

# A NOVEL BIM OPENSOURCE PLATFORM TO SUPPORT DESIGN AND MAINTENANCE OF MARITIME STRUCTURES

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## INTRODUCTION

In the last years, BIM methodology has been particularly used in the buildings and civil infrastructures fields such as bridges, roads, and railways design and maintenance.

The same cannot be said regarding maritime infrastructures, i.e. for design and maintenance of harbor and coastal structures.

The Standard-definition provided by U.S. National BIM can be recalled to better understand BIM's potentialities in maritime infrastructure design and maintenance: *"BIM, Building Information Modeling is the digital representation of physical and functional characteristics of a facility creating a shared knowledge resource for information about it and forming a reliable basis for decisions during its lifecycle, from the earliest conception to demolition"* (Deshpande et al., 2018). It is clear that the model is much more than a simple (geometrical) 3D model and that its usage can be extended to whatever the "facility". Indeed, in a BIM model, different models can be implemented, from financial ones to geometry or graphical ones. In other words, every project generates a flow of information that is shared by the design teams and other stakeholders over the whole lifecycle of the facility.

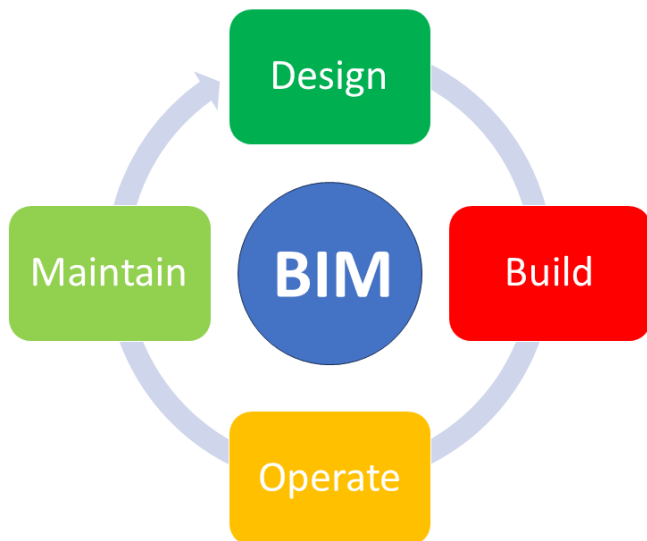


Figure 1 - BIM process

Figure 1 depicts the whole BIM process, from the design-

to the maintenance stage of the facility. Basically, the process begins with creating an intelligent 3D model, subsequently used to facilitate coordination, simulation, visualization, and management of construction projects.

To make the model interactive, the components used to develop a BIM model must have parametric relationships with each other. In this way, any modification in shape, cost, or whatever properties change automatically throughout the whole model. The resulting models are either 4D or 5D containing all the information, from construction information to costs.

The BIM process doesn't end with construction but lasts until the end of the asset's lifecycle. Indeed, the methodology is applied also to infrastructure management.

Thus, BIM allows easier communication among the different people who are part of the project, furthermore, it allows for a reduction of design mistakes and therefore reduces costs.

Maritime structures have two main problems in a BIM process, i.e. geometric and informative issues.

The work of Valdepena et al. (2020) describes a new methodology for Port management that combines conventional methods with new technology with the aim of building up a database for the maintenance of port infrastructure. However, the proposed method focuses just on the whole ports without specific reference to the details of the single components at the small scale (informative issue).

The geometric issue regards the modeling of elements on a small scale. For instance, for the description of rubble mound structures, informative issues are related to the "family" and the class the elements belong to. Indeed, there are no classes and families for elements of maritime structures.

For these and other aspects, the development of BIM methodology related to maritime infrastructures seems to be needed.

## AIM AND PRELIMINARY RESULTS

This research study aims to improve the BIM methodology and to develop an open-source platform to support the design and maintenance of maritime infrastructures.

The methodology follows the same BIM process for

buildings and civil infrastructures. As a result, the main outcome of the study is an open-source platform to develop BIM models of maritime infrastructures.

Blender is proposed to be used in this work. It is an open-source modeling software that has a BIM add-on useful for developing different projects. Among the several reasons that have driven this choice is that Blender makes it possible to assign to the different elements their physical properties (i.e. mass, etc...).

