Designing an accessible and modular temporary tram/bus stop

BY JASPER KUNKELER 4084357

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Chair	**Prof. dr. Peter Vink**	TU Delft
Mentor	**Ir. Ernest van Breemen**	TU Delft
Company Mentor	**Ron Hoogland**	Stadsingenieurs

I would like to thank everyone who have been here with me on this journey. I would like to thank Suzanne Hiemstra-van Mastrigt, my previous chair who sadly couldn't be here till the end. You're a true inspiration and I valued your feedback and support a lot.

Special thanks to my mentor Ernest van Breemen. I can't thank you enough for all the support you have given me through the project. Without your active help I couldn't get through it.

Thank you to all of the Stadsingenieurs, Ad Horst, Ron Hoogland, Yonas Shemsu, Wouter Mutsaerts and Freek Terlouw. Thank you for putting up with me, even though not everything went so smoothly on my side.

I have my gratitude towards Rik Wouters of the Oogvereniging and Casper Schmit from Clientenbelang Amsterdam for sharing their stories about their disabilities.

Also thank you to Peter Vink, while you have only been my chair for a short time, you've been amazing.

Lastly I want to dedicate this to my mother, Marja Kunkeler, who I deeply miss. Hopefully you can witness the end of my journey at the TU Delft from afar.

Summary

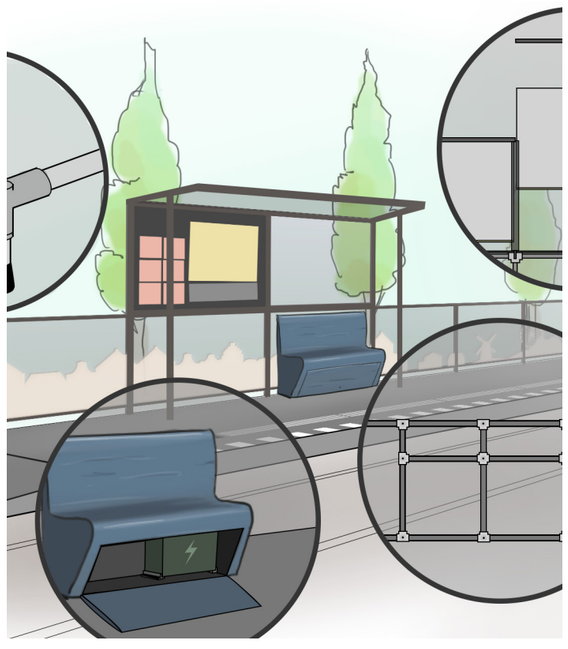
Temporary tram and bus stops can be seen as an overlooked structure in the city. While permanent stops are getting are improving greatly, temporary tram and bus stops are being left behind. Gemeente Amsterdam has the goal to make every stop in the municipality accessible to all users, including people with disabilities (Hoogland & van Baar, 2021). Improving the temporary stops, will contribute greatly to that goal.

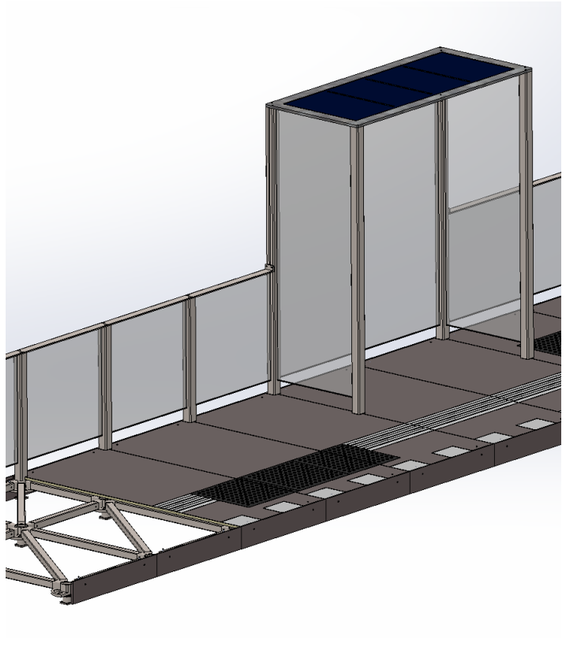
The project has been made possible by the Stadsingenieurs. The Stadsingenieurs is a young engineering firm with a focus on infrastructure and mobility projects within Amsterdam. With their knowledge and experience, they provide integrated project management services. Their projects vary from tram or bus stops to projects with an impact to public transport and traffic.

Current temporary stops are made of concrete slabs placed next to each other. In some cases furniture is added. The stops are often damaged, sometimes to the point where it can get unusable for people with disabilities. Even with the bare minimum design, it takes days to set up the stop. The main reason is to flatten the uneven surface. The process of setting up the temporary stop, disrupts traffic and transport. In some cases the stops lack the facilities to help people with disabilities, like tactile paving or slopes.

People with disabilities have different needs, but there are some essential elements that would improve a stop much. Having the platform level with the boarding entrance, makes it easier for wheelchair users to enter, it also prevents people with visual impairment from tripping over. The use of tactile lines and contrast, makes it possible for people with an visual impairment to use the stop. Slopes makes a platform accessible for wheelchair users and people with strollers. A bench helps people like elderly to rest for a bit.

With the new design, the stop is quick and easy to set up. The surface doesn't have to be flattened with its scaffolding like design and each part it lightweight enough to carry. The new design also keeps people with disabilities in mind. Letting them use public transportation without any assistance.





Content

1. Introduction

Cities are always changing. New buildings arise, constructions are getting older and points of interests change over time. A city can be seen as a dynamic entity. Facilitating public transport in such a city can be quite a challenge. Bus and tram stops require to change with the city, be it for maintenance or improvement. During these changes bus and tram stops are sometimes inaccessible for the traveler. New or temporary points of interests can also be difficult to access for the traveler due to the lack of the infrastructure. This project will take a look into designing a temporary bus and/or tram stop, or possibly a different solution, to facilitate these travelers.

The project is commissioned by the engineering firm Stadsingenieurs as a possible product to sell to Vervoerregio Amsterdam.

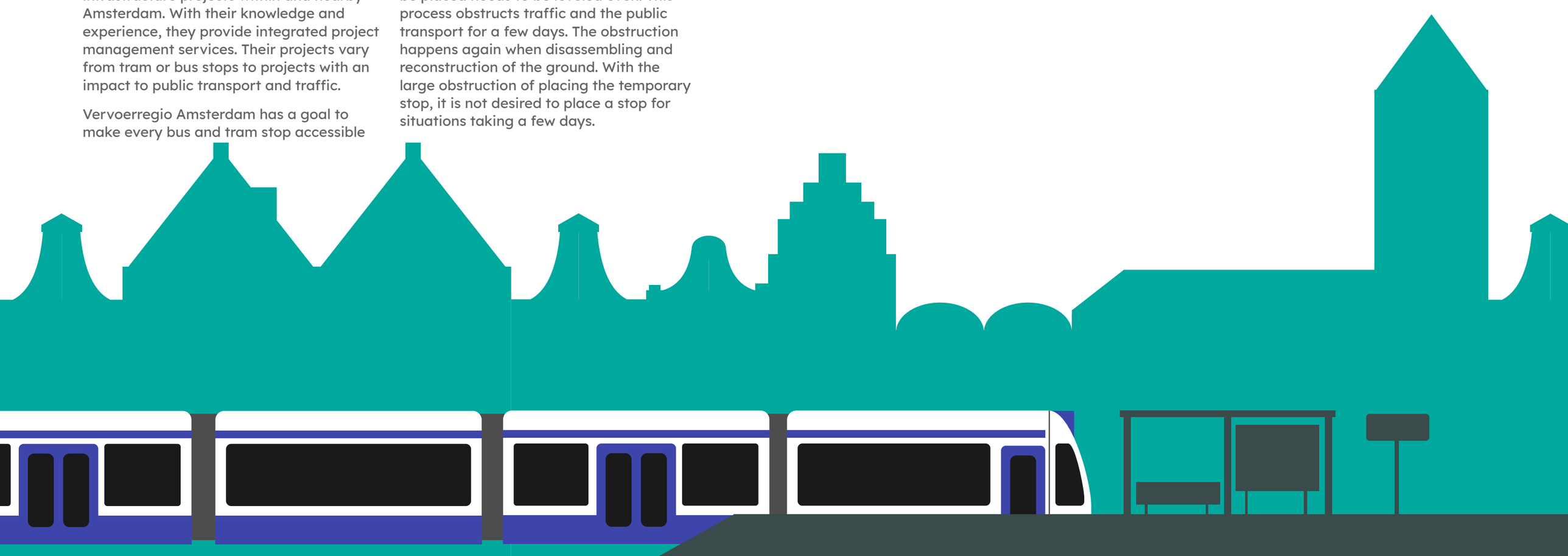
The Stadsingenieurs is the company the assignment originates from. They are an engineering firm with a focus on infrastructure projects within and nearby Amsterdam. With their knowledge and experience, they provide integrated project management services. Their projects vary from tram or bus stops to projects with an impact to public transport and traffic.

Vervoerregio Amsterdam has a goal to make every bus and tram stop accessible to everyone by 2030 (Hoogland & van Baar, 2021), which includes people with disabilities. Most fixed bus and tram stops comply to that goal. Temporary stops however are often not accessible.

Temporary stops are not very convenient to place. The ground where it needs to be placed needs to be leveled even. This process obstructs traffic and the public transport for a few days. The obstruction happens again when disassembling and reconstruction of the ground. With the large obstruction of placing the temporary stop, it is not desired to place a stop for situations taking a few days.

As a starting point, I formulated the following goal:

“The design of a temporary tram/bus stop which allows for all passengers, to use public transport to travel to and from a temporary point of interest in a seamless and intuitive user experience. The assembly, disassembly and setup of the design should feature an equally seamless experience for the employees setting the tram/bus stops up, while the product itself should not disrupt its surroundings and daily public transport.”



