



D2.2

Safety guideline for mineral wool geopolymer production

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1. INTRODUCTION

1.1 BACKGROUND:

CRH Innovation Centre plans on developing a new concrete technology called ‘Alkaline Activated Materials’. To this end, a test system was installed in Hall 1 of the Rainbow Group - Heembeton B.V. site in Veenoord for the production of the **Alkaline Activated Materials**, hereafter referred to as **AAM**. The plan is to use this site to conduct experiments with the three AAM recipes.

The Heembeton B.V. site utilises a joint RA&E based on the Betonhuis method. Section 5 of the Dutch Working Conditions Act (*Arbeidsomstandighedenwet*) requires employers to amend the Risk Assessment & Evaluation to reflect any changes to the work methods or conditions. CRH has asked an external party to draw up a detailed RA&E of the risks that the new AAM process may pose to employees and the work environment.

1.2 OBJECTIVE:

This RA&E provides an assessment and evaluation of the occupational risks presented by the work method for the three experiments with the AAM concrete technology at the Heembeton B.V. site production hall 1 and mixing facility.

1.3 APPLICABILITY:

This specific in-depth RA&E applies to the entire production process for the AAM concrete technology at the Heembeton B.V. site at Boerdijk 30 in Veenoord, hall 1, including:

- Delivery of raw materials
- Dosage and mixing of the raw materials to become AAM mortar in MC 1
- Transport of mortar to hall 1, max 8 lines
- Pouring AAM mortar
- Processing AAM mortar
- Hardening AAM products
- Removing AAM product from the line
- Transport to curing yard
- Storage at curing yard
- Transport to customer
- Criteria 73 quality control and testing mortar and product

The health and occupational risks have been evaluated for the foreseeable standard production process, inspection and maintenance, and emergencies.

As the RA&E was being drafted, the process was being organised for the pilot phase. It is vital that this RA&E is updated to reflect changes to the AAM technology as it approaches the actual production phase, regarding the management of long-term risks, including occupational hygiene exposure risks or risks related to maintenance of the installations involved in the process.

This RA&E was drawn up by Heembeton B.V. specifically for hall 1 and mixing facility 1 at the Veenoord site. No other parts of the site or company were evaluated. The map below provides an overview of the demarcation for this RA&E.

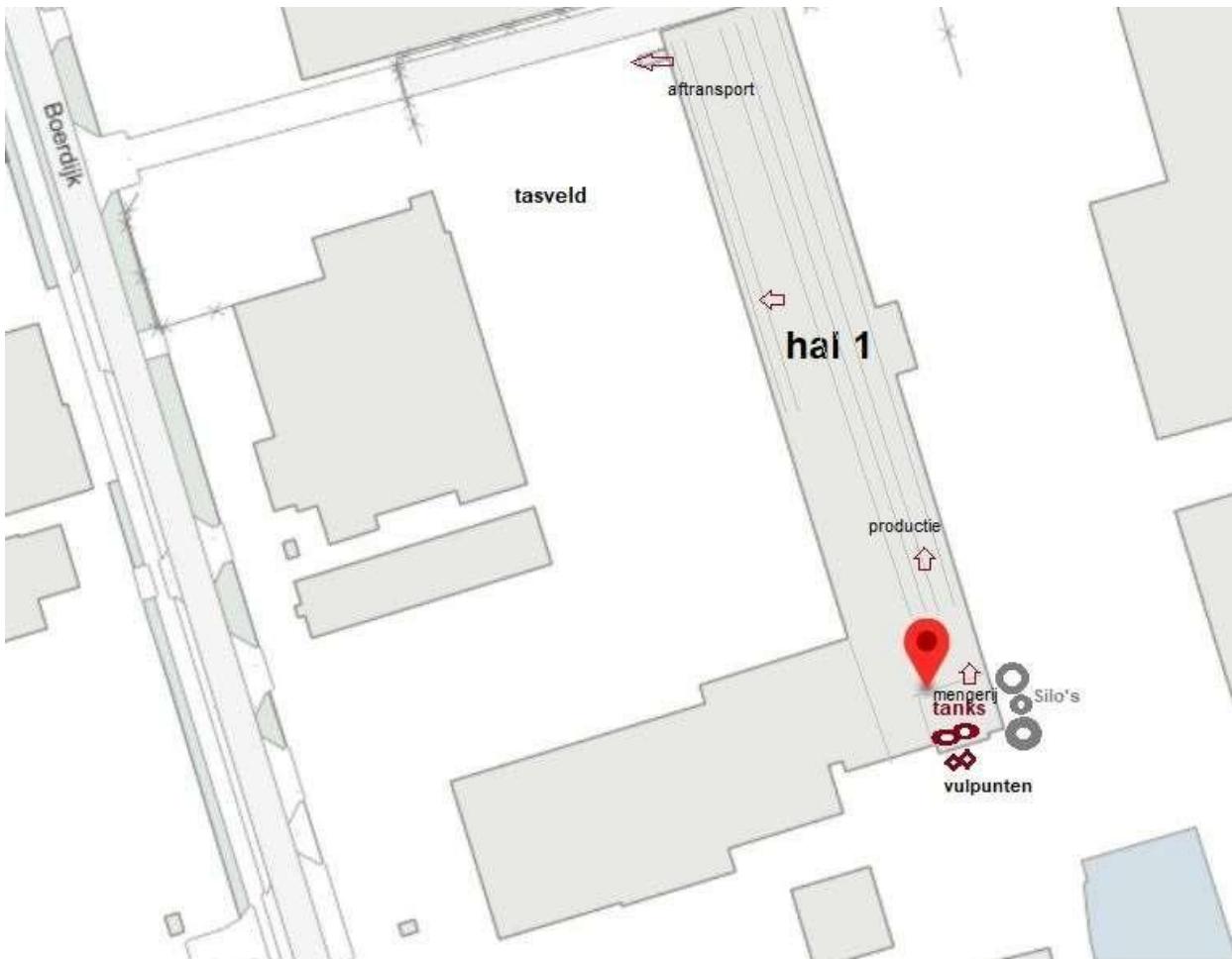


Figure 1: Demarcation of RA&E and FMEA production of AAM by CRH - Heembeton B.V.

2. METHOD

This RA&E was conducted by CRH at the request of the CRH Innovation Programme Manager. As stipulated by the Working Conditions Act, the Heembeton B.V. plant manager obtained internal approval for this RA&E as she bears responsibility for her employees' occupational risks (action).

Both the CRH Innovation Centre and the Heembeton site were asked to provide information needed for the conduct of this RA&E. During the design phase, the supplier of the tank installation - the firm Altop Kunststoftechniek - was asked to provide access to the technical construction portfolio. This is because they were responsible for the installation of the 2.5 m³ sodium hydroxide tank and the 2.5 m³ sodium metasilicate tank, as well as the relevant fill, anti-siphon, dosage and injection boxes.

The key functionaries in the initiation, design and pilot phase were all interviewed on 8 October.

A site visit was then conducted on 30 October, which mainly identified the characteristic differences between the standard work processes, functionaries, resources realised and facilities. The team leader and prevention officer were also provided with practical recommendations to make immediate improvements to the emergency facilities and the standard safety and work instructions.

The key operatives interviewed for this detailed RA&E are:

- Innovation Program Manager - Low CO₂ Built Environment at Innovation Centre for Sustainable Construction CRH
- Materials R&D Manager (Europe) Innovation Centre for Sustainable Construction CRH
- SHEQ Coordinator De Ruwbouw Groep
- Innovation and Product Manager - Heembeton B.V., Lelystad and Veenoord sites
- Team Leader - Heembeton B.V. - Veenoord site - production hall 1
- Head of the Technical Service - Heembeton B.V. - Veenoord site
- Altop Kunststoftechniek Project Leader

The FMEA (Failure Modes and Effects Analysis) evaluation system was used to assess the risks. This is a detailed specialist system for process-oriented risk assessment, which facilitates an analysis of potential faults and consequences for the design of new systems, installations and production processes. This system's strength is its ability to identify the potential likelihood of faults and consequences of the implementation of new processes and installations. An FMEA joint and integrated risk session can also add value, but was not conducted; it was drawn up based on face-to-face interviews instead. However, the underlying RA&E was discussed with the relevant team members on 1 December 2020.

In addition to evaluating the installation and relevant production process, the Working Conditions Act also stipulates that an RA&E provide information about aspects such as organisational working conditions policy. This includes issues such as incorporating employee input, employee involvement, prevention officer, periodic medical exams and Company Emergency Response teams.

