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UTILIZING BUILDING INFORMATION MODELLING TECHNOLOGY TO MODELLING ABUTMENT: REVIT

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ABSTRACT

Building Information Modeling (BIM) has transformed the construction industry by offering a robust platform that integrates design, analysis, and construction processes within a single digital environment. This research explores the application of BIM technology, explicitly using Autodesk Revit, in modeling bridge abutments—an essential component in bridge construction that supports and distributes loads from the superstructure to the foundation. The study aims to demonstrate how BIM enhances the efficiency, accuracy, and sustainability of abutment design and construction. The methodology involves a comprehensive review of existing literature on BIM and bridge abutment design, focusing on technological advanceme nts, case studies, and best practices. Additionally, practical implementation of BIM using Revit is conducted to develop detailed 3D models of abutments, incorporating architectural, structural, and geotechnical elements. The benefits of BIM in this context include improved collaboration among multidiscip linary teams, enhanced visualization capabilities for design optimization, and early detection of clashes and constructability issues. The research investigates the integration of Geographic Information Systems (GIS) with BIM to enhance site selection and environmental assessment phases, ensuring informed decision-making throughout the project lifecycle. Innovations in materials science, such as the use of fiber-reinforced polymers (FRP) and ultra-high-performance concrete (UHPC), are also considered for their potential to enhance the durability and longevity of bridge abutments. Ultimately, this study contribut es to advancing the application of BIM in civil engineering, particularly in bridge construction, by showcasing Revit's capabilities in creating accurate, data-rich models that improve project outcomes.

INTRODUCTION

Bridges are crucial connectors between separated roads by rivers, swamps, lakes, straits, canals, railways, and other crossings (B. M. Waruwu, 2022). The need for transportation infrastructure like bridges has grown over time. Bridge construction facilitates mobility from one area to another. Many developed and developing countries construct bridges within their nations. Prestressed bridges have emerged as a significant innovation in structural engineering worldwide. These bridges use tensioned cables to support the bridge's load, creating a strong and durable structure (F. Kurniasari, 2019). Across the globe, prestressed bridges have become impressive landmarks not only for their architectural beauty but also for their construction efficiency. Examples include the Akashi Kaikyo Bridge in Japan and the Golden Gate Bridge in the United States. Technological advancements have significantly influenced bridge planning. Building Information Modeling (BIM) has revolutionized the field by providing a comprehensive platform for integrating design, analysis, and construction processes, enhancing collaboration, improving visualization, and increasing design accuracy (Z. L. Y. Liu and L. C. Peh, 2019). Revit, a popular BIM software, facilitates detailed modeling of bridge components, enabling precise simulations and clash detection (B. Habte and E. Guyo, 2021). Geographic Information Systems (GIS) are also crucial in site selection and environmental assessment phases, allowing engineers to analyze spatial data and optimize routes (A. AlSaggaf and A. Jrade, 2023). Integrating GIS with BIM further enhances decision-making by providing a spatially informed design environment.

In the Asian region, the demand for bridges is essential due to geographic factors. Asia's diverse geography includes numerous large rivers, valleys, and mountains. Countries in Asia require bridge infrastructure to facilitate the movement of people, goods, and vehicles. This varied topography creates a necessity for bridges to overcome natural obstacles. China stands out as the country with the most bridges in Asia, and it even boasts the longest bridge in the world, the Danyang-Kunshan Grand Bridge, spanning an impressive 164 kilometers. As a developing country transitioning towards becoming a developed nation, Indonesia must enhance development across all sectors. Infrastructure development is crucial to a rapidly growing population (D. G. Pandji, 2021). As an archipelagic nation, Indonesia requires bridges to facilitate mobility between regions. Efficient mobility contributes to population distribution and bolsters economic sectors (R. Romizah, 2022).

Along with the extensive construction of new roads in Indonesia, bridge construction often becomes necessary during implementation (P. R. Rangan, 2019). Currently, the longest bridge in Indonesia is the Suramadu Bridge, connecting Surabaya City and Madura Island, which has 5,438 m. In recent years, advancements in computational tools and methodologies have significantly enhanced the design and analysis of bridge abutments. Finite Element Analysis has become a standard technique, allowing engineers to create detailed models that simulate the behavior of complex abutment geometries under various loading conditions. This method improves the accuracy of stress and strain predictions, leading to more optimized and resilient designs. Building Information Modeling (BIM) has also transformed the planning and execution of bridge abutment projects. BIM facilitates the integration of design, analysis, and construction phases, improving stakeholder collaboration and ensuring more accurate and efficient project delivery (P. Piroozfar, 2019).