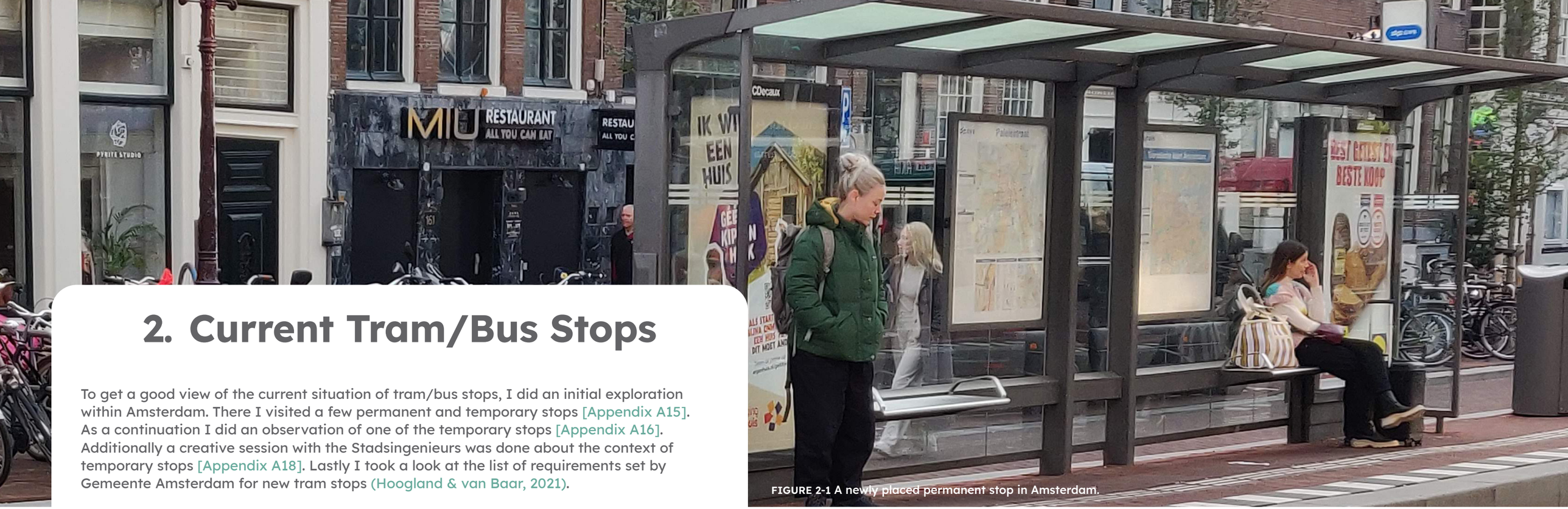


FIGURE 2-1 A newly placed permanent stop in Amsterdam.

2. Current Tram/Bus Stops

To get a good view of the current situation of tram/bus stops, I did an initial exploration within Amsterdam. There I visited a few permanent and temporary stops [Appendix A15]. As a continuation I did an observation of one of the temporary stops [Appendix A16]. Additionally a creative session with the Stadsingenieurs was done about the context of temporary stops [Appendix A18]. Lastly I took a look at the list of requirements set by Gemeente Amsterdam for new tram stops (Hoogland & van Baar, 2021).

Permanent Stops

Accessibility

With the Besluit Toegankelijkheid in het Openbaar Vervoer, the Dutch government set the requirement that public transport should be accessible to people with disabilities (Overheid, 2015). New tram and bus stops in Amsterdam are designed with that in mind.

The height of the platform is defined by the boarding height of the vehicle. This way wheelchair users and people with strollers can enter a vehicle without any assistance. A level boarding height is also beneficial to people with a visual impairment, as they have more difficulties noticing height differences. Busses and trams have a different boarding height. To keep the boarding height level on a combined tram/bus stop, Amsterdam makes use of a Combiband. This is an element which raises busses to match the boarding level of trams. Since the platform is placed higher than the rest of the road, each stop has a slope for wheelchair and stroller users to enter the stop.

Tram and bus vehicles have a retractable ramp for situations when the platform does not sit level with the vehicle. Using these retractable ramps is not always reliable, the wheelchair user is dependent on the willingness of the driver to set up the ramp and automatic retractable ramps have occasionally technical difficulties [Appendix A19].

With the use of the GVB app or website, people are able to plan in their journey where they only travel via stops with wheelchair-accessibility. Stops who are wheelchair accessible have a wheelchair-accessibility indicator next to them. There are no filters or indicators for other forms of accessibility.

Each permanent stop in Amsterdam has tactile paving. With tactile paving, people with visual impairment know where to enter a vehicle, where they can find certain information and if they reach an unsafe area. Each stop has an information column, where at a press of a button, travel information is spoken through a speaker.

While the new stops are very accessible to people with disabilities, the route towards the stop is not always accessible. In some cases tactile paving is not connected properly or walkways are not appropriate for wheelchair users [Appendix A19]. These issues are not a factor on the wheelchair-accessibility indicator on the GVB website.

Other Facilities

Each stop has an abri. An abri is a roofed waiting space for travelers to find shelter for weather like rain, sun or wind. The abri's in Amsterdam also include a bench for people to rest on, static travel information of the route and timetable and advertisement.

For up to date information travelers can look at the DRIS display. DRIS stands for Dynamic Travel Information System. From a DRIS panel the traveler can see which upcoming vehicles are entering the stop, how long it takes for these vehicles to get to the stop and if there are any delays. Attached to the DRIS column is the button, people with a visual impairment can use to receive audio feedback of this information.

Other facilities at stops are waste bins to keep the stop and neighborhood clean, non-smoking tiles, safety lines at the edge of the platform and fences when the stop is raised to a certain level above the surface.

Construction

A 30 meter tram stop can cost about €50,000 (Light Rail Advies, 2019). Construction starts with preparing the surface. The surface needs to be level to place the stop. From there on concrete blocks are placed as borders of the platform, forming an enclosure for granulate to fill it up. Furniture and tiles are placed on top. During the constructions safety precautions need to be made, construction site barriers are required.

Temporary Stops

Temporary stops are placed when the current stop is unavailable or when there is an influx of travelers to a certain destination. While temporary stops should comply to the same rules as permanent stops, they often do not.

Most temporary stops are made out of concrete slabs. These slabs are not at the correct boarding height. To be able to place these slabs, the ground needs to be evened up. In some occasions the slabs are anchored to the surface with the help of screws. Slopes are formed at location with the use of asphalt. The stop always includes an information column with static travel information of the stop and connecting routes. Sometimes furniture like abris and fences are attached to these stops. Temporary stops have tactile lines installed on the concrete slabs, any other tactile indications are missing. Some temporary stops do not include safety lines. The process of placing these stops takes about 2 to 3 days. After the use of the temporary stop, the location needs to be rebuild to its original state.

When visiting some temporary stops, each stop was damaged or poorly installed. Slabs were misaligned, which as a consequence also misaligns the tactile lines. The misalignment also changes up the boarding distance. In some occasions the tactile lines were damaged beyond use, or were missing completely from some slabs. The platforms contained multiple cracks and holes. The addition of facilities like abri's, fences and safety lines were inconsistent. And there was no attention paid to appearance.

One of the stops was used as a cycle lane of cyclists, creating dangerous situations for the travelers. As a consequence, people started waiting outside the stop. Some people had trouble reading the static travel information. Because the stop didn't have any places to sit, people started looking for places to sit on outside the stop. On the GVB app, the location of some temporary stops were not up to date.

FIGURE 2-2 Damaged concrete flooring at a temporary stop.

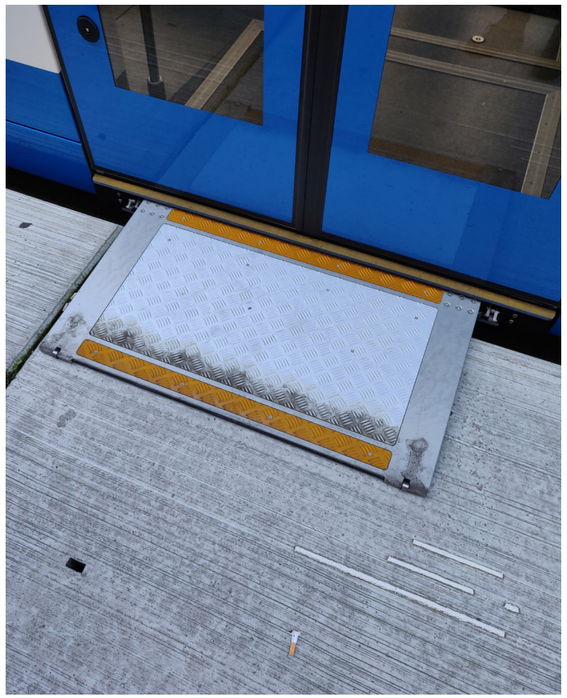


FIGURE 2-3 Retractable ramp from tram.

FIGURE 2-4 No tactile lines at a segment of the temporary stop.

FIGURE 2-5 Uneven concrete flooring at a temporary stop.

3. Stakeholders

With the use of a temporary stop, many stakeholders are involved. An initial exploration of potential stakeholders was done via the context creative session [Appendix A18]. From there on a deeper analysis was made. The most important stakeholders are listed below.

Vervoerregio Amsterdam

Vervoerregio Amsterdam is an organization which entails all the interests in transit of 15 municipalities around Amsterdam. It coordinates everything around transit in their region to different parties like GVB. It's the concession issuer of public transport in Amsterdam. It assigns which companies will maintain the rail infrastructure. And It allocates budgets for different projects surrounding public transport. When it comes to placing new or temporary stops, Vervoerregio Amsterdam will make the decisions. While Vervoerregio Amsterdam makes the decisions, the ownership of the infrastructure stays at the respective municipalities.

One of the interests of Gemeente Amsterdam, Vervoerregio Amsterdam is trying to execute is the accessibility of public transport. The Dutch government signed the Convention on the Rights of Persons with Disabilities and Optional Protocol by the United Nations. In article 9 it states that people with disabilities should be able to participate with public transport on an equal basis as other people (United Nations, 2008). Based on the UN treaty they set up the law which states that Bus and tram stops should be accessible for everyone including people with disabilities (Overheid, 2015). The government current goal is to make public transport accessible by 2040. The requirements of what accessible exactly is, is not yet defined (Rijksoverheid, 2022).

