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The International Conference on Eco Engineering Development 2017 (ICEED 2017)

PREFACE

On behalf of the organizing committee, I would like to express our deepest appreciation for your dedicated contribution and participation in the International Conference on Eco Engineering Development (ICEED) 2017, which will be held in Yogyakarta, Indonesia on 14-15th November 2017 and organized by Faculty of Engineering, Bina Nusantara University, Indonesia.

The major goal of the present conference event is to provide the knowledge enrichment, sharing experiences and result results and innovative technical exchange between International researchers/scholars and practitioners from the academia and industries in the area of ecological engineering and developments. Professors from Singapore, South Korea and Indonesia are invited to deliver keynote speeches regarding to the latest research findingsrelated to the eco engineering in their specific expertise fields and exploring potential advantages that should be contributed for a better future.

There were 61 manuscript papers submitted to the ICEED 2017 conference, which originally come from 6 countries. All of the papers were subjected to be peer-reviewed by our member of technical program committees. 48 papers have been accepted and the authors of those papers were invited to present their research results in the conference.

I would like to thank all authors who have contributed to the present volume, the keynote speakers, general participants, all reviewers and corporate sponsor for committed contributions and their supports to the conference event of ICEED 2017. We also would like to thank IOP Publishings for collaborative support in publication of the conference proceedings.

Finally, I would like to thank also all of the organizing committee members for their hard work, cooperation and team work in ensuring this conference happenned succesfully. My sincere hope that these proceedings will bring more benefits to all participants and contribute to advancing our understanding and awareness of ecological and engineering knowledges and more importantly the commitment to always do the right applications for even more valuable achievements.

Tota Pirdo Kasih, Ph.D
Bina Nusantara University, Indonesia
ICEED 2017 Conference Chair

Welcome speech and Keynotes executive summary

WELCOME SPEECH

First of all, on behalf of the organizing committee of ICEED 2017, we would like to welcome all delegates, all participants to Yogyakarta, Indonesia with a great pleasure. Being held on November 14-15, 2017 at Sheraton Mustika Hotel Yogyakarta, the first event of International Conference on Eco Engineering Development (ICEED 2017) is organized by the Faculty of Engineering, Bina Nusantara University.

The green and ecological development concept has becoming the emerging trends of challenges for all of us, for Engineering Professionals, Scientists as well as Researchers and Academics. With the main purpose to the development of new sustainable ecosystems, manufacturing processes, building design and construction, smart material and communication that have more ecological values as well as to restore the disrupted ecosystems and polluted environment, eco engineering development plays an important role to bridge the harmony of the human wellbeing and the nature through the new advanced technology. The International Conference on Eco Engineering Development (ICEED 2017) goal is to provide the knowledge enrichment and innovative technical exchange between international researchers or scholars and practitioners from the academia and industries in the field of ecological engineering as listed at the related topic of interests. We encourage all of you to actively participate in the discussions and hope the Conference can provide a good platform in the exchange the information of development and innovation as well as new collaborations between scholars, academics, scientists and practitioners.

We would also like to give our appreciation and thank you to the conference organizers, all of reviewers, as well as the authors for their contribution for making the successful of the event of ICEED 2017. We also greatly acknowledge our publishing partner, IOP Publishing, for their collaborative support in publishing the conference proceedings.

Lastly, since the ICEED 2017 conference venue is held at the city of Yogyakarta, we hope that you can explore the city and experience all that the foremost cultural centers of Indonesia could offer. Visiting the magnificent Borobudur and Prambanan temples, going to Sultan's Palace of Keraton, shopping along the Malioboro road may become your wonderful memories of your complimentary participation in ICEED 2017.

Dr. Ir. John Fredy Bobby Saragih, M.Si
Bina Nusantara University, Indonesia
ICEED 2017 General Chair

WELCOME SPEECH

It is an honor for Bina Nusantara University especially Engineering Faculty become an organizer of ICEED 2017. As Vice Rector Research & Technology Transfer, this conference is one of our pride, and it is a result of the growing awareness and willingness of the faculty member for sharing & gathering knowledge with practitioners, researchers, and community toward the green concepts. The appreciation of the participants makes this event rich with update knowledge that are ready to share with the community. Hopefully, this event can be held again in the coming year, and become a house of discuss and share an up to date research and thoughts that are useful for Indonesia and the world. We really hope that you will enjoy ICEED 2017, and had a wonderful experience in the beautiful city of Yogyakarta as one of tourist destinations in Indonesia.

Prof. Bahtiar Saleh Abbas, Ph.D
Bina Nusantara University, Indonesia
Vice Rector Research & Technology Transfer BINUS University

WELCOME SPEECH

In 10 years time ahead, appropriate energy use will be very critical and millennial generation will dominate the workforce. Far reaching impacts on societies, economies, businesses, cultures, and personal lives will come out as an inevitable wave.

Ecology friendly approach and perspective will put all concerns side by side and eco engineering will stand up firmly to support all newly emerging technologies and products. This creates newly heard terminologies, such as connectivity & convergence, eco-city, connected living, just to name a few.

