

# Portfolio M. Zwaneburg

PORTFOLIO OF GRADUATION INTERNSHIP AT HILLEBRAND

MICHIEL ZWANENBURG

<b>General Information</b>	
<b>Document</b>	<b>Portfolio - Graduation Internship</b>
Date	17/06/2022
Student Name	Michiel Zwanenburg
Student Nr.	00078232
University	HZ University of Applied Sciences
Education	Civil Engineering
1 <sup>st</sup> Examiner / Supervisor	Repko, A.
2 <sup>nd</sup> Examiner	Ansiliero de Oliveira Coelho, M.
Company	ASK Romein Hillebrand
In-Company Supervisor	Deckers, D.

Contents

- 1 Internship Company ..... 3
- 2 In-company supervisor ..... 4
- 3 The assignment..... 4
- 4 STARTT-Form ..... 5
  - 4.1 Pt.1 Initiating and directing ..... 5
  - 4.2 Pt. 2 Designing ..... 6
  - 4.3 Pt. 3 Specifying..... 7
  - 4.4 Pt. 7 Research ..... 8
  - 4.5 Pt. 8 Communication and Collaboration ..... 9
- 5 Proof of Work ..... 10
  - 5.1 Pt. 1 Initiating and directing ..... 10
    - 5.1.1 Stakeholders Analysis ..... 10
  - 5.2 Pt. 2 Designing ..... 12
    - 5.2.1 MCA Results..... 12
    - 5.2.2 Results Buckling Check Hangers connection plates ..... 14
  - 5.3 Pt.3 Specifying ..... 16
  - 5.4 Pt.7 Research ..... 16
  - 5.5 Pt. 8 Communication and Collaboration ..... 16
- Appendixes ..... 17
  - Appendix 1 – Start Document ..... 18
    - Originally submitted ..... 18
    - Updated submitted ..... 19
  - Appendix 2 – Meeting Minutes In-company visit ..... 20
  - Appendix 3 – Evaluation of in-company Performance..... 21
  - Appendix 4 – Time Registration ..... 23

# 1 Internship Company

ASK Romein Hillebrand was previously known as just Hillebrand. They are a construction company that focuses on designing and constructing steel structures. Among these structures are mainly bridge decks but also structural elements for all different use cases

ASK Romein Hillebrand is nowadays most active in 4 different branches of steel structures:

## **Industrial Buildings**

ASK Romein is growing as a turnkey Design & Build company. For their international clients, they realise construction projects from design to the final handover. ASK Romein (Hillebrand) has several large recent projects in this category, among which are: (Hillebrand Ask Romein, sd)

- Jumbo DC – Bleiswijk
- Prologis DC3 – Eindhoven
- Snow World – Zoetermeer

## **Steel Constructions**

ASK Romein is a leading player in the Dutch and Belgian steel construction market. They have leading-edge machinery and optimal equipment at their disposal where they provide turnkey solutions for every imaginable steel structure. (Hillebrand Ask Romein, sd)

Among these projects are:

- AFAS Stadion
- City office Utrecht
- Nuon Magnum Civil Works
- Sloecentrale Vlissingen
- Data centres

## **Offshore**

Hillebrand is a division unit of ASK Romein with a Dutch site in Vlissingen that fabricates and delivers complex steel constructions for the offshore and maritime sector. They provide the full range of facilities, yards adjacent to deep water with extensive loading and unloading docks, large storage and production capacity and staff with specific offshore-related training. All the work that they carry out is under the watchful eye of Lloyd's and DNV GL who performs independent quality checks throughout the construction sequence. (Hillebrand Ask Romein, sd)

Among these projects are:

- Focus 30
- Sea Jacks – Zaratan
- Tidal powerplant - Eastern Scheldt Barrier
- Pile Gripper Tool & HSD Deployment frame
- Thialf-Plet Support Tower

## **Bridge Construction**

In addition to fabricating impressive offshore structures, bridge building is one of Hillebrand's specialist areas. With Hillebrand ASK Romein has a strong trump card in the market for specials and hydraulic engineering works. Such as bridges and locks. Thanks to years of experience dating back to 1888 in bridge, road, and waterway construction, Hillebrand has acquired a leading position in the Dutch market. (Hillebrand Ask Romein, sd)

Among these projects are:

- Engewormer and Kwadijkerbrug

- Prins Clausbrug                               – Dordrecht
- Marknesserbrug                               – Emmeloord
- Sluices complex Sambeek                 – Belfeld

And as of writing this portfolio, Hillebrand is at the final tendering phase to acquire the project of replacing the Haringvliet Bridge, which will be an important project due to its scale.

## 2 In-company supervisor

Daphne Deckers is my supervisor within ASK Romein Hillebrand. She had the function of Technical Director when I started and was during the internship period promoted to Location Manager.