To reach this goal, Vervoerregio set the requirement that all new tram/bus stops should be accessible. One of Vervoerregio Amsterdams projects, the Halteplan, was to make the most busy bus stops accessible for everyone. The Vervoerregio gave between 2008 and 2015 a contribution of 95% to the road maintainers to change these stops (Vervoerregio Amsterdam, 2020).

In the program of requirements for concessions, Vervoerregio added the requirement that 90% of the houses in the region should have access to a public transport within a radius of 400m and access to the main public transport infrastructure within 800m. Hospitals and other care instances needs to have access to public transport within a range of 250m (Vervoerregio Amsterdam, 2013). According to Vervoerregio Amsterdam, any distances beyond 500m will leave out elderly people from participating to public transit [Appendix A20].

Travelers

The travelers are the main users of the temporary stop. They will use the stop as a part of their journey towards work, school, social activities, recreation, healthcare, home or other facilities. The stop is used to board and offboard the trams and busses. Other activities they do at tram/bus stops are; waiting, looking up for travel information, resting and throwing trash away.

For travelers to use the temporary stop, it should be reachable and easy to locate. The passenger should have no trouble to enter or exit the stop. Their interaction with the temporary stop should cause no delays compared to normal bus/tram stops. Any use within the temporary stop should not lead to confusion.

They should also feel safe at the stop. Shelter, natural surveillance and reliable real time information are the most influential factors for people to feel safe at a tram or bus stop (Abenoza, Ceccato, Susilo, & Cats, 2018). Natural surveillance is a way to make a criminal more seen. This can be used by increasing the visibility from all angles like see through panels in abris. It can also be achieved by adding more people (Pellington, 2022).

The most important criteria for a traveler to use public transport are decrease of total travel time, price, ease of use, comfort, experience, regularity and reliability. Clean facilities greatly contribute to the comfort of the journey. Waiting at a stop increases the perception of travel time (Bakker, 2018).

Personnel

Many personnel across different stages are involved with the temporary stop. The main groups are, installation/deinstallation, public transport and maintenance.

The upmost important aspect for the personnel is a safe work environment. A safe work environment reduces the amount of injuries and accidents, but it may also improve the workers wellbeing. The work environment should also be ergonomically sound, to prevent injuries in the long term. As a prevention for any injuries or accident, a cluster of laws has been set up under the Arbowet. The employer needs to make sure their business is in compliance with the Arbowet (Rijksoverheid, n.d.).

If the personnel needs to interact with something new, it should be easy to understand how it works. The need for training should be as low as possible.

Neighborhood

While not being a direct user of the stop, the neighborhood is affected by the temporary stop.

Houses and facilities should still be reachable, they don't want any obstruction. Navigating through to and from their building should be clear and quick. Stores, tourist and recreation spots want to keep visibility of their buildings, so they can attract customers.

Residents don't want any nuisance in their neighborhood. Especially noise can be disturbing for them. The neighborhood don't want any damages to their properties or surroundings. And they want their neighborhood to be clean and pretty.

The surrounding traffic wants quick access and clear routing to their destination. There should be no confusion during rerouting. They want to be safe during their journey. Emergency services should be able to access their target without any trouble.

4. Travelers with disabilities

With Vervoerregio Amsterdam's goal to make public transportation accessible for everyone, specifically including people with disabilities, it is important to look how these steps can be taken. To find out how a stop can be made accessible, I talked to a member of the Oogvereniging [Appendix A17], I interviewed an experience expert of Cliëntenbelang Amsterdam [Appendix A19], I listened to some experiences of people with disabilities at a conference about mobility [Appendix A20] and I looked at current guidelines for accessibility.

According to the Centraal Bureau voor de Statistiek, 12.6% of the Dutch population over the age of 12 has at least one physical or sensory disability. 3.4% of the Dutch population has a hearing impairment, 3.6% a visual impairment and 8.8% a motor impairment (CBS, 2023). The group of motor impairment not only includes wheelchair users, but also elderly and people who don't have a lot of energy to move around. About 15.5% of the Dutch population have a psychosocial disorder (CBS, 2021). Psychosocial disorders can be, autism, serious depression, schizophrenia and personality disorders. Despite the large numbers, not many people with disabilities are seen using public transportation. This is because they are not always aware they are able to use it.

Each disability comes with its own set of challenges, but there are occasionally overlaps to some in their needs. Predictability is very important for almost all people with disabilities. They want to know if they are able to make the journey and any changes might make the difference or cause stress. People with disabilities also tend to prefer to not rely on others for assistance. Having autonomy and self-reliance is important for them. People with a visual impairment, wheelchair users and people with strollers prefer to have a level boarding entrance.

A group that don't necessary have a disability, but have similar needs are people with strollers and people with heavy baggage. People with strollers often have the same needs as wheelchair users and people with heavy baggage have similar needs as people with less energy.

People with visual impairments

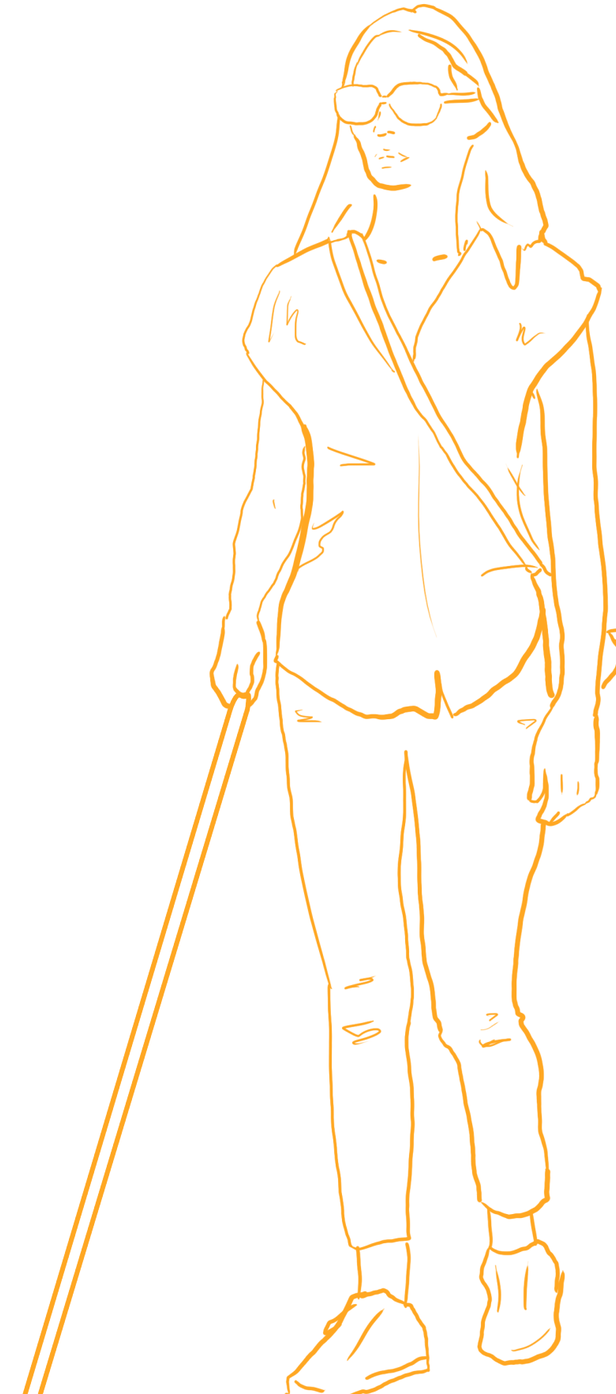
1 million people in the Netherlands have a bad sight even when they wear glasses, meaning they cannot read letters from a newspaper. 222.000 have a more serious visual impairment, of which 76.000 are blind. Another visual impairment is color blindness. With color blindness, a person is not able to differentiate certain colors. 8% of all men have color blindness. This is 0.5% for women. (Oogfonds, n.d.)

For people with serious visual impairment, elements should have different contrasting colors from each other. In the dark their eyesight is worse, a well lit stop improves visibility significantly during the dark. When using light, the light should be distributed equally. If the light is only focused on one spot, the visibility of everything around it will be much worse, due to its contrast.

For people who are blind, tactile paving is necessary. Tactile paving are special tiles on walking routes that can be felt with a white cane. With the help of tactile paving, blind people are able to reach their destination without any outward assistance. Tactile paving exists out of multiple segments: tactile lines, warning indicators, object indicators, boarding indicators and attention areas. Tactile lines indicate the route to walk on, warning indicators tell when there is an unsafe situation ahead, object indicators tell when there is a point of interest up ahead, boarding indicator shows the user where the boarding entrance will be and attention areas indicate there is a difference in the route. Object indicators and boarding indicators often are made of tiles that give an audio feedback when touched with a white cane. The stop should be able to connect to natural guidelines. Natural guidelines are parts of the environment that people with a visual impairment can use to navigate, for example a ledge of a building.

Any height differences on the walking route should be avoided as it can cause people with a visual impairment to trip over. For the same reason, it is best for the boarding entrance to be level with the stop. Walking surfaces should not be slippery. Guiding dogs have trouble performing their job on a slippery surface.

Because blind people partially base their wayfinding on habits, a change of place needs to be clearly communicated. When it comes to getting travel information, blind people either use apps like OVinfo which tells them the information of nearby stops depending on their location, or they use an information column at the stop where they can get information via audio with a press of the button. For people with color blindness, color combinations like green and red should be avoided, unless the information is double coded.



Wheelchair users

About 225.000 to 250.000 people in the Netherlands use a wheelchair (de Klerk, Fernee, Woittiez, & Ras, 2012). The journey of a wheelchair user start with the planning of their route. On the website of GVB there is an indication if a stop is wheelchair accessible. The user has to look for the start and end stop when planning in their journey. This is not always reliable as the accessibility outside the stop is not taken into account. Also there might occur some irregularities where a tram or bus ends up at an alternative destination. In this case, it is not always certain that the new destination is wheelchair accessible.

