



## DEFLECTION ANALYSIS OF THE BUILDING STRUCTURE USING BUILDING INFORMATION MODELING (Case Study: Green House Display BRIN Cibinong Bogor)

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### Abstract

*The National Research and Innovation Agency (BRIN) is currently carrying out the construction of research facilities in various regions in Indonesia, one of which is the construction of the Green House Display Facility Infrastructure located in the Cibinong Science Center and Botanical Garden (CSC-BG-LIPI) area. This study aims to model the structural elements of the BRIN Cibinong Bogor Green House Display building and conduct structural analysis of columns (K10, K11, K12) and beams (B3, B4, B10, B13, BP1, BP2) using Tekla Structures 21 and Tekla Structural Designer 21. The result of this research is that the modeling of structural elements can be done well and in detail, for example, there are no structural components that have clashes. The largest maximum deflection occurs in beam B4 which is 0.004921 m. Based on the deflection calculation in article 24.2 of SNI 2847:2019, the maximum permit deflection value is 0.0125 m. This shows that all beams and columns analyzed meet the maximum allowable deflection requirements based on SNI 1726:2019 and SNI 2847:2019.*

**Keyword:** Green House, Building Information Modeling, Curved Beam, Tekla Structures, Tekla Structural Designer.

### INTRODUCTION

The National Research and Innovation Agency (BRIN) is currently carrying out the construction of research facilities in various regions in Indonesia, one of which is the construction of the Green House Display Infrastructure Facility which is located in the Cibinong Science Center and Botanical Garden (CSC-BG-LIPI) area, Jl. Raya Bogor Km. 46 Cibinong, Bogor Regency, West Java. The construction of this green house is the first in Indonesia which aims to facilitate the development of technology related to the agricultural, forestry and environmental sectors. The green house display will introduce potential plants from various regions in Indonesia. The construction of the BRIN Cibinong Green House Display began in September 2021 with a total building area of around 10,000 square meters. The scope of the green house consists of one unit of small green house with a diameter of about 20 meters, five units of greenhouses with a diameter of about 30 meters, and one main unit of green house with a diameter of about 35 meters with a reinforced concrete structure as the main building structure and a steel structure as the structure. rooftop. The construction of this green house has its own level of difficulty and uniqueness, in addition to the shape of the roof which resembles a dome (dome) also has curvature with different radii.

Various kinds of conflicts in the world of construction generally occur due to misunderstanding or misunderstanding among stakeholders, lack of coordination, lack of funds, lack of time, and so on. Construction projects become easier, faster and of higher quality if the use of information and communication technology is included in them. Current technological developments have succeeded in finding a new technological breakthrough called Building Information Modeling (BIM). Building Information Modeling (BIM) is a set of technologies, processes, methods and policies that are partly or wholly run collaboratively and integrated in a digital model. BIM uses 3D, real-time, and dynamic modeling software to increase effectiveness and productivity in building design and construction. Therefore, it contains all the information about these building elements which are used as a basis for decision making during the life cycle of the building, from concept to demolition [11]. BIM used as a

mediating artifact in synchronous communication options, provides much more effective communication than other types of synchronous communication. BIM as a documentation option in the construction process is superior to other types of media, because BIM has higher accuracy and is able to document something at the same time [24].

Tekla Structures 21 is Building Information Modeling (BIM) based software that can help users model and plan work in more detail and accurately. Tekla software is a new breakthrough in the field of civil engineering and engineering that makes it possible to create and manage data accurately and in detail, and can create 3D models of buildings without neglecting complex materials and structures [7]. Tekla Structures 21 can cover the entire building construction process from concept design, fabrication, execution, construction management, to maintenance of the building itself.

In this final project, the authors carried out 3D and 4D structural modeling of the structural work of the Cibinong-Bogor Green House Display Green House Display using a Building Information Modeling (BIM) based method using Tekla Structures 21 software. Building structure modeling in this study was divided into three modeling stages namely modeling of the lower structure of the building, modeling of the superstructure of the building and modeling of the roof structure of the building. Substructure modeling consists of modeling piles, pile caps, tie beams, and walls. Modeling of the upper structure consists of modeling the structures of columns, beams, slabs and pedestal columns. Modeling of the roof structure consists of modeling the dome roof truss, skylight roof truss, and APG dome roof truss. Structural analysis was performed only on column structures (K9, K10, K11, K12) and beams (B3, B4, B10, B13, BP, BP2).