Daphne Deckers has acquired her degree in Engineering (Ir.) from the open university of Brussel. She has worked previously as Project Engineer, Project Manager, and Project Director at Victor Buyck Steel Constructions. After that, she worked as Managing director at Ferrokonstrukt. She has been with ASK Romein Hillebrand for almost a year now and is responsible for overseeing all projects and communicating with clients and the project leaders.

## 3 The assignment

In Antwerp, are developments ongoing for a new ring section. The new ring will primarily be consisting out of tunnels and lowered road sections. The new road will be constructed as close as possible to the current location of the present road infrastructure, or at some places, it will be built under the current road(s).

As a consequence, the current roads have to be partially/completely removed during the construction. This will have a negative impact on the connectivity of this part of the ring road. To compensate for this impact, a temporary diversion will be constructed so that the traffic flow can continue without creating additional major congestions. This is important as the redesign of the road sections will take place over the span of 10 years.

The temporary road will be a 3-lane one-way road that can be used for either direction, when the construction is taking place at that side of the road. This diversion will consist out of several structures, among which in order: a viaduct over the Groenendaallaan, a viaduct with an on and off-ramp at the location of the Werminval, a tied arch bridge over the 'Albertkanaal' (Albert Channel), a viaduct along the Lobroekdok (Lobroek dock) and a viaduct along the Sportpalijs (Sports Palace) towards Schijnpoort.

Hillebrand is tendering for the construction of the tied arch bridge over the Albert Channel. This temporary bridge will be 150 meters long and will only exist for about 10 years. As the bridge is temporary it has to be simple to transport, build, and remove and dispose.

The overall design of this bridge has roughly been calculated in order to be able to properly tender for this project. However, there has no research been done to how the bridge will be built, transported, and installed. This research will look at the transport possibilities to get the bridge from the construction facility near Flushing to the final destination over the Albert channel in Antwerp.

My assignment is to research the transport and assembly possibilities of the temporary bridge over the Albert Kanaal in Antwerp. The bridge will serve as a temporary alternative route so that they can work on that section of the Ring Road. The bridge will serve as an alternative route for either one of the two directions depending on the phase of the construction works.

## 4 STARTT-Form

### 4.1 Pt.1 Initiating and directing

St.1.2 You define (pre-) conditions, requirements, wishes and shared ambitions and vision, aimed at creating broad-based improvements and solutions.

<b>S</b>	<p><b><i>Provide examples of assignments (situations) demonstrating that you have acquired the relevant competency. Describe briefly what was involved, or which assignment it was about.</i></b></p> <p>To be able to conduct proper research, I had to define pre-conditions, requirements, and interests. From these pre-conditions, requirements and interests I have made a criteria list to analyse the different options and to choose which option was the best suited</p>
<b>T</b>	<p><b><i>Describe your exact role or task. Indicate whether this was a complex task, and why that was the case. What did you need to do?</i></b></p> <p>To find the interests from the stakeholders can be a bit tricky as the project of Hillebrand is part of a larger development. Because it is just one bridge which is part of a bigger system, it was interesting to find and define the interests of the several stakeholders.</p>
<b>A</b>	<p><b><i>Describe in turn, the activities which you carried out in the context of this assignment. Describe what you did in concrete terms.</i></b></p> <p>For the research proposal, I set up a general list of interests from the several stakeholders considering the Oosterweel Connection in total. Then I tried to narrow it down to the specific location. For the final report, I have researched the conditions/interests and how these will affect the option selection. Based on the conditions I have put together a Multi-Criteria Analysis (MCA).</p>
<b>R</b>	<p><b><i>Describe the outcome (result) of the assignment, and how those involved responded to it. What subsequently happened in connection with this outcome?</i></b></p> <p>The result of this assignment is an MCA which grades the different options based on the criteria to find the best suited option. Based on this outcome I was able to build the rest of the assignment defining and describing the assembly phase.</p>
<b>R</b>	<p><b><i>You should reflect on what you have learned from this. What would you approach differently next time, and why?</i></b></p> <p>Next time I would make a list of the importance of each stakeholder to better indicate the importance of ones wishes and demands.</p>
<b>T</b>	<p><b><i>Provide an example of another situation (transfer) in which you could apply this competency.</i></b></p> <p>By defining the conditions and requirements you can better understand the purpose of the project and several design/procedure choices which may seem illogical without the back-knowledge</p>

## 4.2 Pt. 2 Designing

St.2.2 You examine various solutions and designs and make a deliberate, validated selection.