The structure chosen for this RA&E describes the affected areas, so that the document can serve as a useful resource for all stakeholders at the various levels. The objective is to arrive at targeted improvement activities for the specific experimental location, as well as provide guidelines for the Innovation Centre for the further development of the AAM technology.

3. ORGANISATION, POSITIONS AND DUTIES

3.1 OVERARCHING ORGANISATION

Heembeton B.V. is a business unit of De Ruwbouw Groep, which is a subsidiary of the international exchange-listed company CRH. CRH maintains high standards for safety, which are specifically stipulated in 16 life-saving rules that apply to all CRH subsidiaries and units. CRH also operates its own European Innovation Centre, which is involved in projects related to sustainability and product development. This RA&E is an attempt to tie in to the European WOOL2LOOP project for the development of a new geopolymer technology using mineral wool.

De Ruwbouw Groep has appointed several SEHQ officers at the group level. The SEHQ officers offer the various production sites guidance in the implementation of occupational health and safety.

Heembeton B.V. itself has two sites: the main office and a production site in Lelystad, as well as another production facility in Veenoord.

3.2 HEMBETON ORGANISATION -VEENOORD SITE

This RA&E was drawn up specifically for hall 1 and at the Veenoord site. No other parts of the site or company were evaluated. The site's plant manager is responsible for the day-to-day operations of the organisation and for its employees.

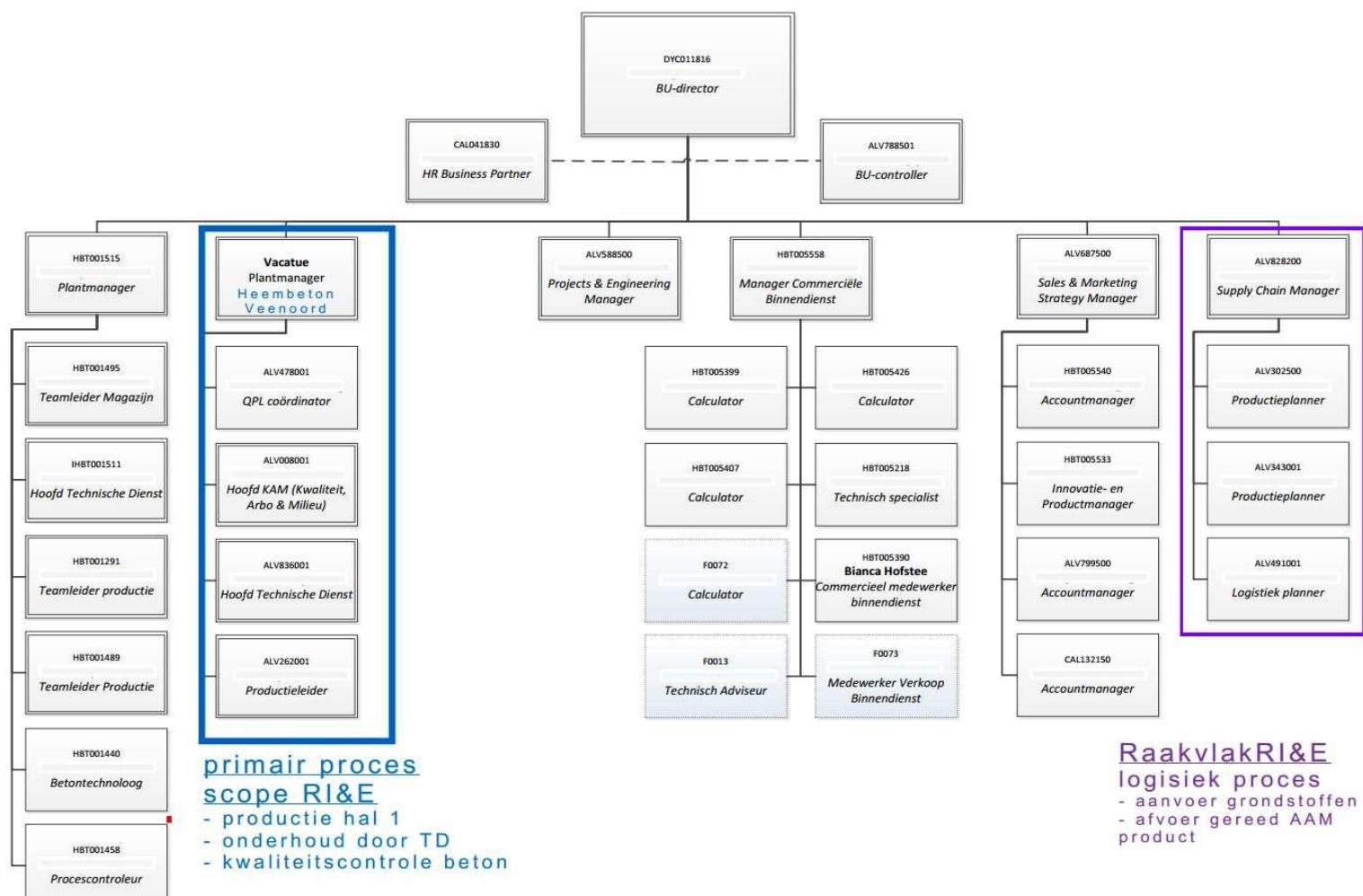


Figure 2: Organisational chart and RA&E areas for AAM concrete production by Heembeton B.V.

3.3 POSITIONS INVOLVED IN PRODUCTION OF AAM[©] CONCRETE

The detailed RA&E identified which positions are affected by the RA&E in the areas of management and organisation, production, facilities or maintenance. The results of this assessment are listed in **table 1** below.

Position	No. of people	Risk exposure	Task i.r.t. RA&E
BU Director Plant Manager	1	None	Final responsibility for RA&E, facilitating organisational and financial participation in PMO, participation in training and instructions, and implementing measures to prevent or mitigate occupational risks.
HSE Coordinator (=Prevention Assistant)	1	None	Assist with conduct and implementation of RA&E, toolboxes, safety inspections, advise and co-authorise high-risk work permits.
Team Leader, Hall 1	1	Low	Administer and provide training and instructions to production staff, toolboxes, implementation of practical management measures in production, safety inspections, reporting, production staff concerns and complaints, participate in PMO.
Head of Technical Service	1	High	Design installation together with tank builder. Administer, inspect and maintain installation, responsible for specific training & instruction for Technical Service staff, issue work permits for TS staff for maintenance to installation involving contact with wet AAM mortar or lyes, administer the LTT key procedure for the AAM installation, clear installation after malfunctions/alarms, responsible for contact with tank supplier, TS staff concerns and complaints, (optional) participate in PMO.
Technical Service staff	9	High	Authorised to resolve mechanical and electrical malfunctions. With work permit, possible contact with fluid alkaline raw materials and wet concrete mortar. Participation in training and instruction (required) and PMO (optional). Reporting hazardous situations and complaints.
Production assistants, incl. pour machine operator		Medium	Mould preparation, production, raking wet AAM mortar, install pour facilities, remove hardened products, clean lines, clean tools/resources, participate in training and instruction (required) and PMO (optional), report hazardous situations and complaints.
Mill Supervisor		Medium	Administer fill basin keys, clear tank installation for drivers, periodic inspection of alarm and fill installation, check drivers for correct PPE and brief CER instruction for drivers.
Mixer cleaner		Low	Authorised to clean mixer without work permit if last product mixed was not AAM mortar. Clean mixer exterior with high pressure, secure lye supply mains in mixer, participate in training and instruction (required) and PMO (optional), report hazardous situations and complaints. If last product mixed was fresh AAM mortar, then a work permit is required for cleaning.
Curing yard assistant	3	Low	participate in training and instruction (required) and PMO (optional), report hazardous situations and complaints.
Concrete Technician	4	Medium	Quality control as stipulated by criteria 73. This may involve contact with the sodium hydroxide and sodium metasilicate in the mixer, as well as the liquid AAM mortar in the lab. Participate in training and instruction (required) and PMO (optional), report hazardous situations and complaints.

Company Emergency Response team (CER)	15	Low	In event of an emergency, authorised to solve the problem according to procedures, Participate in training and instruction (required) and PMO (optional), report hazardous situations and complaints.
Tank lorry driver EXTERNAL	1	Medium	Fill installation and general obligation to report and take action in event of spills/leakage or other problems.
Tank supplier ATOP EXTERNAL	2	High	Maintain and enter tank installation. Work permit to come into contact with raw materials and resources installation. Follow instructions.

