It’s all about the details.

Standardise early procurement of chemical resistant floors.

By Arwin Antes
Standardise early procurement of chemical resistant floors

Bachelor thesis

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Preface

It has been a long time! I started with the bachelor civil engineering when I was an officer–cadet at the Royal Dutch Military Academy. Now it’s many years later, and finally the end is in sight. It took me from Spijkenisse, to Rotterdam, to Breda, to Enschede, back to Rotterdam, to Zoeterwoude, back to Enschede, and finally the last stop in Rotterdam.

During the bachelor thesis, I had to multitask, using 4 different e-mail accounts at the same time. My work as executive manager at a moving company continued (and simultaneously, we opened a new office in Groningen, in addition to the offices in Den Haag and Breda) and every day I had a travelling time of minimal 3 hours. But with the help of many cups of coffee and keeping it going forward, it all worked out.

First of all, I would like to thank André for giving me the chance to do my bachelor thesis at Heineken. Your supervision, support and advice is deeply appreciated and the gained experience will be very useful in my professional future. Hans, thank you for being patient and giving me the directions that this thesis needed. Also, a thank you for all the project managers at Heineken, and Tjeerd Meij and Jeroen van Wijk of Group Purchasing.

Thank you my dear friends, Willem, Jelmer, Jurre, Peter, Leon, Micha, and Daniel; throughout the bachelor program you all have been important to me, in one way or another. Your friendship, advice and loyalty will always be remembered. A very special thanks to my sister and brother-in-law, Ilona and Jan-Arie, and their two beautiful sons, Tijn and Sep. And finally my parents, for being endlessly supportive and always keeping faith. Pap, mam: deze is voor jullie!

Arwin Antes

Rotterdam, March 9, 2014
Summary

The goal of this bachelor thesis is to help Heineken improve the standardisation for the early procurement of chemical resistant floor materials for the construction of breweries. In order to realise this goal, there are three main aspects that need to be viewed:

1. Materials
2. Applicators and manufacturers
3. Procurement

In the first research question, a general overview of a chemical resistant floor will be given, the accessory materials will be described and the minimum requirements will be defined. The second research questions focuses on the applicators and manufacturers, including the process of identifying and selecting them. Furthermore, the different chemical resistant floor systems per applicator will be explored and explained. The third and final research question will review the current and preferred procurement procedure and present a possible alternative.

The answering of these research questions resulted in the conclusion that standardising the procurement will be beneficial on terms of time and costs. The first step is to choose a fixed group of applicators and manufacturers, with the possible floor systems and available materials known upfront. Furthermore, an early procurement, with the materials purchased during the detailed design phase, will save three months, and unforeseen delays can be prevented or captured. In addition, consultants can be excluded and fixed prices with manufacturers can be negotiated, which both result in the reducing of time and costs.

As a result of these fixed prices, an overview must be kept of the cost distribution, based on the applicators quotations. In this manner, the extra charged margins quoted by the applicators (as a result of the fixed prices with the manufacturers) will be clearly visible.

Moreover, the market of appropriate chemical resistant floor applicators and manufacturers is small, so it is questionable whether a tender phase is meaningful. The previous years have shown that almost every floor system is installed by the same applicators, and almost all materials came from the same manufacturers. Therefore, it might be an option to collaborate with these companies in order to develop a customised floor system. Also, new applicators and/or manufacturers can be awarded with a small project in order to explore these companies and thus the market.
# Table of Contents

Preface .................................................................................................................. 2

Summary ................................................................................................................. 3

1 Introduction .......................................................................................................... 6
   1.1 Company profile .......................................................................................... 6
   1.2 Research framework .................................................................................... 7
   1.3 Goal .............................................................................................................. 7
   1.4 Methodology ................................................................................................ 7
   1.5 Research strategy ........................................................................................ 8
   1.6 Research questions ...................................................................................... 10
   1.7 Theoretical framework ................................................................................. 10
   1.8 In advance .................................................................................................... 11

2 Research question I ............................................................................................. 12
   2.1 Which breweries are selected for this research? ........................................ 12
   2.2 What are the specifications of a chemical resistant floor? ......................... 14
       2.2.1 General floor design ........................................................................... 15
   2.3 What are the minimum requirements? ......................................................... 16
       2.3.1 Functional and technical requirements ............................................. 16

3 Research question II ........................................................................................... 17
   3.1 Which applicators and manufacturers have previously been used? .......... 17
   3.2 Who are the preferred applicators and manufacturers? ......................... 18
       3.2.1 Chemical resistant floor applicators ............................................... 18
       3.2.2 Chemical resistant tile manufacturers ......................................... 20
       3.2.3 Drain manufacturers ....................................................................... 21
   3.3 What are the preferred chemical resistant floor systems? ....................... 21
       3.3.1 Van Koetsveld ............................................................................... 22
       3.3.2 Rundmund Saureschutztechnik ....................................................... 22

4 Research question III .......................................................................................... 23
   4.1 Which procurement procedures have previously been used? ............... 23
       4.1.1 Specified costs ................................................................................. 24
   4.2 What is the preferred procurement procedure? ........................................ 25
       4.2.1 Fixed material prices ....................................................................... 26
   4.3 What is a suitable alternative for the current procurement procedure? .... 27
       4.3.1 Standard Request for Quotation format .......................................... 27
       4.3.2 Standard Bill of Quantities format ............................................... 27
       4.3.3 Standard Buyer & Seller Obligations format ................................. 28
       4.3.4 ARW 2012 and STABU catalog ..................................................... 28

5 Conclusions and recommendations ................................................................... 29

Glossary .................................................................................................................. 30

Bibliography .......................................................................................................... 31

Appendices ............................................................................................................. 32
1 Introduction

The final part in the curriculum of the bachelor Civil Engineering at University of Twente is the bachelor thesis. In this thesis, I will apply my gained knowledge of the previous years into a project in the field of civil engineering. The relevant project and associated internship will be at Heineken.

Besides finishing the bachelor program, I have some personal goals. First of all, I wish to develop skills which are required during a civil engineering project and gain experience in this field. Also, I wish to further develop my communication skills both theoretical and practical. Finally, I wish to improve my academic writing and communication skills in English.

1.1 Company profile

The Heineken Company is a beer brewery, established in 1864 by the Heineken family, and currently the number one brewer in Europe and the number three brewer (by volume) in the world. Heineken employs more than 85,000 people over 70 countries and is enjoyed in 178 countries. The company operates in five regions, namely Western Europe, Central and Eastern Europe, Africa and the Middle East, the Americas, and Asia Pacific. The headquarters is located in Zoeterwoude, Netherlands. ¹

The company is divided in different departments, one of which is Supply Chain Services (SCS). The SCS is divided into different subgroups, one of them being the Portfolio and Project Management (P&PM) a schematic representation of which can be found in the chart below. A new addition to this group is the civil engineering department, which was created in order to obtain (and preserve) internal information about the civil engineering projects instead of outsourcing through external contractors.

1 (Heineken N.V., 2013)
1.2 Research framework

It is observed in several projects, namely the construction of breweries, that some of the materials that are procured directly do not arrive in time and therefore cause delays and/or excessive shipping costs. This current procurement procedure also results in (unnecessary) additional handling costs, inefficient control on quality and a high cost–benefit ratio. Standardising this procedure will be beneficial for all future projects.

In this thesis, the chemical resistant floors and associated materials will be discussed. Below are Heineken’s desired approach, deliverables and benefits listed.

Approach
- Identify what materials will be procured directly;
- Standardise specifications;
- Identify manufacturers and applicators;
- Identify current (internal) purchasing procedure;
- Determine existing and develop new framework agreements;
- Standardise Request For Quotation (RFQ) process.

Deliverables
- Well specified list of materials;
- Functional and technical specifications chemical resistant floors;
- International list of manufacturers and applicators;
- Framework contracts with at least 3 manufacturers or applicators;
- Standard RFQs and purchasing procedure;
- System in place to review quality & price.

Benefits
- Shorter lead time because of standardised early procurement;
- All shipment sea transport, no last minute air transport;
- Better pricing because of purchasing power.

1.3 Goal

The purpose of this research is to help Heineken improve the standardisation for the early procurement of chemical resistant floor materials for the construction of breweries, by making an analysis of the current situation and exploring the possibilities for the desired situation.

1.4 Methodology

The research will be categorized as practice-based, since ‘it is conducted in a real–world context, with real problems, and in collaboration with practitioners. Therefore it is much more likely to lead to effective application and real change’.

2 (Van den Akker, 2007)
This research will focus on the problem analysis, diagnosis and design. The modification and evaluation will take place after the new design is implemented, and will be no part of this research.

1.5 Research strategy

As stated before, the main goal of this research is to help Heineken improve the standardisation for the early procurement of chemical resistant floor materials. In order to realise this goal, there are three main aspects that need to be viewed:

1. Materials
2. Applicators and manufacturers
3. Procurement

First of all, there are no specifications for the required materials (tiles, installation materials, drains, and gutters) known within Heineken. Previously, the procurement was outsourced through external consultants who set up the requirements. Therefore, the first step in standardising the procurement is to create one standard set of requirements for the materials. With the use of these requirements, standard materials for the chemical resistant floors can be selected.

Secondly, the consultants used to select the applicators, who then received an invitation to make a quotation. The applicators then quoted a possible floor system and accessory materials, with the latter coming from different manufacturers (tiles from one manufacturer, drains from another). The suggested floor systems and materials (and thus
manufacturers) differed per applicator, but also per project. Therefore, in order to standardise the procurement, standard applicators and manufacturers should be selected. Also, a small number of pre–selected floor systems (per applicator) are desirable for the standardised procurement. Finally, a geographical distribution of the applicators is preferred.

Thirdly, the procurement itself needs to be reviewed and preferably standardised. The procurement starts with a project manager from Heineken contacting a consultancy to set up a request for quotation (RFQ) and select applicators. The received quotations from the applicators are then forwarded to Heineken’s project manager. However, since there are no specifications or requirements known within Heineken (neither about the floor systems nor the materials), the quoted floor systems, the materials and the selected applicators (and thus manufacturers) needed to be reviewed thoroughly and extensively within Heineken. Also, the gained information by the project manager (or other personnel involved in the project) was not preserved. As a result, with every new project, and with every new project manager, the process described above was repeated.

A schematic overview of the current procurement procedure is given below. Standardising the procurement of chemical resistant floors will result in the preservation of knowledge, the saving of time (because of pre–selected floor systems and materials) and reducing of costs (time is saved, consultants can be excluded, fixed prices with both applicators and manufacturers can be negotiated).

![Schematic overview current procurement procedure]

**Figure 1 – Schematic overview current procurement procedure**
1.6 Research questions

In order to research the possibilities for standardising the procurement of chemical resistant floors, the following research questions have been drafted. These questions are created with use of the three main aspects: materials, applicators/manufacturers, and procurement.

Research question I
*What are the requirements for the chemical resistant floors in Heineken’s breweries?*

- Which breweries are selected for this research?
- What are the specifications of a chemical resistant floor?
- What are the minimum requirements?

Research question II
*Who are the applicators and manufacturers for chemical resistant floor materials?*

- Which applicators and manufacturers have previously been used?
- Who are the preferred applicators and manufacturers?
- What are the preferred chemical resistant floor systems?

Research question III
*How can the procurement for chemical resistant floors be improved?*

- Which procurement procedures have previously been used?
- What is the preferred procurement procedure?
- What is a suitable alternative for the current procurement procedure?

1.7 Theoretical framework

The theoretical framework for this research consists of a limited amount of literature. Most of the information presented was received through meetings and documents of previous projects. The meetings took place with the company supervisor André van Bijsterveld and myself, sometimes accompanied by Tjeerd Meij or Jeroen van Wijk of Group Purchasing. During these meetings, information about the technical specifications (applicators and manufacturers), technical requirements (Heineken experts) and procurement procedure (Group Purchasing and Heinekens project managers) was acquired.

The viewed documents were from previous projects (saved in Lotus Notes) and consisted out request for quotations, contracts, specifications, e-mail traffic (and more), and will be labeled as used literature. All the above mentioned gained information was used in order to standardise the procurement of chemical resistant floors. In addition, the ARW 2012 (in Dutch: Aanbestedingsreglement van Werken) and the Dutch STABU catalog will be discussed, as it contains different procurement procedures and overall information about standardised procurement.
An overview of the previously mentioned meetings is given below, and descriptions of these meetings can be found in appendix O.

**Floor applicators**
- Mario Cvitkovic, director Vibrofloors, December 13, 2013
- Daniel van Koetsveld, director Van Koetsveld / Kagetec, January 9, 2014
- Werner Krampe, salesman Rundmund Saüreschutztechnik, January 28, 2014

**Tile manufacturers**
- Volkert Aufderhaar, salesman Argelith, December 10, 2013
- Rainer Tietz, salesman Zahna Fliesen, January 23, 2014

**Heineken experts**
- Jaap Past, Packaging, November 18, 2013
- Klaas Tiktak, Brewing Solutions, November 20, 2013
- Remco van de Bent, Water and Wastewater Treatment Plant, November 25, 2013

In addition, several meetings with both Tjeerd Mei and/or Jeroen van Wijk took place, to discuss the current and desired procurement procedure, and the overall progress of the research. Furthermore, the project managers of the group Portfolio and Project Management were questioned intensively throughout the research.

1.8 In advance

When Heineken’s management decides to build a new brewery (greenfield) or to extend a brewery (brownfield), and the project has an estimated budget above €2.000.000, it will be coordinated from the headquarters in Zoeterwoude, Netherlands. One project manager is appointed (who should have 5–10 years’ experience in the managing of likewise projects), and will make a global design of the brewery and manage all the different stages of the project. Since there is no civil engineering department within Heineken, almost every part will be outsourced. However, the information gained by the project manager during this process is not internally preserved or passed onto other project managers. As a result, during every procurement of chemical resistant floors, the same questions were asked by different project managers.
2 Research question I

What are the requirements for the chemical resistant floors in Heineken’s breweries?

The first research questions focuses on standardising the materials. In order to realise this, minimum requirements for the chemical resistant floors must be drafted. In the first paragraph an overview will be given of the projects that have been chosen for this research. Secondly, the specifications of a chemical resistant floor will be discussed, including the different materials that are used. In the third paragraph, the functional and technical requirements will be formulated.

2.1 Which breweries are selected for this research?

The research began with selecting projects in which chemical resistant floors had been installed. First of all, the projects were selected on the principle of geographic diversity. As previously stated, Heineken has organised the company in five regions, namely:

- Western Europe
- Central and Eastern Europe
- The Americas
- Africa and the Middle East
- Asia Pacific

In order to get an accurate and worldwide overview, a minimum of two projects per region* were selected. A worldwide overview has important advantages:

- Establish an overview of possible applicators and manufacturers per region
- Discover the possible chemical resistant floors that can be installed per region
- Find the advantages and disadvantages in installation per region

* Heineken doesn't own breweries in North America which is because of marketing purposes: Heineken has an imported beer status in North America.

Secondly, all of the greenfields from the past ten years have been selected. These projects give an overview of the complete installation process. At a brownfield project, there is a possibility that only a part of the total system is installed. Thirdly, a complete chemical resistant floor must have been installed in order to be conducted in this research because this research focuses on the procurement of a total floor system.
The selected projects are:

<table>
<thead>
<tr>
<th>Year</th>
<th>City</th>
<th>Country</th>
<th>Region</th>
<th>Type</th>
<th>Project number</th>
</tr>
</thead>
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<td>Burundi</td>
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<td>P. 1244</td>
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<td>Congo</td>
<td>Africa and the Middle East</td>
<td>Brownfield</td>
<td>P.1298</td>
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</tbody>
</table>

Figure 2 – Geographic overview selected projects
While the research continued it became clear that not all the required information (contracts, quotations, specifications) for the selected projects was available. The main reason was the absence of a global database; not all the information was preserved and the information that was preserved, was mostly incomplete. This made it difficult to create a general and accurate overview, considering the limited amount of time available for this research. As so, the number of projects was reduced, which resulted in a new overview of projects.

<table>
<thead>
<tr>
<th>Year</th>
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<th>Region</th>
<th>Type</th>
<th>Project number</th>
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<td>2010</td>
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<td>Brownfield</td>
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</tbody>
</table>

2.2 What are the specifications of a chemical resistant floor?

There are chemical resistant floors installed in Heineken’s breweries and contradictory to what the name might imply, these floors must be resistant to more than just chemicals. During the brewing process, cleaning materials are used which contain different chemicals. Besides that, water with different temperatures is used which can create a thermo shock onto the floor; the floors must be heat resistant as well. A third aspect is the mechanical load, since different machine and equipment will be installed on the floor as well.