Faculty of Engineering, Bina Nusantara University is committed to getting involved in shaping up quality of life of Indonesians and the international community, among others, doing research and emitting the results through conferences and community services.

Today, we will have International Conference on Eco Engineering Development. This two day conference will bring together scientists, engineers, and practitioners to explore the potential of eco-engineering development with respect to improving livelihood, broadening job creation, and advancing technology as well as socio economic development.

We thank all committee members who graciously devoted their time and effort to help prepare and organize this conference. But above all, we thank all authors who conducted the research, wrote the papers and came to Yogyakarta to present their work results to the engineering community. We wish all participants the most pleasant stay in Yogyakarta.

Iman H. Kartowisastro, Ph.D
Bina Nusantara University, Indonesia
Provost and Vice Rector for Academic Development BINUS University

EXECUTIVE SUMMARY KEYNOTE 1

Professor Wong Nyuk Hien
Department of Building
National University of Singapore, Singapore

Theme: "Development of a Smart and Sustainable City for the Tropics"

This paper will introduce the Singapore Smart Nation Programme that was initiated by the Singapore Prime Minister's office in 2015. Under a programme, a total budget of S$19 billion will be set aside for Singapore's science and technology research over the next five years to transform Singapore into a smart and sustainable city.

This paper will discuss one specific roadmap Urban Solutions and Sustainability (USS), which target for researchers to cut ambient temperature by 4 degrees C in residential estates under the Cooler and Calmer Singapore programme. An on-going research in National University of Singapore to develop an integrated Multiscale and Multiphysics Microclimate Model in response to the programme will be highlighted. Specifically, the paper will discuss in details an urban heat island (UHI) prediction tool that has been developed to provide a user friendly platform for urban planners to utilize it for urban planning purposes. The paper will also elaborate on such the tool could ultimately link to Climate model as well as to Building Energy model so that a multiscale approach would be developed.

EXECUTIVE SUMMARY KEYNOTE 2

Professor Kang Chul-Ho
Department of Electronics and Communications Engineering,
Kwangwoon University, South Korea

Theme: "Telecommunications Engineering Development for Sustainable Interactions between Humans and Nature"

The purpose of telecommunications engineering development is to maintain a lasting harmony by the sustainable interactions between humans and nature so that we may restore the disrupted ecosystems and polluted environments for wonderful Indonesia. The advanced telecommunications engineering development will play an important role to bridge the human society and the natural environments for the mutual benefits to humans and nature. Telecommunications Engineering technologies such as AI (Artificial Intelligence), IoT (Internet of Things), WSN (Wireless Sensor Networks), and remote sensing technology with satellites and drones can be developed to restore the integrated ecosystems by Human-to-Nature Interaction (HNI).

Telecommunication is the transmission of signs, signals, messages, words, writings, images and sounds or information of any nature by wire, radio, optical or other electromagnetic systems. Telecommunication occurs when the exchange of information between communication participants includes the use of technology. It is transmitted either electrically over physical media, such as cables, or via electromagnetic radiation. And telecommunications engineers also provide solutions revolving around wireless modes of communication and information transfer, such as wireless telephony services, radio and satellite communications, and internet and broadband technologies.

The final target of sustainable interactions between humans and nature is to recover the polluted environments and fallen humanity by the sustainable monitoring of the five spheres as the following:

1) Recovery of atmosphere by making sky clean from air pollution
2) Recovery of hydrosphere by making water pure from water pollution
3) Recovery of lithosphere by making land fertile from desertification
4) Recovery of biosphere by protecting humans and ecosystems from natural disaster such as earthquake, flooding, typhoon, and global warming etc.
5) Recovery of human sphere by monitoring the artificial destruction such as illegal hunting, forest felling, urban development etc.

Wearable devices with 5 types of sensors (CO2 gas sensor, water quality sensor, terrain change sensor, soil pollution measuring sensor, energy measuring sensor) are connected to IoT that track nature ecosystems, tracking nature health and providing real-time updates to a health service for integrated ecosystems. IoTis a technology, through which devices can interact with each other just

as human brain and five sense organs (eyes, ears, nose, tongue, skin) are interconnected to interact each other in a body. Here, AI machine learning is turning out to be the most beneficial in the environmental sciences, which have generated huge amounts of information from monitoring earth's various system. The crucial role of AIis for a self-driving ecosystem to conduct in-depth learning just like an autonomous driving car. Remote sensing is used in numerous fields, including geography, land surveying and most earth science disciplines such as hydrology, ecology, oceanography, geology. Drones are not a survey technology but a remotely controlled, low-level aerial platform for carrying a variety of sensor e.g. camera, laser scanner or Lidar.

Main idea of this topic is to recover the integrated ecosystems based on AI and IoT platform with machine learning working by IoT-generated data received from 5 types of sensors. Here, wireless sensor networks (WSN) is like the eyes and ears of IoT. It is the bridge that connects the real world to the digital world. And it is also responsible for passing on the sensed real world values to the internet.

