Unloading steel truss bars*	- Backhoe - Mobile Crane	- 2 Operator - 1 skilled worker - 2 Semi Skilled worker		1 Day
3.	Measuring to the required length and marking	 *Figure 3.11: Measuring and marking the required length*		- 1 Skilled worker - 1 Semi-skilled worker	- Measuring tape - Pen marker	3 Days for 36 trusses

4.	Cut the channel sections to the required length	 *Figure 3.12: Worker cut the steel truss using disc cutter*  *Figure 3.13: Worker cut the steel truss using disc cutter*	- Disc cutter - Angle grinder	- 1 skilled worker - 3 semi-skilled worker		3 Days

5.	Build the inverted stool and assemble the subsequent trusses over the template.	 *Figure 3.14: Subsequent trusses installed over the template around inverted tools*		- 1 skilled worker - 1 semi-skilled worker	- Steel truss bar - Hammer	2 Days
6.	Fasten the subsequent trusses with bolt screw.	 *Figure 3.15: Fastening the subsequent trusses parts together*	- Drill gun	-1 skilled worker - 1 semi-skilled worker	- Bolt screw	3 Days

7.	Lifting the bundle of trusses to the top of the roof beam using the mobile crane.	 *Figure 3.16: Lifting the bundle of subsequent trusses to the top of roof beam*	- Mobile Crane	- 1 Operator - 1 skilled worker - 2 semi-skilled worker		1 Day

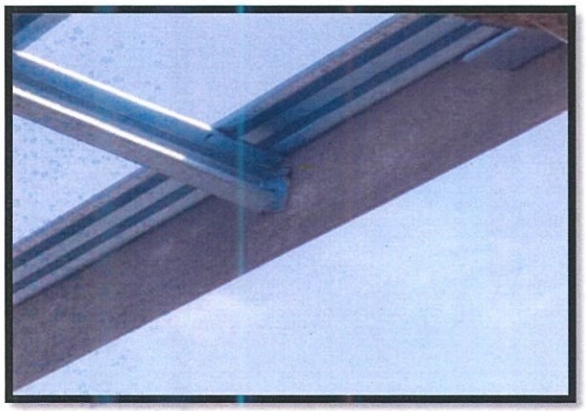
3.3.2 Installation Method Statement Form

Date: 2/11/18 - 16/11/18

NO	OPERATION	SEQUENTIAL DIAGRAM	MACHINERY & PLANT	LABOUR	EQUIPMENT	DURATION
1.	Measure and marking the right position of steel truss on the roof beam	 *Figure 3.17: Workers measure and mark the position for trusses*		- 1 Skilled worker - 2 Semi-skilled worker	- Measuring tape - Pen marker	1 Day

2.	Arranged the steel truss to the right position 1.5 metres distance between frames	 *Figure 3.18: Trusses are arranged to the right position*		- 1 Skilled worker - 3 Semi-skilled worker		1 Day
3.	Install the 'L' bracket to the truss and roof beam	 *Figure 3.19: 'L' bracket are installed to the beam and truss*	- Drill gun	- 1 Skilled worker - 1 Semi-skilled worker	- Bolt screw - 'L' bracket - Hammer	2 Days

4.	Braced all the trusses to specifications	 *Figure 3.20: The subsequent trusses are braced together*	- Drill gun	- 1 Skilled worker - 1 Semi-skilled worker	- Bolt screw	3 Days
5.	Fixing the battens and foil paper	 *Figure 3.21: Battens and foil paper are fixed*	- Drill gun	- 1 Skilled worker - 3 Semi-skilled worker	- Bolt screw - Battens - Foil paper	2 Days

6.	Install fascia board by fixing the edge of trusses to the board	 *Figure 3.22: Fascia board are fixed at the end of truss*	- Drill gun	- 1 Skilled worker - 3 Semi-skilled worker	- Bolt screw - Fascia board	2 Days
7.	Laying roof tiles	 *Figure 3.23: Roof tiles are layed on the battens and foil paper*		- 1 Skilled worker - 3 Semi-skilled worker	- Roof tiles	3 Days

Conclusion

The construction of 'Projek Membina dan Menyiapkan 154 Unit Rumah Link 2 Tingkat (22'x 65') Dan Sebuah Pencawang Elektrik Dua Ruang' which located in Antara Gapi, Hulu Selangor, Selangor used steel trusses which are easier to install, save more time and more economic.