<b>S</b>	<b><i>Provide examples of assignments (situations) demonstrating that you have acquired the relevant competency. Describe briefly what was involved, or which assignment it was about.</i></b> For the transport of the bridge, I had to look into several options and broadly describe them. Each option has its own pros and cons. For the preferred option I then had to find solutions to different problems among which achieving the best stress-free state.
<b>T</b>	<b><i>Describe your exact role or task. Indicate whether this was a complex task, and why that was the case. What did you need to do?</i></b> My assignment was to look into the transportation of the bridge to the final location and assembly in a stress-free situation. The task was challenging as I have not much experience with transport and assemblies. My goal was to define and describe the assembly phase and prove phase concepts as using the hangers as temporary support. Which was challenging
<b>A</b>	<b><i>Describe in turn the activities which you carried out in the context of this assignment. Describe what you did in concrete terms.</i></b> I have searched online for different similar transport cases. However, these were hard to find, in the meantime I have several options written down which could be a viable option for transport. These options were then graded by an MCA, after which the best option was selected to fully work out. For the best option, I have calculated loads and load resistances for (parts of) the bridge.
<b>R</b>	<b><i>Describe the outcome (result) of the assignment, and how those involved responded to it. What subsequently happened in connection with this outcome?</i></b> The result is that I have found the best suiting option for transport and installation after which I have calculated that as part of the assembly, the hangers could be used to support the arch sections together with a support tower in order to reduce the internal stresses from the installation. However, the hangers' connection plates should be made thicker to resist the loads in the connection.
<b>R</b>	<b><i>You should reflect on what you have learned from this. What would you approach differently next time, and why?</i></b> With my limited experience I have found that I should have asked more about bridge assemblies in the start of my assignment. As I have learned a lot about this process in the second half of the internship.
<b>T</b>	<b><i>Provide an example of another situation (transfer) in which you could apply this competency.</i></b> I have gained knowledge about how to assemble a bridge and what methods are used which I would not have guessed by myself. This knowledge would be useful not only in bridges but in all sorts of steel structures.

### 4.3 Pt. 3 Specifying

St.3.1 Specifying and detailing the proposed design. You specify goals, (pre-) conditions and feasibility of the project, such that it directs and shapes development of the product. Based on the programme requirements, including required levels of quality and relevance, you further specify a selected design(s).

<b>S</b>	<b><i>Provide examples of assignments (situations) demonstrating that you have acquired the relevant competency. Describe briefly what was involved, or which assignment it was about.</i></b>
	During the assignment I had to find the most optimal transport and build option which was chosen based on the criteria. Wherefrom I have defined assembly phases of the bridge.
<b>T</b>	<b><i>Describe your exact role or task. Indicate whether this was a complex task, and why that was the case. What did you need to do?</i></b>
	I have looked into different options and orders of assembly and looked at complications that could occur. Due to my limited knowledge of bridge assemblies I had to learn a lot during this process.
<b>A</b>	<b><i>Describe in turn the activities which you carried out in the context of this assignment. Describe what you did in concrete terms.</i></b>
	For the final variant I have among others researched and proposed to move the split of the previous proposed division of the arch as it would benefit the support towers' location. In addition, I have found that the transport of the bridge in one piece instead of two sections would benefit the certainty of the assembly schedule onsite.
<b>R</b>	<b><i>Describe the outcome (result) of the assignment, and how those involved responded to it. What subsequently happened in connection with this outcome?</i></b>
	A few of the most impactful results of my research are the fact that I pointed out to better transport the bridge deck in one section instead of two. Another major point of influence goes to the proposal of moving the arch division in order to line-up the support towers which would benefit the stresses in the main beam. Including the proposal to structure the support tower around the main beam.
<b>R</b>	<b><i>You should reflect on what you have learned from this. What would you approach differently next time, and why?</i></b>
	Next time I would ask sooner in the process to have a meeting with the assembly/construction manager who does the execution phase on the regular. A meeting I attended a few weeks before the draft-deadline gave a lot of extra insight in the construction and assembly methods.
<b>T</b>	<b><i>Provide an example of another situation (transfer) in which you could apply this competency.</i></b>
	The problem solving 'ability' will be useful in any assignment where problems would present themselves before or during a process. This skill would expand in usefulness by gaining experience and this is a great starting point.