The direction of telecommunication engineering developments is the paradigm shift from "Smart to Green" technology to restore the overall integrated ecosystems.

But it depends upon the human morality how to develop the eco engineering. Because the morality of AI for eco engineering development is up to humans in order to control the integrated ecosystems between human society and the nature.

EXECUTIVE SUMMARY KEYNOTE 3

Professor Nur Yuwono
Director of Center for Transportation and Logistics Studies
Gadjah Mada University

Theme: "The Concept of Inland Water Transportation Development in Indonesia"

The Indonesian archipelago is crossed by sea lanes to Europe, Middle East, Africa, East Asia and Southeast Asia. These lanes are dense with commercial vessels and ships for industrial purposes. Currently, Port of Singapore plays a crucial role as an International Hub Portfor logistic transportation to the Indonesian archipelago. Many freight (cargo) are shipped directly from Singapore to (or vice versa) ports in Indonesia such as Belawan, Panjang, Jakarta, Semarang, Surabaya, Pontianak, and others. So far, the port of Singapore serves as an International Hub Port, while the ports in Indonesia serve as collector and feeder ports.

Currently, Indonesia is developing an integrated connectivity system, which known as "*TolLaut*", initiated by the Indonesian President Joko Widodo (JOKOWI). *TolLaut* is an integrated sea transportation system with its connectivity (road, railway and air transportation) to facilitate the logistics network in Indonesian archipelago. This system aims to reduce gaps in commodities price among regions. Transport of goods from Western Indonesia to Eastern Indonesia or vice versa, could be assured. This "*tolLaut*" is actually a development of "*Pendulum Nusantara*" which has been introduced by the former President Susilo Bambang Yudoyono in his MP3EI program. *Tollaut* is implemented by developing the main sea lane (back bone sea lane): Medan (Belawan / Kuala Tanjung) - Jakarta (TanjungPriok / Kalibaru) - Surabaya (Tanjung Perak / TelukLamong) - Makasar (Makasar New Port) - Bitung). In addition, the government will also develop 24 feeder ports and connects each of them with road, railway and air transportation.

It is known that water transportation has many advantages compared to land transportation, including: (1) the vehicle is simpler but has larger capacity, (2) relatively low cost due to inexpensive infrastructure and efficient use of fuel, (3) the maintenance cost of water transportation infrastructure facilities is relatively cheap if it can utilize the existing river, lake or sea (4) lower negative impact on the environment than that caused by road transport (based on a research in Europe, the level of pollution caused by water transportation is only 5 - 6% of what is caused by trucks).

Although generally provides several benefits, water transportation in Indonesia, particularly Inland Water Transportation has stagnated in its development. The above condition is caused by several factors such as (1) the amount of garbage in the river that can disrupt ship's propeller bait, (2) space under bridges is usually narrow and not enough clearance, limiting the size of passing ships, (3) The water level is highly dependent on the season (shallow during dry season and flooding during rainy season), (4) Lack of support from the government, currently there is no advanced technology is used in water transportation development.

Indonesia has several potential areas for inland water transportation development. These areas include (1) Eastern Region of Sumatra Island, (2) Kalimantan Island as a whole, and (3) some parts of Papua Island. For example Borneo has several major rivers that are ideal to be developed as waterways for Inland Water Transportation. Those rivers are: (1) Kapuas River - 1086 km, (2) Kahayan River - 600 km, (3) Kapuas Murung River - 600 km, (4) Barito River -900 km, (5) Katingan River - (6) Mentaya River - 400 km, (7) Seruyan River - 550 km, (8) Lamandau River - 300 km, (9) Mahakam River - 920 km, and (10) KayanRiver - 576 km.

To develop the potential of inland water transportation, the following concepts are proposed:
1. Integrating "TolLaut" and Inland Water Transportation (IWT) system
2. Adopting the concept of "supply chain" which has been developed in Europe
3. Controlling the water depth (water elevation, discharge) along the canal or river by means using control structures
4. Developing special ships which are suitable (appropriate) for local river or canal based on local wisdom.
5. Creating enough clearance space above the water surface, especially under the bridge.
6. Developing appropriate natural and artificial slope protections (soft and hard structures) against wave attack generated by ship movement.
7. Developing appropriate cross structures over the navigation canal.

In the development of inland water transportation in Indonesia, it is necessary to refer to examples that have been successfully developed abroad, such as:
a. The development of integrated inland water transportation in Europe (Rhine corridor, Danube Corridor, East - West Corridor, North - South Corridor)
b. The development of integrated inland water transportation in Alabama
c. The development of Tennessee – Tombigbee Waterway
d. The development of Rhine – Main – Danube Waterway (3500 km)
e. The development of Yangtze River waterway (990 million tons of cargo is annually transported through this river).
f. The development of water tourism (cruise) in Yangtze River and Trent-Severn Waterway.