Table 1: Positions affected by RA&E areas for AAM concrete production by Heembeton B.V.

Comment:

The ‘Risk’ column states whether there is an actual risk of physical contact with the liquid alkaline raw materials, the cement substitute, alternate fillers, wet concrete mortar or the hardened product.

The plan involves the tank supplier conducting maintenance to the sodium hydroxide and sodium metasilicate tank installation, which reduces the risk of Technical Service staff coming into contact with liquid alkali. Their only potential contact risk is posed when acting in the event of a malfunction or technical emergency. In that case, the plan states that a work permit must always be implemented with TRA (action).

The contact risk for the mixing facility cleaner has been evaluated as ‘low’, because the plan is to always mix a conventional mixture afterwards. If the mixing facility is to be cleaned immediately after mixing an AAM mortar, then the work permit procedure must be followed. This will improve awareness of the safe work method.

Production staff in the hall may be at risk of exposure of alkaline mortar via the skin, especially when the mortar is being poured. The work process includes preventive measures such as those discussed when drawing up this RA&E. When the lines are removed, workers must take the possible dust and fibre load into consideration. The exposure risk has been evaluated as ‘medium’ due to the ease of planning the control measures. A quantification of the longer-term exposure risks is included in the Action Plan (action).

In the context of criteria 73, the concrete technician is expected to only come into contact with the liquid cement mortar once per day, especially during tests to determine the flow. The concrete technician may also come into contact with the alkaline liquid raw materials and wet concrete mortar a few times per year, as these must be weighed directly from the mixing facility. This is expected to require some additional safety measures, such as a wash facility. The RA&E Action Plan states that the TRA method will be used as needed to evaluate which specific measures should be implemented (action).

The risk to drivers has been evaluated as ‘medium’ because this task is not very common, and the plan includes control measures in the form of proper instruction and the use of personal protective equipment. However, in the event of a spillage, large quantities of lye may be released at this location. This should be considered when drawing up the CER plan, and has been included as an activity in the Action Plan (action).

4. AAM PRODUCTION PROCESS (EXPERIMENTS)

4.1 GENERAL PROCESS DESCRIPTION

The bulk raw materials for the production of the concrete will be stored in a silo (for cement) and open storage spaces (for sand and gravel) near hall 1.

The work itself will be carried out in production hall 1. This hall is fully self-sufficient and is equipped with its own mixer and transport system. The hall contains eight production lines.

Between 5 and 7 employees generally work in production hall 1. The hall has a team leader, 1 mill supervisor and 5 production assistants.

Concrete mortar is routinely produced in the fully automated mixer, then poured into a Dudik tub and transferred to a pour machine on the line. The pour machine then spreads the concrete mortar over the line. Before the concrete mortar is produced, a steel line mould is prepared with rebar and any pre-pour insertions and then lubricated. Once the concrete has been poured, an assistant rakes the mortar evenly over the mould. At this point, any extra insertions (such as tempex, lifting eyes or ball joints) can be added to the still-wet and plastic concrete. A cart is then used to lay a cover over the line, and the product is left to harden overnight. The next morning, the overhead crane in the hall lifts the finished product from the mould using the lifting eyes, and the product is placed on the transport line. Outside the hall, the crane operator places the product on the curing yard. In general, the panel is left here to continue curing before being delivered to the customer by lorry. The curing yard crane operator then places the products on the trailer. The driver is responsible for securing the load. The product subsequently leaves the site. The RA&E below evaluates the full scope of the process, from filling the tanks and mixer to transport of the product.

4.2 AAM TECHNOLOGY PROCESS SUMMARY

Experiments with the AAM technology are planned to be conducted in production hall 1 and mixing facility 1. The team evaluated the three possible recipes listed in [Appendix 1](#).

The characteristic difference between AAM technology and the current concrete technique is the use of ground granulated blast-furnace slag (GGBS) as a cement replacement, combined with a 30%-50% dose of sodium hydroxide and 45%-50% dose of sodium metasilicate. To facilitate the dosage of the sodium hydroxide and sodium metasilicate, two double-walled 2.5 m³ polymer tanks have been installed. The liquid ingredients are then injected directly into the mixer via an automatic dosing and injection system that is also almost entirely double-walled. No technical adjustments have been made for the dosing of the GGBS.

One recipe uses a mineral wool in addition to the GGBS, sodium hydroxide and sodium metasilicate. As the experiment is intended to be temporary, no automated transport system has been realised for this purpose. The plan is to lift the bags using a pan- or ladder lift to the dosing position (open mixing platform on the 2nd floor). This RA&E recommends considering using a telescoping handler as an alternative to this method. The mineral wool will be dosed in bags at the top of the mixer. A wooden tale has been built to pour the bags into the hopper opening. The recommendations include a measure to prevent the fibres from blowing into the production facility (action). Requirements have been drawn up for the instructions, protective clothing and personal protective equipment for the employee dosing the mineral wool during the experiments.

The production of the test sections will use a standard process: construction of the moulds, mould layout, pour concrete, quality control, finishing (inserting ball joint anchors), lubricate the lines, hardening, removal and transport to the curing yard.

4.3 FMEA PROCESS EVALUATION

In this RA&E, the entire process was evaluated for changes and aspects pertaining to Occupational Health and Safety legislation, as well as the necessary application within the company policy. This table shows a summary of the safety and health measures for the experiments or later phases of the production process. The Appendix to this report includes a more detailed FMEA evaluation.

Visual illustration of process step	Explanation of necessary and implemented FMEA measures
	<p>Silos with GGBS and sand/aggregate storage in bunkers</p> <p>No changes are needed and/or implemented for this process step.</p>
	<p>Fill tanks with sodium hydroxide, sodium metasilicate:</p> <ul style="list-style-type: none"> ✓ Signage and marking (<i>list % sodium metasilicate</i>) ✓ Collision protection ✓ Leak basin beneath fill point ✓ Fill indicator lamp ✓ Secure fill point basin with key lock ✓ Special key for operator ✓ Cleared by authorised employee ✓ Driver fill procedure ✓ Driver personal protective equipment (face screen, safety boots, chemical-resistant gloves) ✓ Emergency eye wash nearby (<i>sign marking location</i>) ✓ Emergency instructions (<i>spills, leakage, skin exposure</i>)

 A photograph showing industrial storage tanks and piping. On the left is a large black vertical tank. To its right is a light-colored cabinet or control panel with glass doors, containing various internal components and piping. Above the cabinet are several smaller stainless steel tanks connected by pipes.	<p>Storage of sodium hydroxide and sodium metasilicate in tanks:</p> <ul style="list-style-type: none">✓ Stable installation, above ground✓ Single-walled tanks✓ Secured with safety fence✓ Tanks equipped with open leak basin (<i>pay attention to dust!</i>)✓ Leak detection (capacitive sensor) in leak basin✓ Double-walled pipes to injection panel✓ Secure injection panel with key lock✓ Pipe signage✓ Injection panel signage (<i>needs improvement!</i>)✓ Single-walled pipes from injection to mixer✓ BRL-K903 standard certified✓ Installed by certified ALTOP installer✓ Maintenance by ALTOP supplier (<i>must be ensured</i>)✓ Tank fall hazard during inspection and maintenance (<i>TRA</i>)✓ CER box and emergency eye wash nearby (marked with sign)✓ Emergency instructions (<i>to be ensured</i>)
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Visual illustration of process step	Explanation of necessary and implemented FMEA measures
	<p>Dosing sodium hydroxide, sodium metasilicate and GGBS in mixer:</p> <ul style="list-style-type: none"> ✓ Supply line for sodium hydroxide and sodium metasilicate fitted with shut-off valves (incl. key) ✓ Position of supply line presents risks of spillage on mixer arm (action) ✓ Line rinse facility after injection box to mixer to prevent caking (action) ✓ Process workers may only stand on mixer with TRA and work permit (<i>embed LTT, incl. PPE/clothing</i>) ✓ Prevent high-pressure nozzle from contacting single fill pipes during cleaning (action) ✓ Emergency eye wash nearby (marked with sign) ✓ Emergency instructions (<i>to be ensured</i>)
 	<p>Transporting bags of mineral wool and dosing in mixer</p> <ul style="list-style-type: none"> ✓ Conduct TRA/LMRA, with following activities embedded: <ul style="list-style-type: none"> ○ Use a safe pan lift/ladder lift OR pallet with telescoping handler to place on platform <ul style="list-style-type: none"> ○ (also check platform weight limit) ○ Secure lift work area (to avoid risk of tipping and/or standing under lift) ○ Further evaluation of handling point on platform due to fall hazard. ○ Safe operation of lift / telescoping handler ✓ Max. weight of bags: 25kg (physical strain) ✓ Use pour equipment (physical strain, windblown dust) ✓ Use safe cutting blade, incl. special cutting gloves and/or cut-resistant work clothing ✓ Physically screen dosage bags from mixing facility environment, production (prevent fibres from blowing into area) ✓ Equip employee with FFP3 respiration protection, face screen, disposable overalls ✓ Facilities for showering, changing clothes after dosing ✓ Dispose of empty bags in closed plastic bag
	<p>Assemble, lay out and lubricate moulds</p> <p>No changes are needed and/or implemented for this process step.</p> <ul style="list-style-type: none"> ✓ When using other lubricants for the moulds or mould components or cleaning lines, ensure that the occupational health and safety aspects are evaluated.