## **METHOD**

The flow of research methods used in this study can be seen in the following figure:

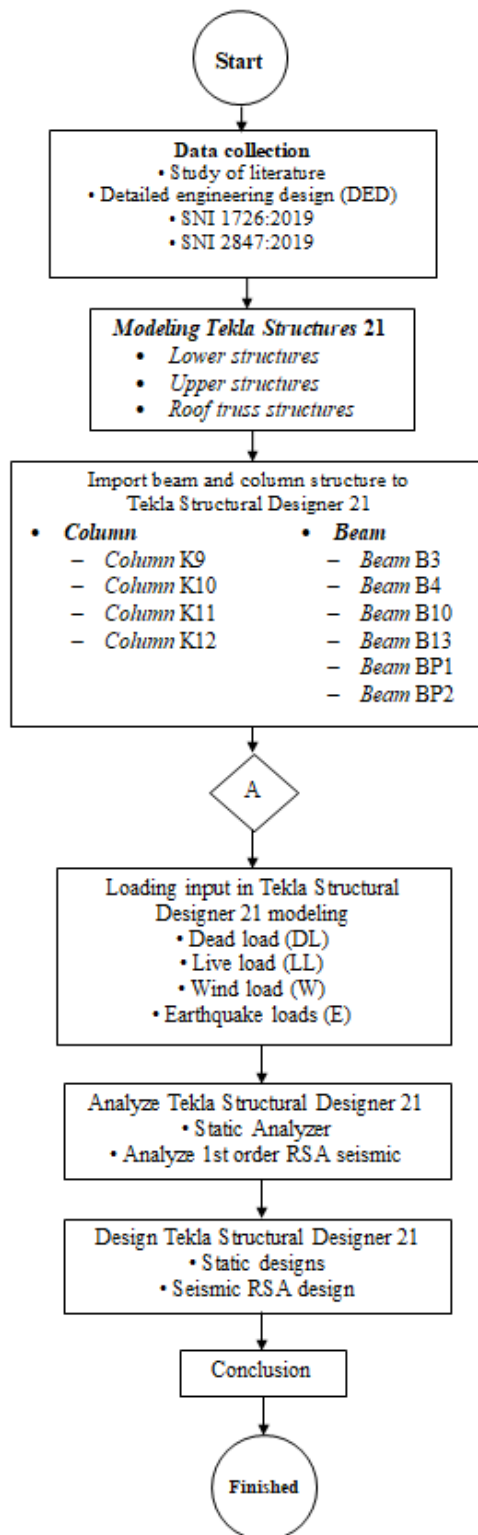


Figure 1. Flow of Research Methods

This research begins by collecting the necessary data, namely Detail Engineering Design (DED). After the data is obtained, a literature study will be carried out from journals, books, regulations, previous research, and studying information related to the building that is the object of research. The quality of the concrete used is  $f_c$  30 MPa and the quality of steel reinforcement is  $f_y$  420 MPa.

Modeling was carried out on all structural elements of the BRIN Cibinong Bogor Green House Display building using Tekla Structures 2021 software. Structural analysis was only carried out on columns (K9, K10, K11, K12) and beams (B3, B4, B10, B13, BP, BP2) using Tekla Structural Designer software 2021.

The calculation of loading refers to SNI 1727:2018. The loads that will be applied are dead loads, live loads, and earthquake loads. The self-weight of structural elements is calculated automatically by the Tekla Structural Designer 21 program. Earthquake loads on Tekla Structural Designer 21 are modeled using the Seismic Wizard. The information entered is in the form of spectrum response parameter data obtained from the puskim.com website which refers to SNI regulations 1726: 2019.

The need for technology in the construction industry, especially in infrastructure projects, is unavoidable considering that coordination between the parties involved is a must and currently almost all fields of work have been automated using software including Architecture, Engineering and Construction [7]. BIM can help stakeholders in construction projects to control conflicts in the early stages of construction and minimize disputes proactively [3]. The BIM methodology seeks to integrate the processes and professionals involved in engineering tasks by working on a coordinated and intelligent 3D virtual modeling platform [14].

