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Spreadsheet Programming Design for Wood Connection Calculations In Wood Structure Course

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Abstract: This study aims to design a spreadsheet programming product for wood connection calculation in wood structure course. This research uses Research and Development (R&D) methods with stages of Define, Design, and Develop. The research instrument used is a questionnaire for product validation by subject expert and media expert. Data analysis of expert validation results was carried out quantitatively-descriptively. The result of this study is a spreadsheet programming product for the calculation of wooden connections called TUSAYU. The validation results show that the resulting spreadsheet programming is eligible for use with an average score percentage of 79.6% (Feasible) in term of subject and 82.8% (Very Feasible) in terms of media.

Keywords: spreadsheet, wood connection, wood structure

Introduction

The use of wood is closely related to human life. Wood as a natural material that is easily found in Indonesia makes the use of wood very diverse, one of which is as a building material. Buildings that use wood as a structural material or component provide a natural feel and artistic value to a building, besides that through the use of wood as a building material, the community can also participate in efforts to improve an environmentally friendly lifestyle and maintain cultural values (Fahriza, Kaskoyo, Safe'I, & Hidayat, 2021).

Wood as a natural material certainly also has limitations including limited wood length, relatively small wood strength, small wood cross-sectional size, and the natural properties of wood that are sensitive to water and relatively large wood shrinkage (Alokabel, Lay, & Wonlele, 2018). Good wood design and care is one way to maintain the quality and strength of wood structures so that they do not experience damage due to lack of maintenance and weather changes (Akbar, 2021), damage to building constituent components due to termites (Andriana & Tharo, 2018), and failure in the connection (Kamaluddin, Basyaruddin, Asih, & Qusairy, 2020) . Learning wood material and design at the university level is one of the real solutions to produce experts who can solve various problems that may occur related to wood structure design so that the needs of industry, consumers, and research fields can be fulfilled (Daneshvar, Goni, Zhang, Kelterborn, & Chui, 2021).

How to Cite:
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Wooden structure is one of the courses in the Building Engineering Education Study Program, State University of Jakarta which studies basic knowledge and planning of wooden structures. Wooden Structure is one of the courses in the Building Engineering Education Study Program, State University of Jakarta which provides basic knowledge in planning a wooden construction. The learning achievement in this course is that students are expected to understand the basic concepts of wood as a building material, and can do the basics of wood construction calculations. In the wood structure course, the material studied includes wood specifications and characteristics, the application of plan drawings based on wood calculations, and analysis of wood construction calculations based on applicable regulations, namely SNI 7973-2013 (Ramadhan & Murtinugraha, 2020).

Based on the results of a preliminary study conducted with the method of distributing questionnaires (questionnaires) to 21 students of the Building Engineering Education Study Program class of 2020, it can be seen that in the Wood Structure course there are material for calculating wooden connection and the final task of planning wooden connections with mechanical fastener based on SNI 7973-2013 and PKKI 1961 regulations. As many as 16 (76.2%) respondents stated that they still have difficulties and 5 (23.8%) have not experienced difficulties in calculating wood connections. The difficulties experienced by respondents, including 4 (four) respondents difficulty understanding the material, 6 (six) respondents difficulty in remembering the stages and rules of calculation, 5 (five) respondents difficulty in the calculation process, and 1 (one) respondent difficulty due to lack of practice questions. In the calculation process carried out in the learning process and final tasks, the majority of respondents can use calculation tools in the form of calculators. However, the use of calculators by respondents is said to still have weaknesses if there is an error in the calculation input. Therefore, as many as 20 (95.2%) respondents are agreed if there are counting tools that can help in calculating wood connections.

The use of integrated technology in learning can be one way to increase student interest (Fauzi, 2017), improve structural analysis skills (Li, Zhang, Jin, Wanatowski, & Piroozfar, 2018), assist educators in delivering material and support students to learn independently (Aydinol & Gültekin, 2010), and help students understand the material (Dmytrenko, Dmytrenko, & Derkach, 2018). The design of a calculation tool aims to produce applications that make the calculation process more effective and efficient (Wijaya & Pranata, 2014), reduce errors in calculations (Roman, Delgado, & Morales, 2021), present calculation results automatically (Jelatu, Jundu, & Men, 2020), and can process large amounts of data (Alfat, Saifudin, & M, 2020).

Based on this background description, this research was conducted entitled "Spreadsheet Programming Design for Wood Connection Calculation in the Wood Structure Course". This research is expected to be an innovation in computing technology in learning Wood Structure courses and wood connection calculations at Building Engineering Education, State Jakarta University. In addition, the use of spreadsheet programming is expected to make the calculation of wood connections in the Wood Structure course more effective and efficient based on applicable regulations.

Method

The method used in this study is Research and Development (R&D) with stages of Define, Design, and Develop. The resulting spreadsheet programming products are then validated by subject experts and media experts using questionnaire instruments. Product assessment is carried out using the Likert scale to measure expert opinions in the form of statements (Sugiyono, 2017). The results of product validation are then analyzed using quantitative-descriptive techniques to describe the value obtained and the advice provided by experts.

Result and Discussion

The spreadsheet programming design research for the calculation of wood connections was prepared with the aim of designing a product in the form of spreadsheet programming that can assist in the calculation of wood connections using bolts and nails in accordance with SNI 7973-2013 in the wood structure course at the Building Engineering Education Study Program, Jakarta State University. The following is a spreadsheet programming produced called TUSAYU. This spreadsheet programming design produces 16 sheets consisting of Dashboard (see Figure 1.), First Page (see Figure 2.), Bolt (see Figure 3.), Bolt-Hint, Bolt-Double Shear, Bolt-Single Shear, Nail (see Figure 3.), Nail-Hint, Nail-Single Shear, Nail-Double Shear, Wood Type, Connection Type, Correction Factor, Melting Mode, Learning Outcomes, and Reference.