The fabrication of roof trusses started with creating a template, then measuring and cutting the channel section to the required length, assemble subsequent truss over the template aligned by the inverted stool, fasten the subsequent truss parts using bolt screw and continue with lifting the subsequent truss bundle to the top of roof beam.

The installation process start by measuring and marked the right position of the subsequent truss, arranged the truss to the right position, installed the 'L' bracket to the roof beam and truss, braced all the trusses together, fixed the foil paper and battens, installed the fascia board at the end of truss and continue with laying the roof tiles.

One of the machines involved in the fabrication and installation of roof truss is the mobile crane which was used to lift the bundle of trusses to the top of roof beam. A backhoe was also used to unload the steel truss bar from the lorry. Disc cutters and angle grinders are used to cut the steel truss bar to the required length and drill guns are used to fasten the subsequent trusses with bolt screws and to install the 'L' bracket on the roof beam.

Finally, the most important thing in this construction site is the safety and health aspect. Toolbox session is conducted once a month to make sure the workers understand the importance of safety and health issues on site. The use of personal protective equipment (PPE) such as safety boots, hard hat and harness is important to avoid serious injury. Other than that, housekeeping is done to make sure the site is clean and safe.

Therefore, it is recommended to all parties to take safety precaution such as use of the harness while working on the roof regarding the fabrication and installation of steel roof truss reinforcement to minimize the contributing factor to building defect and human injury.