The chemical resistant floors are not required in all areas of the brewery. The areas where they are commonly installed:

- Brew house
- Service blocks
- Cellars
- Packaging
- Water treatment plant
- Wastewater treatment plant
- Chemical storage
Currently, there are two general chemical resistant floor options: a tiled floor system or an epoxy floor. The current experience with epoxy floors is that the lifetime is not comparable to a tiled floor. Also, maintenance is required every two years for an epoxy floor, which creates a shutdown in the brewing process. Heineken finds this unacceptable and decided to not consider the epoxy floors for the moment. This research will focus on tiled floors only.

2.2.1 General floor design

Though the specific materials and floor design depends on the system, but a general overview of a chemical resistant floor will be given. The floor design starts with the concrete floor with an optional screed layer on top of it (depending on the flatness of the concrete, will be discussed later). On the concrete/screed surface a bonding layer is attached. The purpose of the bonding layer is to attach the tiles onto the concrete/screed surface and to prevent the tiles from moving horizontally. The tiles will be laid in the bed of bonding layer and the spaces between the tiles will be filled with epoxy material. The tiles and the epoxy material require a number of specifications, in order to create the total resistance of the floor (these requirements will be discussed in paragraph 2.3). Finally, the average lifetime of a tiled floor system is 30 years.


Figure 3 shows the general floor design with stainless steel corners and an expansion joint. Both the concrete and the tiled floor system are subject to expansion and shrinkage and therefore the tiled floor system must be divided into smaller fields with expansion joints. The stainless steel angles are needed for a strong transition from the tiles to the expansion joints. In general, the expansion joints are the weakest part of the tiled floor system, especially in case of heavy traffic (for example, forklifts).
2.3 What are the minimum requirements?

As stated before, there are no minimum requirements known within Heineken. Previously, the projects were outsourced through consultants (for example, Royal Haskoning). These consultants formulated the requirements for the chemical resistant floors in a request for quotation, an example can be found in appendix A. As a part of this research, these requirements were reviewed in order to define the minimal requirements for the chemical resistant floors. A critical note about this process: some requirements could be received from internally known information or Heineken employees. However, some requirements could not be defined properly through internal information or employees and were therefore:

- Adopted from external partners (consultancies, manufacturers, applicators)
- Based on previous projects and experiences

2.3.1 Functional and technical requirements

The minimum requirements are divided into functional and technical requirements. As stated before, the chemical resistant floors will be applied in the below listed area and therefore, only the environmental conditions of these areas are viewed.

- Brew house
- Service block
- Cellars
- Packaging
- Water treatment plant (WTP)
- Waste water treatment plant (WWTP)

The determination of the minimum requirements, or baseline measurement, was an intensive process that continued throughout the whole research. Although the determination of these requirements are an important aspect and were time consuming, they are a small part when considering the whole research. Therefore, the determined requirements can be found in appendices B and C.
3 Research question II

Who are the applicators and manufacturers for chemical resistant floor materials?

This research question focuses on the floor applicators and manufacturers of tiles and drains, which can be selected with the use of the determined minimum requirements. First of all, the known applicators and manufacturers were identified and reviewed, with the use of previous purchasing and installation experiences, and current conditions of the floor. Furthermore, new companies were identified, reviewed, and contacted for information.

In the first paragraph an overview will be given of the previously used manufacturers and applicators. Secondly, an overview of the identified and preferred manufacturers and applicators will be given, distributed per region. In the third paragraph, the different chemical resistant floor systems will be described per preferred applicator.

3.1 Which applicators and manufacturers have previously been used?

In the first research question, an overview was given from the selected projects. In these projects different types of chemical resistant floors were installed, consisting of different materials and installation methods.

There are always three different parties involved during the procurement and installation of the chemical resistant floors:

- Floor applicator
- Tile manufacturer
- Drain manufacturer

In previous projects, the procurement of all materials went mainly via the applicator. However, on some occasions, the procurement went via all three parties. This will be further discussed in the third research question. An overview of the used applicators and manufacturers is given on the next page.
3.2 Who are the preferred applicators and manufacturers?

As stated before, the first step was to identify and review the known applicators and manufacturers. Furthermore, a search was done to identify other applicators and manufacturers. This search was done with the use of Lotus Notes, the software Heineken uses to save data and communications from old projects. In these projects, e-mails were stored and after an intensive and time-consuming search, some new parties were identified. Also, through meetings with known parties, new applicators and/or manufacturers were identified. The third manner was with the use of Internet.

3.2.1 Chemical resistant floor applicators

The identified chemical resistant floor applicators are listed in the table on the next page. As mentioned before, several meetings took place to discuss the possibilities per applicator. However, the information is incomplete since not all companies could be scheduled for a meeting within the time span of this research.

The companies Heineken has previously worked with (Van Koetsveld, Rundmund Säureschutztechnik, Metz, ThyssenKrupp Xervon, Tekser, CSJ Recubrimientos S.A. de C.V.) all received good reviews, based on the procurement and installation experiences of the project managers, and the current conditions of the floors. However, CSJ Recubrimientos S.A. de C.V. received a somewhat negative review, which was mainly because of the old-fashioned manner of installation and the quality of the used materials. Nevertheless, it should be suggested to keep this applicator as a possibility, depending on its future development.
The unknown companies (Vibrofloors, Corrosion Engineering, Protexha, Atlas Minerals & Chemicals, Alphatherm, AB Skanfloor, ACSS, Keratek) were contacted for information, requesting an overview of the offered floor systems (and specifications) and a company profile (including references). Based on this information a selection took place and this resulted in an invitation for both Vibrofloors and Corrosion Engineering. The other companies were currently small and medium enterprises (SMEs) and therefore could not handle the size of the projects, or the cost–benefit ratio would become insufficient.

As a result of the selection process, the applicators listed below were selected. One remark about both ThyssenKrupp Xervon and Corrosion Engineering is necessary, since these companies do not install the floors themselves. They are mediators, with contacts and agreements with companies all around the world. Therefore, when requesting a quotation from either one of them, special attention must be paid to the distribution of responsibilities.
Furthermore, a geographical figure is presented with a schematic overview of the area of operations per region. The order of companies is based on preferred companies per region (as mentioned before, Heineken does not own and build breweries in North America and is therefore left out of the overview).

- **Europe**: Van Koetsveld, Rundmund Saureschutztechnik, Vibrofloors, Tekser
- **Africa**: Van Koetsveld, Rundmund Saureschutztechnik, Vibrofloors, Tekser
- **Americas**: Van Koetsveld, Vibrofloors, Corrosion Engineering
- **Asia**: Metz, ThyssenKrupp Xervon, Van Koetsveld, Vibrofloors

### 3.2.2 Chemical resistant tile manufacturers

The same process used for identifying and reviewing the applicators, was used for the tile manufacturers. An overview of the identified tile manufacturers can be found on the next page. However, the only preferred tile manufacturers will be Argelith and Zahna Fliesen.

The manufacturing of chemical resistant tiles is a very specific process and few companies in the world are able to produce tiles with the required standards. During the different meetings with applicators, it became clear that there are two companies who currently dominate the market: Argelith and Zahna Fliesen. Also, when other companies were identified, it soon became clear that the tile specifications did not meet the requirements and were therefore ruled out as possible manufacturers.
The one quality that makes the Argelith and Zahna Fliesen tiles so good and unique, is the size consistency. The deviation in length, width and thickness is remarkably low and this is very important for the installation of chemical resistant floors. The smallest deviations result in flatness deviations, inconsistent joints (between the tiles) and an overall reduction in floor quality. (Aufderhaar, 2013) (Krampe, 2014) (Koetsveld, 2014)

Therefore, the preferred tile manufacturers will be Argelith and Zahna Fliesen. In appendices D an overview is given of the technical characteristics of both the Argelith and Zahna Fliesen tiles. The test results from both manufacturers can be found in appendices E and F.

3.2.3 Drain manufacturers

The identified drain manufacturers are listed in the table below. A recommendation will be made to identify and investigate other manufacturers in a subsequent research. For the moment, the preferred manufacturers will be Blücher and Wiedemann Technik, because of the previous (positive) experience.

<table>
<thead>
<tr>
<th>Company</th>
<th>Heineken experience</th>
<th>Country</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blücher</td>
<td>Yes</td>
<td>Denmark</td>
</tr>
<tr>
<td>Wiedemann Technik</td>
<td>Yes</td>
<td>Germany</td>
</tr>
<tr>
<td>Quendal Coladeras y Trincheras</td>
<td>No</td>
<td>Mexico</td>
</tr>
<tr>
<td>Grupo Nabar del Norte</td>
<td>No</td>
<td>Mexico</td>
</tr>
</tbody>
</table>

3.3 What are the preferred chemical resistant floor systems?

In the previous paragraph the preferred applicators were selected. In this paragraph, the possible and preferred floor systems will be discussed. However, only the floor systems from Van Koetsveld and Rundmund Saureschutztechnik can yet be described.

The information about the floor systems from the other applicators is incomplete. Therefore, a recommendation will be made to invite Metz, ThyssenKrupp Xervon, Vibrofloors, Tekser, and Corrosion Engineering for a meeting and further investigate the different installation systems.
### 3.3.1 Van Koetsveld

Van Koetsveld has previously installed, and currently offers, three different chemical resistant floor systems:

- Kagetec BS System
- Kagetec GFK System
- Kagetec AR System

In appendix G the three systems are comprehensively described, and this resulted in the below listed preferences. The specifications of the used materials will not be discussed since they have proven their quality and endurance in previous projects.

**First option**  
*Kagetec AR System*

**Second option**  
*Combination Kagetec BS System / Kagetec GFK System*

**Install on existing floor**  
*Kagetec GFK System*

### 3.3.2 Rundmund Saüreschutztechnik

Rundmund Saüreschutztechnik has previously installed, and currently offers, three different chemical resistant floor systems:

- RS – Basic flooring system
- RS – 2–K synthetic resin cement flooring system
- RS – 2–K synthetic resin construction mortar flooring system

In appendix H the three systems are comprehensively described, and this resulted in the below listed preferences. The specifications of the used materials will not be discussed since they have proven their quality and endurance in previous projects.

**First option**  
*RS – 2–K synthetic resin construction mortar floor system*

**Second option**  
*RS – 2–K synthetic resin cement floor system*

**Install on existing floor**  
*RS – 2–K synthetic resin cement floor system*
4 Research question III

How can the procurement for chemical resistant floors be improved?

In research questions I and II, the first steps towards standardising the procurement have been made. In the third and final research question, the procurement itself will be discussed. In the first paragraph a description will be given of the previous procurement procedures, including an overview of the costs distribution. Secondly, an overview of both the current and preferred situation will be given, together with the desired deliverables. In the third paragraph, the alternatives for the current procurement procedure will be given.

4.1 Which procurement procedures have previously been used?

The procurement for the chemical resistant floors was previously outsourced through a consultant. This consultant created and sent a request for quotation (RFQ) to the applicators. A RFQ contains the required information about the project, the specifications and requirements for the chemical resistant floor and the required materials (appendix A). It differed per project whether the RFQ was sent to both manufacturers and applicators, or only to the applicators. As stated before, the manufacturers involved were the tile and drain manufacturers.

After the RFQ was sent, the applicators replied with a quotation. These quotations where checked by the project manager for the technical part and by the Group Purchasing for the financial part. However, during this phase three problems occurred:

- Verifying of the quoted floor system and materials by the project manager
- Comparing the different quotes by Group Purchasing
- As a result of the first two problems, the procurement caused delays and/or excessive shipping costs

Since the procurement was outsourced, and due to the lack of civil engineering knowledge within Heineken, the project managers had difficulties verifying and comparing the technical aspects of the quoted floor system. Also, when the floor system was finally checked and approved, the gained knowledge wasn’t preserved. The main reason was the limited amount of time by the project manager (the floor system is a small part of the whole building process), and since there was no civil engineering department, the gained information was not persevered. Therefore, when another project manager started a new project, the above process was repeated.

Furthermore, the quotations that were compared by Group Purchasing were created in different formats, with the different aspects of the floor system installation incomparable (since there was no reference), for two examples, see appendix I₁ and I₂. As a result, the procurement caused delays which resulted in an overall delay of the whole building process. Also, in order to reduce the delay, excessive shipping costs could arise.
4.1.1 Specified costs

There are five general costs concerning the installation of a chemical resistant floor:

- Tiles
- Stainless steel
- Installation materials
- Installation
- Transport

Tiles costs were defined by the main tile (hexagonal, rectangular or square), skirting tiles, wall tiles, and outside corners. The stainless steel costs contain the drains and gutters, as well as the angles, protection plates and expansion joints. The installation materials were defined by all materials needed to install the floor. The installation materials are too varying per system to make a summation here, but in general: equipment, epoxy, sand/cement (etc). The installation costs contained the man-hours, daily money, flight costs, accommodation, and visa. Finally, the transport costs were defined by FOB Antwerp/Rotterdam, meaning free-on-board in the selected harbour*.

* In this research, only the transport costs to FOB Antwerp/Rotterdam were taken into account. The transport costs from the harbour to the final location are too different per region to be comparable, and the transport inquiries and permits are mostly not requested out of the headquarters in Zoeterwoude. Therefore, not all the required transport information is available and due to the limited time for this research, these costs are not taken into account.

In order to get an overview of the general costs, the costs for the selected projects were specified, see appendices P1 and P2. A critical note about this overview: as stated before, a small number of projects have been selected for this research (due to the limited time span and the lack of preserved information). Therefore, the specified costs give a general idea of the situation and in order to get a full accurate overview, a larger number of projects must be selected in a future research. The average (based on the overview in appendices P1 and P2) quoted floor price per m² is €140,20, with the following average cost distribution:

<table>
<thead>
<tr>
<th></th>
<th>Tiles</th>
<th>Stainless steel</th>
<th>Installation materials</th>
<th>Installation</th>
<th>Transport</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentage</td>
<td>21%</td>
<td>20%</td>
<td>18%</td>
<td>36%</td>
<td>5%</td>
</tr>
</tbody>
</table>

![Pie chart showing cost distribution]
4.2 What is the preferred procurement procedure?

The preferred situation, for both the project managers and Group Purchasing, is when the procurement of chemical resistant floors is standardised. The first step was to gain and preserve information about the chemical resistant floors. The second step was to select a number of standard applicators and manufacturers, including a list of possible chemical resistant floor systems and materials. Both steps have been discussed in the previous research questions. The third and final step is the standardisation of the procurement.

Figure 5 shows a general schedule of the building process, where the procurement for the chemical resistant floors starts in month 8. During the tender phase the RFQ will be sent and the quotations will return, with an average duration of two months. After that the manufacturing of the chemical resistant floor materials (CRFM) will take place, and this will take about a month. (Aufderhaar, 2013) (Koetsveld, 2014) (Tietz, 2014) (Madjsberg, 2013)

The final step is the shipment, which has an average time of three months. The installation of the chemical resistant floor will start in month 14. However, as the figure shows, it could have started in month 11.

At the end of the civil preliminary design, the areas where a chemical resistant floor needs to be installed, are already known. With the help of a standard RFQ, based on the (newly acquired) internal known information, the chemical resistant floors can be procured during the detailed design. Figure 6 shows this preferred situation, where the procurement has been pushed forward, starting in month 6. As a result, three months will be saved.
4.2.1 Fixed material prices

The manufacturer Argelith was asked for an overview of the m² purchased tiles per year. Although an overview of multiple years is preferred, there was only data available for 2013. Also, this overview is not complete since the overview from Zahna-Fliesen is missing (data was not available). However, it can be assumed that the Argelith overview is a roughly estimate about the total installed m² per year, since most of the purchased tiles in 2013 were from Argelith.

<table>
<thead>
<tr>
<th>Company</th>
<th>Year</th>
<th>m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Argelith</td>
<td>2013</td>
<td>41,825</td>
</tr>
</tbody>
</table>

Furthermore, both Argelith and Zahna Fliesen were requested for a price overview for 2014, which can be found in appendices K and L. As can be seen in appendices P₁ and P₂, the average tile price/m² is €28,96 when ordered via the applicator. The used tiles were mainly hexagonal and 18mm thick, while the colours differed per project. As can be seen in the tables below, the average (from all colours) price for an hexagonal, 18mm thick tile from Argelith is €20, the Zahna Fliesen hexagonal, 18.5mm thick tile has an average price of €19.

<table>
<thead>
<tr>
<th>Argelith</th>
<th>Hexagonal</th>
<th>Rectangular / Square</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>15mm</td>
<td>18mm</td>
</tr>
<tr>
<td>Light Grey</td>
<td>€ 19,50</td>
<td>€ 21,50</td>
</tr>
<tr>
<td>Beige</td>
<td>€ 19,50</td>
<td>€ 21,50</td>
</tr>
<tr>
<td>Sand Yellow</td>
<td>€ 20,50</td>
<td>€ 22,50</td>
</tr>
<tr>
<td>Arkona White</td>
<td>€ 20,50</td>
<td>€ 22,50</td>
</tr>
</tbody>
</table>
This price difference is explainable due to the margins charged by the applicator. Also, the applicator can decide to reduce the guarantee of the system when the materials are ordered directly via the manufacturer. However, when tiles are used from the same manufacturer, whether ordered via the applicator or directly via the manufacturer, the specifications will not differ. A simple calculation with use of the 41.825 m² and the price difference of the Argelith tiles (purchased via applicator [€28,96] or directly [€20]), results in an amount of €374.752. This is the amount (roughly) that can be saved on yearly basis, by purchasing directly from Argelith. In addition, the Zahna Fliesen tile can reduce this costs even more because of the lower tile prices.