Innovations in materials and construction techniques have further advanced the field of bridge abutments (J. Zheng, 2022). Using high-performance materials such as fiber-reinforced polymers and ultra-high-performance concrete has developed more robust and durable abutments. These materials offer superior strength-to-weight ratios and enhanced resistance to environmental degradation. Applying prefabrication and modular construction methods has also streamlined the construction process, reducing time and minimizing disruptions. Case studies, such as using precast abutments in accelerated bridge construction projects, demonstrate the effectiveness of these innovative approaches in achieving faster and more reliable construction outcomes. These advancements contribute to more efficient, resilient, and sustainable bridge abutment designs: meters in length and 30 meters in width.

The substructure of a bridge is the most crucial part because of its vital function in transferring the load from the superstructure to the ground (B. Huang, 2022). The substructure ensures the stability and safety of the bridge by preventing shifting, tilting, or collapsing, which can endanger users. By efficiently distributing the load, the substructure helps to avoid excessive pressure on a single point, which could lead to structural failure (M. Ghosn, 2019). Additionally, the substructure is designed to withstand various environmental conditions such as erosion, changes in groundwater, and earthquakes, ensuring the bridge remains functional even when facing extreme ecological changes. Using high-quality materials and proper construction techniques, the substructure provides high durability and longevity, reducing maintenance and repair costs. The substructure is also specifically designed to adapt to local soil conditions, address soil variations, and prevent uneven ground settlement (B. Teodosio, dkk. 2019). Therefore, the planning, design, and construction of a bridge's substructure must be carried out precisely and adhere to strict engineering standards to ensure the bridge's safety and reliability.

Furthermore, BIM advantages continue beyond construction, aiding facility management and maintenance. The digital model is a detailed repository of building information, encompassing equipment specifics, maintenance timetables, and operational data. This information supports proactive maintenance planning and improves operational efficiency by enabling facilities managers to anticipate maintenance needs and optimize building performance over its lifecycle. As BIM technology advances with innovations in interoperability, cloud computing, and artificial intelligence, its role in driving productivity and innovation across the AEC industry is expected to expand, solidifying its position as a foundational tool for modern construction practices (Liu, 2020).

This paper aims to provide information about the research, which focuses on leveraging Building Information Modelling (BIM) technology. Specifically, Autodesk Revit will enhance the design and construction of bridge abutments. Bridge abutments are critical components that support the ends of bridge superstructures and transfer loads to the ground, playing a vital role in structural stability and performance. Traditionally, bridge abutment design relied on 2D drawings and separate engineering disciplines, often resulting in coordination issues and inefficiencies during construction (M. Naji, 2020). Through its integrated 3D modeling capabilities, BIM offers a collaborative platform where architects, engineers, and contractors can work together on a unified digital model. This approach enables real-time visualization, clash detection, and comprehensive analysis of architectural, structural, and geotechnical aspects, improving accuracy, efficiency, and cost-effectiveness in bridge abutment design and construction. By exploring the practical application of Revit in modeling bridge abutments, this study aims to demonstrate how BIM technology can optimize project workflows, enhance decision-making processes, and ultimately contribute to more sustainable and resilient infrastructure development practices in civil engineering.

RESEARCH METHOD

In this research, methods involved gathering information online through Google Scholar and utilizing the Revit application for abutment modeling. The study demonstrates that integrating these approaches significantly enhances the precision and detail in abutment designs. Using Revit, we created highly accurate and detailed models that facilitate improved visualization and simulation of the abutment's performance. Additionally, the wealth of scholarly resources from Google Scholar provided a robust theoretical foundation and supported best practices in BIM technology application. Combining comprehensive online research and advanced modeling tools like Revit has proven an effective strategy for optimizing abutment design in civil engineering projects.

RESULTS AND DISCUSSION

Step Of Modelling

First, the author has to enter the families section and select the template file that is shown in

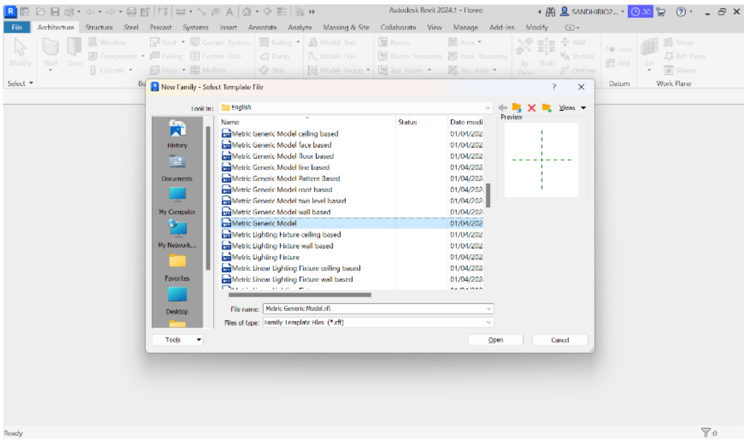

Figure 1. Setting template

Secondly, set up the reference line that will used by using the Reference Plane shown in Figure 2