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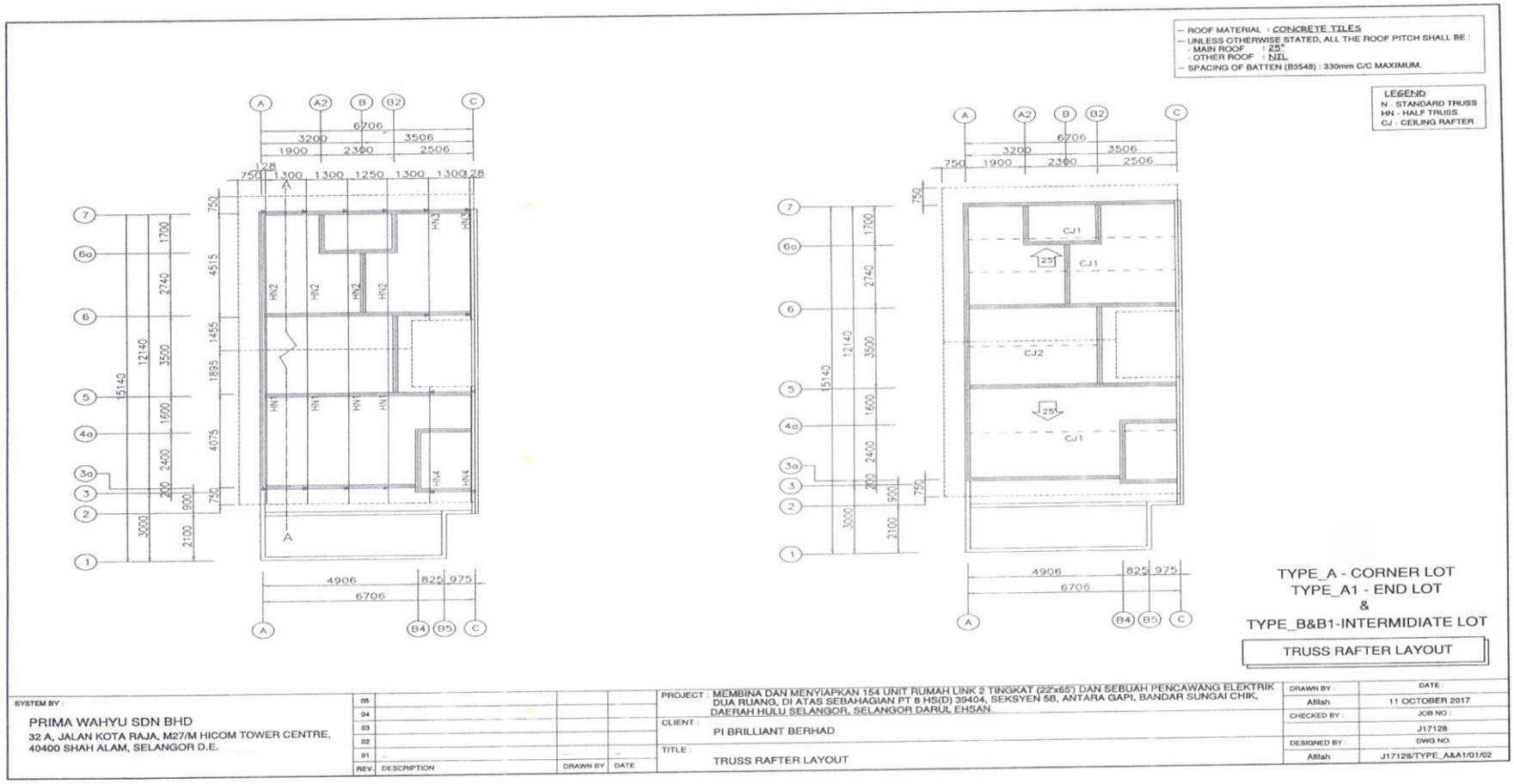
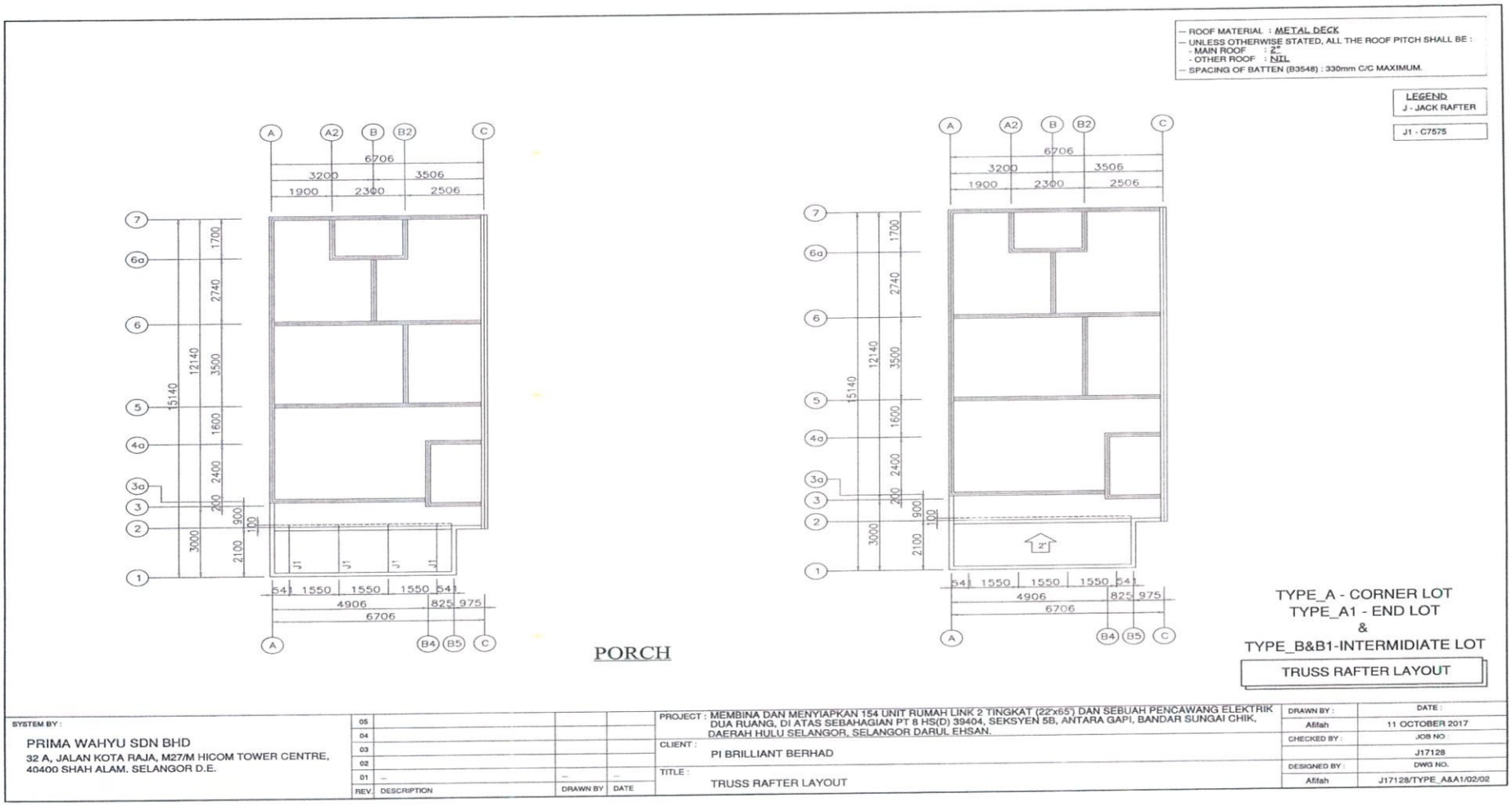
Appendix (A) Truss Layout Drawing Plan