Figure 1. TUSAYU main dashboard

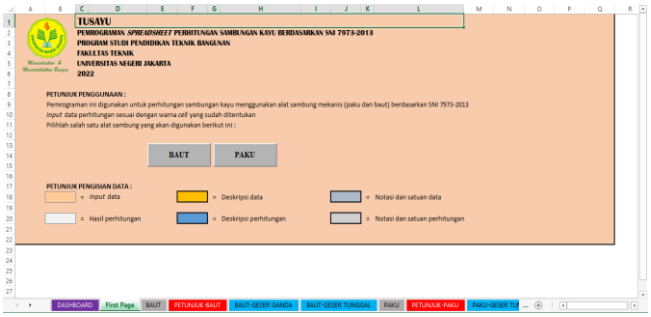

Figure 2. Display to select the fastener type

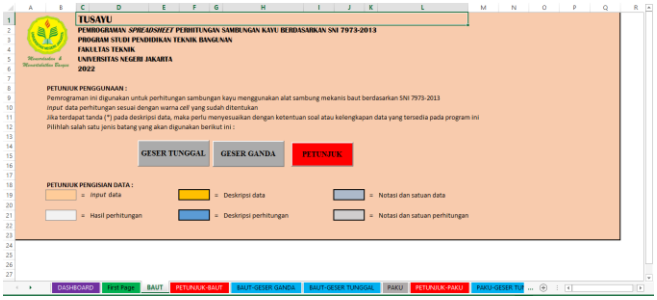

Figure 3.Display to select connection shear type

The spreadsheet programming that has been designed is then validated. Validation is carried out online using questionnaire instruments (questionnaires) by subject experts and media experts. Subject experts provide assessments and corrections to the suitability of calculation procedures with SNI 7973-2013 and wood structure course materials. Subject validation involved Associate Professor of the Department of Civil and Environmental Engineering, Universitas Gadjah Mada and Lecturer of Building Engineering Education Study Program, Universitas Sebelas Maret. Meanwhile, media experts provide assessments and corrections to the suitability of using spreadsheet programming as a learning media and the accuracy of using excel functions. Media validation involved Lecturers of the Curriculum and Educational Technology Study Program, Universitas Pendidikan Indonesia and Lecturers of the Informatics Engineering Study Program, Universitas Mikroskil Medan. The results of the subject expert assessment show that spreadsheet programming meets the "Feasible" criteria with a percentage of value of 79.6% in terms of subject. The results of the media expert assessment show that spreadsheet programming meets the criteria of "Very Feasible" with a percentage of scores of 82.8% in terms of learning media and excel media.

Spreadsheet programming that has gone through the validation stage is then revised according to the advice given by experts so that the quality of the resulting product becomes better. The revisions made include changes to the layout of the calculation sheet, adjustments to the calculation arrangement in descending order, changes to several wood joint calculation terms and formulas, adding criteria and determining variables in the correction factor, adjusting previously used excel formulas, adding list box, adding excel formulas (IFAND, IFOR, IFERROR, and ROUND), added validation of information in input cells and calculation results, changes in the location of navigation buttons, and changes to macro function commands (Visual Basic Application for Excel). The following is a programming view of the spreadsheet after revision of the bolt and nail calculation sheet (see Figure 4 and Figure 5 below).

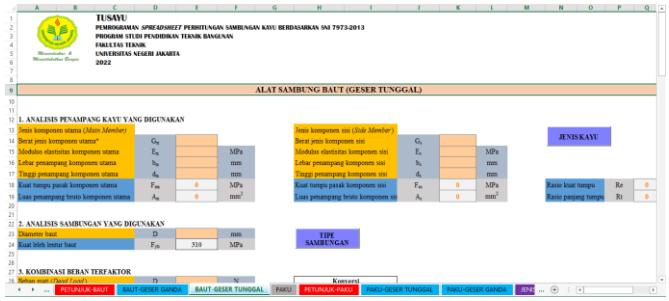

Figure 4. Bolt-Single Shear calculation sheet display

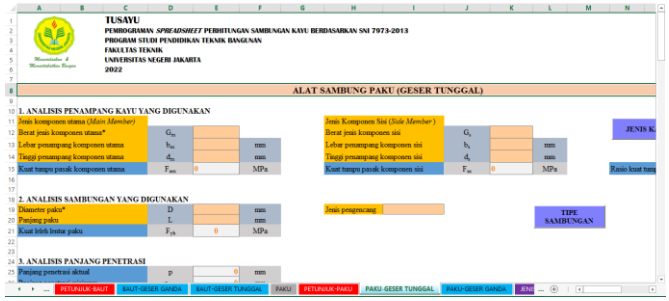

Figure 5. Nail-Single Shear calculation sheet display

Conclusion

This research uses Research and Development (R&D) research methods with stages of Define, Design, and Develop. The research and development carried out resulted in a product design in the form of spreadsheet programming called TUSAYU for the calculation of wood joints in the wood structure course. This

spreadsheet programming can be used to calculate the strength and needs of wood joints with 2 (two) types of mechanical joining tools, namely bolts and nails. The basic calculations used in spreadsheet programming refer to the Semester Learning Plan (RPS) and SNI 7973-2013 concerning Design Specifications for Wood Construction. Based on the product feasibility assessment provided by material experts and media experts, it can be concluded that the resulting spreadsheet programming meets the "Eligible" criteria in terms of material with an average score percentage of 79.6% and meets the "Very Feasible" criteria in terms of media with an average score percentage of 82.8%.

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