#### 4.4 Pt. 7 Research

St.7.3 You examine and report your results and you are able to discuss them and to elaborate meaningful conclusions

<b>S</b>	<p><b><i>Provide examples of assignments (situations) demonstrating that you have acquired the relevant competency. Describe briefly what was involved, or which assignment it was about.</i></b></p> <p>I had to research different methods of assembly and transport options. This was the main activity during my research assignment. The results I found are concluded in the (draft) research report I have submitted along with this document.</p>
<b>T</b>	<p><b><i>Describe your exact role or task. Indicate whether this was a complex task, and why that was the case. What did you need to do?</i></b></p> <p>My role in this graduation internship was to research and find the best method of transportation and assembly which had a great influence on each other. Based on the most optimal transport and assembly option I had to research the assembly phases and what needed to be checked to verify the method of installation. This was a more difficult task than I would like to admit due to the limited knowledge of this topic prior to this assignment. However, this gave me a lot to learn, and the results of this are put together in the research report.</p>
<b>A</b>	<p><b><i>Describe in turn the activities which you carried out in the context of this assignment. Describe what you did in concrete terms.</i></b></p> <p>I have researched different methods and based on that research I have drawn conclusions to define the best transport and assembly method.</p>
<b>R</b>	<p><b><i>Describe the outcome (result) of the assignment, and how those involved responded to it. What subsequently happened in connection with this outcome?</i></b></p> <p>The result of this assignment is a defined assembly process in broad terms with aspects checked and improvements and verifications recommended.</p>
<b>R</b>	<p><b><i>You should reflect on what you have learned from this. What would you approach differently next time, and why?</i></b></p> <p>I have learned a great deal about the assembly of large steel structures and what challenges come along with this. Next time I would try to start with questioning the person who will be responsible for or is normally responsible for the assignment I have carried out. In order to get a head-start in knowledge about how to approach the assignment.</p>
<b>T</b>	<p><b><i>Provide an example of another situation (transfer) in which you could apply this competency.</i></b></p> <p>This competency will be useful in any type of research or variant consideration.</p>

#### 4.5 Pt. 8 Communication and Collaboration

St.8.1 You can use 21<sup>st</sup> century skills and techniques in order to make your reporting appealing and interesting for your client.

<b>S</b>	<p><b><i>Provide examples of assignments (situations) demonstrating that you have acquired the relevant competency. Describe briefly what was involved, or which assignment it was about.</i></b></p> <p>Using MS Word and Excel, SCIA Engineer, and the internet. Automating parts of my report's layout, style, format, etc. I can argue that I am using 21<sup>st</sup> century skills and techniques to make my report more appealing.</p>
<b>T</b>	<p><b><i>Describe your exact role or task. Indicate whether this was a complex task, and why that was the case. What did you need to do?</i></b></p> <p>I have used so far, Word and Excel to get a desired format and design for the report. I have used Excel as a calculation software for hand calculations. Furthermore, did I use AutoCAD to get drawings and measurements. And finally, I have used SCIA Engineer and Technosoft to model and calculate the bridge.</p>
<b>A</b>	<p><b><i>Describe in turn the activities which you carried out in the context of this assignment. Describe what you did in concrete terms.</i></b></p> <p>I have written a report with Word and Excel, I have executed calculations with Excel. Furthermore, did I use AutoCAD to change, create or read drawings of the bridge and its components. And I used SCIA and Technosoft to create load models and others.</p>
<b>R</b>	<p><b><i>Describe the outcome (result) of the assignment, and how those involved responded to it. What subsequently happened in connection with this outcome?</i></b></p> <p>The result of these activities is a well build report (using the office tools) and clear results of calculations and (load) models</p>
<b>R</b>	<p><b><i>You should reflect on what you have learned from this. What would you approach differently next time, and why?</i></b></p> <p>Next time I would try and ask help sooner to get started with SCIA as I had no experience with it.</p>
<b>T</b>	<p><b><i>Provide an example of another situation (transfer) in which you could apply this competency.</i></b></p> <p>All skills with software and digital tools are useful in any situation where you could use one as working efficiently with software is an increasingly important skill.</p>

## 5 Proof of Work

Along with this relative simplified portfolio is a draft Research Report submitted which contains the proof of work. The research report is the result of my research for this internship. For each competence is one example for proof of work given from the research report.

### 5.1 Pt. 1 Initiating and directing

*You define (pre-) conditions, requirements, wishes and shared ambitions and vision, aimed at creating broad-based improvements and solutions*

The proof of work for Pt.1 is the stakeholder analysis Stakeholders. In addition, could the MCA (which results are in chapter 5.2 also be considered as proof of work for this competence.

#### 5.1.1 Stakeholders Analysis

This project's stakeholders influence the location, design, and impact of construction from the new Oosterweel connection.

Among these stakeholders are:

- ASK Romein Hillebrand
- THV ROCO
- The Belgian government
- The Flemish state government
- Road authorities
- The municipality of Antwerp
- Authorities Port of Antwerp
- Local inhabitants
- Local businesses

##### 5.1.1.1 What are the interests of the stakeholders regarding transport and building?

Each stakeholder has different interests in this project. These interests are briefly described below:

#### **ASK Romein Hillebrand**

The interest of ASK Romein Hillebrand is to deliver an excellent product to put itself on the map. The bridge will be one of the largest structures constructed by Hillebrand at the moment of writing, and it desires to have more projects on this scale. Therefore, it is in Hillebrand's interest to deliver good quality, on time and within budget.