As a technology that is quite important in the innovative development of the construction industry, Building Information Modeling (BIM) is widely adopted from the design, construction, to building operations [29]. BIM is a new approach that includes the stages of designing and creating building assets through 3D representation of physical and functional attributes [11].

## RESULTS AND DISCUSSION

Modeling building objects in 3D using the Tekla Structure Application is divided into 2 main parts, which include the lower structure and the superstructure. Modeling is done by making structural elements along with reinforcement details for each structural element. The results of object modeling that has been done in this study are as follows:

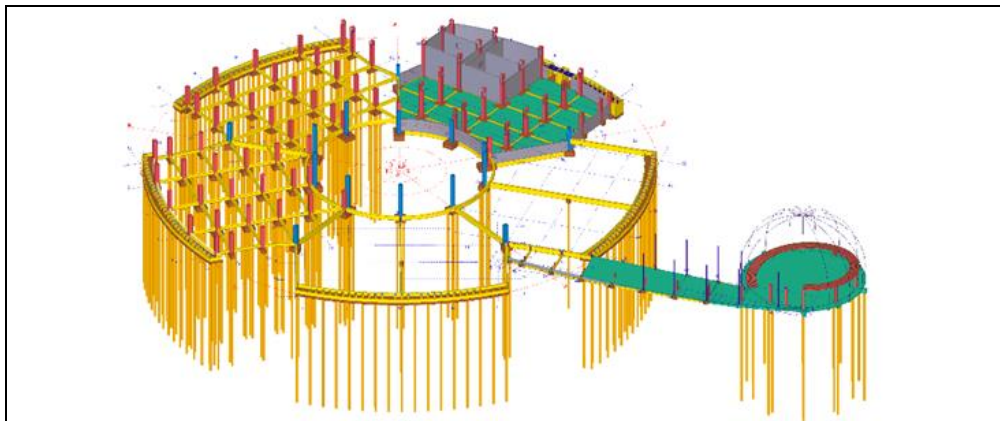


Figure 2. Modeling of the Lower Structure

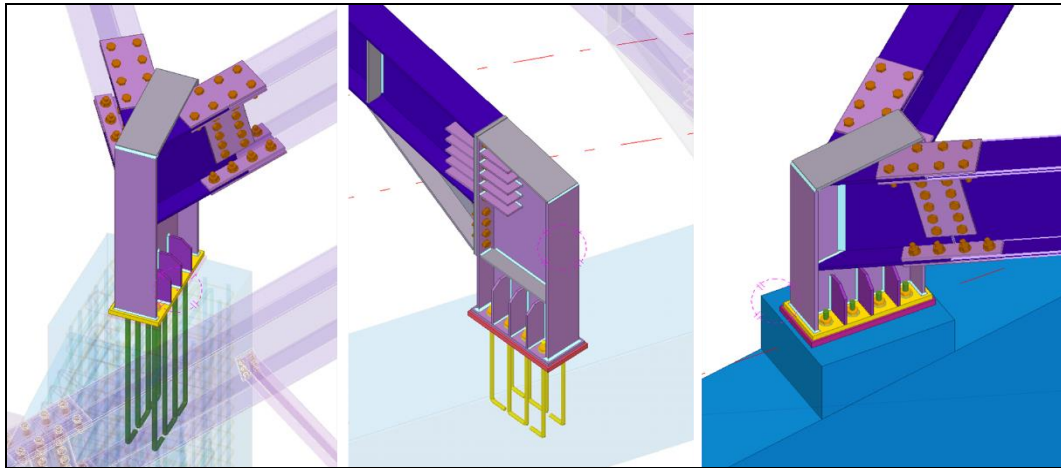


Figure 3. Roof Truss Modeling

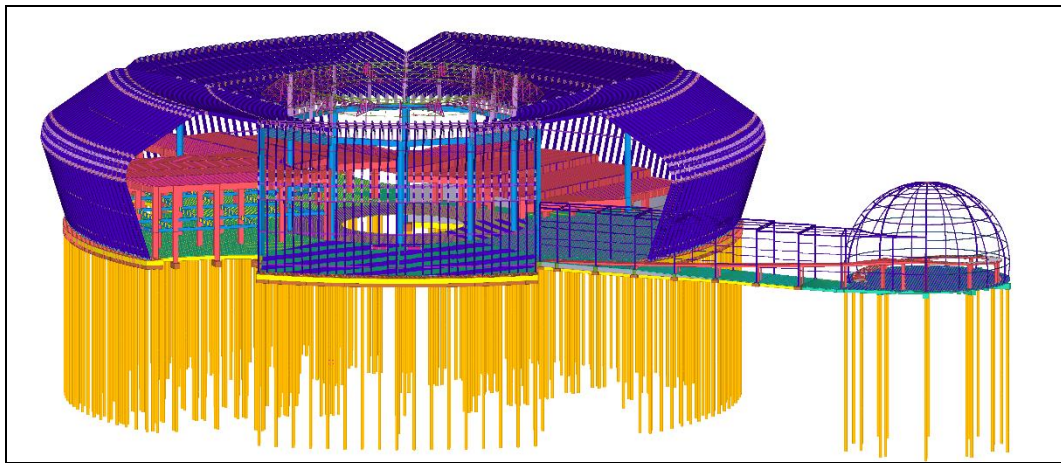


Figure 4. Overall Model

This study analyzed column and beam structures using the Tekla Structural Designer 21 software. Due to time limitations, the structures analyzed were column structures (K9, K10, K11, K12), and beam structures (B3, B4, B10, B13, BP1, BP2).

