Structural performance evaluation based on the bridge Digital Twin developed by the Building Information Modeling Technology

山口大学大学院　学生会員　○Elfrido Elias Tita　山口大学大学院　正会員　渡邊　学歩
山口大学大学院　非会員　Shao Peilun　(株) 長大　正会員　有井　賢次

1. Introduction

Digital Twin (DT) based on Building Information Modeling (BIM) is an innovative technology in the architects, engineers, and construction industry (AEC) these days. It can switch construction design from traditional to new methods, which allows the designing processes to be more efficient, low-cost, and high productivity. BIM is an essential technology in managing whole processes in the project life cycle from design, build, operation and Maintenance (see Fig. 1). In this study, a DT based on BIM technology is conducted to replicate a PC box girder bridge of Comoro in Dili City, Timor Leste. Following, the model is used for interoperability with FEA in order to evaluate detailed stress distribution and the Shear lag effects phenomena on the PC box girder bridge.

2. Case Study: PC Box Girder of Comoro

Comoro Bridge is a PC Box Girder Bridge located in Dili city; Timor-Leste as shown in Photo 1. The bridge was constructed in 2018, which connected the west and east of Dili. Its length is 250m, and its width is 11.5m. The bridge consisted of 6 spans = 35m + 4@45m+ 35m that lay over the Comoro River.

3. Development of Digital Twin bridges based on BIM.

The development of DT based on BIM in this study proceeds as shown in Fig.2. Which is used to model the PC Box girder bridge of Comoro. The modeling processes are as follows; (1) Data sources. Due to the existing bridge, it is necessary to have the bridge information and documents such as the design report and construction drawings. (2) BIM tool. The substructure and superstructure components are developed in BIM Revit Families and integrated in the BIM Revit project for creating the whole bridge model.

4. Evaluation of the Shear Lag Effect

After the DT bridge model is developed in BIM; subsequently, it can be integrated into FE analysis as shown in

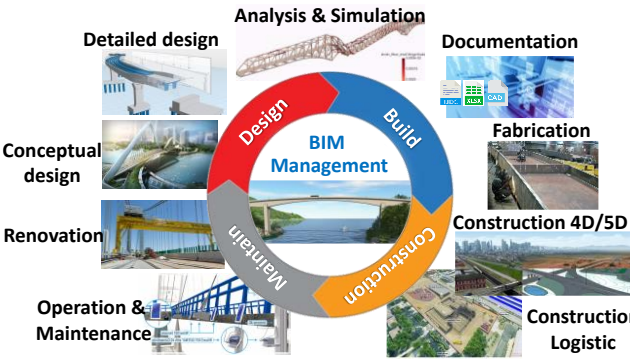


Fig.1. BIM Management Process

Photo.1. Target Bridge

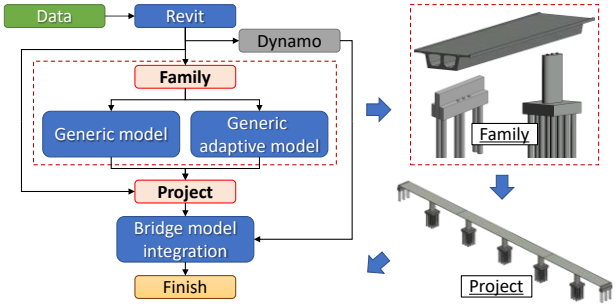


Fig.2. BIM Production Workflow & 3D Bridge Model.

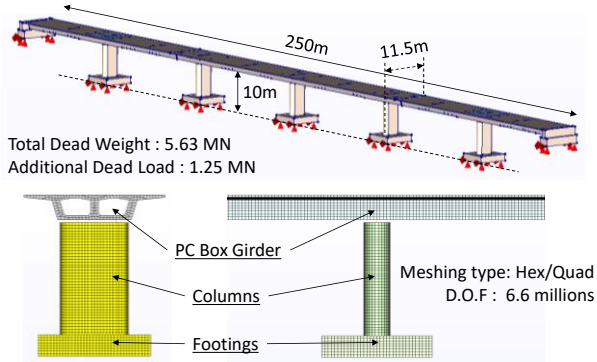


Fig.3. Comoro Bridge FEA Model.

キーワード　Digital Twin, BIM, Bridge, Verification, Shear Lag Effect
連絡先　〒755-0097 宇部市常盤台 2 丁目 16-1　山口大学工学部　創成科学研究科
山口大学工学部　創成科学研究科 TEL0836-85-9302