#### **THV ROCO**

As the client is THV ROCO most interested in a cheap and elegant solution regarding the placement of the bridge without much disturbance to the surroundings, THV ROCO will be the responsible party reporting to the authorities.

#### **Port Authorities**

Because the bridge will be transported through and installed in/near the port area of Antwerp, is it in their interest to see the bridge installed as fast as possible to minimise the disturbance to the daily coming and going of cargo vessels.

#### **Road Authorities**

In the Road Authorities' interest, the transport and installation of the bridge are not disturbing the traffic flow on the already congested ring of Antwerp.

#### **Municipality of Antwerp**

The municipality of Antwerp has the same interests as the Road and Port Authorities to minimise the operation's impact on the economy of the city of Antwerp by hindering traffic.

**State Government**

The state government's interest as a primary investor is to complete the project before the deadline and within budget.

**Belgian Government**

The Belgian government's interest as a primary investor is to complete the project before the deadline and within budget.

**Local Inhabitants/Business Owners**

The local inhabitants and business owners' main interest is to have as little disturbance by the bridge as possible. Disturbances would include noise from constructions, roadblocks, etc. These interests are high, but their influence is low; therefore, it should be considered but not assumed as an obligation.

More detailed research is required to verify and select the interests of importance, which will be definitive in choosing the right option. These interests can be used for multi-criteria analysis; more on this in chapter **Error! Reference source not found..**

5.2 Pt. 2 Designing

You examine various solutions and designs and make a deliberate, validated selection.

For this Pt. I have added the MCA results as proof of work together with the calculation results of the buckling check for the hanger’s connection plates

5.2.1 MCA Results

In order to make an educated choice, the MCA is completed. Based on the three criteria mentioned in chapter **Error! Reference source not found.**, each options score is given. The MCA is combined for the bridge deck, and the arch as both option choices are graded by the same criteria. The scoring indicates the best option to choose based on the criteria. The score for the deck is based on a 2-point system, and for the arch is the score based on a 3-point system. The higher the score, the better. The scores are based on several factors shown in Table 1 - MCA Result.

The best/winning results in Table 1 and Table 2 are highlighted in blue.

**Results**

**Deck** – The MCA results show that option 2 for the Deck would be a better approach. This option is to transport the entire bridge deck in 1 piece. For this, five extra days are calculated in costs for the supports to weld the deck in Flushing. The advantage is in the feasibility as it reduces the risks of delays on-site by difficulties in alignment or setbacks in the welding process of welding the bridge together.

**Arch** – The MCA results show an interesting consistency in the grading. The best option for the arch would be the baseline variant option 1 (see Figure 1), which consists of transporting each arch in 3 sections. The main advantage is that the sections are light and easy to handle, which also results in a smaller crane required. It does require a longer duration with a crane on-site, but this is compensated by a lower cost of a smaller crane. In addition, this option takes advantage of the support towers already required to place the crossbeams in this configuration.

Table 1 - MCA Result

MCA						
Criteria	Weight of Criteria	Options				
		Deck Option 1. [B]	Deck Option 2.	Arch Option 1. [B]	Arch Options 2.	Arch Options 2.
Costs	30%	2	1	3	1	2
Feasibility	55%	1	2	3	1	2
Hinder	15%	1	2	3	1	2
<b>Final Score</b>		<b>1.3</b>	<b>1.7</b>	<b>3</b>	<b>1</b>	<b>2</b>

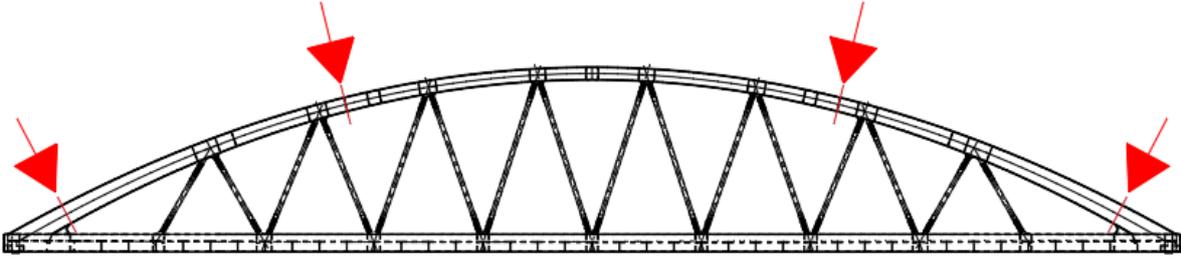


Figure 1 - MCA - Best Variant (Red Arrows point to separation line of different sections)