Visual illustration of process step	Explanation of necessary and implemented FMEA measures
	<p>Pouring AAM mortar:</p> <ul style="list-style-type: none"> ✓ Switch on LOOK OUT sign when AAM mixture is mixed. ✓ Notify authorised TS staff member in event of a malfunction; do not attempt to fix it yourself. ✓ Extra protective clothing when solving malfunctions: chemical-resistant overalls (disposable). ✓ Inform employees about risks, safe work method, PPE and emergency instructions.
	<p>Raking out AAM mortar:</p> <ul style="list-style-type: none"> ✓ Use chemical-resistant gloves (EN 374:2016 type B class AK), face screen and boots (S5), ✓ Change work clothing at end of shift, ✓ Work clothing covering entire body (long sleeves) ✓ Hang tools separately (=5S sign AAM mortar). ✓ Rinse tools with water ✓ Inform employees about risks, safe work method, PPE and emergency instructions.
	<p>Finishing moulds, such as installing insertions:</p> <ul style="list-style-type: none"> ✓ Use chemical-resistant gloves (EN 374:2016 type B class AK), face screen and boots (S5), ✓ Change work clothing at end of shift, ✓ Work clothing covering entire body (long sleeves) ✓ Hang tools separately (=5S sign AAM mortar). ✓ Rinse tools with water ✓ Inform employees about risks, safe work method, PPE and emergency instructions.
	<p>Transport of finished AAM product:</p> <p>No changes are needed and/or implemented for this process step.</p>

Visual illustration of process step	Explanation of necessary and implemented FMEA measures
	<p>Using crane to position elements on the curing yard:</p> <p>No changes are needed and/or implemented for this process step.</p>
	<p>Storage of elements at curing yard:</p> <ul style="list-style-type: none"> ✓ Mark area with sign 'CAUTION: AAM' elements and pictogram for 'wear gloves' ✓ Further research into risk of skin contact for formation of salt crystals during storage at curing yard, combined with damp/precipitation (CRH action).
	<p>Grasping and transport:</p> <ul style="list-style-type: none"> ✓ Further research into risk of skin contact for formation of salt crystals during storage at curing yard, combined with damp/precipitation (CRH action). ✓ Require drivers to wear work gloves, minimum level EN ISO 374-1:2016 type C letter code K (possibly reconsider this minimum requirement after CRH research at curing yard)
	<p>Cleaning machines and lines (incl. mixer, DUDIK tub):</p> <ul style="list-style-type: none"> ✓ The processing procedure agreed upon in the RA&E stipulates that a standard mixture must be run after mixing AAM concrete. This is a source measure; avoid contact! ✓ The method for cleaning machines agreed upon in the RA&E stipulates that the work permit system must be used components with wet AAM residue, with the following quality criteria for personal protective equipment: chemical-resistant <ul style="list-style-type: none"> ○ Gloves EN ISO 374-1:2016 type B letter code AK ○ Face screen ○ Safety shoes S3 / boots S5

Visual illustration of process step	Explanation of necessary and implemented FMEA measures
	<p>Quality control for AAM concrete technician:</p> <ul style="list-style-type: none"> ✓ For daily tests with liquid mortar, use chemical-resistant gloves EN ISO 374-1:2016 type B letter code AK and face screen, safety boots optional. ✓ Work surfaces and tools used in daily quality tests with AAM mortar must be rinsed off with water (ex. bucket). ✓ Draw up specific TRA for contact with alkaline liquid raw materials (=weight test at mixer) ✓ When tapping liquids in mixer, provide option for safe capture of liquids and transport via stairs in enclosed UN-approved packaging. ✓ Inform employees about risks, safe work method, proper PPE and emergency instructions.
	<p>AAM concrete maintenance by Technical Service:</p> <ul style="list-style-type: none"> ✓ Draw up inspection and maintenance register. ✓ Draw up TRAs and possible direct-contact tasks involving alkaline liquid raw materials and wet AAM mortar. ✓ Inform employees about risks, safe work methods, proper PPE and emergency instructions.

Table 2: Positions affected by RA&E areas for AAM concrete production by Heembeton B.V.

4.4 MEASURES TAKEN TO PREVENT OCCUPATIONAL HAZARDS

The production of conventional concrete mixture consisting of sand, (recyclable) aggregate, water, Portland cement, plasticiser, lime and other fillers presents a variety of safety and health risks during the production phase. The characteristic hazards are present in the areas of machine safety, physical strain, noise levels, and exposure to hazardous materials. These are described in the Heembeton B.V. company RA&E. Heembeton B.V. has many years of experience, and many hazards are already prevented and/or managed through the basic production process. This includes measures such as:

- Storage of dust-producing Portland cement or cement replacements in silos, enclosed dosage in mixer
- production of mortar almost fully automated in enclosed mixer
- working with wet concrete mortar with alkaline characteristics (=skin exposure risk)
- wet cleaning of the mixer (prevention of dust inhalation)
- application of LTT work processes in maintenance of mixer, DUDIK and pour machine
- use of overhead crane and lift facilities to remove products from moulds
- issuing employees standard work clothing, gloves and hearing protection
- safety procedures, instructions and toolboxes
- provision of CER and first aid facilities.

4.5. SPECIFIC OCCUPATIONAL RISKS FOR AAM TECHNOLOGY

The planned experiments take precedence, especially regarding differences in hazards regarding exposure to hazardous materials and physical strain. The sodium metasilicate and sodium hydroxide (the alkaloids) have high pH values (highly basic). The liquid sodium hydroxide has a pH of 13 to 14. It can be corrosive to metals, and may cause serious skin burns or eye injuries. To prevent exposure, these new alkaloids are fully enclosed when dosed in the mixer. During dosing in the mixer, the hydroxide reacts immediately and the pH of the mixture is approximately 12 to 13.

This is equivalent to Portland cement concrete. The main difference in the processing phase (on the line) is that the total concentration of alkaline raw materials is significantly higher in the AAM mortar. Employees working with wet AAM mortar and on the production line should therefore take the stronger alkaline characteristics into consideration. Based on the safety information sheet, foreseeable risks include burns and eye injuries. The experience of the Innovation Centre for Sustainable Construction has shown that employees may also experience irritations in the nose and eyes during the phase during and after the AAM mortar is poured. In the phase when the mortar is hardening and removed from the line the next morning, the pH value is equivalent to that of Portland cement: from 12 to 12.5 pH. When the product is placed on the curing yard, employees should be aware that salt crystals may form on the product due to rain or damp. These salt crystals are sodium carbonate that has a higher pH value than standard concrete products. The curing yard therefore presents a risk of skin exposure.

When using the other raw materials, the composition of GGBS is also relevant. It contains a small concentration of heavy metals, for which the leaching has since been determined. However, the inhalation exposure risk has not yet been evaluated. This presents an occupational hygiene risk over the longer term (production phase), and requires further study. An Action Plan and measures for an occupational hygiene study have been drawn up.

The use of mineral wool (microfibres) in the pilot will present a risk of physical strain. The microfibres also present a risk of inhalation, eye contact and skin contact. This may occur during dosing or removing the elements and cleaning the lines. To study future applications for CHR, it is essential that the exposure to fibres and the limit values be determined in greater detail. For short-duration experiments, it is necessary that employees are protected during dosing, removing elements from the line and cleaning the line, mixer, Dudik tub and pour machine. The Action Plan includes measures for these purposes.