Furthermore, the determined tile requirements in appendix C show that an 15mm tile is sufficient as well, and this will (especially on the long-term) reduce the costs even further.

4.3 What is a suitable alternative for the current procurement procedure?

In order to realise the preferred procurement procedure, a standard RFQ must be created with the following items:

- Standard Request for Quotation format
- Standard Bill of Quantities format
- Standard Buyer & Seller Obligations format

4.3.1 Standard Request for Quotation format

As stated before, the previous used RFQ’s were created by consultant companies. With the use of the requirements defined in the first research question, a new RFQ has been drafted. At this moment, the drafted RFQ is being checked and will be revisited if needed. Therefore, the RFQ will not be attached in this thesis.

4.3.2 Standard Bill of Quantities format

In order to compare the different quotations (from applicators), and to check the future quotations for other increasing costs (as a result of the fixed prices with manufacturers), a standard bill of quantities (BOQ) has been created which can be filled in by the applicators. The BOQ has been divided into fillable sheets, based on the different costs: tiles, stainless steel, installation materials, installation, transport.

On the basis of this cost distribution, the different quotations can be properly compared by Group Purchasing. On example of this drafted BOQ can be found in appendix M.
4.3.3 Standard Buyer & Seller Obligations format

The general terms and conditions agreed between the buyer (Heineken) and seller differ per procurement (in general). In previous chemical resistant floor projects, Group Purchasing had to draft and fill the Buyer & Seller Obligations. Since the lack of knowledge about the chemical resistant floors and installation system, this process was time consuming. Therefore, a standard Buyer & Seller Obligations format has been created and can be found in appendix N.

4.3.4 ARW 2012 and STABU catalog

The ARW 2012 (in Dutch: Aanbestedingsreglement van Werken) contains regulations about different procurement procedures. These procedures are not required for Heineken (since it is a private company instead of a public one) but they can be helpful as a guideline. The ARW 2012 procurement regulations contains, among others, information about open and restricted procedures, both national and European (STABU, 2008). For Heineken, the restricted European procedures are most relevant since the procurement and accompanied request for quotations are send to a selected group of (international) applicators and manufacturers. The ARW 2012 itself will not be added as an appendix in this research, since it contains 243 pages, with the information about the restricted procedure beginning on page 42 (for the website, see bibliography). Also, in this thesis the regulations of the ARW 2012 will not be compared with the Heineken procurement, but a recommendation will be made to do so in a later stadium. The same goes for the Dutch STABU catalog, which can be useful since it contains standardised texts which Heineken (or a client in general) can use for the request for quotation (STABU-catalog, 2008).
5 Conclusions and recommendations

All the research questions are discussed and answered, which now leads to the conclusion and recommendations.

It can be concluded that standardising the procurement will be beneficial in terms of time and costs. The first step is to choose a fixed group of applicators and manufacturers, with the possible floor systems and available materials known upfront. As a result, the preferred system and materials can be stated in the request for quotation. Furthermore, an early procurement (with the materials purchased during the detailed design phase) will save three months, and unforeseen delays can be prevented or captured. In addition, consultants can be excluded and fixed prices with manufacturers can be negotiated, which both result in the reducing of time and costs.

As a result of these fixed prices, an overview must be kept of the cost distribution, based on the applicators quotations. In this manner, the extra charged margins quoted by the applicators (as a result of the fixed prices with the manufacturers) will be clearly visible.

Moreover, the market of appropriate chemical resistant floor applicators and manufacturers is small, so it is questionable whether a tender phase is meaningful. The previous years have shown that almost every floor system is installed by the same applicators, and almost all materials came from the same manufacturers. Therefore, it might be an option to collaborate with these companies in order to develop a customised floor system. Also, new applicators and/or manufacturers can be awarded with a small project in order to explore these companies and thus the market.

Finally, a summation of various conclusions and/or recommendations:

- Develop or amplify knowledge management, in order to preserve all internal known information about the chemical resistant floors. In addition, increase coordination between projects managers (sharing experiences).
- Request method statement from the applicators for the pouring of the concrete.
- Request interface document that shows the clear split in work between the applicator and the civil contractor.
- Identify and investigate other stainless steel manufacturers in a subsequent research.
- Invite Tekser, Vibrofloors, ThyssenKrupp Xervon, and Metz for a meeting and further investigate their different installation systems.
- Review the ARW 2012 and STABU catalog in a subsequent research, as it contains useful guidelines for standardised procurement.
Glossary

Breaking strength  The greatest stress in tension that a material is capable of withstanding without rupture

Brownfield  Expending of a brewery

Expansion joint  Assembly designed to safely absorb the heat-induced expansion and contraction of construction materials

Greenfield  New brewery

Heat resistant  Heat property and a measurement of a temperature difference by which an object or material resists a heat flow

Maximum slope  Constructed line that refers to the inclination of that surface to the horizontal

Mechanical load  Load that is made, performed, or operated by or as if by a machine or machinery

Modulus of rupture  Material’s ability to resist deformation under load

Screed  Combination of sand/cement/water to flatten underlying concrete

Size consistency  Shows how much variation deviation in size is allowed

Thermal expansion  The change in volume of a material in response to a change in temperature
Bibliography


Appendices

Appendix A – Request for quotation
Appendix B – Functional requirements
Appendix C – Technical requirements
Appendix D – Technical characteristics Argelith and Zahna
Appendix E – Test results Argelith
Appendix F – Test results Zahna Fliesen
Appendix G – Van Koetsveld floor systems
Appendix H – Rundmund Saureschutztechnik floor systems
Appendix I₁ – Quotation example
Appendix I₂ – Quotation example
Appendix J – Price overview Argelith
Appendix K – Price overview Zahna Fliesen
Appendix L – Bill of Quantity
Appendix M – Buyer & Seller Obligations
Appendix N – DIN-EN-ISO 18202
Appendix O – Overview meetings
Appendix P₁ – General costs overview
Appendix P₂ – Specific costs overview
Appendix A – Request for quotation

Greenfield Brewery Kilinto
Tender Chemical Resistant Tiling

Heineken

30 July 2013
Final Report
9X6075
Document title: Greenfield Brewery Killinto
Document short title: Tender Chemical Resistant Tiling
Status: Final Report
Date: 30 July 2013
Project name: Greenfield Brewery Killinto
Project number: 9X8075
Client: HEINEKEN Supply Chain Services
Reference: 9X8075/R00009/800145/Rott

Drafted by: A.C.P. Hüscher
Checked by: J.M.A. van Klaskonk
Date/initials check: .................. ..................
Approved by: Mr. A.T.M. de Jong
Date/initials approval: .................. ..................

HEINEKEN Supply Chain B.V.

Bachelor Thesis – Chemical Resistant Floors

A company of Royal HaskoningDHV
## CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 INSTRUCTIONS TO QUOTE</td>
<td></td>
</tr>
<tr>
<td>1.1 Instructions to bidders</td>
<td>1</td>
</tr>
<tr>
<td>1.2 Documents</td>
<td>1</td>
</tr>
<tr>
<td>1.3 Preparation and delivery of the quote</td>
<td>1</td>
</tr>
<tr>
<td>1.4 Scope of works</td>
<td>2</td>
</tr>
<tr>
<td>1.5 Shipment</td>
<td>3</td>
</tr>
<tr>
<td>1.6 Floor construction</td>
<td>3</td>
</tr>
<tr>
<td>1.6.1 Brew House, CA/CL, Additive Dosing, Engine room 2, Water</td>
<td>3</td>
</tr>
<tr>
<td>Treatment Plant, Chemical Store and Dosing, Causcit</td>
<td></td>
</tr>
<tr>
<td>Preparation, Chemical Store, Causitic</td>
<td></td>
</tr>
<tr>
<td>1.6.2 Packaging Hall, FST/BBT Area, Spent Grain, Waste Yeast</td>
<td>3</td>
</tr>
<tr>
<td>1.6.3 Battery Charging</td>
<td>3</td>
</tr>
<tr>
<td>1.7 Wall structures</td>
<td>3</td>
</tr>
<tr>
<td>1.8 Installation on site and time schedule</td>
<td>3</td>
</tr>
<tr>
<td>1.9 Bid, bid sum and bid currency</td>
<td>8</td>
</tr>
<tr>
<td>1.10 Purchase conditions</td>
<td>8</td>
</tr>
<tr>
<td>1.11 Information requested from the vendor</td>
<td>8</td>
</tr>
<tr>
<td>1.12 Guaranty</td>
<td>8</td>
</tr>
<tr>
<td>1.13 Validity of bid</td>
<td>8</td>
</tr>
<tr>
<td>1.14 Adjustments</td>
<td>9</td>
</tr>
<tr>
<td>1.15 No obligation</td>
<td>9</td>
</tr>
<tr>
<td>1.16 Shop drawings</td>
<td>9</td>
</tr>
<tr>
<td>1.17 Language of communication</td>
<td>9</td>
</tr>
<tr>
<td>1.18 Travel and lodging</td>
<td>9</td>
</tr>
<tr>
<td>2 TECHNICAL SPECIFICATION</td>
<td>10</td>
</tr>
<tr>
<td>2.1 Floor tiles and plinth tiles</td>
<td></td>
</tr>
<tr>
<td>2.1.1 Tile shaping</td>
<td>10</td>
</tr>
<tr>
<td>2.1.2 The tiles shall be dry pressed clinker tiles or equal approved.</td>
<td>10</td>
</tr>
<tr>
<td>Classification according to EN 178:1995 is Class B1.</td>
<td>10</td>
</tr>
<tr>
<td>2.1.3 Required tile qualities according to the table:</td>
<td>10</td>
</tr>
<tr>
<td>2.2 Sealing and divisional layers</td>
<td>11</td>
</tr>
<tr>
<td>2.2.1 Protective sheet</td>
<td>11</td>
</tr>
<tr>
<td>2.2.2 Bedding screed</td>
<td>11</td>
</tr>
<tr>
<td>2.3 Screed Admixtures for heavy load floors</td>
<td>11</td>
</tr>
<tr>
<td>2.3.2 Stress relief layer for floors exposed to heat shock</td>
<td>11</td>
</tr>
<tr>
<td>2.4 Tile bedding grout</td>
<td>11</td>
</tr>
<tr>
<td>2.5 Expansion / movement joints</td>
<td>11</td>
</tr>
<tr>
<td>2.6 Jointing grout</td>
<td>12</td>
</tr>
<tr>
<td>2.7 Spare tiles</td>
<td>12</td>
</tr>
<tr>
<td>2.8 Installation method of floor tiles</td>
<td>12</td>
</tr>
<tr>
<td>2.9 Tile joint detail</td>
<td>12</td>
</tr>
<tr>
<td>2.10 Installation and supply of stainless steel drainage system</td>
<td>13</td>
</tr>
<tr>
<td>3 APPENDICES</td>
<td>15</td>
</tr>
</tbody>
</table>

Final Report 30 July 2013
1 INSTRUCTIONS TO QUOTE

Employer: Heineken Supply Chain Services
Consulting Engineer: Royal HaskoningDHV Rotterdam
Project: Greenfield Brewery Kllintto, Akaki Kality sub city, Ethiopia
Subject: Chemical resistant floor tile finish

1.1 Instructions to bidders

The bidder is to read carefully the instructions set out below and no claim will be entertained on the grounds of failure to read or comply with these instructions nor for any alleged misunderstanding of their import.

1.2 Documents

The documents and drawings that are listed hereinafter comprise the information that is made available to the bidder for the purpose of preparing and submitting of a lump sum quote for the chemical resistant tile finish at the Greenfield Brewery Kllintto, Akaki Kality area, Ethiopia.

The complete set of documents consists of:

Instructions to Quote
Specifications

Appendices
Breakdown of Bid sum / Contract Bills
Lists of drawings with drawings attached
Purchase conditions (Heineken)

It is the bidder’s responsibility to examine carefully the whole of the documents and to satisfy himself that he understands their full import severally and jointly. No claim will be entertained on the grounds that the vendor failed to see any of the documents.

1.3 Preparation and delivery of the quote

The quote shall be made in the English language. The quotation together with the breakdown of the sum shall be submitted in a hard copy (one original and one copy) and digital files, addressed and delivered to the address stated below at the date and time mentioned in the invitation letter.

Quote for: Greenfield Brewery Kllintto, Akaki Kality sub city, Ethiopia
Chemical resistant floor tiling

Addresses to: Heineken Supply Chain Services
Purchasing Department
Attn. Mr. Tjeerd Melj
Burgemeester Streetsweg 1
2382 PH Zoeterwoude
Tjeerd.melj@heineken.com

Final Report - 1 - 30 July 2013
1.4 Scope of works

The works consists out of the supply and installation of a chemical resistant hexagonal floor tiles including skirting and rectangular tiles, installed according the vibration method included the installation and supply of stainless steel channel drains and grating, stainless steel profiles, joints in the work-related buildings or area’s. Some areas will have square wall tiles up to 1,5m+ finished floor level. Various drainage pits have already been cast in.

Work-related buildings or areas:

**Building B:**
- Brew House
- CA/CL and Additive Dosing
- Spent Grain and Waste Yeast Silo Slab

**Building C:**
- Engine room 2
- Water Treatment Plant
- Chemical Store and Dosing
- Caustic Preparation
- Chemical Store
- Caustic Settling Tanks

**Building E:**
- Packaging Hall
- Battery Charging
- FST and BBT tank area
- Underneath Pipe bridge

The works include all plinths, joints, expansion joints, joint protection profiles, thresholds, make good of cut away area’s for process equipment legs/blocks. Bill of Quantities, to be prepared by the supplier.

In addition following works:
The preparation of shop drawings showing at least the levels with the typical details and tile patterns for expansion joint, expansion joints in traffic area’s, skirting detail, skirting detail around square column, wall tiles, tiled area around a round column of stainless steel and reinforced screed area, transition between different floor finishing surfaces, thresholds, stainless steel gutters.

An installation manual to be prepared in the English language.
1.5 Shipment

The chemical resistant tiles together with special additives and jointing material as well as stainless steel protection profiles and special tools to be packed in second-hand (certified) shippers owned containers which are included in the lump sum price. Details packing lists to be prepared. It is assumed that it will be one supply/delivery to site.

The supply of ordinary sand and cement is out of scope of the bidder. The specifications of the sand-cement screed and quantities required for the works to be indicated within this bid, however to be supplied by the civil contractor.

1.6 Floor construction

1.6.1 Brew House, CA/CL, Additive Dosing, Engine room 2, Water Treatment Plant, Chemical Store and Dosing, Caustic Preparation, Chemical Store, Caustic Settling Tanks

The foundation of the reinforced concrete floor is a concrete slab on footings. The concrete ground slab is horizontal, the screed layer on top of this concrete slab will have a sloped surface towards the drainage system. The installation of the screed layer on top of the concrete floor and around and below the gutters is also part of scope tiling works. The stainless steel channel drains to be installed in the block-out areas.

1.6.2 Packaging Hall, FST/BRBT Area, Spent Grain, Waste Yeast

The foundation of the reinforced concrete floor is a so called: “slab on grade” system. The concrete floor will be sloped towards the drains with fall of approx. 1cm per meter. The installation of the screed layer on top of the concrete floor and around and below the gutters is also part of scope tiling works. The stainless steel channel drains to be installed in the block-out areas.

1.6.3 Battery Charging

The foundation of the reinforced concrete floor is a so called: “slab on grade” system. The concrete ground slab is horizontal, the screed layer on top of this concrete slab will also be horizontal.

1.7 Wall structures

The walls of the Chemical Store and Dosing, Caustic Preparation, Chemical Store, Caustic Settling Tanks to be tiled up to 1,5m+ finished floor level. Structures are reinforced concrete and block work.

1.8 Installation on site and time schedule

The brewery premises is known and located at the address as written below:

Akaki Kality sub city, which is located approximately 17 km south of Addis Ababa, Ethiopia

---

Final Report 30 July 2013

Bachelor Thesis – Chemical Resistant Floors

HEINEKEN Supply Chain B.V.
The following milestones for the installation have been determined for the project and will be applicable.

In addition the floor surfaces have roughly been indicated.