Based on the above description, it can be concluded that the Government of Indonesia has a great opportunity to develop potential natural rivers into an Integrated Inland Water Transportation system, especially in Sumatra, Kalimantan and Papua Islands. In the development, the government needs to adopt eco-waterway concept and make it integrated to the *TolLaut* program.


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Peer review statement

Peer review statement

All papers published in this volume of *IOP Conference Series: Earth and Environmental Science* have been peer reviewed through processes administered by the proceedings Editors. Reviews were conducted by expert referees to the professional and scientific standards expected of a proceedings journal published by IOP Publishing.

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Design of pedestrian truss bridge with Sengon-Rubber laminated veneer lumber

Design of pedestrian truss bridge with Sengon-Rubber laminated veneer lumber

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Abstract. Timber bridges are one of the bridge that has long been used, but nowadays, large dimension of sawn timber has limited supply and also it is not environmental-friendly. Laminated veneer lumber (LVL) is a engineered wood that becomes one of the promising alternative, because it is made from lower quality wood that processed to be used as a more quality one. The bridge planned to be a pedestrian truss bridge with length of 9 m, width of 3 m, height of 2.5 m, and using bolt and steel plate as its connection system. Mechanical properties of LVL obtained directly from laboratory test result. Bridge modeling and planning for wood construction refers to SNI 7973:2013, while the loading refers to SNI 1725:2016. Based on the modelling and calculation, the dimension of truss frame and girder beam which are 9 cm x 9 cm and 9 cm x 18 cm have adequate strengths and satisfy deflection requirement.

Keywords: timber bridge, truss frame, laminated veneer lumber

1. Background

Indonesia is filled with tropical forests and become the second largest in the world after forests in Brazil. Wood or timber is one of the most common used material in Indonesia. On the other hand, timber is a material that has long been used to make a pedestrian truss bridge or light vehicle. The advantages of this type of bridge are light weight, economical for medium spans and has aesthetic value. Timber also can be found easily in tropical area such as Indonesia.

However, nowadays illegal logging excessively occurred causing qualified timber stock decreased. Moreover, it caused the wood supply decrease and the timber value increasingly unaffordable for people to buy. Because of this case, engineered wood can be alternative.

Laminated veneer lumber is one of the alternatives with excellent prospect. It is an engineered wood consist of thin layers or wood veneers that glued together with sengon wood (density of 0.35 kg/m^3) and rubber wood (density of 0.61 kg/m^3) as base materials. Compared to ordinary woods, LVL is more flexible with consistent quality, and has anti-termite properties due to the use of adhesive in each layer. The purpose of this research is to design timber truss bridge wih LVL that can withstand different types of load and apply SNI 7973:2013 about Design and Specification for Wood Construction. The benefit of this research is to make LVL as an alternative material of pedestrian truss bridge with medium span. Scope of this research are:

- Bridge structure is a truss bridge with span of 9 m, width of 3 m, and height of 2.5 m.
- Design loads consist of pedestrians, two-wheeled vehicles, and light vehicles.
- Connection system using steel plate and bolt.
- Wood mechanical properties obtained from laboratory test results.
- Structure analysis using software SAP2000 version 14.
- Bridge load specification using SNI 1725:2016
- Earthquake planning standards for bridges using SNI 2833:2008.
- Structural loads include dead load, live load, earthquake load, and wind load.

Timber truss bridge consists of truss system which has tension or compression structural elements and girder which has flexure and shear elements. SNI 7973:2013 requires truss member which has axial capacity more than axial force due to external load, and the girder has flexural capacity more than ultimate bending moment. SNI 7973:2013 requires deflection of the timber bridge is span/700, then this LVL bridge should satisfies these requirements.

2. Timber Truss Bridge Engineering

2.1 Truss Bridge. Truss bridge consists of two main frames connected by girder and lateral stiffner. It has a triangular pattern fastened by bolts thus making the sctructure more stable. Truss bridge usually used for span of 20 to 375 m. Compared to other bridges, this bridge has higher stiffness value for the same length of span. In addition, it required less amount of material to pframeuce the same rigidity. This is possible because of the efficient truss configuration because of the loads supported axially by the frame in the structure so that the axial forces of the frame can be maximally utilized. An example of truss bridge component can be seen in figure 1.

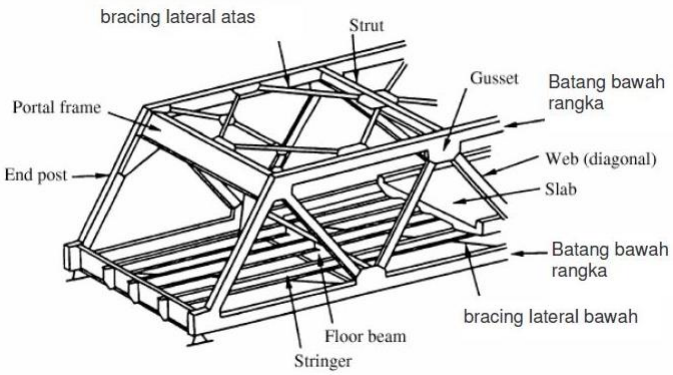

Figure 1. Component of truss bridge (Source: Chen dan Duan, 1999)

Truss bridge has many types because many experts are developing this type of bridge. In this research will be used warren truss. According to Ketchum in his book Design of Highway Bridge, several types of truss bridge as in figure 2.