The study case presented in this work is related to the design of the 2D experimental investigation of the extension of the southern quay at Ortona Port (Middle Adriatic Sea, Italy). The work has been developed by modeling the wave flume and one of the tested configurations concerning the trunk section of the breakwater.

Figure 2 shows different layers of the investigated rubble mound breakwater. In the last one, the deployed accropodes® are visible. The “design” installation follows the standard procedure for this kind of artificial unit, which has been implemented in Blender by using Python scripting.

Figure 3 shows the final configuration of the armor layer. Of course, the proposed method can be applied to different kinds of artificial units. Just as an example, Figure 4 shows the layer armored with tetrapods in its final configuration.

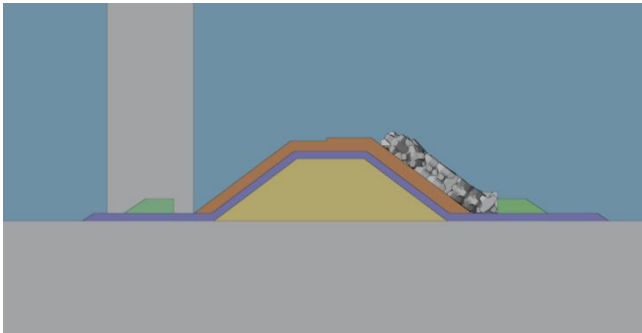


Figure 2 - Blender model

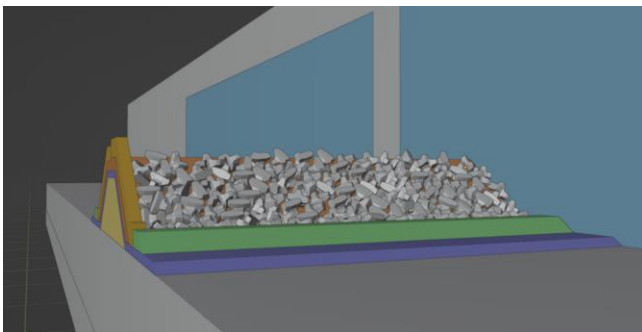


Figure 3 - Accropodes® armor layer

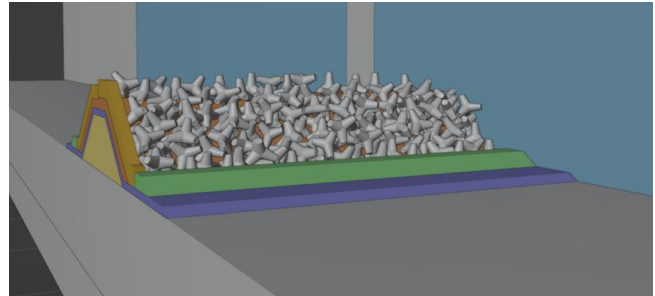


Figure 4 - Tetrapods armor layer

Each unit of the armor has its properties, as well as the other elements of the model. For each single element the informative layer has been applied (see Table 1).

Parameter	Data Type	Example
Type	String	Artificial
Subtype	String	Accropode®
Volume	Float number (m <sup>3</sup> )	8.00
Material	String	Concrete
Material class	String	C30/35
Cost	Float number (€)	400
Manufacturer	String	Llam
Fabrication	Date string	2023.08.03
Method of fabrication	String	....
Epoch of deployment	Date string	2023.09.24
Programmed Maintenance	Date string	2033.09.24
Last maintained	Date string	2023.09.24

Table 1 - Armor properties

Furthermore, the informative layer can be associated with geometric properties and potentially updating itself with them. These are the advantages of parametric modeling.

Preliminary results show the strengths of the proposed method. Further application examples will be illustrated at the conference.

#### REFERENCES

Deshpande (2018): Building Information Modeling (BIM) for infrastructure - Thinking beyond today.

P. Valdepenas, M. D. Esteban Perez, C. Henche, R. Rodriguez-Escribano, G. Fernandez, J. Lopez-Gutierrez (2020): Application of the BIM method in the management of the maintenance in Port infrastructure