Table 2 - MCA Results - Expanded

Criteria	Breakdown	Scores				
		Deck Option 1. [B]	Deck Option 2.	Arch Option 1. [B]	Arch Option 2.	Arch Option 3.
<b>Cost</b>		<b>2</b>	<b>1</b>	<b>3</b>	<b>1</b>	<b>2</b>
Transport Costs		€ 57.600	€ 57,600	€ 11,600	€ 50,400	€ 50,400
Installation Costs		€ 264,000	€ 305,000	€ 152,300	€ 142,400	€ 135,200
<b>Feasibility</b>		<b>1</b>	<b>2</b>	<b>3</b>	<b>1</b>	<b>2</b>
Difficulty to lift		1	2	3	1	2
Installation Complexity		1	2	3	1	2
<b>Hinderance To Surroundings</b>		<b>1</b>	<b>2</b>	<b>3</b>	<b>1</b>	<b>2</b>
Hinderance to traffic		1	1	3	1	2
Hinderance to shipping		1	2	3	1	1

The explanation for each scoring can be found in the appendix 'Error! Not a valid bookmark self-reference.'.

## 5.2.2 Results Buckling Check Hangers connection plates

### 5.2.2.1 Results Buckling Check Hanger Connection

According to the calculations are only two connection plates resistant. The moment forces mainly influence this in the hanger present.

The moment resistance can be increased by choosing thicker plates in the hanger connection. Based on a 5 mm increase are the following dimensions passing the buckling check:

Table 3 - Buckling Check Hanger Plates

Hanger No.	Buckling check					
	Phase 4.2	Phase 5.2	Phase 5.3	Phase 6	Phase 9	Phase 10
1	$0.994 \leq 1$	N.A.	N.A.	$0.995 \leq 1$	$0.826 \leq 1$	$0.988 \leq 1$
2	$0.697 \leq 1$	N.A.	N.A.	$0.814 \leq 1$	$0.753 \leq 1$	$0.844 \leq 1$
3	$0.965 \leq 1$	N.A.	N.A.	$0.789 \leq 1$	$0.891 \leq 1$	$0.910 \leq 1$
4	N.A.	N.A.	N.A.	N.A.	$0.861 \leq 1$	$0.954 \leq 1$
5	N.A.	N.A.	N.A.	N.A.	$0.829 \leq 1$	$0.794 \leq 1$
6	N.A.	$0.829 \leq 1$	$0.848 \leq 1$	$0.856 \leq 1$	$0.829 \leq 1$	$0.794 \leq 1$
7	N.A.	$0.857 \leq 1$	$0.867 \leq 1$	$0.858 \leq 1$	$0.863 \leq 1$	$0.996 \leq 1$
8	N.A.	$0.901 \leq 1$	$0.846 \leq 1$	$0.854 \leq 1$	$0.884 \leq 1$	$0.846 \leq 1$

Table 4 - Results Buckling Check Hanger Connection

Hanger No.	Phase Check with required Thickness					
	Phase 4.2 Check	Phase 5.2 Check	Phase 5.3 Check	Phase 6 Check	Phase 9 Check	Phase 10 Check
1	OK	N.A.	N.A.	OK	OK	OK
2	OK	N.A.	N.A.	OK	OK	OK
3	OK	N.A.	N.A.	OK	OK	OK
4	N.A.	N.A.	N.A.	N.A.	OK	OK
5	N.A.	N.A.	N.A.	N.A.	OK	OK
6	N.A.	OK	OK	OK	OK	OK
7	N.A.	OK	OK	OK	OK	OK
8	N.A.	OK	OK	OK	OK	OK
Hanger No.	Thickness [mm]	Thickness [mm]	Thickness [mm]	Thickness [mm]	Thickness [mm]	Thickness [mm]
1	45	N.A.	N.A.	45	45	70
2	40	N.A.	N.A.	40	40	50
3	40	N.A.	N.A.	40	40	50
4	N.A.	N.A.	N.A.	N.A.	55	60
5	N.A.	N.A.	N.A.	N.A.	60	60
6	N.A.	45	45	45	45	45
7	N.A.	50	45	45	45	45
8	N.A.	50	45	45	45	45

The table shows the required thickness to resist the loads on the connections per-phase basis. From this table is, for each hanger, the thickest plate selected as this would be the required thickness to withstand the load over all phases.

Because the hangers are mounted in pairs to the main beam (except for the outer hangers), is the most significant thickness required for the hangers' connections. (See Table 5).