5 OCCUPATIONAL HEALTH AND SAFETY

5.1 COOPERATION & CONSULTATION, SPECIAL WORKS COUNCIL RIGHTS, AND EXPERT ASSISTANCE

In addition to the technical installation and the primary process, the relevant aspects for the Heembeton Veenoord site organisation must also be evaluated. These are described in Section 3 of the Working Conditions Act, and the relevant aspects for this RA&E are as follows:

- Cooperation, consultation and special Works Council rights, employee participation and stakeholder employees
- Expert assistance to employees in the areas of prevention and protection
- Additional specific expert assistance to employees with specific tasks in the areas of prevention and protection
- Expert assistance in the area of Company Emergency Response
- Information rights for expert employees and individuals, CER team members and occupational health and safety services.

5.1.1. WORKS COUNCIL

Heembeton is represented by three employees in the Works Council at the level of De Ruwbouw Groep. In accordance with Section 12, 1st and 2nd subsections of the Occupational Health and Safety Act, the employer must discuss issues related to the organisation's occupational health and safety policy (action). In that capacity, a measure has been formulated in the Action Plan. Several company officers were involved in the drafting of this RA&E; they are listed in Chapter 2.

5.1.2 PREVENTION OFFICER

Section 13, subsection 7 of the Occupational Health and Safety Act stipulates that the Prevention Officer must assist with the drafting of the RA&E. At Heembeton, the position of Prevention Officer is filled by the coordinating HSE Officer. This HSE Officer is responsible for the overall company RA&E. The former HSE Officer was closely involved in drafting this RA&E. Please note that the coordinating company RA&E is currently undergoing revision. The areas relevant to this RA&E were discussed with the Prevention Officer, including CER issues, training and instructions, PPE policy and PME policy.

5.1.3 OCCUPATIONAL PHYSICIAN AND PERIODIC MEDICAL EXAMS:

Article 4.10a of the Working Conditions Decree stipulates that employees working with hazardous substances must be given the opportunity to undergo an occupational health examination, or 'periodic medical exam'. This is not a new requirement, and due to the potential exposure to quartz dust in standard concrete production it is already offered to employees.

Heembeton has a contract with the ArboUnie occupational health service for this service. The notification of the occupational physician, the conduct of a periodic medical exam and the exchange of information about working with new hazardous substances have not yet taken place. The Action Plan therefore includes a targeted communication and PME recommendation (action, HRM department).

5.2 TRAINING AND INSTRUCTIONS

Section 8 of the Working Conditions Act stipulates requirements for training and instruction of employees regarding occupational risks and measures. The site differentiates between training, information and instructions, which are organised as follows:

Training:

- The Team Leader, Hall 1 is VCA VOL certified.
- The CER team members receive annual

CER refresher training. Information:

- Heembeton shows a training video to new employees.
- Toolboxes are issued on a monthly basis.

Instructions:

- CRH has drawn up a set of life-saving rules for all of its subsidiaries.
- LLT instructions are provided, which include instructions on securing new or changed installations. A check for completeness must still be conducted.

This RA&E has determined that the following toolboxes and instructions must be drawn up for the start of the experiment (action):

- Driver's instruction, tank fill instruction incl. specific driver PPE/CER/LMRA check
- Key management procedure
- Cleaning mixer after mixing AAM concrete mortar
- AAM product ready for transport at curing yard and customer
- Maintenance to AAM installation, mixer, Dudik, pour machine after mixing AAM concrete (mortar)
- PPE matrix for production, maintenance and emergencies involving AAM concrete (mortar) products
- CER instructions for foreseeable emergencies involving AAM concrete (mortar) production process

5.3 EMERGENCIES AND COMPANY EMERGENCY RESPONSE

Section 15 of the Occupational Health and Safety Act provides that employees must consider potential emergencies and accidents and to train CER team members and equip them with proper resources and facilities. Heembeton has a CER team consisting of 5 team leaders and around 20-25 CER team members. The team structure ensures that CER team members are present in every hall, including hall 1. It also ensures that annual exercises are conducted in the halls. Hall 1 has effective basic facilities for Company Emergency Response purposes.

As part of the new work process, further elaboration of the CER facilities has begun. An eye-rinse station has been installed near the tank installation in hall 1. The inspection verified that this is in proper working order and is easily accessible, even for drivers. Special eye rinse bottles (Diphoterine®) have been supplied near the pour machine, the mixing facility (recommendation near the injection box), the mixer fill platform, the CER box near the tank

installation, and the quality lab.



The current eye-rinse stations have been market. Another must be installed near the mixing facility and marked.

The installation of a CER box near the tank installation has been discussed. This will include: eye-rinse bottle, chemical-resistant gloves and work overalls, face screen (with or without safety helmet), absorbent gravel.

Up-to-date floor plans and targeted training and instruction for CER team members must still be arranged. These should include at least the following instructions (action):

- Risks and measures for CER team members' safety in event of contact with alkaline fluids, new cement replacement/fillers, spills and leaks (small, medium, large).
 - Treating victims with burn injuries on skin/hands
 - Treatment after eye contact
 - Handling contaminated clothing

5.4 WORK PERMITS

Heembeton uses a system of work permits for all uncommon and high-risk work activities. Usually the line manager issues these permits to the individuals charged with performing the task. This is done by filling in the 'Work permits' form illustrated. If the form is filled in, no TRA need be drawn up. If the task also involves other departments (production, Technical Service), then the person responsible for the other department is also involved in issuing the permit.

1. Detaillierte Beschreibung		2. Relevante Anforderungen		3. Beurteilung der Erfüllung										
<p>1.1. Produktbeschreibung</p> <p>Produktname: L1000</p> <p>Produkttyp: Werkzeug</p> <p>Hersteller: ABC Werkzeuge</p> <p>Produktbeschreibung: Ein universelles Handwerkzeug für die Montage von Schrauben und Bolzen.</p> <p>Technische Spezifikationen:</p> <ul style="list-style-type: none"> Größe: 100 mm Material: Stahl Farbe: Schwarz gewicht: 0,5 kg <p>Verwendungsbereich: Montagearbeiten in der Automobilindustrie</p>		<p>2.1. Anforderungen an das Produkt</p> <p>2.1.1. Funktionelle Anforderungen</p> <ul style="list-style-type: none"> A1: Schrauben und Bolzen können leicht angezogen werden. A2: Der Griff ist sicher und ergonomisch geformt. A3: Das Werkzeug ist leicht zu reinigen. A4: Es kann verschiedene Schraubengrößen handhaben. <p>2.1.2. Nichtfunktionale Anforderungen</p> <ul style="list-style-type: none"> NF1: Geringe Größe und geringes Gewicht. NF2: Robuste Konstruktion. NF3: Preiswerte Herstellung. 		<p>3.1. Beurteilung der Erfüllung</p> <table border="1"> <thead> <tr> <th>Kriterium</th> <th>Erfüllt</th> <th>Nicht erfüllt</th> </tr> </thead> <tbody> <tr> <td>Funktionelle Anforderungen</td> <td>Erfüllt</td> <td>Nicht erfüllt</td> </tr> <tr> <td>Nichtfunktionale Anforderungen</td> <td>Erfüllt</td> <td>Nicht erfüllt</td> </tr> </tbody> </table> <p>3.2. Bemerkungen</p> <p>Das Produkt L1000 entspricht den funktionellen Anforderungen. Die nichtfunktionalen Anforderungen sind teilweise erfüllt, da es eine geringe Größe und ein geringes Gewicht aufweist. Die robuste Konstruktion und die Preiswerte Herstellung müssen noch optimiert werden.</p>		Kriterium	Erfüllt	Nicht erfüllt	Funktionelle Anforderungen	Erfüllt	Nicht erfüllt	Nichtfunktionale Anforderungen	Erfüllt	Nicht erfüllt
Kriterium	Erfüllt	Nicht erfüllt												
Funktionelle Anforderungen	Erfüllt	Nicht erfüllt												
Nichtfunktionale Anforderungen	Erfüllt	Nicht erfüllt												
<p>4. Dokumentation</p> <p>4.1. Dokumente</p> <ul style="list-style-type: none"> D1: Produktbeschreibung D2: Technische Zeichnung D3: Materialliste D4: Montageanleitung D5: Sicherheitsdatenblatt <p>4.2. Dokumentationsstatus</p> <ul style="list-style-type: none"> Dokument 1: Dokumentiert Dokument 2: Dokumentiert Dokument 3: Dokumentiert Dokument 4: Dokumentiert Dokument 5: Dokumentiert 		<p>5. Dokumentation</p> <p>5.1. Dokumente</p> <ul style="list-style-type: none"> D1: Dokumentation der Anforderungen D2: Dokumentation der Beurteilung D3: Dokumentation der Dokumentation <p>5.2. Dokumentationsstatus</p> <ul style="list-style-type: none"> Dokument 1: Dokumentiert Dokument 2: Dokumentiert Dokument 3: Dokumentiert 		<p>6. Dokumentation</p> <p>6.1. Dokumente</p> <ul style="list-style-type: none"> D1: Dokumentation der Anforderungen D2: Dokumentation der Beurteilung D3: Dokumentation der Dokumentation <p>6.2. Dokumentationsstatus</p> <ul style="list-style-type: none"> Dokument 1: Dokumentiert Dokument 2: Dokumentiert Dokument 3: Dokumentiert 										