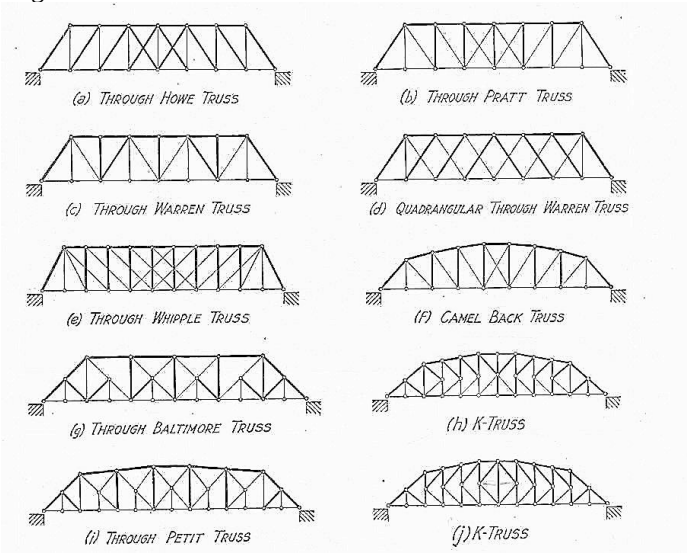

Figure 2. Types of truss bridge (Source: Milo S, 1920)

2.2 Laminated veneer lumber.
LVL (Laminated Veneer Lumber) is one of the promising alternative, because it is made from lower quality wood that processed to be used as a more quality wood. Technology utilization of engineered wood as a material of structural components in construction of engineered wood buildings in earthquake prone areas has the potential to fast-growing-wood from Industrial and Community of Plantation Forest (Junjunan, 2014).

Figure 3. Laminated veneer lumber

2.3 Loads of pedestrian bridge
Pedestrian bridge is a bridge designed for pedestrians and also include light vehicles such as bicycles, carts, animal-drawn vehicles, and motorcycles. The loads used in a pedestrian bridge modeling are dead load, live load, wind load, and earthquake load. Dead load is load that come from the bridge or section of the bridge that being reviewed, including any additional elements considered to be a single unit. Live load is the load that come from pedestrians, light vehicles, and farm animals. In this research, the bridge designed to be able to pass the pick-up truck. Some specifications related to the calculation and design of wooden bridge structure refers to Design Specification for Wood Construction (SNI 7973:2013), Bridge Loads (SNI 1725:2016), and for earthquake loads refer to Seismic Design Standards for Bridges (SNI 2833:2008).

2.3.1 Dead Load. Dead load is a permanent load that acts on the structure, it comes from the weight of its own structure from the weight of the truss frame, girder, and bridge deck. The bridge weight has been calculated automatically by the program, without manual input.

2.3.2 Live Load. Live load is a non-permanent and fluctuating load that works on the bridge deck, it comes from pedestrians and light vehicles. Because this bridge operates as an emergency bridge and earmarked for pedestrian. It is a distributed load and centered line load with 50% of design load. (Puslitbang Jalan and Jembatan, 2015). So the pedestrian load is 4.5 kPa that works on the bridge floor, and centered line load in the middle span is 24.5 kN/m.

2.3.3 Wind Load. Wind load works on the bridge structure and designed in extreme conditions, where the wind speed at this condition is 30 m/s if the location is more than 5 km from sea shore. The amount of wind load is calculated using:

$$TEW = 0{,}006\, C_W\, {V_w}^2\, A_b \quad (1)$$

where:
V_W = wind loads $[m/s]$,
C_W = drag coefficient,
A_b = area equivalent to the side of the bridge [m^2].

2.3.4 Seismic Load. Seismic loads are calculated based on PGA (Peak Ground Accelerations) in Indonesia Earthquake Hazard Map 2012 for Bandung. The method of seismic analysis using dynamic response spectrum. The design spectrum response curve for all soil types in Bandung is as shown in figure 4.