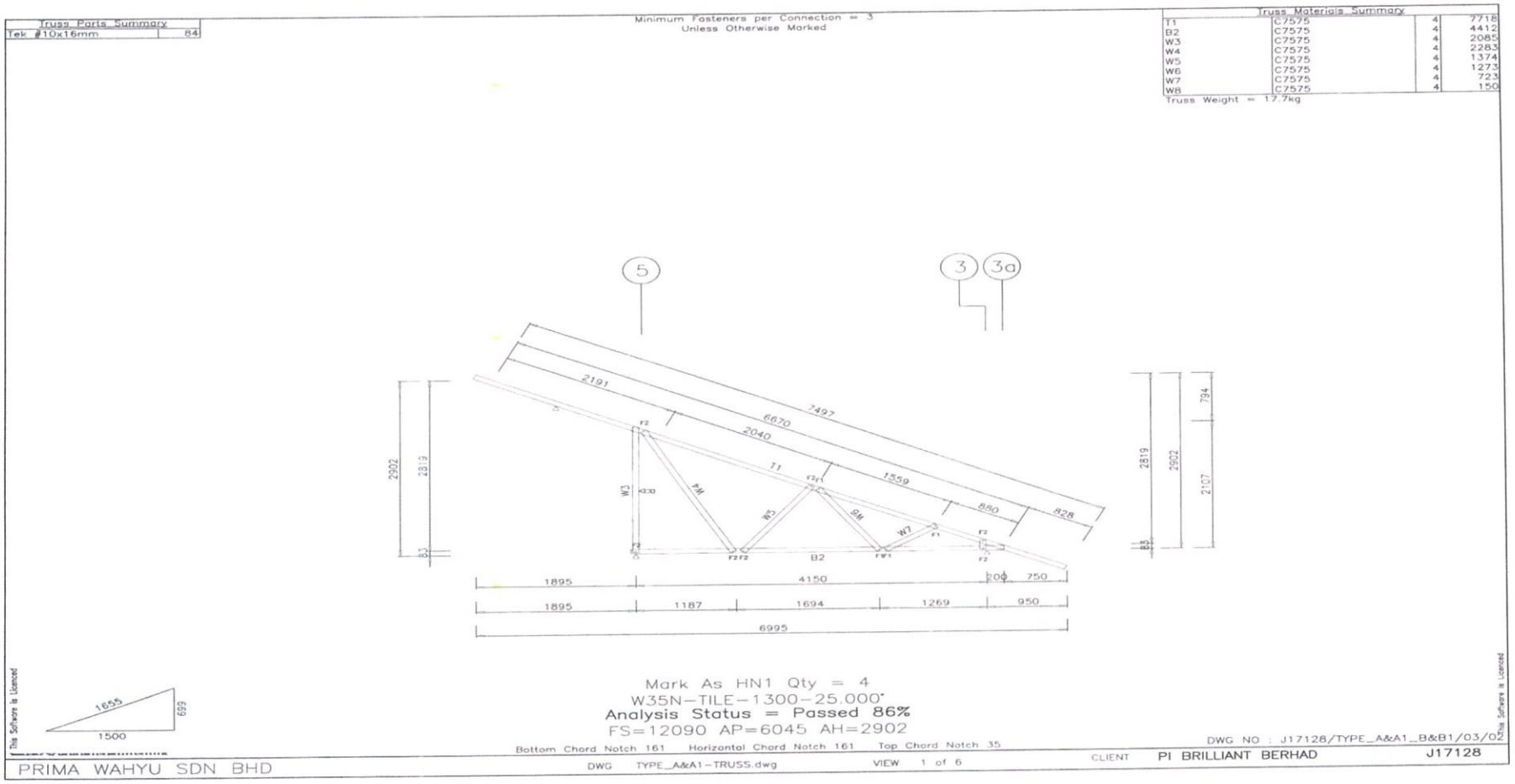
Source: Prima Wahyu Sdn Bhd (2017)