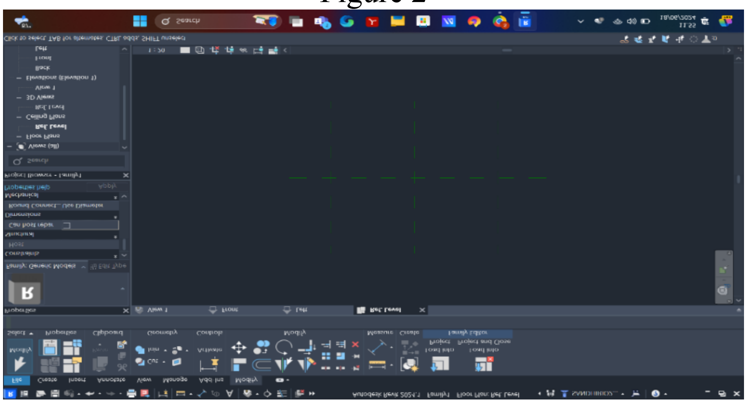

Figure 2. Refference line

The next step is modeling the first base, the first base we can start by going to create, choosing excretion, and selecting the rectangle shown in Figure 3

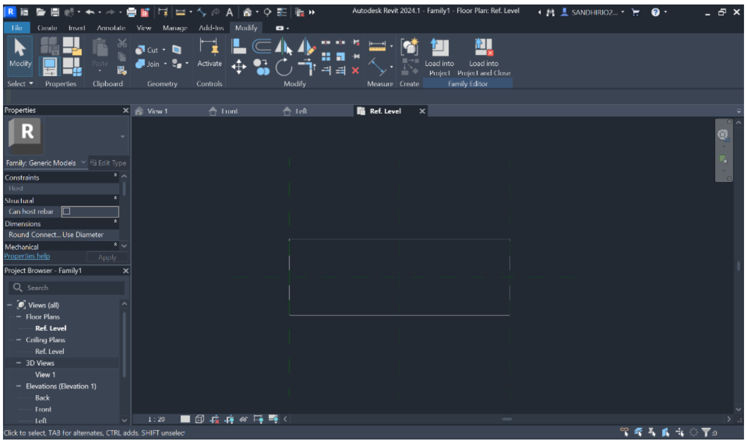

Figure 3. Modeling the First Base

After modeling the second base, we can start to make the second base shown in Figure 4

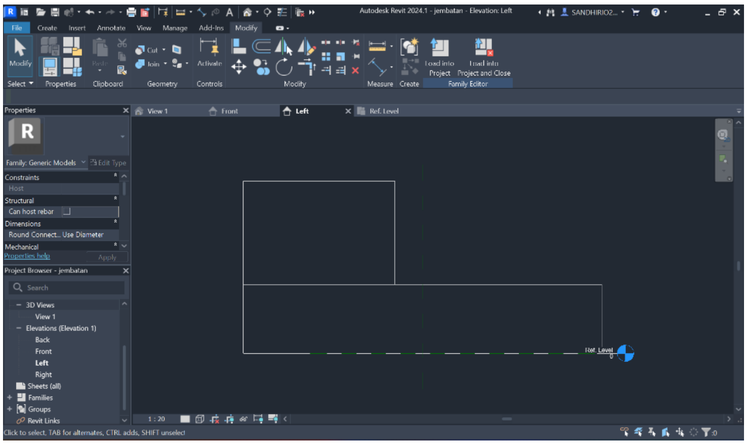

Figure 4. Modeling The Second Base

The next step was adding the material of the abutment at the material browser shown in Figure 5

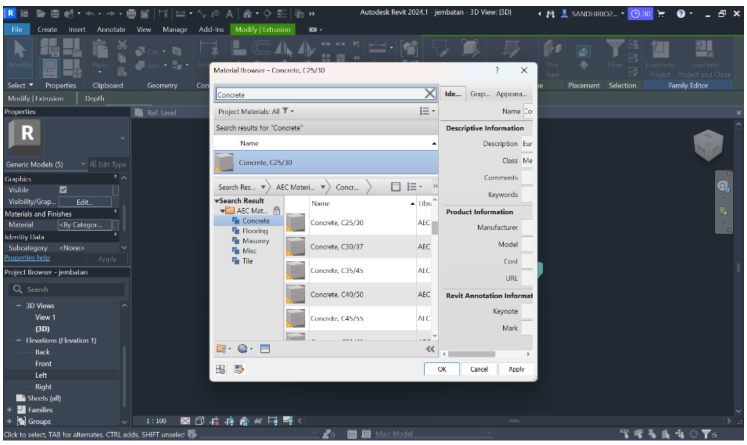

Figure 5. Adding Material

The next step was adding the parameters of the abutment at the material browser shown in Figure 6