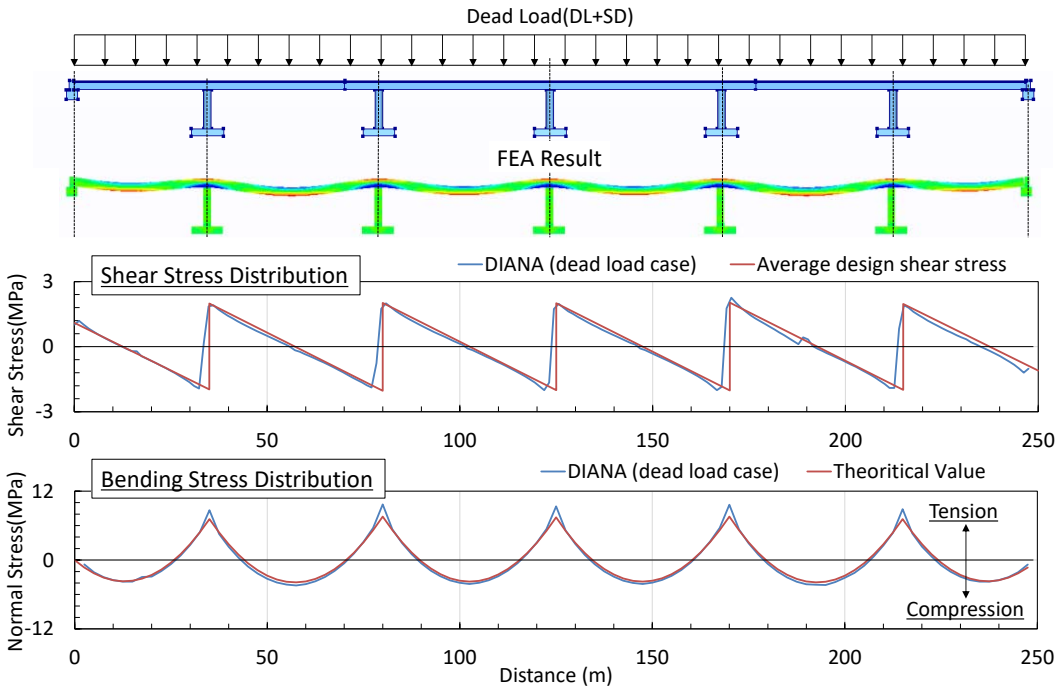
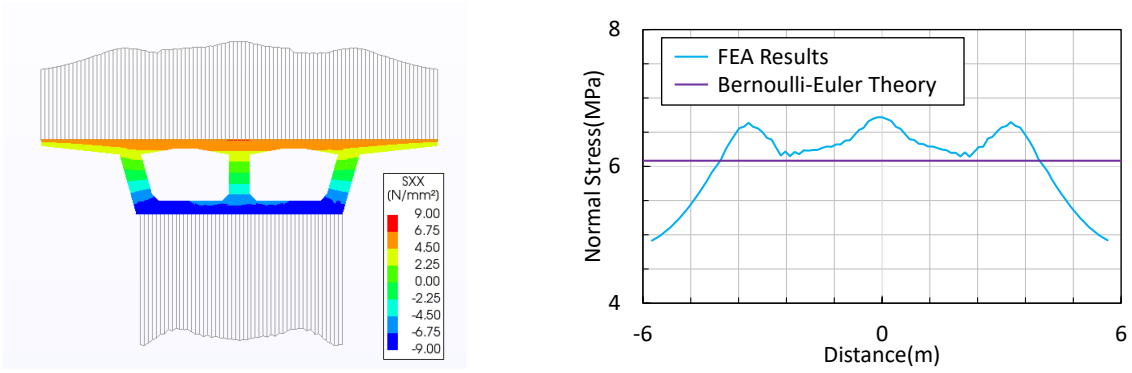


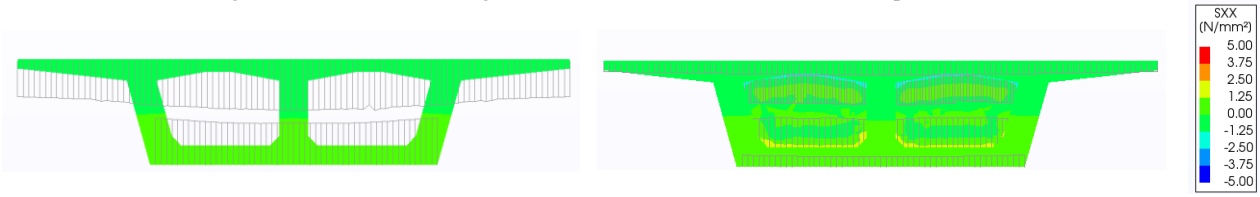
Fig.4. Verification of the Structural Model by the FEA



(a) Contour Map of the Normal Stress Distribution

(b) Normal Stress Distribution at the Top flange

Fig.5. The Effect of Shear Lag on the Normal Stress Distribution at the Top of the Column P3



(a) L/4 away from Pier 3

(b) Mid Span

Fig.6. The Effect of Shear Lag on the Normal Stress Distribution at the L/4 away from Pier 3 & Mid Span

Fig.3. Thereafter, the bridge model is used to conduct the finite element analysis in order to evaluate the stresses due to the dead load effect on the structure as shown in Fig.4. Finally, the shear lag effect phenomenon in PC box girder sections can be evaluated as well. Then, the results show that the shear lag effect highly occurred at the location of the piers, and it reduces linearly towards the mid-span as shown in Fig.6.

5. Conclusion

1) Digital twin based on BIM is a cutting-edge technology in the AEC industry that can be changed the traditional method, enhances productivity, and increases competitiveness.

2) The Digital twin model can be integrated with Finite Element analysis for evaluating the detailed stress distribution and the Shear lag effect on the PC Box Girder of Comoro.