New tram and bus stops have a few requirements to take wheelchair users into account. There is a slope going up to the platform, there is extra space to maneuver around at the entrance areas, the abri has enough space for wheelchair users and the platform is within an acceptable level range with the vehicles.

While these requirements will be enough for most wheelchair users, some wheelchair users might still run into some issues. There is often only one slope placed per platform, which requires wheelchair users to sometimes make a long detour, where they also have to go through some crowds. While the platform should be wide enough for wheelchair users, some crowds make it difficult for them to pass through. Another issue is the levelness of the platform, the current 5cm requirement might be hard to reach for people with less strength or for people with wheelchairs with smaller wheels, like sport wheelchairs. Lastly it is not always clear where the boarding entrance will be. Preparation is key for a person with a disability. For both the person and the bus or tram, it would save much more time and stress if the wheelchair users can park themself in front of the boarding area.

When a stop does not comply to the requirements, the wheelchair user is often dependent on assistance. This is often in form of retractable ramps in busses or trams. These are not reliable because they are prone to malfunctioning or the driver does not want to assist.

5. Design Brief

This is a reformulated design brief based on the findings of the analysis phase. The framework on the design brief is based on the Problem Definition defined by Roozenburg & Eekels (Roozenburg & Eekels, 1998). Next to that I have defined a selection of focus points in the design. These have been discussed with Vervoerregio Amsterdam [Appendix A21] and the Stadsingenieurs and these have been adjusted based on their feedback.

Problem Definition

“Current temporary tram/bus stops are not up to the standards of the municipality of Amsterdam. They are often not useable by people with disabilities, take long to set up and are not in line with the cities vision.

The new design should be a tram/bus stop that allows all passengers, including people with disabilities, to use the public transport connected to it. The assembly and disassembly should be done quickly to prevent any interference with the public transport line and nearby traffic. Any damages the the environment should be prevented. The set up should be able to be done ergonomically for the employees.”

Focus Points

I’ve formed the following focus points:

Accessibility
People with disabilities should be able to use the product. Self-reliance is important for people with disabilities. If assistance is needed, this will be taken away.

Maintenance
During the use of the stop, the stop might need to be maintained occasionally. This can be for repairing, cleaning or replacing parts. What also should be kept in mind is the frequency and occasions of the maintenance.

Durability
The product should be able to last during its use. The product will be used a lot during its life and will face situations like harsh weather, accidents and vandals. Damages can reduce the experience, and need to be repaired.

Implementation
The product will most likely be placed in an area designated for other things. By blocking the area and adding more nuisance it can have a negative impact on the neighborhood. With installing the product, the area can get damaged. The product should fit into an area with an uneven surface. Lastly, there might be dependencies from the surrounding area like electricity.

Installation
It is important that traffic and public transport is not hindered by the installation and deinstallation of the stop. The most optimal way is to install the stop in the short time frame during the night. Additionally, the installation and deinstallation should be ergonomically for the personnel.

Sustainability
Requirements and expectations of new sustainable products are increasing. The product should be able to keep up with the future and not have a negative impact on the environment.

Safety
Safety of all people involved is important. Accidents should be prevented at all costs. The feeling of being safe is also considered here.

Traveler Experience
The stop is used by its people. At the stop people board the vehicles, but they also wait, rest and look up for travel information. The experience surrounding these activities influence if and how people are using the stop.

6. Program of Requirements

As a base for the upcoming design, a program of requirements and wishes is made. Requirements are criteria the upcoming stop design must follow. The wishes are not required in the design, but fulfilling these will improve the design. Each requirement and wish is numbered for easy reference. Also at each requirement and wish includes an explanation or source on why it is included.

Sources

Many of the requirements come from the same sources. These sources will be indicated differently than the usual sources, making it easier to look up the specific guideline/ requirement at the source. Sources which a referred one or few times, are indicated the usual way. Below is a list of the sources with different indications.

- CROW - Richtlijn Toegankelijkheid (CROW, 2014)
  - Indicated as [CROW X.X.X]
  - CROW is an institute which creates guidelines and recommendations for infrastructure, public spaces, traffic, transport and safety. This document contains design guidelines to make public spaces accessible to people with disabilities.
- Gemeente Amsterdam - Integraal Programma van Eisen Operationeel Systeem Tram Gemeente Amsterdam (Hoogland & van Baar, 2021)
  - Indicated as [TTC.XXX]
  - This document is a program of requirements, made by Gemeente Amsterdam, for new tram stop designs.
- PBT Consult – Routegeleiding (PBTconsult BV, 2013)
  - Indicated as [PBT X]

PBT Consult is an consultancy office, providing their expertise of accessibility. In this document they specify design guidelines for designing tactile paving for people with visual impairments.

Requirements

R1. Dimensions

R1.1. Length of the platform should be at least **31m** for use of one tram line, **62m** for two tram lines and **50m** for a bus and tram combination.

Distance is dependent on the length and amount of the vehicles **[TTC.0.45]**.

R1.2. The dimensions of the stop should be accordingly to its status of a **quiet** or **busy** stop.

Busy and quiet stops are defined by the GVB on a yearly basis **[TTC.037]**.

SAFETY

R1.3. The width of the safety margin should be **30cm**.

Every platform has a margin of safety along the edge, indicated by a blocked border. This margin is usually 30 cm, but can vary depending on how safe the situation is **[CROW 3.2.4]**. Gemeente Amsterdam uses 30x30cm tiles for its safety marking **[TTC.293]**.

R1.4. The safety line should be a dashed line of blocks of contrasting colors.

Contrasting colors are being used so people with visual impairment are able to notice the line **[PBT 1]**. Gemeente Amsterdam uses 30x30cm black and white tiles for its safety marking **[TTC.293]**.

R1.5. Unevenness on the walking surface should be at maximum **5mm**.

People tripping over an uneven surface should be prevented **(CROW, 2019)**. People with visual impairment are more susceptible to this as they are unable to see the unevenness **[Appendix A17]**.

R1.6. The walking surface needs to have a skid resistance of at least **65** according to NEN 2873.

People slipping on the platform should be prevented **(CROW, 2019)**. Guiding dogs have more trouble to perform their job when the surface is slippery **[Appendix A17]**.

MANEUVER SPACE

R1.7. Two spaces for wheelchair users to be able to maneuver should be located at **10.4m** to **14m** and **18m** to **23.8m** from the front of the platform.

These areas are where the wheelchair entrances are located of the vehicles **[TTC.109]**. The wheelchair entrances of a vehicle are at the second entryway of a vehicle **[CROW 3.2.2]**.

R1.8. These maneuver areas should be clear of any objects for at least **2.1m** in width and **1.5m** in length.

In front of the boarding entrances there should be plenty of space for wheelchair users to turn around **[Appendix A19]**. For wheelchairs to be able to maneuver decently, the maneuver area needs to be 1.5m by 1.5m **[CROW 3.2.4]**. In Amsterdam the width is longer than the recommended 1.5m, because it takes 60cm extra space for the retractable ramps of the vehicles into account **[TTC.113]**.

R1.9. Over a section of maximum **0.5m** long, a minimum object-free width of **1.2m** is allowed. For busy stops the minimum object-free width is **1.8m**.

This is meant to create space for objects like trash bins **[CROW 3.2.4]**. Gemeente Amsterdam has added the additional requirement of 1.8m for busy stops**[TTC.113]**.

R1.10. There should be an overhead clearance of at least **2.3m** above the walking area and object-free areas.

This height should be heigh enough for tall people or people with umbrellas to freely walk around, without have the feeling the need to hunch down or risking a collision **[CROW 2.2.2]**. This is especially important for people with a visual impairment **[PBT 2]**.

R1.11. The width of the platform should have a minimum of **2.3m** for quiets stops and **2.8m** for busy stops.

This is the total width of the platform **[TTC.037]**. For when trams stop at both sides see **R1.12.**

R1.12. Platforms where vehicles stop on both sides should have a minimum width of **3m**.

The initial width is set at 3m, but it can be higher depending on the transfer capacity **[TTC.041]**.

BOARDING HEIGHT

R1.13. The horizontal and vertical distance between vehicle and platform cannot be more than **5cm**.

The vertical and horizontal distance between the vehicle and platform should be below 5 cm. This way most wheelchair users are able to cross the gap without any help **[CROW 3.2.1]**. People with visual impairment also benefit from this **[Appendix A20]**. See also **W1.1.**

R1.14. The height of the platform should be **18cm** for busses and **24cm** for trams and tram-bus combination.

Trams and busses each has different boarding heights, trams are 24 cm above ground and busses at 18cm **(Hoogland & van Baar, 2021)**.

R1.15. To keep the vehicles level in a tram-bus combination stop, a **Combiband** should be used.

To ensure the same entry height of trams and busses at a combined stop, a Combiband is used. The Combiband is an elevation for busses to ride on, to match the height of the tram vehicles. The height of the stop with a Combiband is 24cm **(Hoogland & van Baar, 2021)**.

OTHER

R1.16. For drainage the platform may slope of a maximum of **2%** away from the road side.

2% should be sufficient for drainage **[CROW 3.2.5]**. Gemeente Amsterdam uses 1% as minimum **[TTC.157]**.

R2. Components

R2.1. The stop should contain **a slope** if the platform height is not the same as the surface at the entrance.

People with wheelchairs and strollers should be able to enter the stop **[Chapter 4]**.

R2.2. The slopes for people to enter on should not be steeper than **1:25**.

If the slopes are steeper it would require wheelchair users to much energy to climb the slope **[CROW 2.2.9]**.