Appendix (B) Truss Rafter Layout Drawing



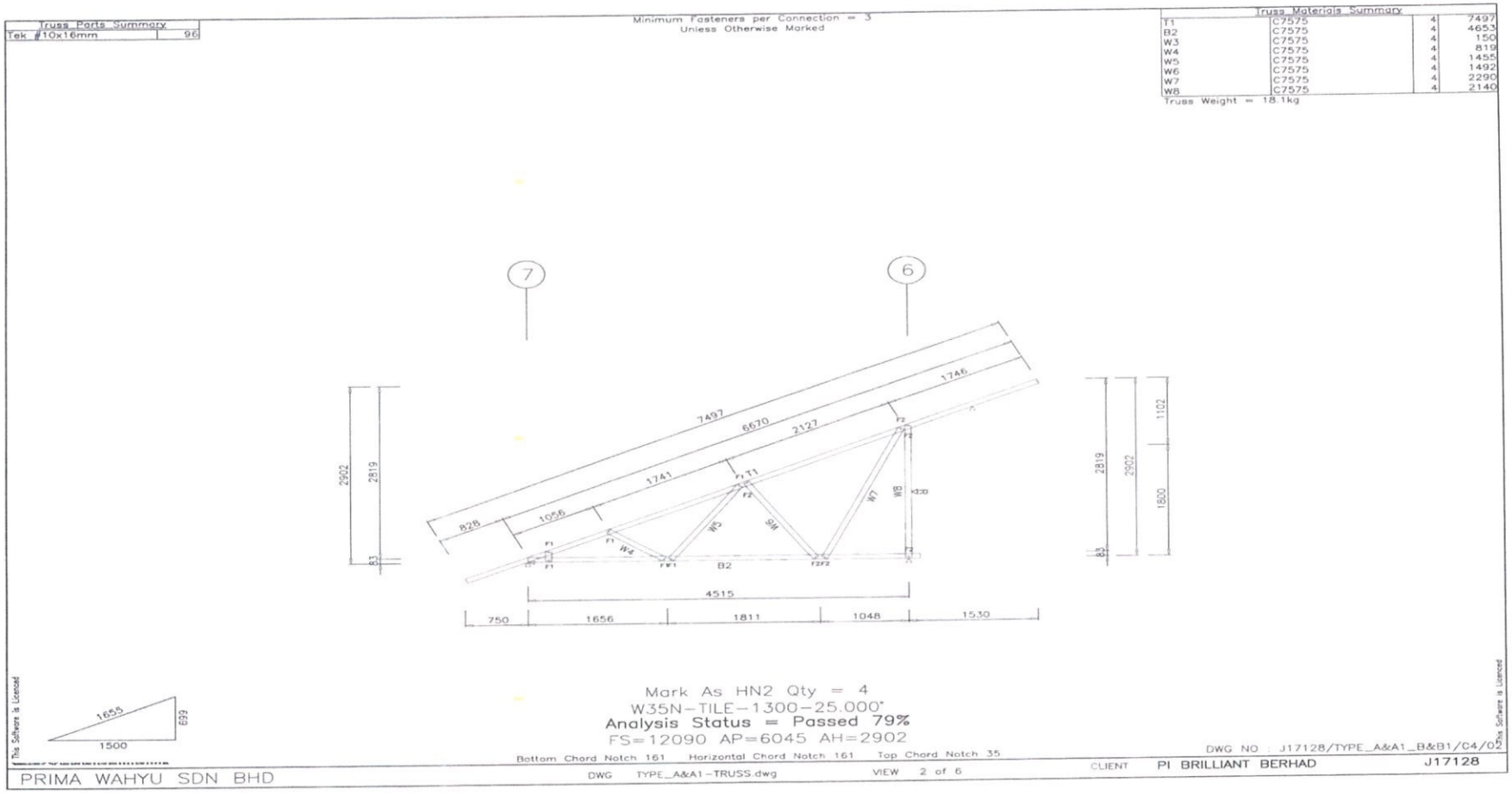
Source: Prima Wahyu Sdn Bhd (2017)