The HSE Officer must be involved for high-risk tasks. The former HSE Officer agreed that the HSE department should conduct a TRA, but this is not a standard work method throughout the Heembeton organisation. This work process should be improved as part of the management of risks described in this RA&E. We recommend that the following process be implemented (action):

- Define high-risk tasks in the RA&E
 - Evaluate the connections, risks and measures using the TRA method (= mini FMEA)
 - Issue a work permit (=form)

In accordance with this recommendation, the following tasks have been identified as ‘high risk’ in this RA&E:

1. Maintenance on the tank installation and pipes containing sodium hydroxide/sodium metasilicate.
2. Standing on/in the tanks.
3. Maintenance and cleaning of machines where wet AAM mortar residue may be accumulated.
4. Quality tests that may involve direct contact with the liquid alkali and AAM mortar.

We recommend drawing up a TRA for these tasks and using the work permit method (action). Embed the minimum safety measures (PPE and instructions) described in this RA&E in the TRA and work permits.

5.5 UNACCOMPANIED WORK

Employees should be prohibited from working unaccompanied on the installation (action). When conducting maintenance, a second person must always be in the direct visual vicinity, and a CER team member must be available for contact (action). This should be embedded in the instructions.

6. OCCUPATIONAL HEALTH AND SAFETY ASPECTS

6.1 TOOL AND MACHINE SAFETY

The tank installation was installed by a certified installation technician. The team has evaluated the technical tank portfolio (project 2019-2030). The documents provided include:

- Installation statement regarding incomplete machines in accordance with Appendix II, sub B of the Machinery Directive 2006/42/EG dated 06-10-2020
- Draft tank installation certificate BRL-K903/08
- Tank and bin conformity certificate BRL-K21009/03, dated 07/07/2020
- Test reports DIN EN 10204

The team has determined that the tank installation for the 50% sodium hydroxide and 50% sodium metasilicate meet the requirements of BRL K903-08 and design principles PGS 31, and the tanks themselves are certified in accordance with BRL K 21009. The installation utilised certified welders in its construction.

The following apply:

KIWA BRL K903/08 2011-02-01 “Kiwa procescertificaat voor Regeling Erkenning Installateurs Tankinstallaties (REIT)” Including revision sheets 2011/12/15, 2013/01/01, 2014/02/14, 2015/04/01 and 2015/09/21.

KIWA BRL-K21009/02 “beoordelingsrichtlijn voor het Kiwa productcertificaat voor stationaire, drukloze, gelaste, enkelwandige of dubbelwandige thermoplastische kunststof tanks voor de bovengrondse opslag van chemicaliën” dated 2015/15/03.

Hazardous Materials Publication Series 31: 2018 (version 1.1), “Overige gevraaglijke vloeistoffen: opslag in ondergrondse en bovengrondse tankinstallaties”.

The technical construction file must still be checked for the applicability of the requirements from NEN 60204-1 regarding electrical equipment, and EN-EN-ISO 14122 series due to the tanks' permanent access resources. It is unknown whether and to what degree the supplier also provides a statement of compliance (action).

The main areas of improvement regarding the design are (action):

- List the sodium metasilicate % for which the certification is applicable on the installation certificates and tank labels.
- Ensure that the Siemens control panel is secured so that the recipe cannot be changed on the spot; embed organisational authorisations for changing the recipe and any double-check.
- Label and mark the injection panel.
- List lower design temperature limit on tank type plate (=10°C).
- Secure opening to BRL test strips with padlock.
- Ventilate the tank outside, rather than inside the building.
- Prevent concrete dust from settling on installation and electrical ducts (incl. injection casing, but also spillage from hopper above tanks).
- Prevent the injection pipes from colliding against the injection panel and mixer.
- Embed the inspection and maintenance agreements with the tank supplier.
- Draw up safety and work instructions for foreseeable installation inspections and maintenance.

6.2 EXPLOSION SAFETY, ATEX

This section is not applicable. The products present in the tanks do not have intrinsic dust characteristics subject to legislation pertaining to explosion safety.

6.3 PHYSICAL STRAIN (LIFTING, PULLING, PUSHING)

The experiment with AAM mortar and mineral wool presents a foreseeable risk in the area of lifting. The process uses 5-6 bags of max. 25kg per m³ of AAM mortar. Each experiment will produce 5-10 m³, for a total of approx. 50 m³. The plan for the supply of bags will involve installing a conveyor belt in the hall to move the bags to the platform. We recommend drawing up a TRA specifically for this task (action). We recommend considering whether a pallet can be placed on the mixing platform using an electric telescopic handler, and if there is a safer and more beneficial alternative for the carry- and lift strain (action).

Verreiker 2600 kg. 6 mtr. Elektrisch



Otherwise, the production of AAM concrete does not present other physical risks than the production of standard concrete.

6.4 PHYSICAL FACTORS

6.4.1. NOISE

The Occupational Health and Safety Act requires zoning for noise levels of 85 dB(A) or higher. The new AAM tank installation is located inside the production hall. The evaluation has shown that the relevant noise level is caused by the two dosing pumps. These are membrane pumps with a noise level of L_{WA} 74.0 to 96.0 dB (A) and L_{pf}, 1 m 57.7 to 78.8 dB(A). These pumps are installed in the injection box on the mixing platform. The evaluation has determined that the installation need not be zoned in accordance with the Occupational Health and Safety Act.

6.4.2. VIBRATION

The Occupational Health and Safety Act stipulates limits for hand-arm and body vibrations. The AAM tank installation itself does not present a risk of vibration to employees. This Occupational Health and Safety aspect therefore needs no further elaboration.

6.4.3. HAZARDOUS MATERIALS

The AAM mortar contains alkaline raw materials, mineral wool and ground granulated blast-furnace slag (GGBS) as a cement replacement. All of these substances are subject to provisions from Section 4.2 of the Occupational Health and Safety Decree. The quantification of their exposure risks are therefore required by law.

This can be performed by means of measurements and/or calculations, which need to be conducted (action).

The MSDS sheets were used to check whether any Carcinogenic Mutagenic or Reprotoxic substances are present. The evaluation has determined that this is not applicable.

The composition and relevant occupational hygiene characteristics of the raw materials in the three AAM test mixtures are listed in **table 3**. **Appendix 1** shows the recipes evaluated in this RA&E.

Storage medium	Substance	CAS no.	GHS label	H statements or information
Tank 2.5 m3	Sodium hydroxide 30% to 50%	1310-73-2	 c	H290, with corr. 1 H314, current corr. 1B H335, STOT SE 3
Tank 2.5 m3	Sodium metasilicate 45% to 50% =sodium silicate solution	1344-09-8	 c  xi	H315, current corr. 2 H318, eye cat 1 H335, STOT SE 3 Supplier uses trade name Crystal, GHS label 07 also obtained via ECHA site Reach reg no. missing on MSDS.
Silo x m3	ground granulated blast-furnace slag (GGBS)	65996-69-2	No labels	This substance is an irritant to the eyes and respiratory tract. Chance of lung injuries with long-term and repeated unprotected exposure. Prevent formation of dust. pH ≥ 11.5 when in contact with damp skin or eyes. Skin contact with wet concrete or mortar may cause skin irritations, dermatitis and redness.
Bags, max. 25kg	Lapinius mineral fibres in accordance with note Q	65997-17-3* 287922-11-6		The safety information sheet is not consistent. It states 65997-17-3* with EC number 926-099-9 and a Q note. Reach registration number 01-2119472313-44 is not found. CAS no. 1010446-98-6 also not found. Depending on the fibre length and biopersistence, may present H351 carc 2 and H315, but the supplier offers a Q note. Further research into the fibre length is included in the Action Plan (action). Man-made vitreous (silicate) fibres with random orientation with alkaline and alkali earth oxides (Na ₂ O+K ₂ O+CaO+MgO+BaO) content greater than 18% by weight and fulfilling one of the Nota Q conditions.