**Site layout with indication of areas:**

**Building B:**
- Brew House
- CA/CL and Additive Dosing
- Spent Grain and Waste Yeast Silo Slab

**Building C:**
- Engine room 2
- Water Treatment Plant
- Chemical Store and Dosing
- Caustic Preparation
- Chemical Store
- Caustic Settling Tanks
Building E:
- Packaging Hall
- Battery Charging
F: FST and BBT tank area:
- Underneath Pipe bridge
<table>
<thead>
<tr>
<th>Item</th>
<th>area</th>
<th>Start</th>
<th>finish</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shipment Materials to site</td>
<td></td>
<td>September 2013</td>
<td>Wk 39</td>
</tr>
</tbody>
</table>

**BUILDING B**

1. Brew House

<table>
<thead>
<tr>
<th>Item</th>
<th>area</th>
<th>Start</th>
<th>finish</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tiling and Installation gutters</td>
<td>Approx, 1004 m²</td>
<td>December 2013</td>
<td>December 2013</td>
</tr>
<tr>
<td>Tiling</td>
<td>Approx, 9 x 77 m²</td>
<td>December 2013</td>
<td>December 2013</td>
</tr>
</tbody>
</table>

2. CA/CL and Additive Dosing

<table>
<thead>
<tr>
<th>Item</th>
<th>area</th>
<th>Start</th>
<th>finish</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tiling</td>
<td>Approx, 2x25 m²</td>
<td>March 2014</td>
<td>March 2014</td>
</tr>
</tbody>
</table>

**BUILDING C**

4. Engine room 2

<table>
<thead>
<tr>
<th>Item</th>
<th>area</th>
<th>Start</th>
<th>finish</th>
</tr>
</thead>
<tbody>
<tr>
<td>Installation gutter</td>
<td>Approx, 8.8 m³</td>
<td>December 2013</td>
<td>December 2013</td>
</tr>
<tr>
<td>Tiling and Installation gutters</td>
<td>Approx, 322 m²</td>
<td>January 2014</td>
<td>January 2014</td>
</tr>
</tbody>
</table>

5. Water Treatment Plant

<table>
<thead>
<tr>
<th>Item</th>
<th>area</th>
<th>Start</th>
<th>finish</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tiling and Installation gutters</td>
<td>Approx, 26 m²</td>
<td>January 2013</td>
<td>January 2014</td>
</tr>
<tr>
<td>Wall Tiles</td>
<td>Approx, 116 m²</td>
<td>January 2013</td>
<td>January 2014</td>
</tr>
</tbody>
</table>

6. Chemical Store and Dosing

<table>
<thead>
<tr>
<th>Item</th>
<th>area</th>
<th>Start</th>
<th>finish</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tiling</td>
<td>Approx, 62 m²</td>
<td>January 2013</td>
<td>January 2014</td>
</tr>
<tr>
<td>Wall Tiles</td>
<td>Approx, 116 m²</td>
<td>January 2013</td>
<td>January 2014</td>
</tr>
</tbody>
</table>

7. Caustic Preparation

<table>
<thead>
<tr>
<th>Item</th>
<th>area</th>
<th>Start</th>
<th>finish</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tiling</td>
<td>Approx, 271 m²</td>
<td>January 2014</td>
<td>January 2014</td>
</tr>
<tr>
<td>Wall tiles</td>
<td>Approx, 96 m²</td>
<td>January 2014</td>
<td>January 2014</td>
</tr>
</tbody>
</table>

9. Caustic Settling Tanks

<table>
<thead>
<tr>
<th>Item</th>
<th>area</th>
<th>Start</th>
<th>finish</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tiling</td>
<td>Approx, 80 m²</td>
<td>March 2014</td>
<td>March 2014</td>
</tr>
<tr>
<td>Wall tiles</td>
<td>Approx, 52 m²</td>
<td>March 2014</td>
<td>March 2014</td>
</tr>
</tbody>
</table>

**BUILDING E**

10. Packaging Hall

<table>
<thead>
<tr>
<th>Item</th>
<th>area</th>
<th>Start</th>
<th>finish</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tiling and Installation drains</td>
<td>Approx, 8188 m²</td>
<td>January 2014</td>
<td>February 2014</td>
</tr>
</tbody>
</table>

11. Battery Charging

<table>
<thead>
<tr>
<th>Item</th>
<th>area</th>
<th>Start</th>
<th>finish</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tiling</td>
<td>Approx, 96 m²</td>
<td>March 2014</td>
<td>March 2014</td>
</tr>
<tr>
<td>FST and BBT tank area F</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>------------------------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. Underneath Pipe bridge</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tiling and installation drains</td>
<td>Approx. 177 m²</td>
<td>March 2014 Wk 10</td>
<td>March 2014 Wk 11</td>
</tr>
</tbody>
</table>

* All areas with coved skirting tiles height > 100 mm height included corner places

Main time schedule:
End of week 2013-33: Submission of bid
Week 2013-35: Contract award
Week 2013-36: Shop drawings for approval
Week 2013-39: All material packed, ready for shipment to Ethiopia
Week 2013-46: Custom clearance and transport to brewery
Week 2013-49: Materials at brewery premises ready to use
1.9 Bid, bid sum and bid currency

The quotation and all other prices and rates in the documents shall be expressed in Euro.

The total contract sum will be a lump sum based on the Bill of Quantities, using the indicated unit rates for materials and labour for the duration of the contract.

1.10 Purchase conditions

General Purchasing Terms and Conditions (Heineken)
See Appendix.

1.11 Information requested from the vendor

The vendor shall submit in addition to his offer:
- Bill of Quantities;
- Method statement for installation of floor and wall tiles;
- Curling time required for the tiled floor;
- Built-up of the floor finish system for normal, heavy traffic and heat shock condition, included bedding screed and bonding information;
- Typical detail of offered tile system, at least plinth, gutter, column (round and square) connection, expansion joint, walls, etc;
- Expansion and movement joints;
- Typical floor pattern also related to above indicated typical details;
- Sample offered hexagonal and square tiles;
- Teams on site, number of persons and key person;
- Time schedule to be confirmed include number of worker;
- Format warranty statement.

1.12 Guaranty

The floor finish must be guaranteed for a period of 10 years against defects in the tile finish/system caused by wear and tear and not caused by inappropriate use. A formatted warranty statement shall be submitted with the bid submission.

1.13 Validity of bid

The bid shall remain a valid offer, open for acceptance at any time up to 60 days from the date of submission.
1.14 Adjustments

The employer, or the Consulting Engineer on his behalf, reserves the right to discuss with a vendor any adjustments in the quote and rates of the bill of quantities.

1.15 No obligation

The Employer will not reimburse the bidder for cost incurred in the preparation of the offer, nor is the Employer obliged to accept the lowest quote. The Employer also reserves the right to cancel the procedure. Should this situation arise, no compensation whatsoever regarding cost of preparation of the offer will be allowed to the vendor.

1.16 Shop drawings

The preparation of shop drawings, showing isometric projection of the process drainage system is part of the scope of works of the supplier. The final shop drawings to comply with the latest information as submitted by the process equipment suppliers and updated civil drawings. The drawings to be approved by the consulting engineer.

These costs are deemed to be included in the quotation.

1.17 Language of communication

The language of communication between the Employer, bidder and the Consulting Engineer shall be English. All letters, documents and other written forms of communication during tender phase are in English.

The representative of the supplier at site should be capable speaking and reading English language.

1.18 Travel and lodging

The costs for flight tickets and travel documents need to be included in the bid. The costs for transport and lodging will be included in the bid.
2 TECHNICAL SPECIFICATION

2.1 Floor tiles and plinth tiles

2.1.1 Tile shaping

The tiles shall be dry pressed clinker tiles or equal approved.

Classification according to EN 176:1992 is Class B1.

Preferred/reference tile supplier: Argelith, Germany

2.1.2 Required tile qualities according to the table:

<table>
<thead>
<tr>
<th>Properties</th>
<th>Required</th>
<th>ISO/EU-Norm</th>
<th>For</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floor tile pattern</td>
<td>hexagonal</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>tile top surface</td>
<td>smooth surface</td>
<td>EN 10545-2:1997</td>
<td>surface properties</td>
</tr>
<tr>
<td>Thickness</td>
<td>18 mm</td>
<td>EN 10545-2:1997</td>
<td>dimension</td>
</tr>
<tr>
<td>form and dimension of tiles</td>
<td>Hexagonal 108x125mm, only rectangular 100x200mm near joints and drains etc</td>
<td>EN 10545-3:1997</td>
<td></td>
</tr>
<tr>
<td>Wall tile pattern</td>
<td>square</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thickness</td>
<td>15 mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>form and dimension of tiles</td>
<td>Square 198x198mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>resistance to stains</td>
<td>Light grey</td>
<td>EN 10545-14:1997</td>
<td></td>
</tr>
<tr>
<td>colour</td>
<td></td>
<td>EN 10545-16:1997</td>
<td>To be sampled</td>
</tr>
<tr>
<td>water absorption</td>
<td>&lt; 0.5%</td>
<td>EN 10545-3:1997</td>
<td></td>
</tr>
<tr>
<td>modules of rupture</td>
<td></td>
<td>EN 10545-4:1997</td>
<td></td>
</tr>
<tr>
<td>compressive strength</td>
<td>&gt;150 N/mm²</td>
<td></td>
<td></td>
</tr>
<tr>
<td>resistance to collision</td>
<td></td>
<td>EN 10545-5:1997</td>
<td></td>
</tr>
<tr>
<td>resistance to deep abrasion</td>
<td>max. 10 cm³/50cm²</td>
<td>EN 10545-6:1999/C1:99</td>
<td>test method</td>
</tr>
<tr>
<td>linear thermal expansion</td>
<td></td>
<td>EN 10545-8:1996</td>
<td>test method</td>
</tr>
<tr>
<td>thermal shock resistance</td>
<td>Required</td>
<td>EN 10545-9:1996</td>
<td>test method</td>
</tr>
<tr>
<td>resistance to acid and lye</td>
<td>Required</td>
<td>EN 10545-13:1997</td>
<td></td>
</tr>
<tr>
<td>skirting tiles</td>
<td>height &gt; 100 mm</td>
<td>See requirement for floor tiles, covered bottom, also inside</td>
<td></td>
</tr>
</tbody>
</table>
### 2.2 Sealing and divisional layers

#### 2.2.1 Protective sheet

A bonded floor screed with use of bonding agent has been emphasized however the supplier may advice for a non bonded system. In all cases the recommended system to be motivated by the supplier.

### 2.3 Bedding screed

The bedding specified with minimum thickness of 50 mm.

The bedding screed shall be a mixture of sand, cement and modification admixtures, with the following characteristics:

- Average Compressive strength: \( 21.0 \text{ N/mm}^2 \)
- Average Tensile strength: \( 2.0 \text{ N/mm}^2 \)
- Average Shear bond strength: \( 3.5 \text{ N/mm}^2 \)

Supplier shall provide with his quote-submission, information about materials (composition, thickness etc.).

#### 2.3.1 Screed Admixtures for heavy load floors

Admixtures used for bedding and setting of floor tiling in areas with heavy (traffic) loads:

- Building B and C.

#### 2.3.2 Stress relief layer for floors exposed to heat shock

Stress relief layer (and possible other materials) used for bedding of floor tiling in areas subjected to heat shock.

### 2.4 Tile bedding grout

System to be motivated by the bidder.

### 2.5 Expansion / movement joints

Bidder shall provide and install chemical resistant polyethylene or similar material at movement / expansion joints. Sketch with proposed panel layout is included in the attachment.
Movement / expansion joints in longitudinal direction shall be at the construction joints, which are located as shown in the floor plans, if any.
The expansion / movement joint materials shall have the same degree of chemical resistance as the tiles.
Movement joint shall also be provided at least wall junctions, pillars, columns and fixed built-in elements and other elements which penetrate the surface of the floor.

2.6 Jointing grout

The jointing grout material shall be of the same chemical resistance as the floor tiles.
The water absorption rate shall be lower than 0.3%.
The supplier shall submit the form of the tile joint.

2.7 Spare tiles

The supplier shall supply sufficient materials to allow for breakage, cutting-losses, etc.
In addition 5% extra materials must be handed over to the buyer as spare.

2.8 Installation method of floor tiles

The method of installation of the floor tiles shall be a vibration process.
The equipment items are, in general, all standing with stainless steel legs on top of the tiled floor.

2.9 Tile joint detail

The supplier shall state in his offer the minimal / maximal dimensions of the joint width and depth.
2.10 Installation and supply of stainless steel drainage system

The stainless steel drainage channels, to be installed and connected (push-fit system) in the dedicated area/silo-ceil-outs. The supplied drains are from BLÜCHER or other trademark using similar systems. A typical installation manual of the materials supplied by this company must be made available at site, and all materials to be installed accordingly.

The drain channel with adjustable legs to be jointed together or welded system (section of < 8 meter supplied, gasket bolts, push fit pipe/outlet box connection), put in place and to be lined afterward, concrete to be poured around.

Following drains, but not limited to, to be installed as indicated in the table:

<table>
<thead>
<tr>
<th>Item</th>
<th>Area</th>
<th>Width (m)</th>
<th>Length</th>
<th>Min HS</th>
<th>Max HS</th>
<th>Diameter of outlet (D)</th>
<th>No of outlets</th>
</tr>
</thead>
<tbody>
<tr>
<td>300 mm</td>
<td>1. BH</td>
<td>300 mm</td>
<td>7.5 m</td>
<td>175</td>
<td>0.5%</td>
<td>OD 150 mm</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>300 mm</td>
<td>290.0 m</td>
<td>175</td>
<td>0.5%</td>
<td>OD 100 mm</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>300 mm</td>
<td>90.0 m</td>
<td>175</td>
<td>0.5%</td>
<td>OD 100 mm</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>300 mm</td>
<td>8.4 m</td>
<td>175</td>
<td>0.5%</td>
<td>OD 150 mm</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>300 mm</td>
<td>8.4 m</td>
<td>175</td>
<td>0.5%</td>
<td>OD 150 mm</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>300 mm</td>
<td>8.4 m</td>
<td>175</td>
<td>0.5%</td>
<td>OD 150 mm</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>300 mm</td>
<td>8.4 m</td>
<td>175</td>
<td>0.5%</td>
<td>OD 150 mm</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>300 mm</td>
<td>10.0 m</td>
<td>175</td>
<td>0.5%</td>
<td>OD 150 mm</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>300 mm</td>
<td>7.0 m</td>
<td>175</td>
<td>0.5%</td>
<td>OD 150 mm</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>3. SGWY</td>
<td>300 mm</td>
<td>5.5 m*</td>
<td>175</td>
<td>0.5%</td>
<td>OD 160 mm</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>300 mm</td>
<td>5.5 m*</td>
<td>175</td>
<td>0.5%</td>
<td>OD 160 mm</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>4. SIT2</td>
<td>300 mm</td>
<td>6.8 m</td>
<td>175</td>
<td>0.5%</td>
<td>OD 90 mm</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>5. WTP</td>
<td>300 mm</td>
<td>9.0 m</td>
<td>175</td>
<td>0.5%</td>
<td>OD 90 mm</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>300 mm</td>
<td>9.0 m</td>
<td>175</td>
<td>0.5%</td>
<td>OD 90 mm</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>10. PH</td>
<td>300 mm</td>
<td>99.8 m**</td>
<td>175</td>
<td>0.5%</td>
<td>OD 900 mm</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>300 mm</td>
<td>49.8 m*</td>
<td>175</td>
<td>0.5%</td>
<td>OD 900 mm</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>12. FSTI</td>
<td>300 mm</td>
<td>66 m</td>
<td>175</td>
<td>0.5%</td>
<td>OD 900 mm</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

Stainless steel ladder grating
* Stainless steel grating, heavy duty, 7000 kg.
** Partly closed stainless steel cover grating over 6,9m1

<table>
<thead>
<tr>
<th>Item</th>
<th>Area</th>
<th>Width</th>
<th>Length</th>
<th>Diameter of outlet (D)</th>
<th>No of pieces</th>
</tr>
</thead>
<tbody>
<tr>
<td>S.S. Glass cabinet (incl. filter basket and s.s grating)</td>
<td>10. PH</td>
<td>300 mm</td>
<td>815 mm</td>
<td>OD 125 mm</td>
<td>2 pcs</td>
</tr>
<tr>
<td></td>
<td>300 mm</td>
<td>815 mm</td>
<td>OD 160 mm</td>
<td>3 pcs</td>
<td></td>
</tr>
<tr>
<td></td>
<td>300 mm</td>
<td>815 mm</td>
<td>OD 900 mm</td>
<td>1 pcs</td>
<td></td>
</tr>
</tbody>
</table>

Final Report - 30 July 2013
Refer to Appendix for specification of some of the above mentioned items by Blücher.
3 APPENDICES

A. Breakdown of Bid sum / Bill of Quantities
B. Lists of drawings
C. Purchase conditions
D. Supplier & customer obligation form
A. Breakdown of bid sum / Bill of quantities

The following cost information to be submitted:

**Bill of quantities:**
The bidder to prepare a clear bill of quantities.
The cost to be indicated per item and quantity; unit divided in materials and installation costs in Akul Kality, Ethiopia.
In addition the day rates for labour and equipment to be indicated.