Appendix (C) Truss Parts Analysis Result



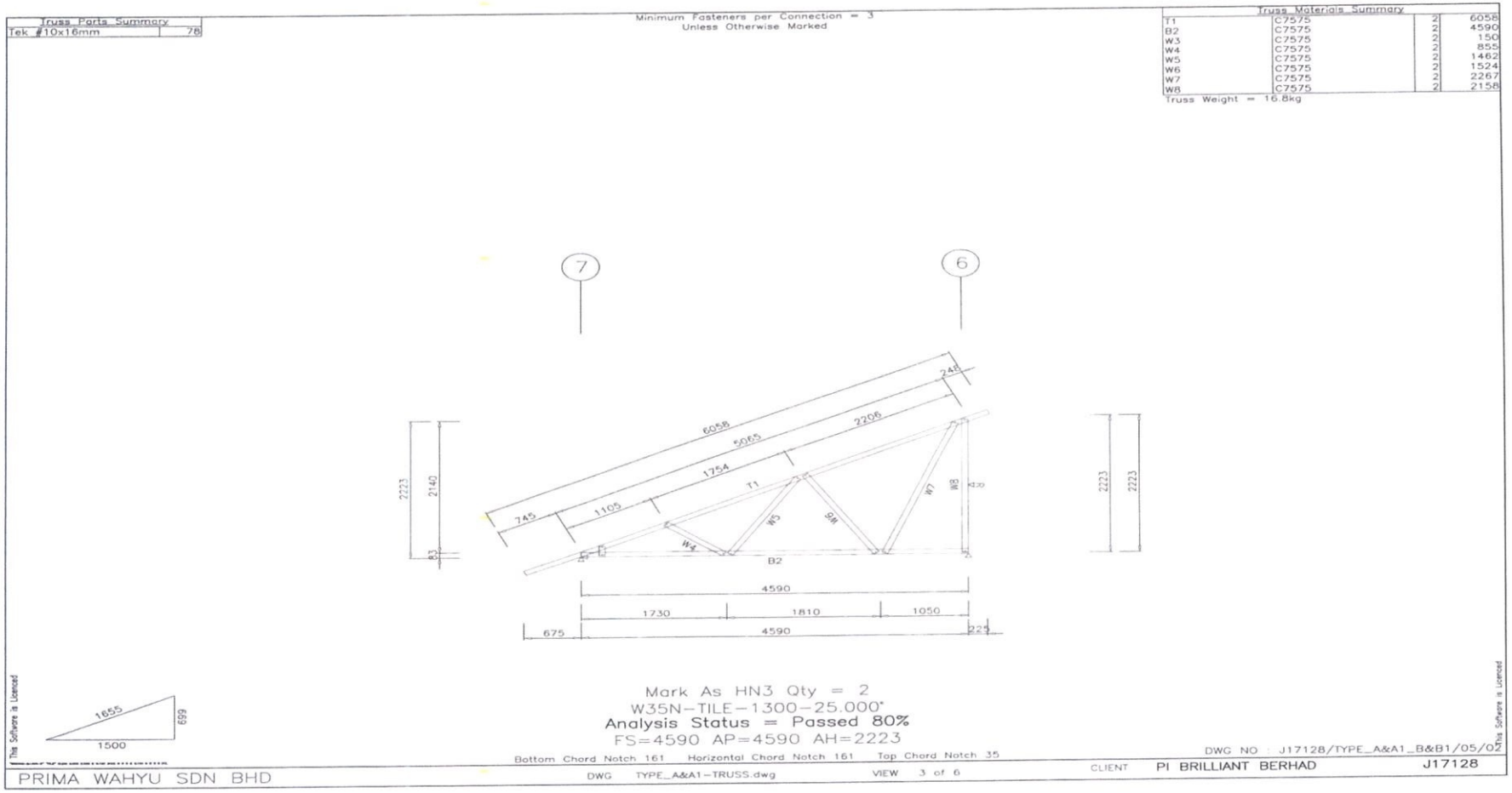
Source: Prima Wahyu Sdn Bhd (2017)