R2.3. Next to a slope a handrail should be installed at a height of **0.85** to **0.95m**.
[CROW 2.2.9]

R2.4. The slope's handrail has a diameter of **30** to **50mm**.
[CROW 2.2.9]

R2.5. The carry capacity of the slope's handrail is **2000N**.
[CROW 2.2.9]

FENCING

R2.6. If the platform height is above 15cm or the outer side of the stop is next to a road or streetway used by motorized vehicles, a **1m** high fence needs to be placed on the outer side of the stop.
The fence will prevent people from falling off the platform. It will also separate the stop from the rest of the road, preventing people from randomly entering and exiting the stop at unwanted areas. The minimal platform height indicated by CROW is 25 cm **[CROW 3.2.5]**. Gemeente Amsterdam has set a minimal platform height of 15 cm **[TTC.197]**.

LIGHTING

R2.7. The minimum light intensity on the platform should be **10 lux**.
Good lighting is essential for increase of visibility. Especially people with visual impairment have a significant reduction of vision without lighting **[CROW 2.2.7] [CROW 3.3.3][Appendix A19]**.

R2.8. Lighting should be distributed **uniformly** on the platform.
If light is not distributed equally, visibility in darker areas will be lower than without lighting **[CROW 2.2.7]**

R2.9. Lighting should never be placed in a way that it might blind people.
[CROW 2.2.7]

R2.10. The minimum light intensity in abris should be **50 lux**.
[CROW 3.3.3]

SHELTER

R2.11. Tram and bus stops should facilitate **shelter** against the sun, wind and rain.
Tram stops need to facilitate shelter against sun, wind and rain for the travelers **(Zedde, 2020)**.

R2.12. For an abri to facilitate shelter, it should have a depth of minimal **0.9m**.
To be able to shelter the travelers from sun, wind and rain the abri needs to have a depth of at least 0.9m **[CROW 3.3.3]**.

R2.13. The minimum width of an abri is **1.4m**.
This is the minimum width wheelchair users are able to use the abri **[CROW 3.3.3]**. Gemeente Amsterdam uses 4m wide abris. For busy stop they use two 4m abri's or one 8m abri **[TTC.217]**.

R2.14. The minimum height of an abri is **2.3m**.
People should be able to walk under the abri **[CROW 3.3.3]**.

R2.15. The abri's side panels should be **transparent**.
To ensure safety by natural surveillance, the side panels of abris should be transparent. This way there is visibilities from all sides **(Zedde, 2020)**.

R2.16. On transparent panels, at the height of **1.4** to **1.6m** should be an opaque marking.
For visibility of the panel, preventing collision **[CROW 3.3.3]**.

R2.17. There should be a **gap** between the floor and the side panels.
To prevent trash or leaves from piling up **[3.3.3]**.

RESTING

R2.18. The temporary stop should have a place for passengers to **sit** on.
Tram stops should have a place to sit **(Zedde, 2020)**. During the observation is was noticeable that some people were affected by the lack of benches **[Appendix A17]**.

R2.19. Height of a sitting surface should be between **0.45** to **0.5m**.
[CROW 3.3.3]

R3. Guidance for Visual Impaired People

R3.1. **Tactile paving** is required on a temporary stop.
Tactile pavement are guiding lines and indicators specifically designed to guide people with a visual impairment along their route. These are often placed where there is a lack of natural guiding lines, where more information is required or when safety is of the essence **(Havik & Melis-Dankers, n.d.)**.

Tram and bus stops require tactile pavement due to safety, as the travelers move close to the vehicles **[PBT 2]**. It will also allow people with visual impairment to use the stop without requiring any external help **[CROW 2.2.12]**.

According to the Dutch legislation "Besluit toegankelijkheid van het openbaar vervoer" art 5.1.b, a stop or station requires tactile paving or an alternative for routing guidance of people with visual impairment **(Overheid, 2015)**.

R3.2. Tactile paving should only be placed in areas safe for pedestrians.
Tactile paving are always placed on safe areas. When entering an unsafe area it will be indicated by the paving **[PBT 2]**.

R3.3. Tactile paving should be usable from **both directions**.
[PBT 2]

R3.4. Tactile paving should have a **contrasting color** from the floor it is placed on.
Most people with a visual impairment are still able to see slightly, using contrast increases visibility of certain objects **[PBT 2] [Appendix A17]**.

NATURAL GUIDING LINE

R3.5. The end of tactile paving should connect to a nearby natural guiding line.
Natural guiding lines are already existing elements from the environment, which at first where not meant to guide people with a visual impairment. Examples of natural guiding lines are walls of buildings, fences, walkway ridges and gras. The end of tactile paving should always follow with natural guiding lines **(Havik & Melis-Dankers, n.d.)**.

R3.6. At the connection of tactile paving and natural guiding line, there should be **60cm** or **less** distance between the lines.
The distance between the natural guiding line and the tactile paving should be less than 60cm **[PBT 5]**.

TACTILE LINES

R3.7. The sides of the tactile lines should be an object-free walking area of **60cm** to each side.
Tactile lines are the main element of the tactile paving. These lines guide the user across the length of the route. This margin is to ensure the safety of people with visual impairments **[PBT 2]**. This can be reduced to 30cm for short moments if safety is ensured **[TTC.153]**.

R3.8. Tactile lines should have a width of **30cm**.
The allowable widths are 30 and 60cm **[PBT 4]**. 60cm width is an older variant, newer designs use 30cm width **[Appendix A17]**. Gemeente Amsterdam uses 30 x 30cm tiles **[TTC.329]**.

R3.9. The minimal length of an uninterrupted tactile line should be **1.8m**.
[PBT 4]

R3.10. The tactile line can have a bend-radius of a minimum of **10m**.
[PBT 4]

R3.11. The tactile line should have a ribbed pattern across its length. With the height of the ribs between **3** to **5cm**.
The height is dependent on the rest of the shape **[PBT 4]**.

ATTENTION AREA

R3.12. Place an attention area when there is a change of route. Changes of route are; when a route turns more than 15°, when a route splits into multiple directions and when a route heads into a slope.
An attention area is an indication of change during the route. Usually the attention area is a simple interruption of the tactile paving **[PBT 5]**.

R3.13. Attention area's dimensions should be of a maximum of **60** by **60cm**.
[PBT 5]

R3.14. When the ground has a lot of texture, use a smooth tile for the attention area.
Usually attention areas don't need any special tiles. This is only needed if it hard to differentiate due to the uneven ground **[PBT 5]**.

WARNING INDICATOR

R3.15. Place a warning indicator to indicate dangerous situations like crossings and the top of the stairs.
Warning indicators are placed to indicate dangerous situations **[PBT 4]**.

R3.16. If the end of a route of tactile paving cannot connect to natural guiding line, place a warning indicator at the end of a guiding line.
This should preferably be prevented **[PBT 4]**. See also **R3.5.**

R3.17. Between the tactile line and the warning indicator should be an attention area.

The attention area emphasizes a change **[PBT 4]**.

R3.18. The length of the warning indicator should be **60cm**.

Length from perspective of the tactile line **[PBT 4]**.

R3.19. The width of the warning indicator should be at least **60cm**.

[PBT 4]

R3.20. Warning areas should be pattern of knobs.

[PBT 4]

R3.21. The knobs of the warning area should have a diameter of **2.5cm**.

[PBT 4]

R3.22. The knobs of the warning area should have a height of 5mm.

[PBT 4]

OBJECT INDICATOR

R3.23. Place an Object indicator to indicate certain information or function points.

Object indicators are markers with a lower priority than warning indicators **[PBT 4]**. Gemeente Amsterdam uses this to direct blind travelers to the DRIS speaker **[TTC.185]**.

R3.24. If the point of interest is not directly next to the tactile line, another tactile line can be placed coming out directly from the object indicator.

[PBT 4]

R3.25. Between the object indicator and main tactile line should be an attention area.

[PBT 4]

R3.26. There should be no attention area between object indicator and the branching tactile line.

[PBT 4]

R3.27. The object area's dimensions should be **60** by **60cm**.

[PBT 4]

R3.28. The sound or feel of object indicator should be notably different from the rest of the surface when using a white cane.

[PBT 4] Gemeente Amsterdam uses sound tiles for the DRIS object indicator **[TTC.189]**.

R3.29. The color of the object indicator should be notably different from the rest of the pavement.

[PBT 4]

BOARDING INDICATOR

R3.30. A boarding indicator should be placed at the boarding area of the stop.

With the use of a boarding indicator a person with a visual impairment is able to find the entrance of the vehicle **[PBT 4]**. People with visual impairment always enter at the front entrance of the vehicle **[CROW 3.2.2]**.

R3.31. There should not be an attention area between the tactile line and boarding area.

The tactile line and boarding area are connected to each other **[PBT 4]**.

R3.32. The dimensions of the boarding area should be **180** by **60cm**.

The long side should go along the platform length. PBT indicates 90 by 60cm for the dimensions of the boarding area **[PBT 4]**. Tram stops in Amsterdam have a higher width **[TTC.181]**. The increase in width is to facilitate multiple types of trams with different entrances.

R3.33. The location of the boarding area is from **2.45** to **4.35m** from the front of the stop.

This is a requirement set by Gemeente Amsterdam, this should facilitate all vehicles in Amsterdam **[TTC.177]**.

R3.34. The sound or feel of boarding indicator should be notably different from the rest of the surface when using a white cane.

[PBT 4] Gemeente Amsterdam uses sound tiles for boarding indicators **[TTC.177]**.

R3.35. The color of the boarding indicator should be notably different.

[PBT 4]

R4. Information Display

R4.1. All travelers should be able to access the travel information of their planned route.

Travelers need to be able to prepare their journey **[CROW 4.1.2]**. Predictability is very important for people with disabilities **[Appendix A20]**. The minimum is to let people access information via their phone. People with disabilities should not be excluded **(Overheid, 2015)**.

R4.2. Travelers with disabilities should be able to see the state of accessibility of the stop via the internet.

Before planning, travelers with disabilities should know if they are able to use the stop. **(Overheid, 2015)[Appendix A19]**.

COLOR USAGE & LETTERING

R4.3. Information should be displayed in contrasting colors from its background, with a color rendering index of at least **60**.

The contrast makes it easier for people with visual impairment to differentiate the elements **[Appendix A17]**. The color rendering index also changes depending to the light source **[CROW 2.2.7]**. For dynamic information displays the color rendering index is different, see **R4.14**.