**Container and shipment:**
The cost to be indicated for the transport of the bulk of the materials to Antwerp FOB, included the cost for the shippers owned containers to be indicated.

**Preparation shop drawings**
The cost to be indicated for the preparation drawings.
B. List of drawings

Building B:
[1] Brew House
[2] CA/CL and Additive Dosing
[3] Spent Grain and Waste Yeast Silo Slab

Building C:
[4] Engine room 2
[5] Water Treatment Plant
[6] Chemical Store and Dosing
[7] Caustic Preparation
[8] Chemical Store
[9] Caustic Settling Tanks

Building E:
[10] Packaging Hall

FST and BBT tank area F:
[12] Underneath Pipe bridge

[16] Specification of Annular grating by Bööcher;
[17] Specification of removable water trap by Bööcher;
[18] Specification of filter basket by Bööcher;
[19] Civil drawings, for your information.

The information submitted in the specification prevails over the drawings.
C. Purchase conditions

General purchasing terms and conditions Heineken
Separately attached.
D. Supplier & customer obligation form

Separately attached.

---
Appendix B – Functional requirements

Mechanical load
The dynamic mechanical load on the floors comes from hand palletizers and forklifts, the static mechanical load comes from the equipment (tanks, packaging machines). At this moment there is no information available about the values of these loads. However, there are no experiences known where the floor was damaged because of these loads. Therefore, the mechanical load will be defined as hand palletizer.

Chemical resistance and chemicals used
The chemicals used during the brewing process differ widely per brewery. However, some commonly used chemicals per area can be used as a basic requirement and will be listed below. (Bent, 2013) (Past, 2013) (Tiktak, 2013)

WTP
- Reverse osmosis
- Brine
- HCl

WWTP
- NaOH (sodium hydroxide, also known as caustic soda)
- HCl (hydrochloric acid)
- FeCl₃

Brew house, service block, cellars
Cleaning chemicals:
- HCL
- NaClO₂
- Anti scailant
- FeCl₃
- Biocide
- NaOH

Packaging
- Naoh
- H₃PO₄ (Phosphoric acid)
- Biocides
- HCl
- NaClO₂
- Anti scailant
- FeCl₃
Heat resistance and thermo shock
Currently there are very few heat shocks at the breweries. This is because of the installed fixed drain points, so the water is directly poured into the drains. Only at the filling line (packaging) a real heat shock occurs, but this is a distributed spill of 5 minutes per day (average) with the water temperature between 60–80°C, and sporadic 85°C. (Past, 2013)

Below are some other areas listed worth mentioning. (Past, 2013)

- Clean in place (CIP) unit
  - One or two times per week small sprinkle with caustic soda temperature 60–80°C

- Filling line
  - Caustic soda temperature 60–80°C, sporadic 85°C
  - Distributed spill of 5 minutes per day

- Pasteurizer
  - Water overflow

- Washing machine
  - Continued flow with water temperature 50–55°C (only polluted, not aggressive)
  - Sporadic a water temperature of maximum 80°C

Maximum slope
In consultation with the chemical resistant floor applicators and based on previous projects, the minimum slope has been determined to be 15mm/m.

Flatness
The flatness tolerances for the concrete are determined according to DIN–EN–ISO 18202, see appendix O.

<table>
<thead>
<tr>
<th>Distance between measuring points (m) up to</th>
<th>0.1</th>
<th>1</th>
<th>4</th>
<th>10</th>
<th>15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Limit values (mm)</td>
<td>1</td>
<td>3</td>
<td>9</td>
<td>12</td>
<td>15</td>
</tr>
</tbody>
</table>

Colour
Different colours have been used in previous installed chemical resistant floors. As a part of the standardisation, three colours per tile manufacturer are selected.

<table>
<thead>
<tr>
<th>Argelith</th>
<th>Zahna Fliesen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arkona White</td>
<td>Lichtgrau uni</td>
</tr>
<tr>
<td>Light Grey</td>
<td>Weiß ubi</td>
</tr>
<tr>
<td>Beige</td>
<td>Gelb uni</td>
</tr>
<tr>
<td>Sand Yellow</td>
<td></td>
</tr>
</tbody>
</table>
The selected colours are light because of the following advantages:

- Cleanability: a light coloured floor has advantages for identifying the stains
- Light reflection: a light coloured floor generates more light reflection
- Aesthetics: a light coloured floor creates a cleaner image

The above listed requirements result in the following overview:

<table>
<thead>
<tr>
<th>Functional requirements</th>
<th>Brew house</th>
<th>Service block</th>
<th>Cellars</th>
<th>Packaging</th>
<th>WTP</th>
<th>WWTP</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mechanical load</strong></td>
<td>Handpalletizer, forklifts</td>
<td>Handpalletizer, forklifts</td>
<td>Handpalletizer</td>
<td>Handpalletizer, forklifts</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td><strong>Chemical resistance</strong></td>
<td>HCl, NaClO₂, Anti scailant, FeCl₃, Biocide NaOH</td>
<td>HCl, NaClO₂, Anti scailant, FeCl₃, Biocide NaOH</td>
<td>HCl, NaClO₂, Anti scailant, FeCl₃, Biocide NaOH</td>
<td>NaOH, H₃PO₄, Biocides, HCl NaClO₂, Anti scailant, FeCl₃</td>
<td>Reverse osmosis Brine</td>
<td>NaOH HCl FeCl₃</td>
</tr>
<tr>
<td><strong>Thermo shock</strong></td>
<td>max. 85° C</td>
<td>max. 85° C</td>
<td>max. 85° C</td>
<td>max. 85° C</td>
<td>max. 85° C</td>
<td>max. 85° C</td>
</tr>
<tr>
<td><strong>Maximum slope</strong></td>
<td>10mm/m¹</td>
<td>10mm/m¹</td>
<td>10mm/m¹</td>
<td>10mm/m¹</td>
<td>10mm/m¹</td>
<td>10mm/m¹</td>
</tr>
<tr>
<td><strong>Colour</strong></td>
<td>Argelith Arkona White</td>
<td>Arkona White Light Grey</td>
<td>Arkona White Beige</td>
<td>Arkona White</td>
<td>Arkona White</td>
<td>Arkona White</td>
</tr>
<tr>
<td></td>
<td>Lichtgrau uni</td>
<td>Lichtgrau uni Weiß ubi</td>
<td>Lichtgrau uni Gelb uni</td>
<td>Lichtgrau uni</td>
<td>Lichtgrau uni Weiß ubi</td>
<td>Lichtgrau uni</td>
</tr>
<tr>
<td></td>
<td>Weiß ubi</td>
<td>Weiß ubi</td>
<td>Weiß ubi</td>
<td>Weiß ubi</td>
<td>Weiß ubi</td>
<td>Weiß ubi</td>
</tr>
<tr>
<td></td>
<td>Gelb uni</td>
<td>Gelb uni</td>
<td>Gelb uni</td>
<td>Gelb uni</td>
<td>Gelb uni</td>
<td>Gelb uni</td>
</tr>
</tbody>
</table>
Appendix C – Technical requirements

Tile requirements
The tile requirements are defined through a number of specifications, which will be discussed in this paragraph.

Shape
There are three different shapes that are used in tiled floor systems: rectangular, square and hexagonal. Rectangular and square shapes are the classic tile dimensions, and the hexagonal shape has been developed at the end of the '90s (Argelith, Zahna). Since then, the use by the tiled floor applicators has increased enormously because of the advantages it has compared to rectangular and square tiles.

The advantages of the hexagonal tiles:

- The unevenness of the underlying concrete can be compensated better
- Creates more flatness
- More sufficient slopes can be created
- Faster to apply

* In figures 2 and 3 the difference in slopes can be seen. For a channel drain, both rectangular/square and hexagonal tiles are suitable to create a sufficient slope. For a gully drain, hexagonal tiles are more suitable to create the sufficient slope.

However, the hexagonal tiles are more expensive than the rectangular and square tiles. For now, it has been decided that the hexagonal tiles are the preferred first choice tiles, and the rectangular and square tiles the second choice. Whether first or second choices tiles are chosen, depends on the project and the available budget.

(Aufderhaar, 2013) (Koetsveld, 2014)
**Thickness**
In all of the reviewed projects in this research, the thickness of the used tiles has been 18mm. However, there are tiles with the same, but with a thickness of 15mm and 12mm. Furthermore, a brewery in Singapore was found where 14mm tiles were used. In December 2013, a project manager went to Singapore, reviewed the floor and concluded that the floor was (still) in good condition (year of installation: 1989). Because of this example, we decided to discover the possibilities of a less thick tile. During the meetings with the different applicators, it had been commonly agreed that a tiled floor system with 15mm tiles is possible. The 12mm tiles are not (yet) an option, because the floor system itself is equally important as the tile. Since every millimetre helps for the total performance of the floor it has been decided that for future projects, a thickness of 15mm will be used. ([Auferhaar, 2013](#)) ([Tietz, 2014](#))

**Water absorption**
During the brewing process, water continuously falls on the floor and therefore a low percentage of water absorption is required. Based on previous projects, the requirement for water absorption in weight % (max. individual value 0.6 %) is ≤ 0.5 %, according to DIN–EN–ISO 14111 Annex G.

**Modulus of rupture**
As a result of the mechanical load on the floor, a requirement is needed for the modulus of rupture. Based on previous projects, the requirement will be ≥ 35 N/mm² according to DIN–EN–ISO 14111 Annex G.

**Breaking strength**
As a result of the mechanical load on the floor, a requirement is needed for breaking strength. Based on previous projects, the requirement will be ≥ 1300 N according to DIN–EN–ISO 14111 Annex G.

**Size consistency (deviation)**
An important tile specification is the size consistency, since it will influence the laying of the tiles and therefore the total performance of the floor. Based on previous projects, the deviation in % of the average length/width from the work size will be ± 1.0 % according to DIN–EN–ISO 14111 Annex G.

**Resistance against wear (deep abrasion)**
In order to gain a 25–year lifetime for the tiled floor system, a specification for the deep abrasion of the tile is required. Based on previous projects, the resistance against wear will be max. 175 mm³ according to DIN–EN–ISO 14111 Annex G.

**Thermal expansion**
As a result of the heat shock on the floor, a specification for the thermal expansion is required. Based on previous projects, the coefficient of linear thermal expansion from ambient to 100° C in 1/K will be max. 9 x 10⁻⁶/K⁻¹ according to DIN–EN–ISO 14111 Annex G.
**Thermal shock resistance**
As a result of the heat shock on the floor, a thermal shock resistance is required according to DIN–EN–ISO 14111 Annex G.

**Slip resistance**
In order to guarantee a certain safety for personnel, a specification for the slip resistance is required. Based on previous projects, the slip resistance will be R11 according to DIN–EN–ISO 14111 Annex G.

**Drain requirements**
The requirements for the drains will not be supplemented in this research.
### Appendix D – Technical characteristics Argelith and Zahna

<table>
<thead>
<tr>
<th>Testing according to</th>
<th>Requirements according to DIN–EN–ISO 14111 Annex G</th>
<th>Test results Argelith</th>
<th>Test results Zahna Fiesien</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dimensions tolerances and surface quality</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Length and width</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>– deviation in % of the average length/width from the work size</td>
<td>DIN EN ISO 10545–2</td>
<td>± 1.0 %</td>
<td>± 0.1 %; – 0.1 %</td>
</tr>
<tr>
<td>– deviation in % of the average length/width from the average length/width of all test specimens</td>
<td>DIN EN ISO 10545–2</td>
<td>± 0.5 %</td>
<td>± 0.1 %; – 0.1 %</td>
</tr>
<tr>
<td>Thickness</td>
<td>DIN EN ISO 10545–2</td>
<td>± 10%</td>
<td>± 2.5 %; – 3.2 %</td>
</tr>
<tr>
<td>Straightness of sides</td>
<td>DIN EN ISO 10545–2</td>
<td>no requirement</td>
<td>–</td>
</tr>
<tr>
<td>Rectangularity</td>
<td>DIN EN ISO 10545–2</td>
<td>no requirement</td>
<td>–</td>
</tr>
<tr>
<td>Center curvature</td>
<td>DIN EN ISO 10545–2</td>
<td>no requirement</td>
<td>–</td>
</tr>
<tr>
<td>Edge curvature</td>
<td>DIN EN ISO 10545–2</td>
<td>no requirement</td>
<td>–</td>
</tr>
<tr>
<td>Warpage</td>
<td>DIN EN ISO 10545–2</td>
<td>no requirement</td>
<td>–</td>
</tr>
<tr>
<td>Surface quality</td>
<td>DIN EN ISO 10545–2</td>
<td>min. 95 % free from visible defects</td>
<td>fulfilled</td>
</tr>
<tr>
<td><strong>Physical properties</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water absorption in weight % (max. individual value 0.6 %)</td>
<td>DIN EN ISO 10545–3</td>
<td>≤ 0.5 %</td>
<td>0.04 ± 0.00</td>
</tr>
<tr>
<td>Open porosity in cm³</td>
<td>DIN EN ISO 10545–3</td>
<td>no requirement</td>
<td>0.10 ± 0.01</td>
</tr>
<tr>
<td>Apparent relative density in g/cm³</td>
<td>DIN EN ISO 10545–3</td>
<td>no requirement</td>
<td>2.39 ± 0.00</td>
</tr>
<tr>
<td>Bulk density in g/cm³</td>
<td>DIN EN ISO 10545–3</td>
<td>no requirement</td>
<td>2.39 ± 0.00</td>
</tr>
<tr>
<td>Modulus of rupture in N/mm²</td>
<td>DIN EN ISO 10545–4</td>
<td>≥ 35 N/mm²</td>
<td>78.0 ± 6.9</td>
</tr>
<tr>
<td>Breaking strength for thickness ≥ 7.5 mm in N</td>
<td>DIN EN ISO 10545–4</td>
<td>≥ 1300 N</td>
<td>16682 ± 1458</td>
</tr>
<tr>
<td>Resistance against wear (deep abrasion)</td>
<td>DIN EN ISO 10545–6</td>
<td>max. 175 mm³</td>
<td>113 ± 3</td>
</tr>
<tr>
<td>Coefficient of linear thermal expansion from ambient to 100° C in 1/K</td>
<td>DIN EN ISO 10545–8</td>
<td>max. 9 x 10⁻⁶/K⁻¹</td>
<td>6.4 x 10⁻⁶</td>
</tr>
<tr>
<td>Thermal shock resistance</td>
<td>DIN EN ISO 10545–9</td>
<td>required</td>
<td>fulfilled</td>
</tr>
<tr>
<td>Frost resistance</td>
<td>DIN EN ISO 10545–12</td>
<td>required</td>
<td>fulfilled</td>
</tr>
<tr>
<td>Slip resistance</td>
<td>DIN EN ISO 51130</td>
<td>according to manufacturer’s data</td>
<td>R11 compliant</td>
</tr>
<tr>
<td><strong>Chemical properties</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resistance against household chemicals and swimming pool salts</td>
<td>DIN ISO EN 10545–13</td>
<td>min. UB</td>
<td>fulfilled: UA</td>
</tr>
<tr>
<td>Resistance against acids and alkalis of low and high concentration</td>
<td>DIN ISO EN 10545–13</td>
<td>to be stated by manufacturer</td>
<td>fulfilled: ULA</td>
</tr>
<tr>
<td>Resistance against stains</td>
<td>DIN ISO EN 10545–14</td>
<td>≥ class 3</td>
<td>Class 4; class 5</td>
</tr>
</tbody>
</table>
Appendix E - Test results Argelith

**TEST CERTIFICATE No. 6006E/07 dated 2007-10-17**

Client: Argelith Bodenkeramik H. Bitter GmbH, P.O.B. 1240, D-49145 Bad Essen, GERMANY

Test specimen: Fine Porcelain stoneware tiles unglazed, hexagon 18 mm, light grey, 1st choice work size 108.3x125.0x18 mm