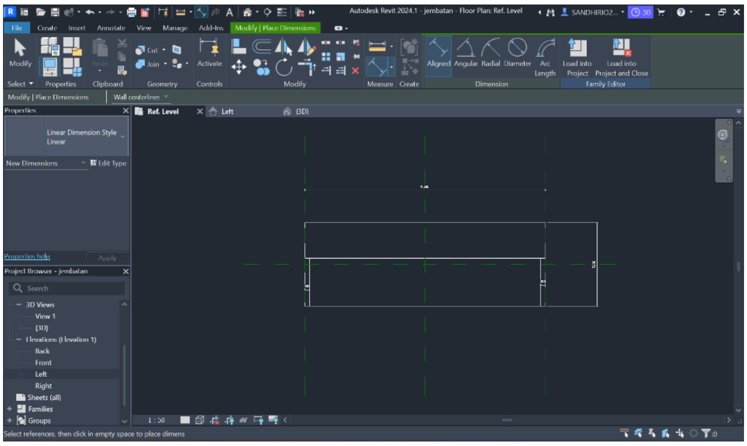

Figure 6. Adding parameters

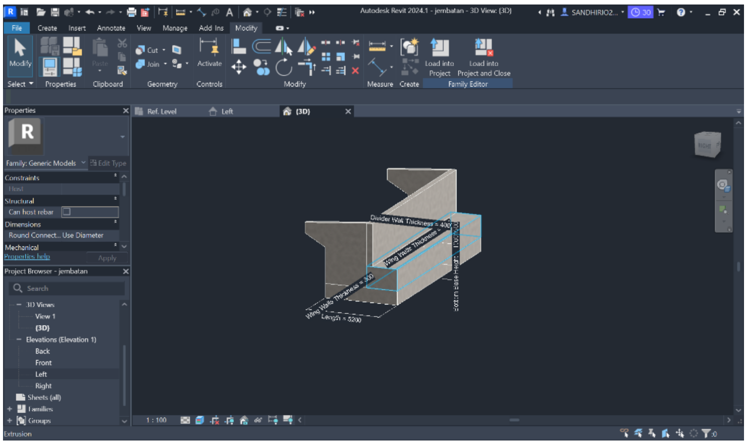

Figure 7. Adding to The Project Template

View Of Abutment Model

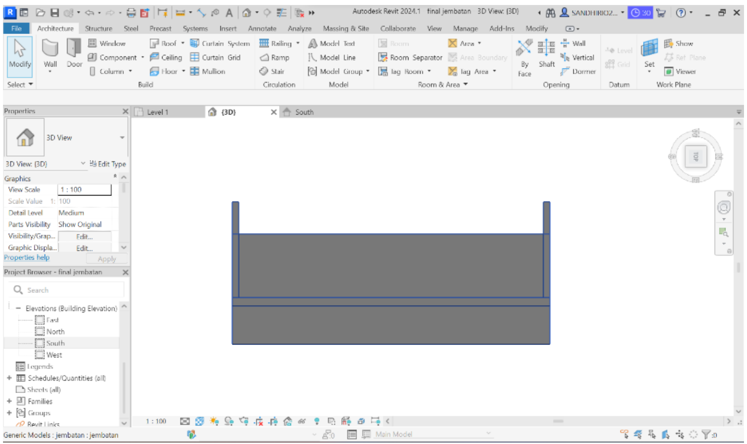

Figure 8. Top View

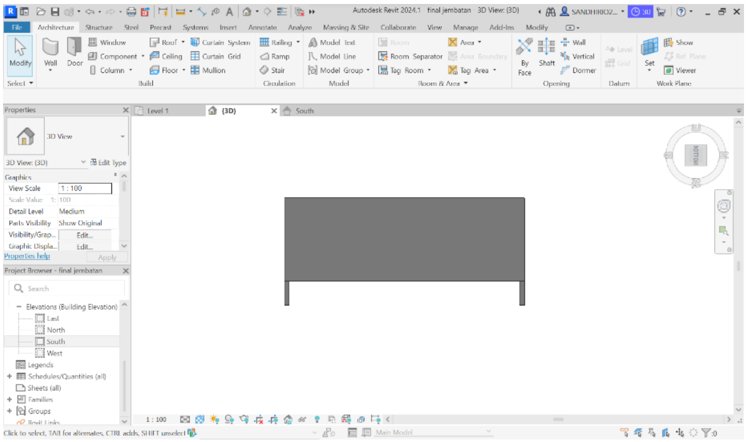

Figure 9. Bottom View

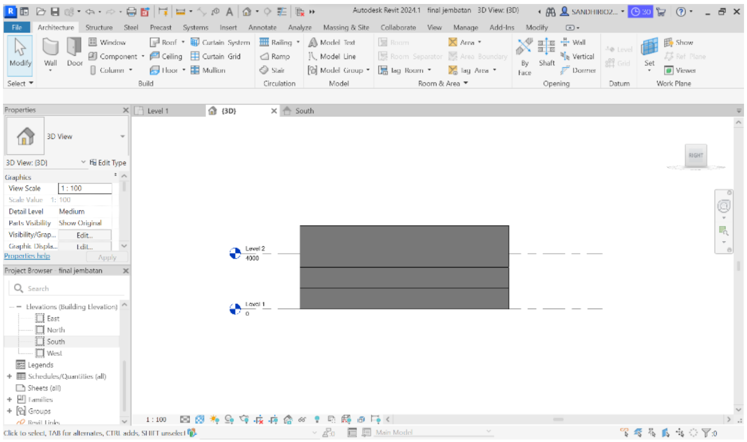

Figure 10. Front View

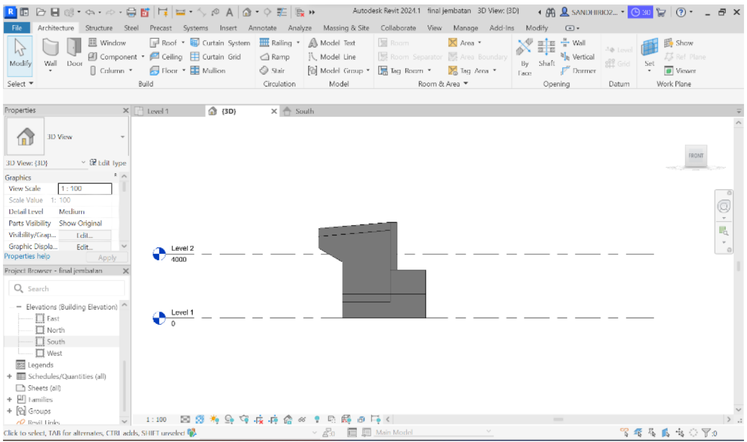

Figure 11. Side View

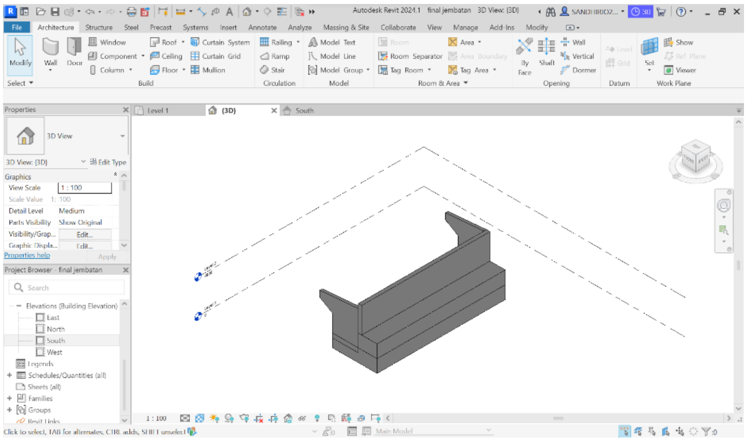

Figure 12. Side Top View

CONCLUSION

Integrating Building Information Modelling (BIM) technology, specifically through Revit, has revolutionized the modeling of abutments in civil engineering. This research demonstrates that Revit significantly enhances the accuracy and detail of abutment models, ensuring precise geometric and material representation. Additionally, BIM technology facilitates seamless collaboration among stakeholders, leading to early identification and resolution of potential issues, which reduces costly modifications during construction. Revit's automated processes improve efficiency in quantity take-offs, cost estimations, and scheduling tasks. At the same time, its advanced visualization and simulation capabilities provide comprehensive insights into the abutment's performance under various conditions. Adopting BIM with Revit in abutment modeling offers substantial benefits, promoting more accurate, efficient, and collaborative project execution and heralding a new era of innovation and resilience in infrastructure development.

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