R4.4. Information should visible for color blind people.

Either make use of good color combinations, double coding or extra information placement **[CROW 2.2.7]**. Color blindness can be simulated via apps like Chromatic Vision Simulator.

R4.5. The color usage for accessibility information should be green lettering on a white background.

These colors are universally used for this purpose **[CROW 4.1.3]**.

R4.6. Colors used for rerouting during construction should be black letters on a yellow background.

These are the colors used in Amsterdam in this situation **(Gemeente Amsterdam)**.

R4.7. Colors used for rerouting specific companies should be black letters on a green background.

These are the colors used in Amsterdam in this situation **(Gemeente Amsterdam)**.

R4.8. The font used on signs should be sans-serif, including ascenders and descenders.

This type of font is very clear to read **[CROW 4.1.3]**.

R4.9. The size of text should be in proportion of **1/100** of the reading distance.

[CROW 4.1.3]

DYNAMIC TRAVEL INFORMATION

R4.10. A DRIS should only display departing information up to an hour away.

[CROW 4.1.4]

R4.11. A DRIS should display up to two of the closest departing vehicles.

[CROW 4.1.4]

R4.12. On the DRIS panel, the first departing vehicle should be displayed on top.

[CROW 4.1.4]

R4.13. A DRIS should mention the end station and minutes until departure of the displayed vehicles.

Minutes until departure because it is easier to calculate than actual times **[CROW 4.1.4]**.

R4.14. The color rendering index of text on background on a digital information panel, should be at least **70**.

The brightness of the panel should adjust depending on the light intensity of the environment, to keep the correct color rendering index **[CROW 4.1.4]**.

OTHER

R4.15. Signs to points of interests are allowed if the point of interest is within **1500m** of the stop. These signs should have a maximum of **3 lines**.

[CROW 4.2.1]

R4.16. The temporary stop should include a **smoking free zone tile**.

Specific requirement set by Gemeente Amsterdam **[TTC.193]**.

R4.17. Platform should have a **drainage system**.

Rain should not stay on the platform. See also **R1.16.**

R5. Maintenance

R5.1. Cleaning and reparations should be done within **5 days** of reporting the incident.

Damage and trash are inconvenient for the traveler, especially for people with a visual impairment **[CROW 6.1]**.

R5.2. Damages to facilities for people with disabilities should be repairable.

Examples of these are tactile paving, slopes and boarding distance **[Appendix A15]**.

R5.3. The stop should be maintained to be not slippery during the autumn and winter.

[CROW 6.1]

R5.4. The stop should be inspected every **14 days** for damages and uncleanliness.

The stop should be inspected regularly **[CROW 6.1]**. Gemeente Amsterdam inspects their stops every 14 days.

R5.5. Actions the personnel should perform for maintenance, should comply to the **Arbowet**.

The Arbowet is a set of rules to keep personnel healthy and safe during their work (Rijksoverheid, n.d.).

R6. Installation

R6.1. Possible activities that interrupt the tram/bus schedule should be conveyed during the night, between **0:30** and **6:00**.

Trams and busses should not be delayed. Activities that could possibly interrupt them should be done when the trams and busses are not using the infrastructure.

R6.2. Actions the personnel should perform for installation and installation, should comply to the **Arbowet**.

The Arbowet is a set of rules to keep personnel healthy and safe during their work **(Rijksoverheid, n.d.)**.

R6.3. Maximum weight one single personal is allowed to carry is **23kg**.

This number is based on the NIOSH-test, the carry capacity according the test might differ per situation **(Ministerie van Sociale Zaken en Werkgelegenheid, 2023)**.

R6.4. For any work activities on the tram lane, there needs to be permissions from the tram lane manager.

(RailAlert, 2018)

R6.5. For any work activities on the tram lane a risk analysis needs to be made.

(RailAlert, 2018)

R6.6. Work activities on the tram lane needs to be reported to the Centralized traffic control.

(RailAlert, 2018)

R6.7. Work activities concerning electronical installations should only be performed by specialized personnel.

(RailAlert, 2018)

R6.8. Construction vehicles should always keep a distance of at least **1m** from overhead lines. This is **0.5m** when the vehicle has a working height limiter.

(RailAlert, 2018)

R6.9. The personnel should be informed on possible risks and safety precautions.

(RailAlert, 2018)

R7. Usage

R7.1. The stop should be useable for people with disabilities.

People with disabilities should be able to have access to the same public transport as everyone else. If this is not possible, the public transport provider needs to provide an alternative service **(Overheid, 2015)**. Lack of public transport leads to isolation and decreases opportunities **[Appendix A20]**. Because autonomy and self-reliance is very important for people with disabilities, it is preferred if they can access the same transit as everyone else **[Appendix A19]**.

R7.2. The route towards a tram/bus stop should be accessible for people with disabilities.

According to Besluit Toegankelijkheid van het Openbare Vervoer art 5.3. Tram/bus stops should always be accessible from public roads **(Overheid, 2015)[Appendix A19]**.

R7.3. People with disabilities should be able to use the stop without assistance.

Autonomy is important for people with disabilities, but also assistance is not reliable enough for people to depend on **[Appendix A19]**.

R7.4. Additional delay due to relocation of the stop should be no longer than 1 minute.

(Stakeholders: Passengers)

R7.5. The stop should not interfere with emergency services.

Emergency services should still be able to perform their tasks.

R7.6. Houses, stores and facilities in the neighborhood should always be accessible.

People should not be locked out.

R7.7. The stop should facilitate natural surveillance.

Natural surveillance ensures that crimes can be seen, this results in people feeling more safe **[Chapter 3]**.

Wishes

W1. Measurements

W1.1. The horizontal and vertical distance between vehicle and platform should preferably be **2cm**.

2cm is a comfortable distance for most wheelchair users. People with visual impairment also benefit from this **[Appendix A19] [CROW 3.2.1]**. See also **R1.13.**

W2. Components

W2.1. Lighting color temperature should preferably be at 3000K.

Travelers tend to prefer a warm color temperature for lighting. This improves the ambiance for the travelers and increases the perception of safety **[CROW 2.2.7]**.

W2.2. Abris should preferably use standard sizing by used by Amsterdam of **4m** width.

Gemeente Amsterdam uses Abris of 4m wide. At busy stops two abris are placed **[TTC.211]**.

W2.3. A temporary stop should preferably have a **waste bin**.

If people are able to deposit their waste, the stop and neighborhood stays clean.

W2.4. The deposit height of a waste bin should preferably be **0.9** to **1.2m**.

This is a comfortable height for people to use **[CROW 3.3.3]**.

W2.5. A stop should preferably have on both ends **a slope** for wheelchair users to enter.

When a wheelchair users comes from a side without slope, they need to move themselves all around which can be taxing to them, especially if they have to maneuver through crowds **[Appendix A19]**.

W3. Guidance for Visual Impaired People

W3.1. Tactile lines should be preferably of the color **white**.

While a good contrast is good enough, using the color white is more consistent to other tactile lines **(PBT 4)**.

W3.2. Warning indicators should be preferably of the color **white**.

Sames as with W3.1 **(PBT 4)**.

W4. Information Display

W4.1. Travel information should preferably displayed as blue lettering on white background.

This combination is used most of the time for public transport **[CROW 4.1.3]**.

W4.2. Information should preferably be displayed on two different heights of **1.8** and **1.2m**.

There is a difference in preference of reading height. Children and wheelchair users are at a completely different height than the average user. It is preferred to have two different travel information points at each their level at the tram station. These don't have to stand right next to each other **[CROW 4.1.3]**.

W4.3. If information can only be displayed once, the preferred reading height is **1.4** to **1.6m**.

While less comfortable than the two sign option, this height ensures the sign is readable for users of all lengths **[CROW 4.1.3]**.

W4.4. Travel information should preferably be displayed in the same way as in other stops of the same route.

For consistency, to prevent any confusion.

W4.5. Information should be clear and easy to understand.

During the observation, people had trouble understanding the information at the stop. This can be prevented **[Appendix A16]**.

W4.6. The stop should preferably have indications of where the boarding entrances are.

This lets people prepare where they can stand, especially helpful for wheelchair users **[Appendix A19]**.

W5. Installation

W5.1. Installation and deinstallation of the stop should be complete during a single night between **0:30** and **6:00**.

Continuation of **R6.1.** Current temporary stops take 2 to 3 days to set up **[Appendix A15]**.

W5.2. The installation and deinstallation should cause as few delays as possible for the public transport and surrounding traffic.

With the temporary nature of the stop, any extra delays affect the usefulness of the stop.

W5.3. Installation and deinstallation should preferably done as quickly as possible.

The quicker it is done, the quicker traffic and public transport will be able to resume.

W5.4. Installation and deinstallation should require as few labor force as possible.

Less labor force is cheaper and less taxing for the personnel.

W5.5. Damage to the roads and environment should be kept to a minimum during installation and installation.

Any damage will need to be repaired afterwards, which adds time and costs.

W5.6. Noise disturbance of installation and deinstallation should be as low as possible.

The stop needs to be installed during the night to not interrupt the public transport schedule.

W6. Usage

W6.1. The passenger should preferably have no additional delay due to the different placement of the stop.

Public transport users like to have reliability in their transport uses.

W6.2. There should preferably be guidance for the travelers from old to new platform.

Important for people who rely on habits like people with visual impairment and people with cognitive disabilities **[Appendix A17]**.

W6.3. The unintended bicycle usage should be at a minimum.

Bicycles driving on the stop interfere with the passengers and creates unsafe situations **[Appendix A16]**. Any designs against cyclists should not negatively impact wheelchair users **[Appendix A19]**.

W6.4. Visibility of nearby stores and facilities should be retained.

Without visibility, stores and facilities might lose possible clients and profit.

W6.5. Noise disturbance of use should be as low as possible.

The stop should be placeable in residential areas.

W7. Other

W7.1. The temporary stop should be preferably as sustainable as possible.

Negative impact to the world should be at a minimum.