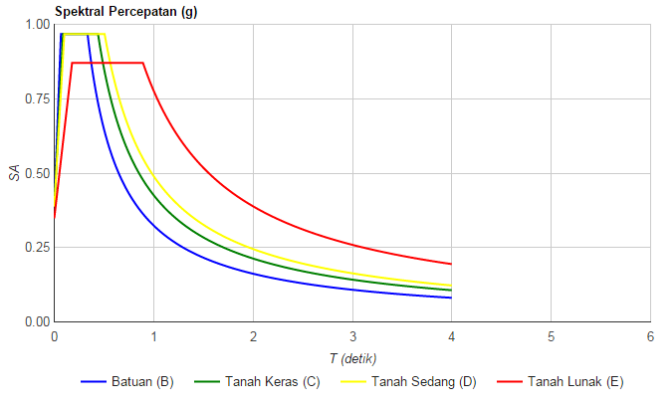

Figure 4. Response spectrum curve for Bandung (Source: http://puskim.pu.go.id, 2016)

Response spectrum function based on design response spectrum parameters for earthquake with soft soil categories to analyze the structure dynamicaly due to earthquake in Bandung, the design response spectrum parameter for soft soil of Bandung city can be seen in table 1.

Table 1. Design response spectrum parameter for soft ssoil of Bandung

Variable	Value	Variable	Value
$\boldsymbol{PGA}$ (g)	0,577	$\boldsymbol{PSA}$ (g)	0,519
$\boldsymbol{S_s}$ (g)	1,450	$\boldsymbol{S_{MS}}$ (g)	1,305
$\boldsymbol{S_1}$ (g)	0,486	$\boldsymbol{S_{M1}}$ (g)	1,166
$\boldsymbol{C_{RS}}$	0,977	$\boldsymbol{S_{DS}}$ (g)	0,870
$\boldsymbol{C_{R1}}$	0,905	$\boldsymbol{S_{D1}}$ (g)	0,777
$\boldsymbol{F_{PGA}}$	0,900	$\boldsymbol{T_0}$ (detik)	0,179
$\boldsymbol{F_A}$	0,900	$\boldsymbol{T_S}$ (detik)	0,893
$\boldsymbol{F_V}$	2,400		

2.4 CSIRO method of proporsional point determination

Methods for determining the point or burden of proportional limit or often called the yielding point for the experimental test results in the laboratory are several ways, i.e. Karacabeyli and Ceccoti, CEN, CSIRO, EEEP, Yasumura and Kawai, and 5% Offset Method. In this research will be used CSIRO method. The schematic model of proportional point determination for the CSIRO method is shown in figure 5.

The steps for determining the proportional load with the CSIRO method are as follows:
- Create a graph between load and deformation, with X-axis as deformation and Y-axis as load.
- Calculate 40% of the maximum load and pull the horizontal line until it is tangent to the curve.
- Read the deformation at the point of the tangent line.
- Multiply the number of deformations by 1,25 and plot the number of multiplications on the Y axis.
- Drag a vertical line at the value of the multiplication until it is tangent to the curve.
- Read the load at the point of the tangent line and that is the point of proportionality.

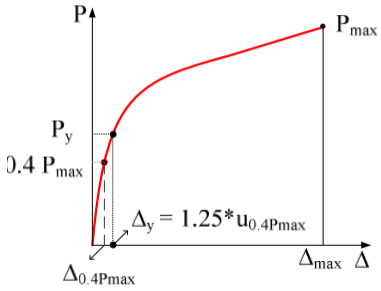

Figure 5. CSIRO Method of proporsional point determination (Source: Munoz, 2007)

3. Research methodology

3.1 Wood Mechanical Properties Testing. Wood mechanical properties is a data for structural modeling, without this data modeling will not be possible. Therefore, to obtain accurate wood mechanical data and in accordance with the wood material used, testing is done in the laboratory. These requirements, tools and test methods refer to applicable Indonesian National Standard. Mechanical properties tested by considering which data will be used in the modeling and calculation, the tests are compressive strength test of wood (SNI 03-3958-1995), bending test of wood (SNI 03-3959-1995), shear test of wood (SNI 03-3400-1994).

3.2 Bridge modelling
Bridge modelling includes defining material from laboratory test data, defining the size and shape of the frame, and loads the bridge frame. The extrude view of the bridge model is shown in figure 6.

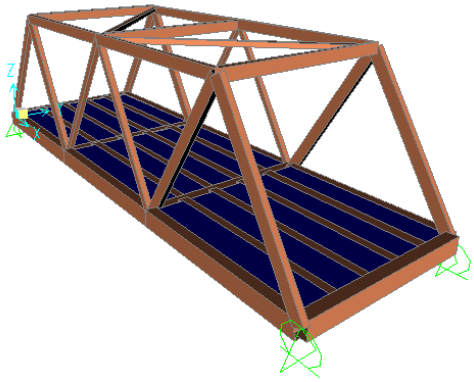

Figure 6. Extrude view of the bridge (Pangestu, L., 2017)

3.3 Structural analysis
Analysis of this structure can be done if the bridge modeling is completed and continued by running the structure in software. Structural analysis aims to determine the behavior of structures and forces acting on the bridge due to the work load. Output of the structural analysis are frame force, moment and shear force, which will then be used to design the dimensions of the truss and girder. According to SNI 7973:2013, for truss member, the nominal tension or compression force reduced with resistant factor should be more than ultimate tension or compression force ($\emptyset P_n > P_u$). For girder, the nominal bending moment and shear force reduced with resistant factor should be more than ultimate bending moment and shear force ($\emptyset M_n > M_u$ and $\emptyset V_n > V_u$).