Table 5 - Required Thickness of Hanger Plates in bridge deck

Hanger No.	Required Thickness [mm]	Thickness plates at the main beam [mm]	Thickness plates at the arch [mm]
1	70	70	70
2	50	50	
3	50		60
4	60	60	60
5	60		
6	45	50	50
7	50		
8	50	50	

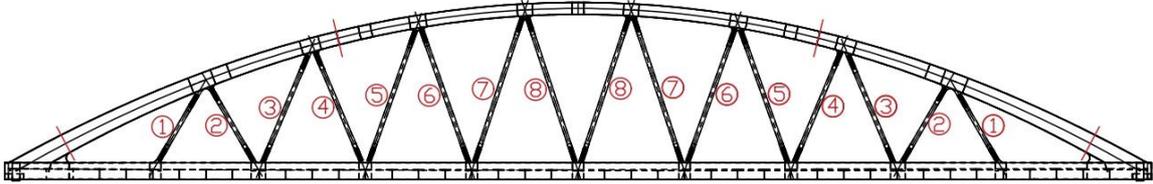


Figure 2 – Numbering Hangers

5.2.2.2 Conclusion Hanger Check

From the calculation result, we can conclude that the conservative buckling check verifies the strength of the tubular profiles. The results show that the hangers are quite well resistant against axial compressive- and Lateral buckling with a proper safety margin.

The hanger connections, however, are not resilient against the moment and compressive forces of the arch standing on top of them. This connection's main problem is the weak axis's moment force. To adjust for these moment forces, are the required thicknesses calculated.

### 5.3 Pt.3 Specifying

*Specifying and detailing the proposed design. You specify goals, (pre-) conditions and feasibility of the project, such that it directs and shapes development of the product. Based on the programme requirements, including required levels of quality and relevance, you further specify a selected design(s).*

For the proof of work of this competence I want to refer to the conclusion of my report where most of the results are described in a condensed 1,5 pages. In addition, can the calculations of the buckling check, wind loads, also be considered as proof of work. Instead of copying the entire report into this document, will I refer to those parts of the report.

### 5.4 Pt.7 Research

*You examine and report your results and you are able to discuss them and to elaborate meaningful conclusions*

The results of the report are concluded and discussed in the last two chapters, Conclusion, and Discussion and Recommendations. In these chapters are the research methods and results discussed and concluded

### 5.5 Pt. 8 Communication and Collaboration

*You can use 21<sup>st</sup> century skills and techniques in order to make your reporting appealing and interesting for your client.*

The report itself is full of references and hyperlinks etc. to make it easier to navigate through the report. In addition, function of office is used as citations, automatic (page) numberings etc. Other 21<sup>st</sup> century skills I have used are the SCIA models, AutoCAD drawings, Extensive Excel – hand calculations, internet research and lucid-charts.

All of these skills came together for getting the results required and combining them into the Research Report which is the final product of my thesis.

## Appendixes

Appendix 1 – Start Document

Appendix 2 – Meeting Minutes – In company visit

Appendix 3 – Evaluation of in-company performance

Appendix 4 – Time Registration

## Appendix 1 – Start Document

Originally submitted

*This Start Document is Submitted to on-stage, however, the research topic has changed just after starting the thesis. For the updated Start Document, see the next page.*

**Student:** Michiel Zwanenburg\_\_\_\_\_ **Number:** \_78232\_\_\_\_\_

**Topic of thesis project:** Remodelling and calculating an existing/in construction steel bridge structure design, to look for optimisations regarding the amount of materials used and the costs of that bridge structure.

**Client/organisation:** ASK Romein Hillebrand

**Professional competencies to be acquired (bachelor specific):**

Pt.1 Initiating and directing,

Pt.2 Designing,

Pt.3 Specifying,

Pt.7 Research,

Pt.8 Communication and collaboration,

**Provisional statement of the research (background, problem statement, research question, objective):**

The goal of the assignment is to remodel and recalculate an existing/in construction steel bridge structure and to control the initial design. Then I will attempt to optimise the design by changing design aspects to reduce the amount of materials needed. (A sub question could be to reduce construction costs as well) The research question will look like: How could [bridge] be optimised by reducing materials needed. The objective is to find a way to save materials (and thus costs) on the design of a bridge.

**Professional product:**

May include, but not limited to:

A portfolio (Proving acquirement of competences)

A research report (including the research findings of optimalisations)

Models of the bridge\*

\*I will submit all work/results, but it is depending on the rules of ASK Romein Hillebrand to what extent. (Some companies don't want critical data to be shared)

Updated submitted

*This Start Document is not submitted to on-stage, because the research topic has changed just after starting the thesis. For the original Start Document, see the previous page.*

**Student:** Michiel Zwanenburg\_\_\_\_\_ **Number:** \_78232\_\_\_\_\_

**Topic of thesis project:** Researching the best transport and installation method. This method will then have to be validated by models and calculations.