W7.2. The stop should preferably visually in line with the other stops on its line.

This keeps public transport consistent and predictable.

W7.3. The stop should fit into the image of the city.

The municipality has a say over the stop **[Chapter 3]**.

W7.4. The stop should be compatible with other cities.

Eventually Stadsingenieurs might want to sell this concept to other cities.

7. Inspiration

Within the space of mobility there is already some great innovation. In this chapter I explore some of which might be a good inspiration for the project.

THE INNOVATIEROUTE

The InnOVatieroute is a collaboration between HTM, RET. EBS and the MRDH. They create innovative solutions in the space of public transit for the future. What makes their collaboration unique is that they are able to test their solutions with the current public transport.

Solutions they thought of are augmented reality wayfinding and a moveable abri (OV Magazine, 2022).

POP-UP BUSHALTE

The Pop-up Bushalte is a temporary bus stop concept which can be used for events or construction. The design is a more elaborate bus stop sign including DRIS (Studio Bus Sala, n.d.).

SCAFFOLDING

Scaffolding is a temporary structure used for building and maintaining buildings. Sometimes for extra measures to stay in place, they have additional diagonal legs with rubber feet. These should add enough friction to the surface.

PLASTICROAD

The PlasticRoad is a road of recycled plastics. It is a modular construction, making it easy to install. It also has some extra space under the road, making it a good solution against flooding, but it can also be used to store cables and sensors (CirculinQ, n.d.).

SHARED TRANSPORT

An upcoming trend in Amsterdam is shared transport. By sharing transport vehicles like cars, (cargo)bikes and scooters, people don't have to buy a vehicle individually. This in turn, saves space within cities (Gemeente Amsterdam, 2023).

MOBJECT

Mobjects are a public transit solution on a lower distance. It should fit in right between walking and busses and trams. A Mobject looks like a moving Abri at the speed of a person walking. The Mobject are accessible and easy to use (Gran Studio, 2019).

GREEN ABRI

To combat water hinder in the cities, green abri's have been introduced in Amsterdam. Water hinder in city happens quicker because of the paving where the water has no chance to escape. These Abri's contain green walls and/or roofs, and a water storage. The plants of the green walls and roof gain water from the rain, excess is stored in a container. Through an irrigation system the stored water is used to water the plants during dry periods (Amsterdam Rainproof, n.d.).

THE TIMELESS ABRI

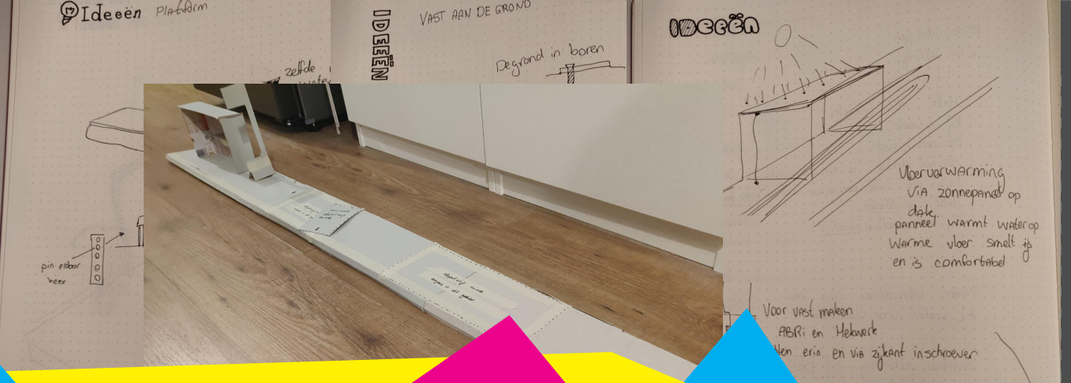
Fabrique was assigned to design a new abri for the region Rotterdam and the Hague. The result is the Timeless Abri. One interesting addition to the abri is the semi-transparent roof, which has a pattern based of the area it is placed in (Fabrique, n.d.).

GROENE BOUWHEKKEN

To make construction sites more pleasing to look at and at some greenery, Groene Bouwhekken can be placed. Groene Bouwhekken are fences with plants in planters attached to them. Included with the fences is a service to take care of the plants once a two weeks (Groene Bouwhekken, n.d.).

TENTS

Just like scaffolding, are tents temporary structures. There are made to set up quickly, but also to be light weight.

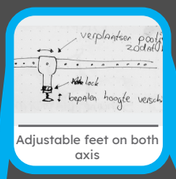


8. Ideation

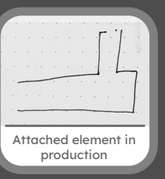
With the design brief and program of requirements defined, the ideation phase had begun. The ideation phase started with a creative session with the Stadsingenieurs [Appendix A22]. There, many ideas were generated and of the favorites were some mock ups made. Afterwards I generated more ideas based on subproblems. To get a better sense of the scale, I also made an on scale mock-up of a tram stop. The ideas were afterwards categorized. These categories were used in a morphological chart (Roozenburg & Eekels, 1998). The starting points of three concepts were chosen via the morphological chart, where each concept uses one solution per subproblem. Afterwards more ideation happened to fit the sub ideas together into the concepts.

1. Attach to surface
2. Platform level stability
3. Furniture attachment
4. Installation

Drill into surface



Adjustable feet on both axis

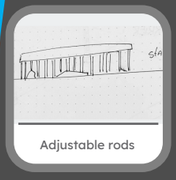

Attached element in production

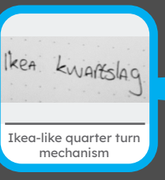

Screw in from the bottom


Welding or glueing

Build as much as possible at the workshop

Large weight

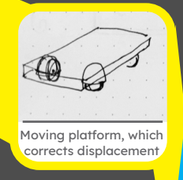

Adjustable rods



Ikea-like quarter turn mechanism

Screw in from inside of the furniture

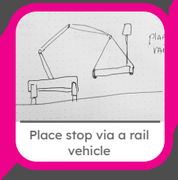

Jacking up the platform

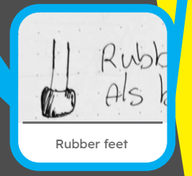

Moving platform, which corrects displacement

Airbed as platform basis


Magnet attachment


Screw in from side attachments

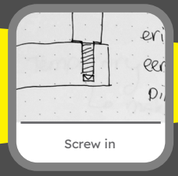

Place stop via a rail vehicle

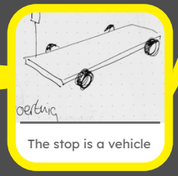


Rubber feet

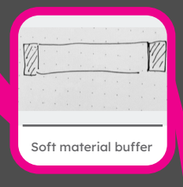

Crane on right height for filler product placement


Magnetic coil attachment


Screw in

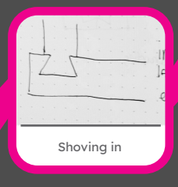


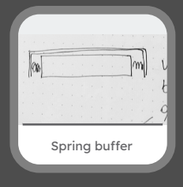
The stop is a vehicle

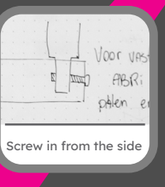

Soft material buffer


Grid container


Pressing in

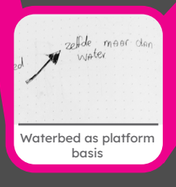

Shoving in


Spring buffer



Screw in from the side


Tight tolerances



Waterbed as platform basis


Screw in diagonally


Turning into position

5. Adjustable width

- Foldable system
- Placing extra platform element
- Rollable into a fence
- Rollable
- Shoving out

6. Lighting

- Fence emitting light
- Glow in the dark lighting
- Lanterns attached to fences
- Light follows person
- Light as safety marking
- Platform emits uniform light

7. Prevent slipping

- Handrail
- Heated floor
- Moveable seats into vehicles
- Rough texture flooring
- Rubber flooring

8. Abri

- Abri without pillar
- Air barrier abri
- Completly roofed platform
- Foldable abri
- Folding bench
- Retractable abri wall
- Solar panel roof

9. Sustainability

- Flower or plant fences
- Make platform of recycled material
- Make use of existing elements
- Old fishing nets as filling under concrete
- Platform is one giant solar panel
- Sustainability information

10. Vandal proof

- Camera security with flash light
- Make the stop very expensive looking
- Retractable spikes against cars
- Use bouncy material
- Visibile repairs

11. Wayfinding from old location

- Lines on ground to show the way
- Place a person for direction
- Sign at old location
- Speakers at the old stop
- Warning on travel app

12. Energy supply

- Friction energy
- Solar energy
- Via overhead line
- Wind energy
- Install it at main network
- Replaceable batteries

13. DRIS

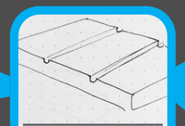
- Led display
- Split flap display
- E-ink display
- Audio output
- A poster with times

14. Recognizability

- Entrance arcs
- Make it art
- Sign with icon and name
- Use bright and specific colors for tram stop
- Specific tram/bus soundtrack near stop