Table 3: Composition, GHS labels, H statements and comments for the AAM mortar, three test mixtures, Heembeton B.V.

H290 = May be corrosive to metals
 H314 = Causes severe skin burns and eye damage
 H315 = Causes skin irritation

H318 = Causes serious eye damage
 H335 = May cause respiratory irritation H351
 = Suspected of causing cancer

Formally, the GHS labelling for sodium metasilicate must depict a warning pictogram on and around the installation. This is not necessary for sodium hydroxide. The sign posted at the fill point shows a GHS label environmental danger. This is not applicable, and may be removed (action).

Heembeton must set limits for exposure to sodium metasilicate and sodium hydroxide (action). Limits have been set for inhalation and skin exposure. For sodium hydroxide, a daily limit value of 1 mg/m³ and short term limit value of 2 mg/m³ are recommended. For orthosilicic acid, a daily limit of 5.61 mg/m³ and short-term limit of 11.22 mg/m³ are recommended. For both substances, the recommended limit for skin exposure is 1.49mg/kg body weight. This is a dermal limit based on the ECHA for orthosilicic acid. As the orthosilicic acid is present in the highest concentration in the mixture, it can be considered to be normative. For inhalation exposure to mineral fibres, a daily limit value of 1 mg/m³ and short-term limit of 2 mg/m³ are recommended. For GGBS, we recommend determining an inhalation limit value for respirable and inhalable substances, either with or without a more detailed determination of other possible compounds or elements. Specifically: (heavy) metals, iron, aluminium, magnesium, silicon and calcium, as well as silicon dioxide.

We recommend that the inhalation and dermal exposure risks for the various tasks and raw materials (filling, processing mortar on the line) be calculated, and possibly measured as well (action).

6.5 PHYSICAL FACTORS - CLIMATE

With the exception of filling the tanks and final transport, the production work will be conducted indoors. Production hall 1 is equipped with natural ventilation. This is a large hall with rolling doors that can be opened to let in fresh air. The hall is not equipped with specific ventilation facilities on the Dudik tub, the pour machine and the production lines. The mixer is located indoors, and is fully enclosed. The mixer is also not equipped with point ventilation.

CRH's experience using geopolymers has shown that the processing phase of wet AAM concrete mortar may present a risk of odour and nasal and/or eye irritation. It is important that any employee's complaints during the pilot phase be monitored. Based on experience, we recommend paying attention to ventilation, and to install point ventilation at specific locations if necessary. As the product approaches a phase of definitive and regular production, this may require additional attention, depending on the employees' experiences. For the moment, the Action Plan includes the measure of opening the doors during the experimental phase (action).

The entire hall and mixing facility space is properly lit. The exterior area also provides sufficient illumination at the fill points. The TS has indicated that there is also sufficient illumination at the corner of the tank installation to conduct maintenance.

6.6 WORK CLOTHING, PERSONAL PROTECTIVE EQUIPMENT

Heembeton employees are issued standard S3 safety shoes, a high-visibility work overall and different types of work gloves. The lowest code for the gloves supplied is EN 388:2016 code 211X. The current resources have been evaluated to provide insufficient safety, and therefore require improvement (action).

With consideration for the alkaline components, this RA&E recommends the following minimum requirements for work clothing and personal protective equipment:

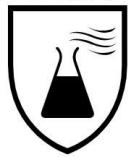
Protection	Norm	for possible contact with wet mortar or sodium hydroxide 50%, orthosilicic acid 50%, mineral wool
Eye/face protection	EN 166	Face shield to protect against fluid droplets Also when dosing mineral wool.
Skin protection, hands	EN ISO 374-1/Type B 	Chemical resistant to primary alcohols, acids and lyes Minimum requirement: EN-ISO 374-1 type B, letter code AK The minimum is EN 388 level 2 for letters A and D.
Skin protection, body	EN 13034 	Limited* protection against small volumes and droplets of liquid chemicals * This clothing offers practical comfort and is not too hot. (include instruction to remove clothing and gloves after contact).
Safety shoes	EN ISO 20345:2011 (CE EN-345) Type S2	When working with AAM mortar on the lines (production workers), chemical-resistant safety shoes must be at least level S2. But CRH has required class S3.
Safety boots	EN ISO 20345:2011 (CE EN-345) Type S4	When working with liquid alkali (driver), safety boots with minimum level S4 are required. But CRH has required class S5.
Respiration protection	EN 149 FFP3	When dosing mineral wool and cleaning production lines (scraping and sweeping), breathing protection with at least level FFP3 is required.

Table 4: Minimum quality criteria for personal protective equipment when working with liquid raw materials and/or wet AAM mortar at Heembeton B.V.

We recommend embedding the minimum quality and safety level for work clothing and PPE from this RA&E in any instructions and notifications to be drawn up in the future (action).

Depending on the experiments, a policy should be drawn up for the use of work gloves at the curing yard and during transport. For the moment, this RA&E stipulates EN ISO 374-1: 2016 type C, letter code AK. The same applies to removing elements from the line and cleaning the line.

When accessing systems that may harbour mortar residues, we recommend wearing chemical-resistant disposable overalls (action). We recommend supplying disposable overalls in the CER box next to the tank installation (action). These disposable overalls are not expected to be needed during standard cleaning and maintenance, as the plan is to mix a conventional mortar after the AAM mortar.

6.7 HEALTH AND SAFETY SIGNAGE

Article 8 of the Occupational Health and Safety Decree requires employers to install effective health and/or safety signage at the workplace if the hazards at the workplace or any equipment give cause to do so.

The team has noted that the location has made a good start with installing signage, including:

- GHS labels, prohibition and rule pictograms and CER markings at the loading dock.
- GHS labels, prohibition and rule pictograms on the tanks.
- CER markings near the eye rinse and emergency shower stations in hall 1.
- CAUTION sign on the mixing platform and pour machine, which can be illuminated automatically or manually when mixing AAM mortar.
- Alkaline fluid flow direction markings on the fill, siphon and injection pipes.

The illustrations below show the current state of affairs:



We recommend removing the GHS pictogram for environmental hazard, as this is not applicable and may cause confusion regarding environmental legislation obligations. The injection box lacks signage and instructions (action). The CAUTION sign is missing the warning to wear safety glasses or a face shield for the production of AAM concrete (action). We recommend listing the following under the gloves: type B, AK (action). We recommend setting aside a special location on the curing yard for the storage of test elements, and marking them with a CAUTION! AAM CONCRETE sign and a warning to wear work gloves (action). The type of gloves in this phase needs to be determined in more detail, depending on the expected formation of salt crystals and pH level.

6.8 WORKPLACE LAYOUT, FALLING, STUMBLING AND WORKING AT HEIGHT

The team has evaluated whether the new installation presents additional risks in the areas of working at height, falling and stumbling. The tanks are installed within a fence on a floor that is slightly elevated. The edge of the floor presents a stumbling hazard, and has been properly marked.

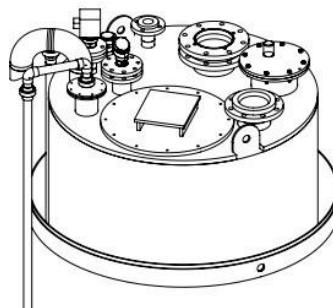


The Occupational Health and Safety Act stipulates that the use of ladders must be prevented at the source, and therefore in the design phase, if possible. Fall hazards must be evaluated based on a 2.5-metre guideline, but situations presenting a risk of falls of less than 2.5 metres must also be evaluated.



The tanks are 2.5 metres tall. The top of the tank is not equipped with a platform or access. It is not necessary to stand on the tanks to perform maintenance. This is because the top is fitted with components such as a manhole opening, BRL leak detection strips, access to pipes, access to level transmitter, etc.

We recommend installing a platform on the wall-facing side to minimise the risk of falling during inspections and maintenance.



7. ACTION PLAN

When drawing up this RA&E, the location began implementing measures to contribute to the prevention and/or mitigation of the occupational burden on the employees.