Appendix (D) Truss Parts Analysis Result



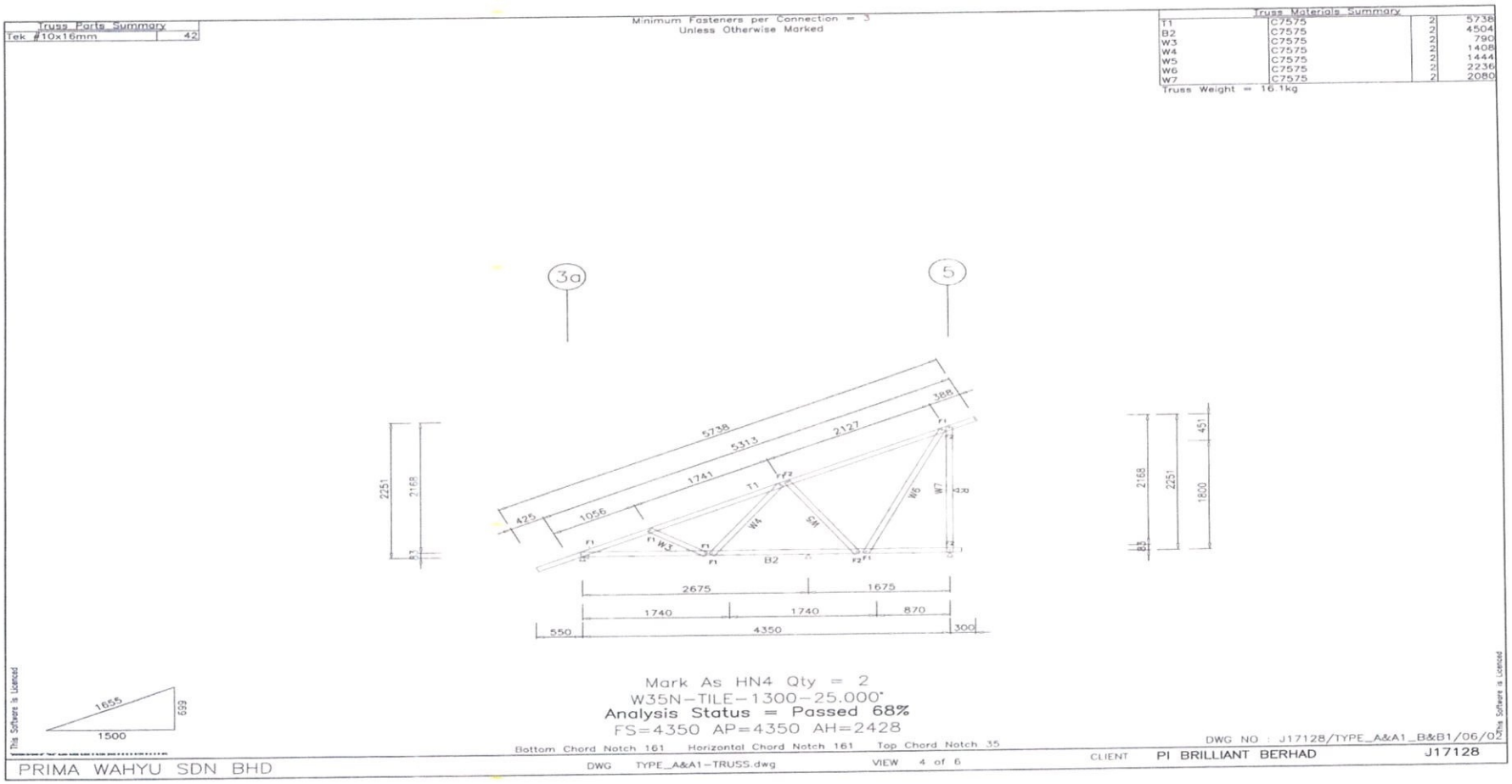
Source: Prima Wahyu Sdn Bhd (2017)