3.4 Design of frame and wood connection
Calculation and analysis to design frame dimensions and wood connection, refers to the Design Specification for Wood Construction (SNI 7973: 2013). Failure of the connection system could be

caused by failure of connected members or failure of fasteners, such as fracture due to shear on fasteners. Number of fasteners should be designed to resist this failure

$$\emptyset F_{nv} A_b n_b > P_u \quad (2)$$

where:

$\emptyset$ = resistance factor,
F_{nv} = nominal shear strength of fastener [MPa],
A_b = fastener cross area [mm^2],
P_u = ultimate tension or compression force [N],
n_b = number of fasteners.

3.5 Check deflection

Maximum deflection at middle of span obtained from SAP2000 in *Deform Shape Fiture* with amount of 10.12 mm. In SNI 7973:2013 sub chapter 2.4, to fulfill the structure comfort criteria, a structure must have smaller deformation/displacement than allowed delfection. Allowed deflection for expose to weather frame is:

$$\delta_{max} < \frac{1}{700} l \quad (3)$$

Since the deflection of the bridge under dead and live loads of 10,12 mm less than the allowed deflection of 12,86 mm, then the bridge satisfies the deflection requirement.

4. Data and analysis structure

4.1 Mechanical properties of laminated veneer lumber. From laboratory test results, mechanical properties of LVL such as compressive strength of parallel fiber, flexural bending, and shear strength are obtained. Usually, the wood tensile strength is greater than the compressive strength, then the value of tensile strength refers to the compressive strength. Test results obtained value of compressive strength of 13.85 MPa with modulus elasticity of 3,998 MPa, bending strength of 32.04 MPa with E of 10,626 MPa, and shear strength of 2.87 MPa (Pranata, Y.A., et al, 2017).

4.2 Output shear force diagram and moment bending diagram in SAP2000. Based on the result of analysis, maximum deflection occurred at 10.12 mm, while the allowable deflection is 12.85 mm, it means allowable deflection condition is fulfilled. The largest tensile force occurs on Frame 66 is 116.065,83 N, the biggest compressive force occurs as seen in figure 7 that is equal to -119.682,64 N. The biggest moment occurs on Frame 40 is 5,021,378 Nmm. As for the maximum shear force also occurs on Frame 40 that is 14.648,33 N. These maximum forces will be used as a reference to design the dimensions of the truss frame and its connection. Names of the truss frame 1 can be seen in figure 8, while names of the girder in Figure 8. The result of force diagram of frame is shown in figure 10, while 3D moment diagram results are shown in figure 11.

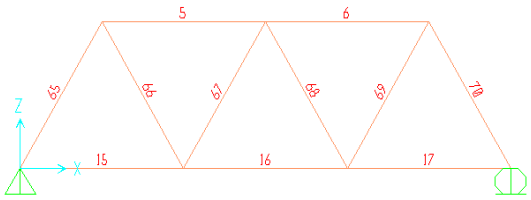

Figure 7. Names of the truss frame 1

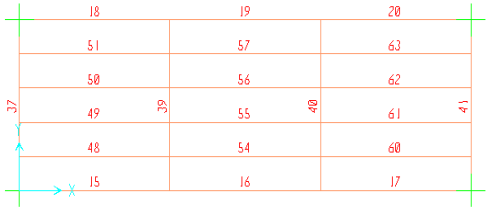

Figure 8. Names of the girder beam

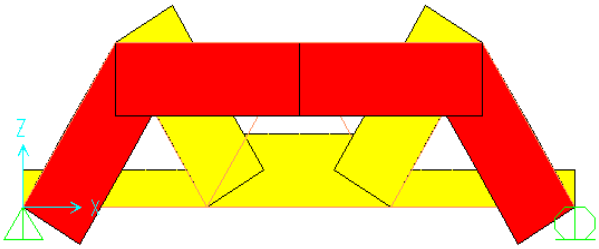

Figure 9. Force diagram of frame

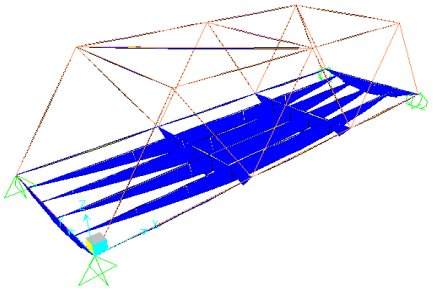

Figure 10. 3D Bending moment diagram

4.3 Dimension of frame and girder

Frame dimension used refers to the availability of LVL timber which provided by the manufacturer. The size that provided by the manufacturer is multiple of 9 cm, the example size can be used are 9 cm x 9 cm, 9 cm x 18 cm, 18 cm x 18 cm, and 18 cm x 27 cm. The results of analysis, the frame with the largest force used as a reference in determining the dimensions of the frame. The largest tension member is located on the Frame 66 with the dimension 9 cm x 18 cm. The largest compression member is on the Frame 3 with the dimension 9 cm x 18 cm, meanwhile the frame with no force will be used dimension 9 cm x 9 cm. The greatest moment among all girder frame occurred in frame 40, then after that got the dimension of all girders are 9 cm x 18 cm. The side view of the truss bridge frame is shown in figure 11, while the top bridge girder is shown in figure 12.