<table>
<thead>
<tr>
<th>Tested material properties</th>
<th>Requirements according to DIN EN 14411-1:G</th>
<th>Testing according to DIN EN 14411-1:G</th>
<th>Test results</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dimensional tolerance and surface quality</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Length and width</td>
<td>± 1.0 %</td>
<td>+ 0.1 %; - 0.1 %</td>
<td></td>
</tr>
<tr>
<td>- deviation in % of the average length/width from the work size</td>
<td>± 0.5 %</td>
<td>+ 0.1 %; - 0.1 %</td>
<td></td>
</tr>
<tr>
<td>- deviation in % of the average length/width from the average length/width of all test specimens</td>
<td>± 10 %</td>
<td>+ 2.5 %; - 2.5 %</td>
<td></td>
</tr>
<tr>
<td>Thickness</td>
<td>no requirement</td>
<td>no requirement</td>
<td>fulfilled</td>
</tr>
<tr>
<td>Straightness of sides</td>
<td>no requirement</td>
<td>no requirement</td>
<td>fulfilled</td>
</tr>
<tr>
<td>Rectangularity</td>
<td>no requirement</td>
<td>no requirement</td>
<td>fulfilled</td>
</tr>
<tr>
<td>Center curvatures</td>
<td>no requirement</td>
<td>no requirement</td>
<td>fulfilled</td>
</tr>
<tr>
<td>Edge curvatures</td>
<td>no requirement</td>
<td>no requirement</td>
<td>fulfilled</td>
</tr>
<tr>
<td>Warpage</td>
<td>no requirement</td>
<td>no requirement</td>
<td>fulfilled</td>
</tr>
<tr>
<td>Surface quality</td>
<td>no requirement</td>
<td>no requirement</td>
<td>fulfilled</td>
</tr>
</tbody>
</table>

| **Physical properties** |  |  |  |
| Water absorption in weight-% (max. individual value 0.5 %) | ≤ 0.5 % | 0.04 ± 0.00 | 0.10 ± 0.01 |
| Open porosity in % | no requirement | no requirement | fulfilled |
| Apparent relative density in g/cm³ | no requirement | no requirement | fulfilled |
| Bulk density in g/cm³ | no requirement | no requirement | fulfilled |
| Modulus of rupture in N/mm² | min. 35 N/mm² | 78.0 ± 6.9 | 16682 ± 1458 |
| Breaking strength for thickness ≥ 7.5 mm in N | min. 1300 N | 113 ± 3 |  |
| Resistance against wear (deep abrasion) | max. 175 mm² | 6.4 x 10⁻³ |  |
| Coefficient of linear thermal expansion from ambient to 100°C in 1/K | max. 9 x 10⁻⁶/K |  |  |
| Thermal shock resistance | required | 10545-9 | fulfilled |
| Frost resistance | required | 10545-12 | fulfilled |

| **Chemical properties** |  |  |  |
| Resistance against household chemicals and swimming pool salts | max. UN | 10545-13 | fulfilled: ULA |
| Resistance against acids and alkalies of low and high concentration | to be stated by the manufacturer | 10545-13 | fulfilled: ULA |
| Resistance against stains | Chromium green | Class 4 |  |
| | Olive oil | Class 3 |  |

**Remarks:**
The Argelith fine porcelain stoneware tiles hexagon 18 mm light grey comply in all tested material properties with the requirements of the product standard DIN EN 14411:2007-03, annex G, Group Bla UGL.

Page 1 of 1
Appendix F – Test results Zahna Fliesen

LEISTUNGSERKLÄRUNG
gemäß Anhang III der Verordnung (EU) Nr. 305/2011
Nr. 001AC2013-007-01


2. Typen-, Chargen- oder Seriennummer oder ein anderes Kennzeichen zur Identifikation des Bauprodukts gemäß Artikel 11 Absatz 4:
   Trockengepresste keramische Fliesen und Platten mit geringer Wasseraufnahme, Gruppe Bla, unglasiert UGL

3. Vom Hersteller vorgesehener Verwendungszweck oder vorgesehene Verwendungszwecke des Bauprodukts gemäß der anwendbaren harmonisierten technischen Spezifikation:
   Bodenbeläge im Innen- und/oder Außenbereich, einschließlich Treppen, in Gebäuden und Industriebauten

4. Name, eingetragener Handelsname oder eingetragene Marke und Kontaktanschrift des Herstellers gemäß Artikel 11 Absatz 5:
   Zahna Fliesen GmbH, Paul-Utzscheider-Straße 1, D-06895 Zahna-Ellter

5. Gegebenenfalls Name und Kontaktanschrift des Bevollmächtigten, der mit den Aufgaben gemäß Artikel 12 Absatz 2 beauftragt ist:
   nicht relevant

6. System oder Systeme zur Bewertung und Überprüfung der Leistungsbeständigkeit des Bauprodukts gemäß Anhang V:
   System 4

7. Im Falle der Leistungserklärung, die ein Bauprodukt betrifft, das von einer harmonisierten Norm erfasst wird: (gegebenenfalls Name und Kennnummer der notifizierten Stelle)
   nicht relevant

8. Im Falle der Leistungserklärung, die ein Bauprodukt betrifft, für das eine Europäische Technische Bewertung ausgestellt worden ist: (gegebenenfalls Name und Kennnummer der Technischen Bewertungsstelle)
   nicht relevant

9. Erklärte Leistung
<table>
<thead>
<tr>
<th>Wesentliche Merkmale</th>
<th>Leistung</th>
<th>Harmonisierte technische Spezifikation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brandverhalten</td>
<td>Klasse A1FL</td>
<td>Klassifiziert ohne Prüfung (CWT)</td>
</tr>
<tr>
<td>Abgabe gefährlicher Stoffe, für</td>
<td>NPD</td>
<td>EN ISO 10545-15</td>
</tr>
<tr>
<td>Cd</td>
<td>NPD</td>
<td>EN ISO 10545-4</td>
</tr>
<tr>
<td>Pb</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bruchlast</td>
<td>Min. 1300 N</td>
<td>EN ISO 10545-4</td>
</tr>
<tr>
<td>Rutschhemmende Eigenschaften</td>
<td>Min. μ = 0,30</td>
<td>DIN 51131</td>
</tr>
<tr>
<td>Oder R-Klasse*</td>
<td></td>
<td>DIN 51130</td>
</tr>
<tr>
<td>Taktilität</td>
<td>NPD</td>
<td>CEN/TS 15209</td>
</tr>
<tr>
<td>Dauerhaftigkeit, für Innenbereiche</td>
<td>Bestanden</td>
<td>EN ISO 10545-12</td>
</tr>
<tr>
<td>Außenbereiche: Frost-Tau-Wechselfestigkeit</td>
<td>Bestanden</td>
<td>-</td>
</tr>
</tbody>
</table>

*) Siehe Kartonbedruck


Unterzeichnet für den Hersteller und im Namen des Herstellers von:

Marco Wissing
Leiter Produktion

(Zeichen- und Funktionsangabe)

Zahna, 01.07.2013

(Ort und Datum der Ausstellung)

(Unterschrift)
Appendix G – Van Koetsveld floor systems

**Kagetec BS System**
The Kagetec BS system, is the most basic and used installed system. The bonding layer is placed on the concrete after 14 days of curing (even though the common curing time is 28 days, in practical application the system can be installed after 14 days). On top of the bonding layer a mortar bed is laid and another bonding layer, wherein the tiles are laid. The joints between the tiles are filled with epoxy resin. The maximum field size (as previously stated, the field surrounded by expansion joints) is 150m$^2$. The field size is also dependent on the cracks in the concrete caused by shrinkage. Cracks $< 0.3$ mm are covered by all Kagetecs systems. When the cracks are $\geq 0.3$ mm they will be filled with epoxy resin.

When the flatness tolerances of the concrete are not according to DIN–EN–ISO 18202, a screed layer (combination of sand/cement/water to flatten underlying concrete) must first be poured over the concrete.

Remarks
- Required concrete curing time 14 days
- Field size 150m$^2$
- Floor accessible for equipment after 24 hours
- 15mm tile possible
- Warranty on the system is 10 years

**Kagetec GFK System**
The main difference with the BS System is the absence of the mortar bed, which is (together with the expansion joint) the weakest part of the system. Instead, a plastic mesh reinforcement in epoxy adhesive is installed which makes the floor stronger than the BS System. The tiles are completely encased in epoxy resin. The floor costs are 10% higher and this system is normally combined with the BS System, whereas the GFK system is used for the areas with multiple cracks in the concrete.

Remarks
- Required concrete curing time 14 days
- Field size 150m$^2$
- Floor accessible for equipment after 24 hours
- 15mm tile possible
- Warranty on the system is 10 years
- System can be placed on existing floor

**Kagetec AR System**
The AR System uses an epoxy layer which is directly placed on the concrete, after 4–5 days of curing time. This is possible because the concrete continues its curing under the epoxy layer. As a result of the epoxy layer, no cracks will appear. This makes it possible to realise bigger field sizes, with a maximum of 350–400m$^2$. As a result, fewer expansion joints can be used and the floor will be stronger.
When the flatness tolerances of the concrete are not according to DIN–EN–ISO 18202, a screed layer must first be poured. However, this can be done with a wet/wet combination of both screed and epoxy poured directly onto the concrete.

Also, the AR System uses more materials, but requires less labour which makes the installation twice as fast as the BS and GFK System.

Remarks
- Required concrete curing time 4–5 days
- Field size 350–400m²
- Floor accessible for equipment after 24 hours
- 15mm tile possible
- Warranty on the system is 10 years
- Installation twice as fast then BS and GFK system

(Koetsveld, 2014)
Appendix H – Rundmund Saüreschutztechnik floor systems

RS – Basic flooring system
The RS – Basic flooring system is the most basic system. The bonding layer is placed on the concrete after 2–4 weeks of curing (depending on the geographical location). Upon the bonding layer a screed layer will be poured, and another bonding layer on top wherein the tiles are being laid. The joints between the tiles are filled with epoxy resin.

Remarks
- Required concrete curing time 14–28 days
- Field size 150m²
- Floor accessible for equipment after 1 week
- 15mm tile possible
- Warranty on the system is 5 years, 10 years discussible
- Minimum temperature of 5°C required
- Thickness of floor system 70–80mm

RS – 2–K synthetic resin cement flooring system
The RS – 2–K synthetic resin cement flooring system is ideal to install over an existing floor but can also be installed directly on concrete. However, a flat surface is required according to DIN–EN–ISO 18202. The system uses a wet/wet combination with screed and an epoxy (with quartz sand), poured directly onto the concrete (after 14 days of curing). The joints between the tiles are finished with epoxy resin.

Remarks
- Required concrete curing time 14 days
- Field size 200–250m²
- Floor accessible for equipment after 24 hours
- 15mm tile possible
- Warranty on the system is 5 years, 10 years discussible
- Minimum temperature of 5°C required
- Thickness of floor system 23–25 mm

RS – 2–K synthetic resin construction mortar flooring system
The RS – 2–K synthetic resin construction mortar flooring system is ideal to install when the concrete finish doesn’t meet the surface requirements. The system uses a resin construction mortar directly on the concrete (after 14 days of curing) wherein the tiles are being laid. The joints between the tiles are finished with epoxy resin.

Remarks
- Required concrete curing time 14 days
- Field size 200–250m²
- Floor accessible for equipment after 24 hours
- 15mm tile possible
- Warranty on the system is 5 years, 10 years discussible
- Minimum temperature of 10–15°C required
- Thickness of floor system 25–30 mm
Appendix I - Quotation example

ANEGEOT

<table>
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<tr>
<th>Projekt</th>
<th>Kundennummer</th>
<th>Unser Zeichen</th>
<th>Rechnungsnummer</th>
<th>Datum</th>
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<td>30962</td>
<td>12277</td>
<td>WK/L</td>
<td>AN179006</td>
<td>05.05.2013</td>
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QUOTATION

Quote for: "Braza - Brasserie Nationale, Port-au-Prince, Haiti"
"Chemical resistant floor tile finish New Filling Line"

Dear Mr. Brinkerink,

we have pleasure in forwarding details offer for the supply and installation of both
the "RS-Tile-System" specified.

We look forward to being of service in the near future.

Your sincerely

RUNDMUND Vertriebs GmbH & Co. KG
-Säureschutztechnik-

i.V. Warner Krampe
(Handy: 0949-171/7437745)
### ANGEBOT

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<thead>
<tr>
<th>Position</th>
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<th>Einheit</th>
<th>Einzelpreis</th>
<th>Gesamtpreis</th>
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<tbody>
<tr>
<td><strong>Titel 1</strong></td>
<td>&quot;RS - materials&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.1</td>
<td>set Hexagonal floor tiles R11 white-lightgrey or beige</td>
<td>2190</td>
<td>m²</td>
<td>29.50 €</td>
<td>64.605,00 €</td>
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<tr>
<td>1.2</td>
<td>set Skirting tiles</td>
<td>222</td>
<td>m</td>
<td>16.00 €</td>
<td>3.996,00 €</td>
</tr>
<tr>
<td>1.3</td>
<td>set Outside corners</td>
<td>10</td>
<td>Stck.</td>
<td>3.71 €</td>
<td>37.10 €</td>
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<tr>
<td>1.4</td>
<td>set Rectangular tiles 10 x 20 white-lightgrey or beige</td>
<td>150</td>
<td>m²</td>
<td>29.50 €</td>
<td>4.425,00 €</td>
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<tr>
<td>1.5</td>
<td>set RS-VSK R</td>
<td>4675</td>
<td>kg</td>
<td>4,50 €</td>
<td>21.037,50 €</td>
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<tr>
<td>1.6</td>
<td>set Set Retarder</td>
<td>800</td>
<td>kg</td>
<td>2,50 €</td>
<td>2.000,00 €</td>
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<td>1.7</td>
<td>set Quarzsand</td>
<td>9600</td>
<td>kg</td>
<td>0,20 €</td>
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<td>1.8</td>
<td>set V2A-Special-steel 40x40x4 mm</td>
<td>70</td>
<td>m</td>
<td>16,00 €</td>
<td>1.120,00 €</td>
</tr>
<tr>
<td>1.9</td>
<td>set V2A-Special-steel 60x60x6 mm</td>
<td>6</td>
<td>m</td>
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<td>173,04 €</td>
</tr>
<tr>
<td>1.10</td>
<td>set RS XMB 100</td>
<td>50</td>
<td>kg</td>
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<td>1.11</td>
<td>set RS XLB 6</td>
<td>150</td>
<td>kg</td>
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<td>200</td>
<td>kg</td>
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<td>1.13</td>
<td>set RS resin 80-66-E</td>
<td>860</td>
<td>kg</td>
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<td>1.14</td>
<td>set RS hardener 30-101 E</td>
<td>430</td>
<td>kg</td>
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<tr>
<td>1.15</td>
<td>set RS jointmortar EN CF (for skirting)</td>
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<td>kg</td>
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<td>1.393,60 €</td>
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<tr>
<td>1.16</td>
<td>set RS-Flex FD Plast (expansion joints)</td>
<td>170</td>
<td>kg</td>
<td>14,50 €</td>
<td>2.465,00 €</td>
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<tr>
<td>1.17</td>
<td>set Roundcord 15 mm</td>
<td>700</td>
<td>m</td>
<td>0,50 €</td>
<td>350,00 €</td>
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<tr>
<td>1.18</td>
<td>set Adhesive tape 30 mm + 50 mm</td>
<td>40</td>
<td>Rollen</td>
<td>2,64 €</td>
<td>113,60 €</td>
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<tr>
<td>1.19</td>
<td>set Foil - PE</td>
<td>2</td>
<td>Rollen</td>
<td>61,80 €</td>
<td>123,60 €</td>
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<tr>
<td>1.20</td>
<td>set Spare tiles</td>
<td>70</td>
<td>m²</td>
<td>29.50 €</td>
<td>2.085,00 €</td>
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**Summe Titel 1**: 124.643,94 €

---

**Übertrag:** 124.643,94 €
## Titel 2  
"Process Drainage"

### 2.1 set  
**Industrial box-section channel**  
Typ: IKR-220-300-SR-FVB  
Length: 3.350 mm  
in welded, not in flanged design,  
edge protection and grid support  
reinforced by means of welded and closed  
stainless steel rectangular profiles,  
height-adjustable mounting feet every 1.000 mm,  
with inside longitudinal and transverse slope,  
surface of the channel blasted with glass beads,  
Material: 1.4301 (AISI 304)  
Covert: bar grate cover 25x8 mm, pickled  
Channel profile [mm]: 220  
Width [mm]: 300  
Initial depth [mm]: min 175.0  
Longitudinal slope [%]: 0.5  
Wall anchors: ca. every 500 mm  
Priced: 1 piece 2.127,00 €  
Gesamt: 2.127,00 €  

### 2.2 set  
**Industrial box-section channel**  
Typ: IKR-220-300-SR-FVB  
Length: 6.350 mm  
in welded, not in flanged design,  
edge protection and grid support  
reinforced by means of welded and closed  
stainless steel rectangular profiles,  
height-adjustable mounting feet every 1.000 mm,  
with inside longitudinal and transverse slope,  
surface of the channel blasted with glass beads,  
Material: 1.4301 (AISI 304)  
Covert: bar grate cover 25x8 mm, pickled  
Channel profile [mm]: 220  
Width [mm]: 300  
Initial depth [mm]: min 175.0  
Longitudinal slope [%]: 0.5  
Wall anchors: ca. every 500 mm  
Priced: 1 piece 4.125,00 €  
Gesamt: 4.125,00 €  