Appendix (E) Truss Parts Analysis Result



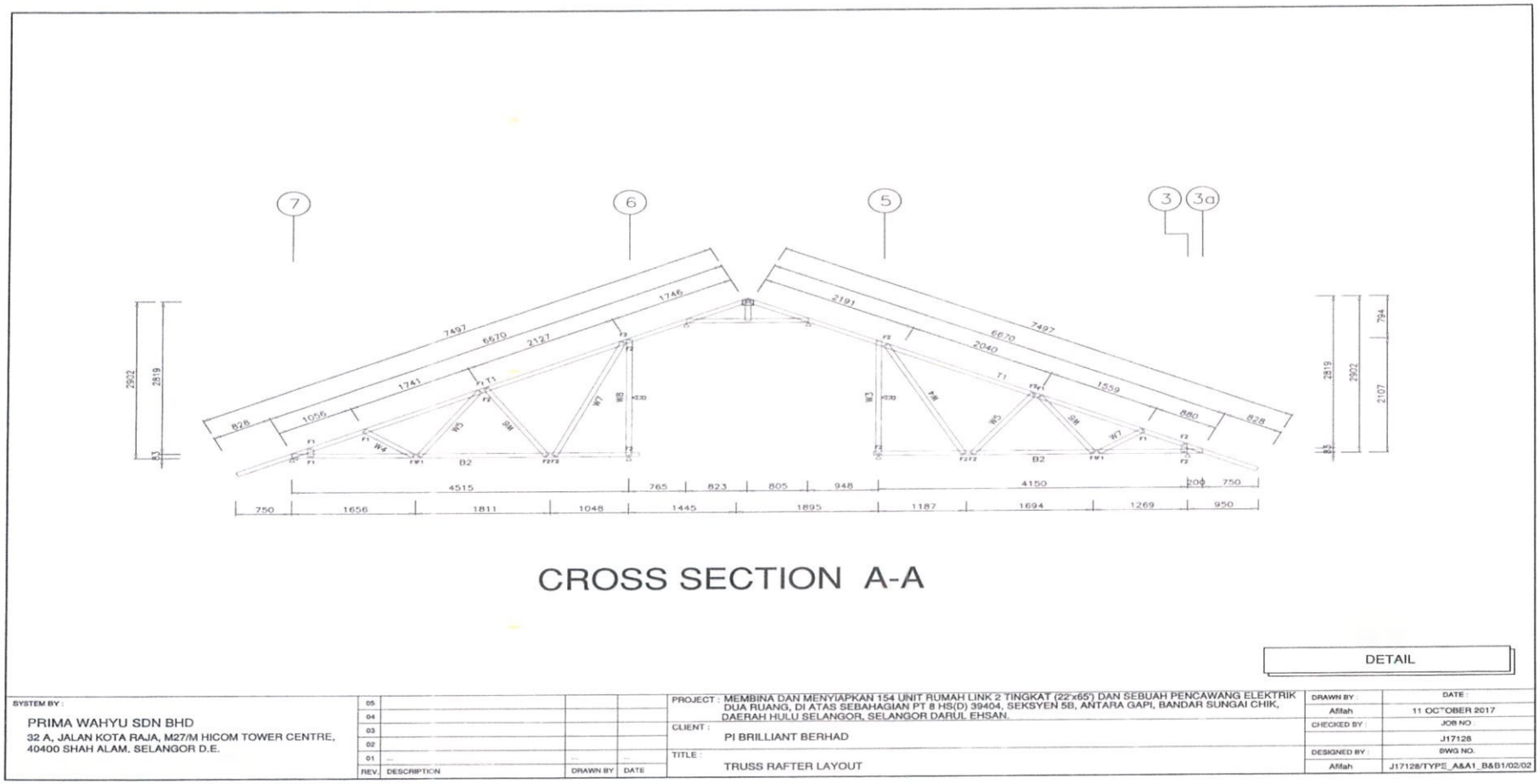
Source: Prima Wahyu Sdn Bhd (2017)

Appendix (F) Truss Parts Analysis Result



Source: Prima Wahyu Sdn Bhd (2017

Appendix (G) Truss Rafter Layout Cross Section A-A



Source: Prima Wahyu Sdn Bhd (2017