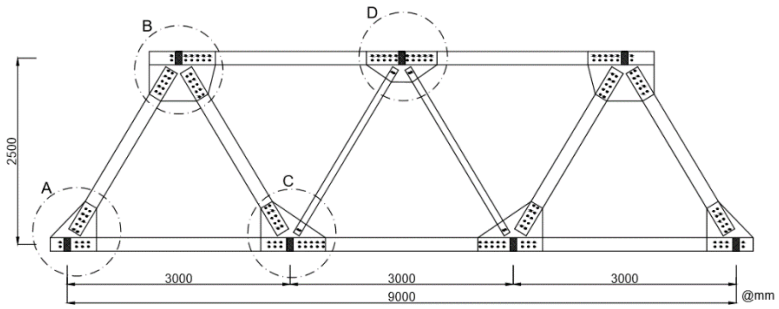

Figure 11. Side view of the frame

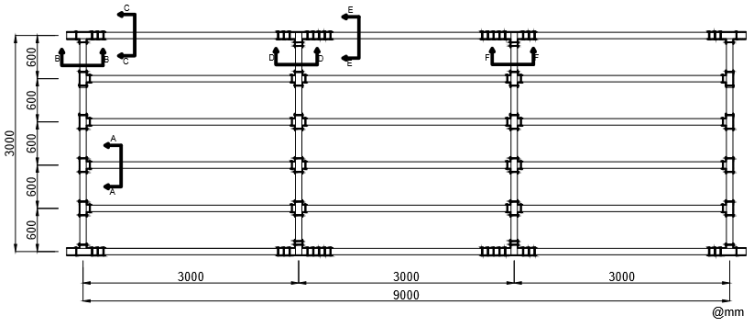

Figure 12. View of girder

Principles in designing compression and tension members are $\varphi P_n > P_u$ and for girders $\varphi M_n > M_u$, as summarize on table 2, table 3, and table 4, respectively.

Table 2. Compression members design

Member	3	4	5	6	65	70	89	94
Ultimate axial load (P_u) (*N*)	119683	118754	119607	118412	116603	115442	115483	116074
Design axial strength (φPn) (N)	120900	120900	120900	120900	120900	120900	120900	120900
Section capacity ratio	0,99	0,98	0,99	0,98	0,96	0,95	0,96	0,96
Check φPn > Pu	OK	OK	OK	OK	OK	OK	OK	OK

Table 3. Tension members design

Member	15	16	17	18	19	20	69	90
Tension Strength (Pu) (N)	78479	100467	75457	69567	109837	77836	114904	114740
Design tension strength (φPn) (N)	283295	283295	283295	283295	283295	283295	283295	283295
Section capacity ratio	0,28	0,35	0,27	0,25	0,39	0,27	0,41	0,41
Check φPn > Pu	OK	OK	OK	OK	OK	OK	OK	OK

Table 4. Girder design

Batang	39	40	41	55	56	57
Factored moment (Mu) (N.mm)	5018928	5021378	2854330	3195223	3195076	3127896
Design flexural strength (φMn) (N.mm)	20627108	20627108	20627108	20627108	20627108	20627108
Section capacity ratio	0,24	0,24	0,14	0,15	0,15	0,15
Check φMn > Mu	OK	OK	OK	OK	OK	OK

4.4 Design of connection

Refers to the greatest force in frame, the connection using bolt 20 mm, thick of steel plate 10 mm, number of bolts consist of 10 pieces made two lines with amount of 5 bolts one line. Steel connection details can be seen on figure 13.

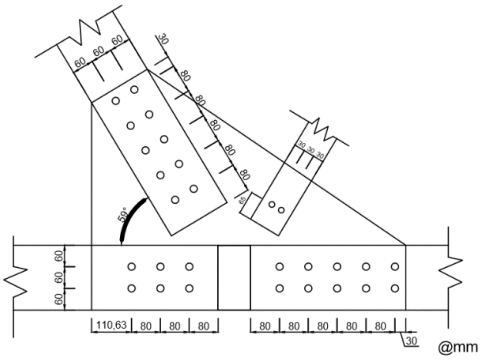

Figure 13. Detail of connection C

5. Conclusions

From the design of LVL pedestrian truss bridge, it can be concluded that with frame dimensions of 9 cm x 9 cm and 9 cm x 18 cm, the design of bridge is strong enough to withstand the working-loads. This is indicated by the fulfillment of the maximum bridge deflection, the truss frame design and girders are able to withstand the shear force and bending moment acting on the frame, as well as the connections designed able to distribute the force on trusses and girder beams.

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