### 2.3 set  
**Industrial box-section channel**  
Typ: IKR-220-300-SR-FVB  
Length: 7.450 mm  
in welded, not in flanged design,  
edge protection and grid support  
reinforced by means of welded and closed  
stainless steel rectangular profiles,  
Priced: 1 piece 4.587,00 €  
Gesamt: 4.587,00 €  

**Übertrag:**  
135.482,94 €
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<td>Übertrag:</td>
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<td>135.482,94 €</td>
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height-adjustable mounting feet every 1.000 mm, with inside longitudinal and transverse slope, surface of the channel blasted with glass beads.
Material: 1.4301 (AISI 304)
Covert: bar grate cover 25x8 mm, pickled
Channel profile [mm]: 220
Width [mm]: 300
Initial depth [mm]: min 175,0
Longitudinal slope [%]: 0,5
Wall anchors: ca. every 500 mm

2.4 set **Industrial box-section channel**
Typ: IKR-200-300-SR-FVB
Length: 44.000 mm
in welded, not in flanged design, edge protection and grid support reinforced by means of welded and closed stainless steel rectangular profiles, height-adjustable mounting feet every 1.000 mm, with inside longitudinal and transverse slope, surface of the channel blasted with glass beads.
Material: 1.4301 (AISI 304)
Covert: bar grate cover 25x8 mm, pickled
Channel profile [mm]: 220
Width [mm]: 300
Initial depth [mm]: min 175,0
Longitudinal slope [%]: 0,5
Wall anchors: ca. every 500 mm

<table>
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<th></th>
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<th>28.984,00 €</th>
<th>28.984,00 €</th>
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</table>

2.5 set **Industrial box-section channel**
Typ: IKR-220-300-SR-FVB
Length: 3.500 mm
in welded, not in flanged design, edge protection and grid support reinforced by means of welded and closed stainless steel rectangular profiles, height-adjustable mounting feet every 1.000 mm, with inside longitudinal and transverse slope, surface of the channel blasted with glass beads.
Material: 1.4301 (AISI 304)
Covert: bar grate cover 25x8 mm, pickled
Channel profile [mm]: 220

<table>
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<tr>
<th></th>
<th></th>
<th>1 piece</th>
<th>2.503,00 €</th>
<th>2.503,00 €</th>
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</table>

Übertrag:  |  |  | 166.969,94 € |
**ANGEBOT**  

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<th>Menge</th>
<th>Einheit</th>
<th>Einzelpreis</th>
<th>Gesamtpreis</th>
</tr>
</thead>
</table>
| Übertrag:| Width [mm]: 300  
Initial depth [mm]: min 175.0  
Longitudinal slope [%]: 0.5  
Wall anchors: ca. every 500 mm |       |         |             | 166.969,94 € |
| 2.6 set  | Removable water trap  
included in glass catcher | 2     | piece   | 866,00 €    | 1.376,00 €   |
| 2.7 set  | Pumpcump  
800 x 800 x 800  
Cover: Ladder grate  
Material: AISI 316 L  
Thickness: 2 mm | 1     | piece   | 2.217,00 € | 2.217,00 €   |
|          | **Summe Titel 2**                                                   |       |         |             | **45.919,00 €** |
| Titel 3  | “Supervisor - hours”                                                 |       |         |             |             |
| 3.1 set  | Supervisor                                                          | 2200 h|         | 55,00 €     | 121.000,00 € |
|          | **Summe Titel 3**                                                   |       |         |             | **121.000,00 €** |
| Titel 4  | “flight- and travel-expende”                                         |       |         |             |             |
| 4.1 set  | flight- and travel-expences for supervision (6 persons) and          | 6     |         | 3.800,00 €  | 22.800,00 €  |
|          | projectmanager                                                      |       |         |             |             |
|          | **Summe Titel 4**                                                   |       |         |             | **22.800,00 €** |
| Titel 5  | “Lodging (Hotel and food)”                                           |       |         |             |             |
| 5.1 set  | Lodging (Hotel and food)                                            | 1 pschl.|         | 7.200,00 €  | 7.200,00 €   |
|          | 6 persons x 30 days x 40 €                                           |       |         |             |             |
|          | **Summe Titel 5**                                                   |       |         |             | **7.200,00 €** |
| Übertrag:|                                                                      |       |         |             | **321.562,94 €** |
## ANGEBOT

### Position | Text | Menge | Einheit | Einzelpreis | Gesamtpreis
--- | --- | --- | --- | --- | ---
| Übertrag: | | | | | 321.562,94 €

### Titel 6 "Transport-cost's"

| 6.1 | set Material FOB Antwerpen 6 x 40 feet container shippers owned containers 1 Pacht | | | 22.500,00 € | 22.500,00 €

### Zusammenstellung Titel

| Titel 1 | "RS - materials" | 124.643,94 €
| Titel 2 | "Process Drainage" | 45.919,00 €
| Titel 3 | "Supervisor - hours" | 121.000,00 €
| Titel 4 | "flight- and travel-expenses" | 22.800,00 €
| Titel 5 | "Lodging (Hotel and food)" | 7.200,00 €
| Titel 6 | "Transport-cost's" | 22.500,00 €

### Summe Titelzusammenstellung

| | | 344.062,94 €

---

### Netto Gesamtpreis

| | 344.062,94 €
| + 0,00% Umsatzsteuer | 0,00 €
| Gesamtpreis | 344.062,94 €

---

### Payment Conditions

100 % Material + Transport:
Payment after arrival FOB Antwerpen

100 % Payment for services:
After completion of installation

Payment shall be effected 14 days with 2 % discount or 30 days netto.
### Appendix I2 – Quotation example

**HEINEKEN**

---

**van koetsveld & grimberg**  
Säureschutz ....

Berna - Brasseries Nationale d’Haiti S  
Mr. Alexander Brinkerink

Port au Prince, Haiti

---

**KAGETEC Industry Bodenplatten**

48699 Gronau  
Pöntigstr. 7a  
Tel: 0523 22 54 31  
Fax: 0523 22 47 00  
Internet: http://www.kagetec.de  
e-mail: info@kagetec.de

Bankverbindung:  
Deutsche Bank AG Gronau  
BLZ 403 000 79  
Konto-Nr. 360 395  
Swift: DEUTDE3S041  
Ust.-Id-Nr. DE 122 767 373

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### Angebot

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<th>Preis</th>
<th>Summe</th>
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<tr>
<td>1</td>
<td>2.565,00</td>
<td>m²</td>
<td>floor tiles hexagonal, hexagonal/rectangular floor tiles, fully vitrified with spacer on bottom cross profile</td>
<td>31,14</td>
<td>79.874,10</td>
</tr>
<tr>
<td>2</td>
<td>380,00</td>
<td>m</td>
<td>skirting tiles, of same colour as Pos. 1</td>
<td>15,00</td>
<td>5.700,00</td>
</tr>
<tr>
<td>3</td>
<td>95,00</td>
<td>pcs.</td>
<td>internal/external angles of same colour as Pos. 1</td>
<td>6,00</td>
<td>570,00</td>
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<tr>
<td>4</td>
<td>3.025,00</td>
<td>kg</td>
<td>Grouting material comp. A</td>
<td>15,19</td>
<td>45.949,75</td>
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<tr>
<td>5</td>
<td>1.512,50</td>
<td>kg</td>
<td>Grouting material comp. B</td>
<td>15,19</td>
<td>22.974,88</td>
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<td>6</td>
<td>715,00</td>
<td>bag</td>
<td>Quartzsand fine 715 bags à 25 kg</td>
<td>2,95</td>
<td>2.109,25</td>
</tr>
</tbody>
</table>

---

van Koetsveld & Grimberg, Säureschutztechnik GmbH  
Geschäftsführer: Michael van Koetsveld, Hans Grimberg  
Handelsregister HRB 668  
Amtsgericht Gronau  
... durchsicht bis auf den Gegenstand

---

Bachelor Thesis – Chemical Resistant Floors  
HEINEKEN Supply Chain B.V.
<table>
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<th>Summe</th>
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<td>7</td>
<td>216,00</td>
<td>bag</td>
<td>Quartzsand rough</td>
<td>2,95</td>
<td>637,20</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Country of origin: Germany</td>
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<td></td>
</tr>
<tr>
<td>8</td>
<td>115,00</td>
<td>kg</td>
<td>expansion joint material</td>
<td>33,00</td>
<td>3.795,00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>thermoplastic material for expansion joints, fungicide</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>70,00</td>
<td>kg</td>
<td>Fixing material for expansion joints</td>
<td>13,60</td>
<td>952,00</td>
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<tr>
<td>10</td>
<td>670,00</td>
<td>ltr</td>
<td>Ethanol cleaner</td>
<td>2,75</td>
<td>1.842,50</td>
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<td>11</td>
<td>31,00</td>
<td>m</td>
<td>Stainless steel angles, 40x40x4mm</td>
<td>16,50</td>
<td>511,50</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Stainless steel corner protection angles (material 1.4301) with welded anchors fitted each 50 cm.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>23,00</td>
<td>pc</td>
<td>stainless steel protection plates 10x50 cm</td>
<td>60,00</td>
<td>1.380,00</td>
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<td></td>
<td></td>
<td></td>
<td>supply of st. steel plates for heavy traffic areas as transition between 2 different floor finishes (for example between concrete and tiles).</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Please inform if necessary</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>300,00</td>
<td>kg</td>
<td>tile adhesive</td>
<td>1,65</td>
<td>495,00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>12 bags á 25 kg</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>epoxy modified bonding layer material between tile and mortarbed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>3,00</td>
<td>pc</td>
<td>small - materials</td>
<td>300,00</td>
<td>900,00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>as styrofoam, adhesive tape, primer etc</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>5,00</td>
<td>pcs.</td>
<td>flight costs</td>
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<td>5.000,00</td>
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<td>150,00</td>
<td>pcs.</td>
<td>daily money</td>
<td>30,00</td>
<td>4.500,00</td>
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<td>Beschreibung</td>
<td>Preis</td>
<td>Summe</td>
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<td>-------</td>
<td>-------</td>
<td>-------------------------------------------------------</td>
<td>---------</td>
<td>---------</td>
</tr>
<tr>
<td>17</td>
<td>1,00</td>
<td>pcs.</td>
<td>installation costs</td>
<td>81.450,00</td>
<td>81.450,00</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>5 persons for 30 days, incl. travel time</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>6,00</td>
<td>pcs.</td>
<td>freight costs FOB Antwerp</td>
<td>2.800,00</td>
<td>16.800,00</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>including second hand containers 20 ft, shippers owned</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>145,00</td>
<td>pcs.</td>
<td>hotel costs</td>
<td>165,00</td>
<td>23.925,00</td>
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<tr>
<td>20</td>
<td>1,00</td>
<td>pcs.</td>
<td>Return machines after completion</td>
<td>2.375,00</td>
<td>2.375,00</td>
</tr>
</tbody>
</table>

Summe 301.741,18
Endsumme 301.741,18
### Appendix J - Price overview Argelith

#### Heineken Price overview 2014

<table>
<thead>
<tr>
<th>Colour</th>
<th>Hexolith Hex 108 x 10 mm</th>
<th>Rectangular / Square 98 x 98 mm</th>
<th>skirting / wall finish 198 x 198 mm</th>
<th>Internal / External Corners 194 x 110 mm covered base skirtings</th>
<th>Fitting to covered base skirtings</th>
<th>exw price per m²</th>
<th>exw price per piece</th>
</tr>
</thead>
<tbody>
<tr>
<td>Argeli</td>
<td>21,50 €</td>
<td>20,50 €</td>
<td>14,00 €</td>
<td>7,00 €</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arctic</td>
<td>22,50 €</td>
<td>21,50 €</td>
<td>14,00 €</td>
<td>7,00 €</td>
<td></td>
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</table>

**Verona II. Choice**

<table>
<thead>
<tr>
<th>Colour</th>
<th>Hexolith Hex 108 x 15 mm</th>
<th>Rectangular / Square 98 x 98 mm</th>
<th>R11</th>
<th>R11</th>
<th>ONLY R10 available</th>
<th>25 pcs per m²</th>
<th>exw price per m²</th>
<th>exw price per piece</th>
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<tr>
<td>Argeli</td>
<td>19,50 €</td>
<td>18,50 €</td>
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<td></td>
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<td>Arctic</td>
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<td>19,50 €</td>
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<td></td>
<td></td>
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*All prices net ex works; not including pallet, seaworthy container packaging and storage cost.*
### Appendix K – Price overview Zahna Fliesen

<table>
<thead>
<tr>
<th>Shape</th>
<th>Format</th>
<th>Thickness</th>
<th>Profile</th>
<th>Color</th>
<th>up to 5 sqm</th>
<th>5 - 10 sqm</th>
<th>10-30 sqm</th>
<th>30 sqm and more sqm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hexagonal</td>
<td>100 x 115</td>
<td>15</td>
<td>R11</td>
<td>PG1 Lichtgrau uni</td>
<td>17.70 €</td>
<td>16.70 €</td>
<td>16.20 €</td>
<td>15.70 €</td>
</tr>
<tr>
<td></td>
<td>100 x 115</td>
<td>18.5</td>
<td>R11</td>
<td>PG1 Lichtgrau uni</td>
<td>19.50 €</td>
<td>18.50 €</td>
<td>18.00 €</td>
<td>17.50 €</td>
</tr>
<tr>
<td></td>
<td>100 x 115</td>
<td>18.5</td>
<td>R11</td>
<td>PG2 Weiβ uni</td>
<td>18.70 €</td>
<td>17.70 €</td>
<td>17.20 €</td>
<td>16.70 €</td>
</tr>
<tr>
<td></td>
<td>100 x 115</td>
<td>18.5</td>
<td>R11</td>
<td>PG2 Weiβ uni</td>
<td>20.50 €</td>
<td>19.50 €</td>
<td>19.00 €</td>
<td>18.50 €</td>
</tr>
<tr>
<td></td>
<td>100 x 115</td>
<td>18.5</td>
<td>R11</td>
<td>PG3 Gelb uni</td>
<td>19.70 €</td>
<td>18.70 €</td>
<td>18.20 €</td>
<td>17.70 €</td>
</tr>
<tr>
<td></td>
<td>100 x 115</td>
<td>18.5</td>
<td>R11</td>
<td>PG3 Gelb uni</td>
<td>21.50 €</td>
<td>20.50 €</td>
<td>20.00 €</td>
<td>19.50 €</td>
</tr>
<tr>
<td>Rectangular</td>
<td>100 x 200</td>
<td>15</td>
<td>R11</td>
<td>PG1 Lichtgrau uni</td>
<td>15.00 €</td>
<td>14.50 €</td>
<td>14.00 €</td>
<td>13.50 €</td>
</tr>
<tr>
<td></td>
<td>100 x 200</td>
<td>18.5</td>
<td>R11</td>
<td>PG1 Lichtgrau uni</td>
<td>18.00 €</td>
<td>17.50 €</td>
<td>17.00 €</td>
<td>16.50 €</td>
</tr>
<tr>
<td></td>
<td>100 x 200</td>
<td>18.5</td>
<td>R11</td>
<td>PG2 Weiβ uni</td>
<td>16.00 €</td>
<td>15.50 €</td>
<td>15.00 €</td>
<td>14.50 €</td>
</tr>
<tr>
<td></td>
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<td>18.50 €</td>
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<td>17.50 €</td>
</tr>
<tr>
<td></td>
<td>100 x 200</td>
<td>18.5</td>
<td>R11</td>
<td>PG3 Gelb uni</td>
<td>17.00 €</td>
<td>16.50 €</td>
<td>16.00 €</td>
<td>15.50 €</td>
</tr>
<tr>
<td></td>
<td>100 x 200</td>
<td>18.5</td>
<td>R11</td>
<td>PG3 Gelb uni</td>
<td>20.00 €</td>
<td>19.50 €</td>
<td>19.00 €</td>
<td>18.50 €</td>
</tr>
<tr>
<td>Square</td>
<td>150 x 150</td>
<td>15</td>
<td>R11</td>
<td>PG1 Lichtgrau uni</td>
<td>15.00 €</td>
<td>14.50 €</td>
<td>14.00 €</td>
<td>13.50 €</td>
</tr>
<tr>
<td></td>
<td>150 x 150</td>
<td>16.5</td>
<td>R11</td>
<td>PG1 Lichtgrau uni</td>
<td>18.00 €</td>
<td>17.50 €</td>
<td>17.00 €</td>
<td>16.50 €</td>
</tr>
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<td></td>
<td>150 x 150</td>
<td>16.5</td>
<td>R11</td>
<td>PG2 Weiβ uni</td>
<td>18.00 €</td>
<td>17.50 €</td>
<td>17.00 €</td>
<td>16.50 €</td>
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<tr>
<td></td>
<td>150 x 150</td>
<td>16.5</td>
<td>R11</td>
<td>PG2 Weiβ uni</td>
<td>19.00 €</td>
<td>18.50 €</td>
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<td>17.50 €</td>
</tr>
<tr>
<td></td>
<td>150 x 150</td>
<td>16.5</td>
<td>R11</td>
<td>PG3 Gelb uni</td>
<td>17.00 €</td>
<td>16.50 €</td>
<td>16.00 €</td>
<td>15.50 €</td>
</tr>
<tr>
<td></td>
<td>150 x 150</td>
<td>16.5</td>
<td>R11</td>
<td>PG3 Gelb uni</td>
<td>20.00 €</td>
<td>19.50 €</td>
<td>19.00 €</td>
<td>18.50 €</td>
</tr>
</tbody>
</table>
### Appendix L – Bill of Quantity