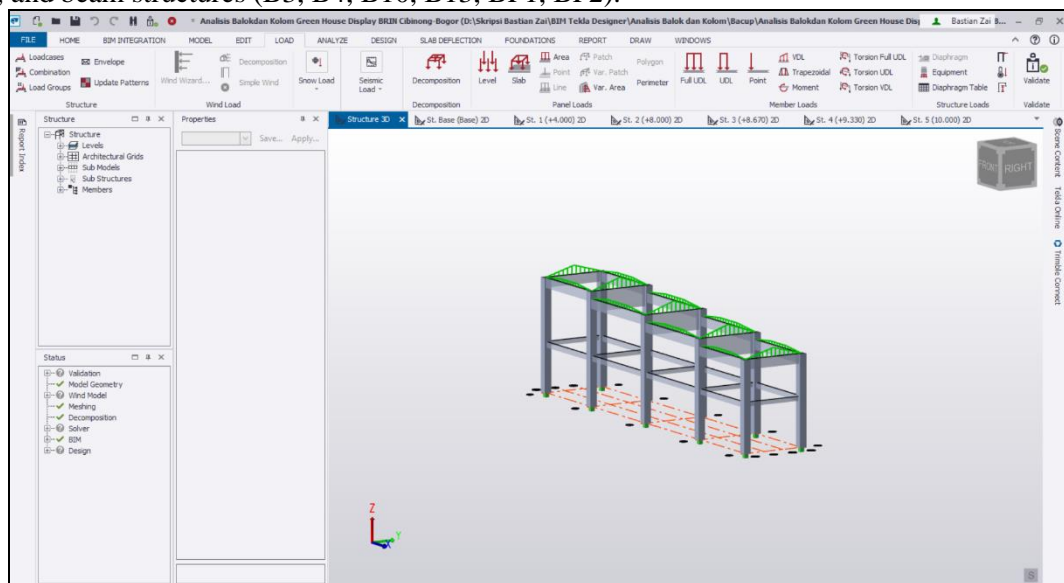


Figure 5 Beam and Column Modeling in Tekla Structural Designer 21

The results of the analysis using the Tekla Structural Designer 21 software show that all columns have a size of 700x700 mm with main reinforcement 16D25 D13-100 mm stirrup reinforcement and hooked reinforcement 90° 2D13-100 mm. Beams B3 and B4 have a size of 500x900 mm with reinforcement in the area of top bars 10D25, bottom bars 5D25 stirrup 2D10-100 mm, reinforcement in field area top bars 5D25 bottom bars 10D25 stirrup 2D10-150 mm, and side bars 4D10. Beam B10 has a size of 600x900 mm with the same reinforcement system as beams B3 and B4. Beam B13 has a size of 450x1900 mm with reinforcement in the area of support top bars 8D25 bottom bars 4D25 stirrup 2D13-100 mm, reinforcement in field area top bars 4D25 bottom bars 8D25 stirrup 2D13-150 mm, and side bars 10D10. BP1 beam has a size of 300x400 mm with the main reinforcement 5D19 stirrup D10-150 mm for the support area and D10-200 mm for the field area. BP2 beam has a size of 300x500 mm with main reinforcement 5D19 stirrup D10-150 mm for support area and D10-200 mm for field area and 2D10 for side bar.

