Miter gates and footbridge design

Group 27
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Introduction

Inland waterway transport has become very important for the economy of many regions in The Netherlands. This is the case of the Eefde lock which was built in 1993 and declared National Monument in 2003. However, the current lock is not able to cope with the increasing demand for the ships. This makes the current waiting time to be more than 30 minutes, which is a lot for a vessel. Therefore, it was decided to construct a second lock chamber next to the old one.
The main objective was to design a convenient, safe, efficient and sustainable system which will function in a fully energy-neutral manner.

Design Method and Strategy

- Nigel Cross method

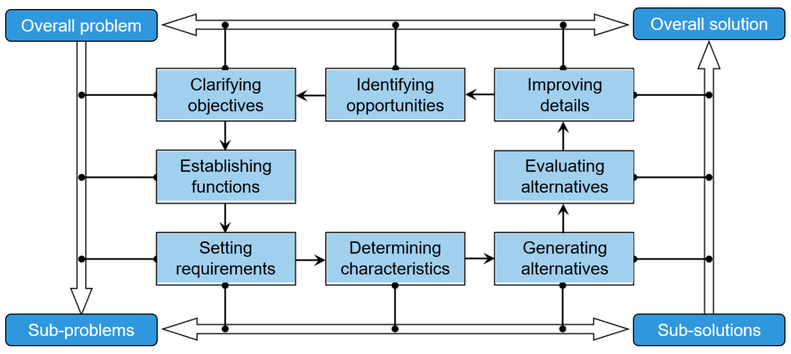

Figure 1. Schematization of Nigel Cross method

- The design process followed the Nigel Cross method is an integrated model and considers the overall problem. That problem is subdivided into sub-problems which will have sub-solutions. In the end, the sub-solutions are part of one big solution, which should be able to solve the presented problem.

Structural Mechanics

- Design of miter gates and pedestrian bridge made of steel

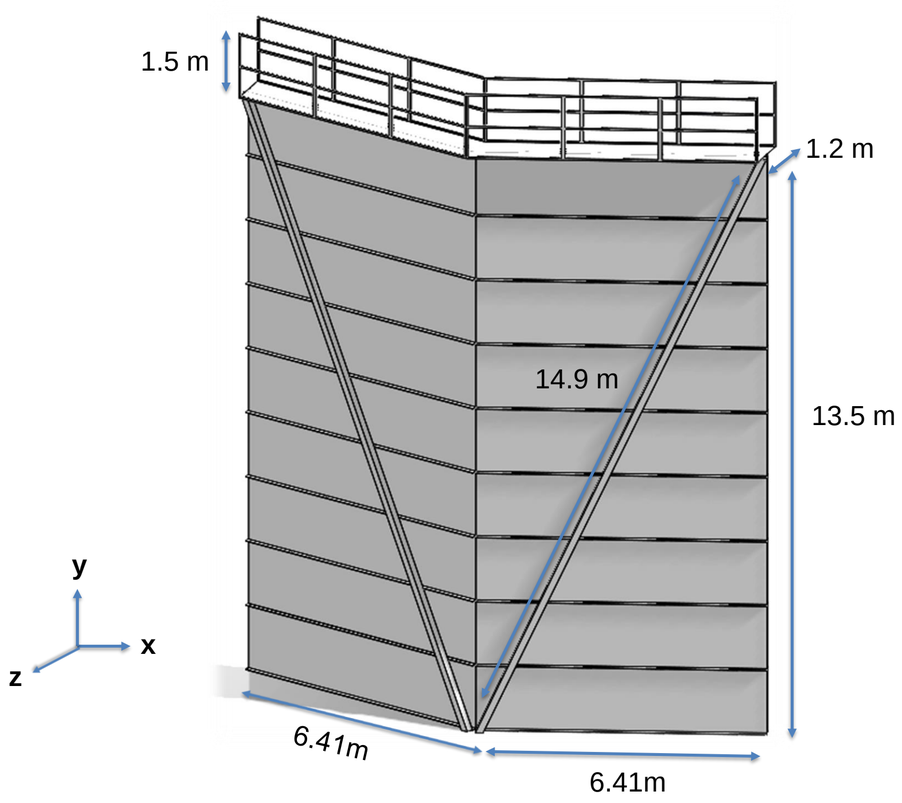

Figure 2. Final structural design

- Connections

  Bolted Connection made between the beam of the footbridge and the beam of the miter gate.

  Welded Connection made between the beams and the plate of the bridge.

Environmental and Economic Sustainability

Life Cycle Assessment (LCA) method was used to evaluate the environmental and economic impact of three miter gates made of steel, timber and concrete; this method is based on the scheme of International Organization for Standardization (ISO) 14040 and 14044.

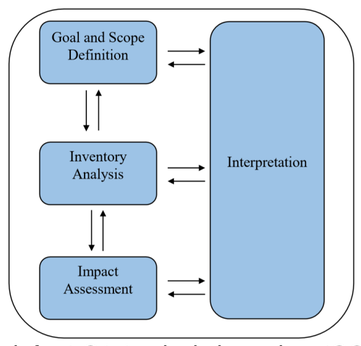

Figure 3. Framework for LCA Analysis based on ISO 14040, 14044

Environmental

-The Life Cycle Impact Assessment (LCIA) was done using GaBi software to model the life cycle for each miter gate.
-The analysis of results was done with CML 2001 method in which four impact categories were analysed to know which alternative is the best, giving as result steel miter gates which has a less environmental impact.

Economic

-Cost break down structure that represents the different costs that will be involved during the Life Cycle of each miter gate.
-An excel sheet was used to calculate the Life Cycle Cost (LCC) and Net Present Value (NPV) of each alternative. Giving as result timber gates that have fewer costs during their entire life cycle.

Social Sustainability

Social Sustainability is referred to as the commitment among the involved people in the project to meet the needs of the current and future society (Vallance, Perkins, & Dixon, 2011). For this purpose, the first five steps of Ravesteijn's RRI framework were applied to the Eefde lock project. The rights and needs of the least well-off and future generations were considered. The acquired knowledge was applied in the design of the Eefde lock:

- Along with the stakeholder analysis.
- Landscape plan to improve the recreation and environment around the lock.
- Safety and sustainability were important criteria in order to select the best alternative for the design.
- LCA realized in order to reduce the environmental impacts for present and future generations.
- For the energy in the built environment, the sustainability and nuisance for the people were important criteria in order to select the most suitable energy technology.

Energy Use in the Built Environment

- It was aimed to make the lock system completely energy neutral
- The total energy demand was equal to 7962.96 kWh/year
- Three renewable energy technologies were considered: photovoltaics, wind turbine and bulb turbine. After doing a multicriteria analysis by considering them it resulted that the most optimal energy technology is a wind turbine which will be used to supply the total energy demand of the lock

Conclusion

All the different parts were integrated together which resulted in a stable, safe, convenient, sustainable, efficient and energy-neutral system, satisfying the main objective of this project. In addition, it was proved that steel miter gates are the most optimal in terms of sustainability and wind turbines will supply the energy generated by it.

References

Vallance, S., Perkins, H., & Dixon, J. (2011). What is social sustainability? A clarification of concepts. Geoforum, 342-348. Retrieved from https://reader.elsevier.com/reader/sd/pii/S0016718511000042?token=D60961F3FAE9399F1FACB203B1926F9286AF27ABF5AF5F78FA14C700EC135037FDC3C0367D1ABC8E329B28C361310B4 0

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