<table>
<thead>
<tr>
<th>Position</th>
<th>Group</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Tiles</td>
<td>After completion of the installation, a minimum of 2% of all tile types should be handed to buyer</td>
</tr>
<tr>
<td>B</td>
<td>Installation materials</td>
<td>XXXX</td>
</tr>
<tr>
<td>C</td>
<td>Stainless steel</td>
<td>Channel, drains, expansion joints, corners, angles, protection plates</td>
</tr>
<tr>
<td>E</td>
<td>Installation</td>
<td>Personnel and equipment</td>
</tr>
<tr>
<td>F</td>
<td>Transport</td>
<td>XXXX</td>
</tr>
<tr>
<td>G</td>
<td>Tender phase</td>
<td>XXXX</td>
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</table>

#### Specified costs - Tiles

<table>
<thead>
<tr>
<th>Position</th>
<th>Description</th>
<th>Color</th>
<th>Thickness</th>
<th>Dimension</th>
<th>Unit</th>
<th>Price per unit</th>
<th>Quantity</th>
<th>Total price</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Hexagonal floor tiles</td>
<td>m²</td>
<td>€</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>Square tiles (2 %)</td>
<td>m²</td>
<td>€</td>
<td>-</td>
<td>0</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>Rectangular floor tiles</td>
<td>m²</td>
<td>€</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>Square tiles (2 %)</td>
<td>m²</td>
<td>€</td>
<td>-</td>
<td>0</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>5</td>
<td>Skirting tiles</td>
<td>m²</td>
<td>€</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>6</td>
<td>Square tiles (2 %)</td>
<td>m²</td>
<td>€</td>
<td>-</td>
<td>0</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>7</td>
<td>Outside corners</td>
<td>m²</td>
<td>€</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>8</td>
<td>Square tiles (2 %)</td>
<td>m²</td>
<td>€</td>
<td>-</td>
<td>0</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>9</td>
<td>Wall tiles</td>
<td>m²</td>
<td>€</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>10</td>
<td>Square tiles (2 %)</td>
<td>m²</td>
<td>€</td>
<td>-</td>
<td>0</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

**Total costs**

<table>
<thead>
<tr>
<th></th>
<th>€</th>
</tr>
</thead>
</table>

Bachelor Thesis – Chemical Resistant Floors

HEINEKEN Supply Chain B.V.
### OBLIGATIONS OF CUSTOMER AND SUPPLIER

The Customer and the Supplier shall arrange and pay for the following facilities, undertakings etc. as marked in accordance with the points indicated below. Those points not marked shall be considered irrelevant to the particular agreement between the Customer and the Supplier unless it can be clearly shown that such an omission was made by error.

<table>
<thead>
<tr>
<th>Client:</th>
<th>xxxx</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project:</td>
<td>xxxx</td>
</tr>
<tr>
<td>Project No.:</td>
<td>xxxx</td>
</tr>
<tr>
<td>Date:</td>
<td>xxxx</td>
</tr>
<tr>
<td>Revision:</td>
<td>xxxx</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Arranged by:</th>
<th>Paid by:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supplier</td>
<td>Customer</td>
</tr>
<tr>
<td>Supplier</td>
<td>Supplier</td>
</tr>
</tbody>
</table>

### A PERMISSION BY AUTHORITIES

1. Permission to build/construct the plant
2. Permission to install the equipment
3. Permission to import the equipment
4. Permission for the Supplier’s staff to enter the Buyer’s country (visa)
5. Permission for the Seller’s staff to work in the Buyer’s country/site (work permit)

### B INSURANCE

1. Transport (including marine) DDP

### C INSPECTIONS AND TESTS

1. Inspection of the site setup regarding SHE issues as required by law
<table>
<thead>
<tr>
<th>Group</th>
<th>Applicable to</th>
<th>Column 1</th>
<th>Column 2</th>
<th>Column 3</th>
<th>Column 4</th>
<th>Column 5</th>
<th>Column 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Unfinished upper surfaces of floors, subfloors and concrete bases</td>
<td>10</td>
<td>15</td>
<td>20</td>
<td>25</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Unfinished upper surfaces of floors, subfloors and concrete bases subject to heavy impact requirements (e.g., resilient flooring, industrial flooring, etc.)</td>
<td>5</td>
<td>6</td>
<td>12</td>
<td>15</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Finishes (e.g., ceramic tile)</td>
<td>2</td>
<td>4</td>
<td>10</td>
<td>12</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>As group 3, tiles subject to more stringent requirements</td>
<td>2</td>
<td>3</td>
<td>9</td>
<td>12</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Unfinished walls and ceilings</td>
<td>5</td>
<td>10</td>
<td>15</td>
<td>25</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Finished walls and ceilings (e.g., plastered walls, wall claddings and linings, suspended ceilings)</td>
<td>3</td>
<td>5</td>
<td>10</td>
<td>20</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>As group 5, but subject to more stringent requirements</td>
<td>2</td>
<td>3</td>
<td>8</td>
<td>15</td>
<td>20</td>
<td></td>
</tr>
</tbody>
</table>

* Intermediates values shall be taken from figures 1 and 2, and shall be given to the nearest millimetre.

1. The flatness tolerances in column 6 also apply to distances between measuring points of over 10m.

---

Table 5: Flatness tolerances

Legend:
- Column 1: Position deviations (limit values), in mm, for distances between measuring points, in m, up to
- Column 2: 1
- Column 3: 3
- Column 4: 5
- Column 5: 6
- Column 6: 7

---

Diagram: Distance between measuring points.
Appendix O – Overview meetings

Floor applicators

Mario Cvitkovic, director Vibrofloors, December 13, 2013

- Application by Vibrofloors or via partner.
- Previously worked with Budweiser, Inbev Anheuser, SABMiller and Pepsi.
- Area of operation also contains South-America since 3 years.
- Warrantee of systems is 10 years.
- During the first 5 years 2 visits + written report by maintenance manager.
- In the CIP area higher grade resin.
- A test will be done and a certificate will be given after floor is finished.
- No big reducing in costs because of a thinner tile, estimated €5–6 per m².
- Stainless steel drains will be installed by Vibrofloors.
- No forklifts on the floors are recommended.
- Thinset method is possible without screed.
- Preferred applicator is Argelith.
- Floor installation of 3000m² per day is possible with 7–8 men during 30 days.
- Expansion joint is weakest part of the floor and needed every 8x8m² or every 10x12m².
- Structural movement joints required for wet areas.
- Company arrives while the floor is being poured.
- The epoxy resin needs 7 days to fully chemically cure.
- Argelith tiles have a higher density than Zahna.
- Any fully vitrified tile is sufficient.
- Hexagonal tiles are preferred in small areas with a lot of slopes.
- In big areas the rectangular or square tiles are sufficient as well.


- Application via partner since it is a mediator.
- Previously worked in food and chemical industry.
- Thinner tile results in more floor damage.
- Tiles are laid in full bed joint and thinset resin.
- Hexagonal tiles are faster to lay.
- Supply of materials and systems, and training programs for local applicators.

Daniel van Koetsveld, director Van Koetsveld / Kagetec, January 9, 2014

- GFK system and BS system have previously been used together.
- GFK system almost same as BS system, but a different bonding layer of epoxy resin.
- AR system is strongest of all, field size is much bigger and no mortar bed under it.
- Fabric fiber mesh is used when it’s a hot area and also to divide cracks in the floor.
- <0.3 mm cracks are covered by the floor systems.
- If there are few cracks they are filled with epoxy resin, when many cracks the use foil.
- Mortar bed has a minimum curing time of 14 days.
- AR system: more materials, less labor and best price/performance ratio.
- Size fields depends on underlying concrete, can be between 250m² and 400m².
- Different prices between line or gully/spot drains.
- Roof on top is important during floor application.
- No or lesser curing time needed with AR system then with BS and GFK system.
- Preparation of the floor is really important.
- Channel drains must always be extended by expansion joints.
- Slope must be 15mm/m¹.
- It is preferred it local contractor boxed out channels for the drains.
- Time to gain with AR system: installation double as quick.
- Any mm helps for the total floor system, so thinner tiles are not preferred.
- Inbev Anheuser uses same systems as Heineken.
- Field size GFK max 150m², BS max 150 m², AR max 300–400 m².
- Wiedemann is advised for drains, instead of Blucher.

Werner Krampe, salesman Rundmund Säureschutztechnik, January 28, 2014

- Warranty is standard 5 years.
- 2500m² can be laid in 3–4 weeks.
- Wait 2–3 days for making joints because the water should leave.
- Applicator should assist while pouring concrete.
- 2–k synthetic mortar system is strong in short time, good price, can be installed over old floor, is better for unevenness, total thickness is 30mm.
- 2–k resin cement systems is cheaper, screed layer is required, and has a small/thin layer of epoxy. Floor can be accessed after 1 day.
Tile manufacturers

Volkert Aufderhaar, salesman Argelith, December 10, 2013

- Temperature is important, because tile absorbs heat slowly. This heat creates movement so thickness is important.
- Previously bad experiences with 12mm tiles.
- Also problems with application with 12mm thickness, because the joints are too thin to be properly filled with epoxy.
- Difference between 15mm and 18mm is between €0.30–€0.50 per m² on freight, €3–€4 on total costs per m².
- Anti-slip R11 is European law, not required in other countries.
- Joint is most important part of the floor.
- Humidity, temperature, size of areas: all decided the installation method.
- Light grey color tiles are cheapest.
- The more lighter the tile, the more expensive (much more heat is needed).
- With lighter floor, you see more dirt. Eventually you’ll become slave of your own floor, because of a lot of cleaning.

Rainer Tietz, salesman Zahna Fliesen, January 23, 2014

- Maximum production capacity is 50,000m² per month, FOB Antwerp or Rotterdam.
- Customised tile is possible from a minimum of 2000m².
- Less transport costs with 15mm tile. However, less point load on the floor.
- Specifications for 15mm and 18.5mm are the same.
- Consistency of tiles according to DIN–EN–ISO 14411.

Heineken experts
Jaap Past, Packaging, November 18, 2013
Klaas Tiktak, Brewing Solutions, November 20, 2013
Remco van de Bent, Water and Wastewater Treatment Plant, November 25, 2013
### Appendix P1 – General costs overview

<table>
<thead>
<tr>
<th>Year</th>
<th>City</th>
<th>Country</th>
<th>Project</th>
<th>Surface [m²]</th>
<th>Total costs</th>
<th>Total costs/m²</th>
<th>System costs (without drainage)</th>
<th>System costs/m² (without drainage)</th>
<th>Tile price/m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>Seville</td>
<td>Spain</td>
<td>P.0476</td>
<td>34706</td>
<td>€ 2.547.514,44</td>
<td>€ 73,40</td>
<td>€ 2.112.727,80</td>
<td>€ 60,88</td>
<td>€ 25,89</td>
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<tr>
<td>2008</td>
<td>Lagos</td>
<td>Nigeria</td>
<td>P.1189</td>
<td>1300</td>
<td>€ 197.415,44</td>
<td>€ 151,86</td>
<td>€ 132.263,65</td>
<td>€ 101,74</td>
<td>€ 31,64</td>
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<td>2008</td>
<td>Tangerang</td>
<td>Indonesia</td>
<td>P.1214</td>
<td>2550</td>
<td>€ 306.926,84</td>
<td>€ 120,36</td>
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<td>2008</td>
<td>Lubumbashi</td>
<td>Congo</td>
<td>P.1175</td>
<td>3550</td>
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<td>€ 102,67</td>
<td>€ 240.921,50</td>
<td>€ 67,87</td>
<td>€ 19,24</td>
</tr>
<tr>
<td>2010</td>
<td>Guangzhou</td>
<td>China</td>
<td>P.1227</td>
<td>9002</td>
<td>€ 768.780,83</td>
<td>€ 85,40</td>
<td>n/d</td>
<td>n/d</td>
<td>n/d</td>
</tr>
<tr>
<td>2010</td>
<td>Paramaribo</td>
<td>Suriname</td>
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<td>€ 232,89</td>
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<td>€ 180,43</td>
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<td>2011</td>
<td>Kinshasa</td>
<td>Congo</td>
<td>P.1266</td>
<td>2300</td>
<td>€ 301.464,69</td>
<td>€ 131,07</td>
<td>€ 262.033,78</td>
<td>€ 113,93</td>
<td>€ 32,19</td>
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<tr>
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<td>Burundi</td>
<td>P.1244</td>
<td>930</td>
<td>€ 180.899,99</td>
<td>€ 194,52</td>
<td>€ 130.764,31</td>
<td>€ 140,61</td>
<td>€ 33,07</td>
</tr>
<tr>
<td>2012</td>
<td>Aba</td>
<td>Nigeria</td>
<td>P.1295</td>
<td>6358</td>
<td>€ 961.378,57</td>
<td>€ 151,21</td>
<td>€ 795.072,97</td>
<td>€ 125,05</td>
<td>€ 33,55</td>
</tr>
<tr>
<td>2013</td>
<td>Kilinto</td>
<td>Ethiopia</td>
<td>P.1294</td>
<td>11300</td>
<td>€ 1.501.222,47</td>
<td>€ 132,85</td>
<td>€ 1.251.012,60</td>
<td>€ 110,71</td>
<td>€ 23,69</td>
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<td>2013</td>
<td>Port-au-Prince</td>
<td>Haiti</td>
<td>P.1332</td>
<td>2565</td>
<td>€ 342.090,81</td>
<td>€ 133,37</td>
<td>€ 301.741,18</td>
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<tr>
<td>2013</td>
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<td>P.1298</td>
<td>3600</td>
<td>€ 522.550,76</td>
<td>€ 145,15</td>
<td>€ 422.793,75</td>
<td>€ 117,44</td>
<td>€ 25,86</td>
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</tbody>
</table>

Average  

| Tile price/m² | € | 140,20 | € | 115,05 | € | 28,58 |

### Legend

**Tiles**  
The defined costs include all ordered tiles.

**Installation**  
The defined costs include manhours, daily money, flight costs, accommodation, visa.

**Installation materials**  
The defined costs included all used materials during installation, namely: grouting, sand, expansion joints, expansion fillers, adhesives, bonding layer, small materials, stainless steel angels, stainless steel covers.

**Transport**  
The defined costs only included freight costs FOB Antwerpen or FOB Rotterdam.

**Drainage**  
The defined costs include stainless steel gutters, drains, spot drains, glass catcher, filter baskets.

**n/d**  
Not defined

**n/a**  
Not applicable
## Appendix P2 – Specific costs overview

<table>
<thead>
<tr>
<th>Year</th>
<th>City</th>
<th>Country</th>
<th>Specified costs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>Tiles</strong></td>
</tr>
<tr>
<td>2007</td>
<td>Seville</td>
<td>Spain</td>
<td>€ 898.554,93</td>
</tr>
<tr>
<td>2008</td>
<td>Sedibeng</td>
<td>South Africa</td>
<td>€ 615.500,00</td>
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<tr>
<td>2008</td>
<td>Lagos</td>
<td>Nigeria</td>
<td>€ 41.134,65</td>
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<tr>
<td>2008</td>
<td>Tangerang</td>
<td>Indonesia</td>
<td>€ 78.230,00</td>
</tr>
<tr>
<td>2008</td>
<td>Lubumbashi</td>
<td>Congo</td>
<td>€ 68.301,50</td>
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<td>2010</td>
<td>Guangzhou</td>
<td>China</td>
<td>n/d</td>
</tr>
<tr>
<td>2010</td>
<td>Paramaribo</td>
<td>Suriname</td>
<td>€ 12.584,70</td>
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<td>2011</td>
<td>Kinshasa</td>
<td>Congo</td>
<td>€ 74.025,67</td>
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<tr>
<td>2011</td>
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<td>Burundi</td>
<td>€ 30.759,34</td>
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<td>Aba</td>
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<td>2013</td>
<td>Kilinto</td>
<td>Ethiopia</td>
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<td>Haiti</td>
<td>€ 86.144,10</td>
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<td>Congo</td>
<td>€ 103.394,20</td>
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</tbody>
</table>

**Average**: 21% 20% 18% 36% 5%