From the results of the analysis using Tekla Structural Designer 21, the maximum deflection values for each beam were obtained, including beams BP1 0.00066 m, BP2 0.003083 m, B3 0.003774 m, B4 0.004921 m, B10 0.002453 m, and B13 0.000805 m. The biggest maximum deflection occurs in beam B4 which is 0.004921 m. Based on the deflection calculation in article 24.2 of SNI 2847:2019, the maximum allowable deflection value is 0.0125 m. This shows that all the beams analyzed meet the maximum allowable deflection requirements based on SNI 2847:2019.

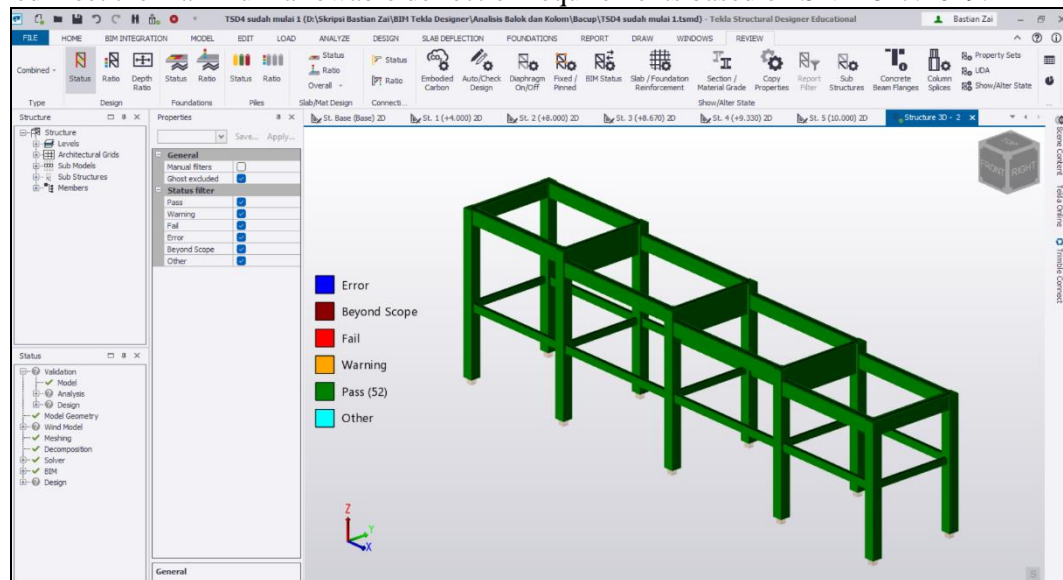


Figure 6 Analysis and design - pass status

## CONCLUSION

1. After modeling the structure of the Green House Display building BRIN Cibinong Bogor based on Building Information Modeling (BIM) using Tekla Structures 21 software, it can be concluded that 3D BIM modeling of structural elements can be carried out properly and in detail, for example there are no structural components that experience clashes. Tekla Structures 21 can manage revisions or changes to the model automatically so that users do not need to check the details of the model repeatedly. Through BIM 4D, all activity progress during the project period can be monitored and visualized so that it is more optimal.
2. BIM-based evaluation of column structures (K10, K11, K12) and beam structures (B3, B4, B10, B13, BP1, BP2) of the BRIN Cibinong Bogor Green House Display building using Tekla Structural Designer 21 software, the largest maximum deflection occurs in beam B4 is 0.004921 m. Based on the deflection calculation in article 24.2 of SNI 2847:2019, the maximum allowable deflection value is 0.0125 m. This shows that all the beams and columns analyzed meet the maximum allowable deflection requirements based on SNI 1726:2019 and SNI 2847:2019.

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