**Client/organisation:** ASK Romein Hillebrand

**Professional competencies to be acquired (bachelor specific):**

Pt.1 Initiating and directing,

Pt.2 Designing,

Pt.3 Specifying,

Pt.7 Research,

Pt.8 Communication and collaboration,

**Provisional statement of the research (background, problem statement, research question, objective):**

The goal of the research is to find the most optimal method of transporting the bridge to the final destination. Because this cannot happen in one part, it has to be divided. The bridge will arrive in sections on location. Therefore, an assembly method has to be researched in order to install the bridge stress-free.

**Professional product:**

May include, but not limited to:

A portfolio	(Proving acquirement of competences)
A research report	(Including the research findings of optimisations)
SCIA models of the bridge	(Used in the report)
AutoCAD Drawings	(Used in the report)
Hand/Excel Calculations	(Used in the report)

# Meeting Notes

Attendees:	Location:	ASK Romein Hillebrand Vlissingen
A. Repko [Examinator 1]	Date and time:	21-03-2022 13.00
D. Deckers [Supervisor]	Duration:	50 minutes
M. Zwanenburg [Student]	Objective:	In-Company visit, discussing progress.

## Minutes

Discussion topic	Result/Action
Discussing the research questions	Order of questions need some adjustment - Option selection needs to move up
Goal of research questions	Better phrasing of the questions
General order of the research	Project Activities seems misplaced and should be spread out over the other chapters The report should be restructured to match with the re-ordering of research questions
Naming of components	Options for transport should rephrased
Quality and Quantity	Variant description of the variant study will be quantitative and global. Variant selection will be done qualitative Qualitative description of selected variant
What will be checked by calculations?	Calculations can include: - Wind loads and temporary bracing - Strengthening measures for temporary load concentrations during construction - Supports of bridge during different phases and the loads. (Including the strengthening measures) - Stress-Free installation support structures
Submission of Research Proposal and Portfolio	The Research Proposal will be submitted as soon as the evaluation is received by Michiel, discussed changes will be submitted in a second attempt. (A. Repko will reject the first version and add as comment to change the discussed topics from this meeting.)
Variant Study	The student could discuss the transport options with experts and will compare his findings to the experts' idea. This could be added as an appendix to verify or challenge the student's findings.





## Appendix 4 – Time Registration

	Internship Time Registration										
Student	Michiel Zwaneburg, 78232										Planned Start date of the week
Weeknr	Mo	Tu	We	Th	Fr	Sa	Su	Total week	Cumulative	Planned schedule	Start date of the week
1								0.00	0.00		03/01/2022
2								0.00	0.00		10/01/2022
3								0.00	0.00		17/01/2022
4								0.00	0.00		24/01/2022
5								0.00	0.00	40	31/01/2022
6	5.00	8.00	9.50	8.00	9.50			40.00	40.00	80	07/02/2022
7	9.50	9.00	9.00	9.00	9.00			45.50	85.50	120	14/02/2022
8	10.00	9.25	8.50	8.50	8.00			44.25	129.75	160	21/02/2022
9	9.50	8.50	6.50	9.00	8.00			41.50	171.25	200	28/02/2022
10	9.00	10.00	5.00	8.50	7.00			39.50	210.75	240	07/03/2022
11	9.75	11.25	8.50	9.00	9.25	6.50	4.00	58.25	269.00	280	14/03/2022
12	7.50	8.50	9.00	8.50	4.50			38.00	307.00	320	21/03/2022
13	8.00	9.00	4.00	8.50	8.00			37.50	344.50	360	28/03/2022
14	11.50	8.50	8.50	9.75	8.75	7.50	1.00	55.50	400.00	400	04/04/2022
15	8.00	4.00	9.50	9.50	8.00			39.00	439.00	440	11/04/2022
16	7.00	8.50	9.00	8.50	8.00			41.00	480.00	480	18/04/2022
17	9.25	9.00	1.00	9.25	8.75		1.00	38.25	518.25	520	25/04/2022
18	6.00	9.00	9.00	9.00	6.50			39.50	557.75	560	02/05/2022
19	8.75	8.25	8.75	8.50	10.75			45.00	602.75	600	09/05/2022
20	9.50	9.25	5.50	10.75	10.00		4.50	49.50	652.25	640	16/05/2022
21	14.00	16.00	13.50	3.00	10.00			56.50	708.75	680	23/05/2022
22	8.25	13.50	10.00	14.00	12.00			57.75	766.50	720	30/05/2022
23		7.00	8.00	12.00	3.50		4.00	34.50	801.00	760	06/06/2022
24	9.50	9.50	11.50	14.50	12.50			57.50	858.50	800	13/06/2022
25								0.00	858.50		20/06/2022
26								0.00	858.50		27/06/2022
27								0.00	858.50		04/07/2022
28								0.00	858.50		11/07/2022
29								0.00	858.50		18/07/2022
30								0.00	858.50		25/07/2022
<b>Total hours</b>								<b>858.50</b>			