Who	RA&E section	Measure	Schedule
HB	2	Approval of RA&E by plant manager or Heembeton BU director	
HB	4.2 + 6.3	Study healthiest and safe work method for test with mineral wool (telescoping handler vs. pan lift vs. ladder lift)	
HB	4.2	Prevent mineral wool fibres from blowing away during tests via screening platform/fill position	
HB	4.2 6.5	Issue proper PPE (minimum: disposable overalls, face shield, FFP3 respiratory protection, gloves, boots) to employee dosing mineral wool in the mixer. Ensure that the employee can shower and change clothes (clean undergarments) after filling.	
CRH	4.5 + 6.4.3	For further development of AAM with GGBS and mineral wool, study the risks of exposure to microfibres of mineral wool and dust in more detail. Specifically, evaluate the fibre structure and any foreseeable and unforeseeable exposures during the production phase and delivery to the customers. For example: removing elements from lines, dry cleaning of mixer/machines/lines, mechanical processing of AAM concrete (ex.: drilling, sanding, grinding). Investigate heavy metals in the GGBS substance.	
CRH /HB	4.5 + 6.4.3	Operationally record the company-specific limit values for skin and inhalation exposure to the AAM raw materials (=sodium hydroxide, sodium monosilicate, GGBS and mineral wool).	
CRH/HB	4.3+ 6.4.3	When using other mould lubricants, evaluate them for occupational hygiene aspects and avoid using other lubricants that may be hazardous for employees.	
CRH	4.5 + 6.4.3	Investigate skin exposure risks of sodium carbonate crystals when storing products in the curing yard. Quantify and calculate the skin exposure risks in production.	
CRH	4.5 6.5	Set minimum glove requirements for the finished product phase. (provisionally at least EN ISO 374:2016 type C, class K).	
HB	5.1.1	Communicate the new AAM production process and underlying RA&E and prevention measures with the Works Council.	
HB	5.1.2	Ensure that the policy actions in this RA&E are applied to the overarching HB RA&E.	
HB	5.1.3	Communicate the new occupational risks with the occupational physician.	
HB	5.1.3	Implement the PME recommendation.	
HB	5.2 6.5	Provide documentation for specific instructions regarding: <ul style="list-style-type: none"> - Driver's instructions (PPE, CER, fill instructions) - Key management procedure - Dosing mineral wool during tests - Removing elements and cleaning lines with AAM concrete during the tests - Maintenance and cleaning after running AAM mortar machines - Transport to the curing yard and customer - PPE matrix - CER instructions 	
HB	5.3	Mark the location of the eye-wash stations (pour machine, injection box, mixing facility)	
HB	5.3	Mark the CER box (on floor plan as well)	
HB	5.3	Equip the CER box as needed (chemical overalls, face shield, chemical-resistant gloves, absorbent)	

HB	5.4	<p>Embed the obligation to conduct a TRA and issue work permits as needed for cleaning, maintenance or quality measurements to the installation in procedures or work instructions, if direct contact is possible with:</p> <ul style="list-style-type: none"> - (wet) AAM mortar - 50% sodium hydroxide - 50% sodium monosilicate <p>Or standing on tanks</p>	
HB	5.5	Prohibit employees from working on the installation unaccompanied (action).	
HB	5.5	Embed close visual monitoring by CER team member when conducting maintenance on tank installation or pipes containing liquid alkali.	

Who	Section RA&E	Measure	Schedule
HB	6.1	<ul style="list-style-type: none"> <input type="checkbox"/> List the sodium metasilicate % on the installation certificates and tank labels. <input type="checkbox"/> Ensure that the Siemens control panel is secured so that the recipe cannot be changed on the spot; embed organisational authorisations for changing the recipe and any double-check. <input type="checkbox"/> Label and mark the injection panel. <input type="checkbox"/> List lower design temperature limit on tank type plate (=10°C). <input type="checkbox"/> Secure opening to BRL test strips with padlock. <input type="checkbox"/> Ventilate the tank outside, rather than inside the building. <input type="checkbox"/> Prevent concrete dust from settling on installation and electrical ducts (incl. injection casing, but also spillage from hopper above tanks). <input type="checkbox"/> Leak basin is open-topped, which could lead to false alarms due to accumulation of dust in the leak basin sensor. Perhaps use a closed-top leak basin? <input type="checkbox"/> Prevent the injection pipes from colliding against the injection panel and mixer. <input type="checkbox"/> Draw up safety and work instructions for foreseeable installation inspections and maintenance. <input type="checkbox"/> Embed the inspection and maintenance agreements with the tank supplier. <input type="checkbox"/> Install maintenance platform on top of tanks on the wall side. 	
HB	6.5	Ventilate the production hall when working with AAM by opening the doors and windows as needed (cross-ventilation).	
HB	6.6	Record the required PPE in the instructions, draw up a PPM matrix for working on tasks involving sodium hydroxide, orthosicic acid, GGBS and mineral wool. The following minimum requirements are: EN ISO 374-1:2016 gloves type B, class AK, face screen EN 166 and safety boots S5, and chemical-resistant disposable overalls (suitable for lyes), if necessary.	
HB	6.7	<p>Remove the environmental hazard pictogram from the sign at the loading dock. <u>Replace it with the GHS pictogram 'Hazard' (=exclamation mark).</u></p>	
HB	6.7	<p>Complement the CAUTION sign at the pour machine and mixing platform with a 'gloves' pictogram and the text 'Type B, Class AK'. <u>Require face protection or safety glasses.</u></p>	
HB	6.7	Set aside a special location in the curing yard for AAM elements, mark this location and require employees to wear at least EN ISO 374-1:2016 type C, class K gloves.	
HB	6.8	Draw up a detailed TRA for inspection and maintenance tasks! Explanation: Fall hazard for maintenance and inspection on the top of the tank. Ladders are a low level of prevention from a safety standpoint.	
HB	2.2. + 6.8	Ensure that this RA&E is updated with improvement measures from future specific TRAS, future reports and incidents, but especially embed them in the future FMEA table.	

APPENDIX 1 PME RECOMMENDATION

With regard to the AAM installation, the period medical exam must pay attention to identifying possible health effects of the raw materials used and listed in the safety information sheet. These are:

Sodium hydroxide 30%-50%

4.2. Belangrijkste acute en uitgestelde symptomen en effecten

Symptomen/letsels na contact met de huid	: Brandwonden.
Symptomen/letsels na contact met de ogen	: Ernstig oogletsel.
Symptomen/letsels na opname door de mond	: Kan schadelijk zijn in geval van inslikken en terechtkomen in de luchtwegen.

Orthosilicic acid 45%-50%

Symptomen/letsels na contact met de huid	: Irritatie.
Symptomen/letsels na contact met de ogen	: Ernstig oogletsel.

Most important symptoms and effects, both acute and delayed Handling of this material may generate dust which can cause mechanical irritation of the eyes, skin, nose and throat.

Mineral wool Lapinus fibres (Rockwool Group)

Ground granulated blast-furnace slag (GGBS)

Algemene opmerkingen	: Deze informatie is hoofdzakelijk gebaseerd op stofdeeltjes van het materiaal.
Bij inademing	: Inademing van stof kan irritatie van de luchtwegen veroorzaken. Keelpijn, hoesten, niezen, kortademigheid. Blootstelling kan een astmatische reactie veroorzaken. Kans op aandoening van de longen.
Bij huidcontact	: Niet irriterend. Licht irriterend en/of dermatitis aan de huid door mechanische werking. Overgevoeligheid bij herhaald of langdurig contact met stof is mogelijk.
Bij oogcontact	: Stofdeeltjes kunnen fysieke verwondingen aan het oog veroorzaken. Bij contact met ogen kan door wrijving het hoornvlies beschadigen, onmiddellijk of later irritatie, roodheid, zwelling of pijn veroorzaken. Direct of langdurig contact met grotere hoeveelheden gemalen gegrانuleerde hoogovenslak (nat of droog) kan resulteren in matige oogirritatie (conjunctivitis of blefaritis).
Bij inslikken	: Kan irritatie veroorzaken van het spijsverteringsstelsel. Zie ook inademing.

The PME must at least include the following physical examinations:

- Lung function exam
- Vision exam (far away and close-up)
- Medical check of face, hands, wrists, feet for skin conditions, dermatitis.

The lubricants and plasticisers have not been evaluated, and their potential health risks have not been processed in these PME recommendations.