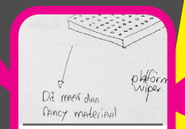
15. Drainage


Embrace it and add fontain for fresh water


Gutter in platform


Peforated platform


Platform wiper

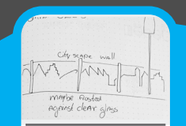


Porous material


Slanted platform

16. City vision

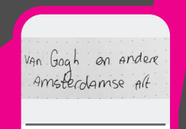
Cheese tasting stand



Cityscape on fence

I AMsterdam letters


Pile of trash at the stop



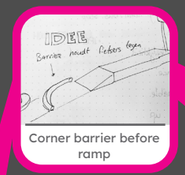
van Gogh or other Amsterdam art

Windmill powered Dris

17. Stop cyclists

Art piece on ramp

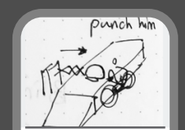

Camera at the stop



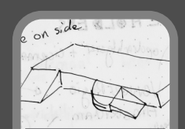
Corner barrier before ramp

Gates at entrance

Gutter on the ramp



Punching cyclists out of the platform



Slope on the side

Spikes

Tram writing on the ramp

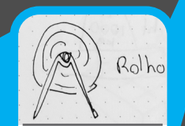

Wheelchair crane

Wheelchair elevator

Wheelchair icon on ramp

18. Storage


Gravel container



Save in a roll


Stackable solution like stackable chairs

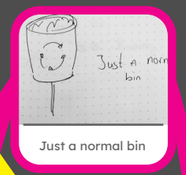
Use sideway racks


Use vertical racks

19. Discarding waste

Discard waste under the floor

Dunking the waste

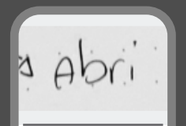


Just a normal bin

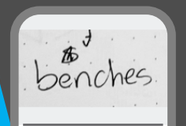
Roomba cleaner

Retractable waste bin

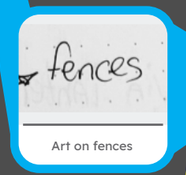
20. Personal touch



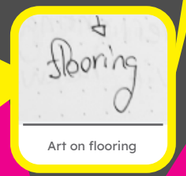
Art in abri



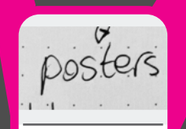
Art on benches



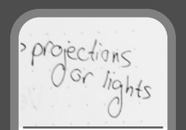
Art on fences



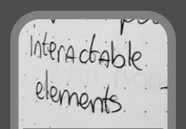
Art on flooring



Art on posters



Art via projections



Interactable art

21. Fun

Discoball flooring

Escape room or puzzle, solved

Let people draw on fences

Let people place stickers on fences

Loud and cool music

Selfiespots

Interactable art

Workable ping pong on flooring

Temporal art

Let people draw on fences

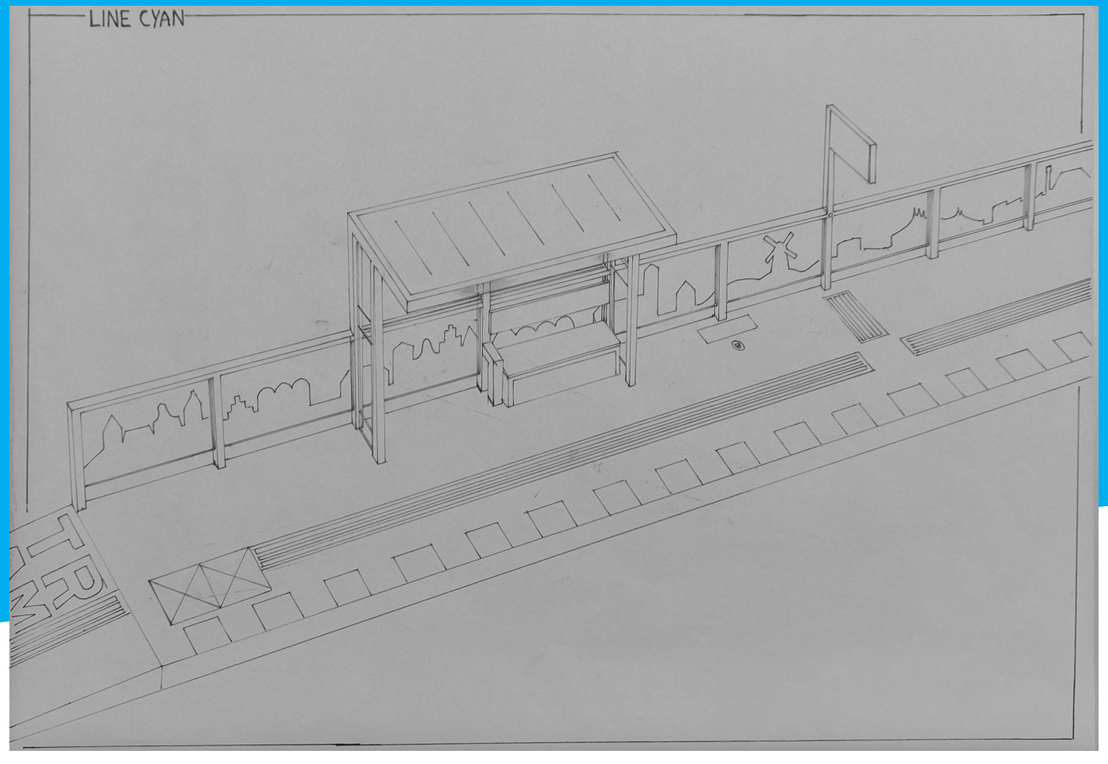
Let people place stickers on fences

Loud and cool music

Selfiespots

Smoke machines

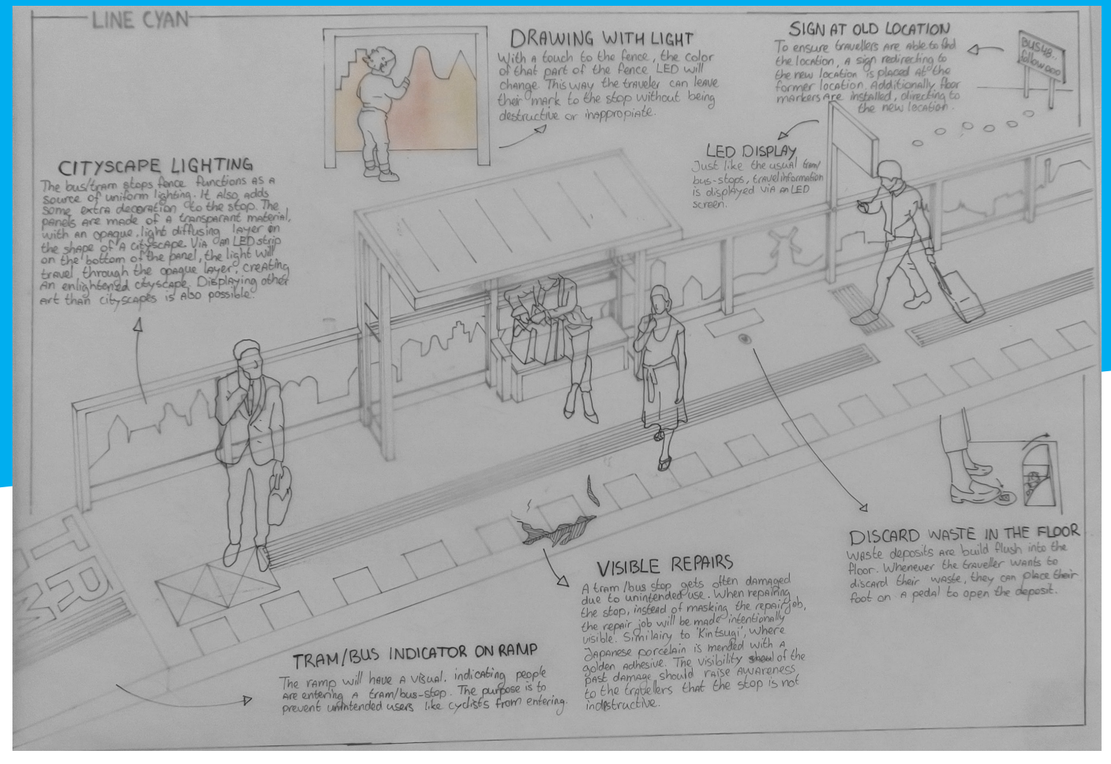
9. Concepts

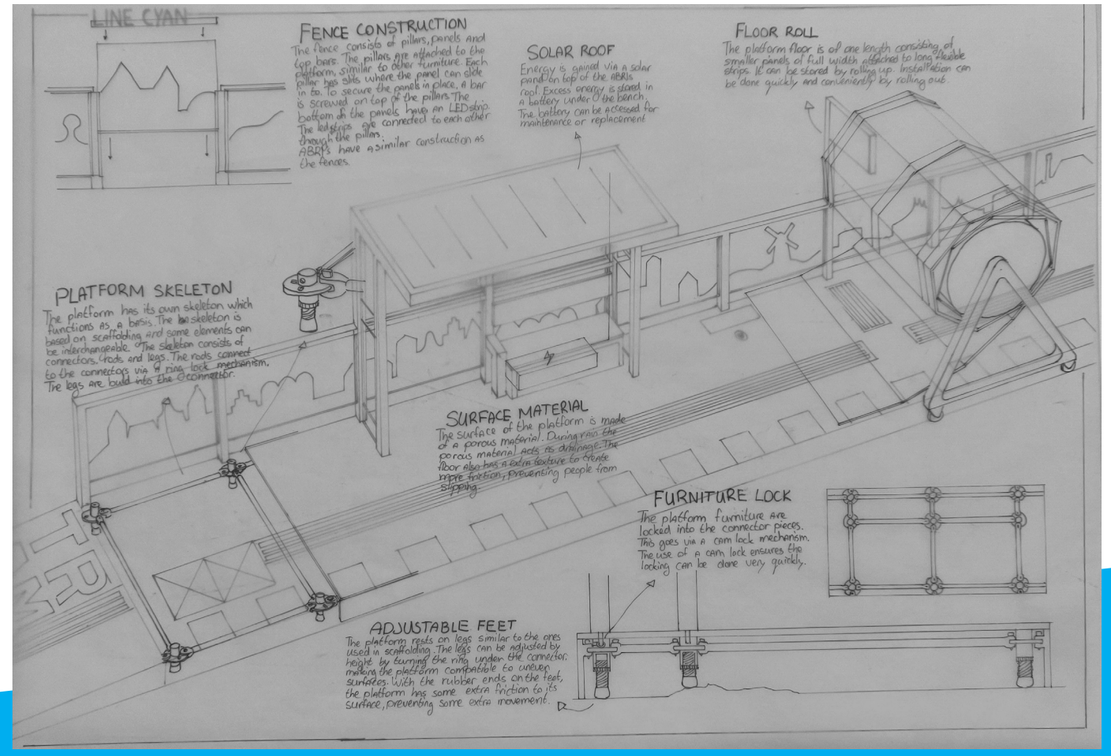


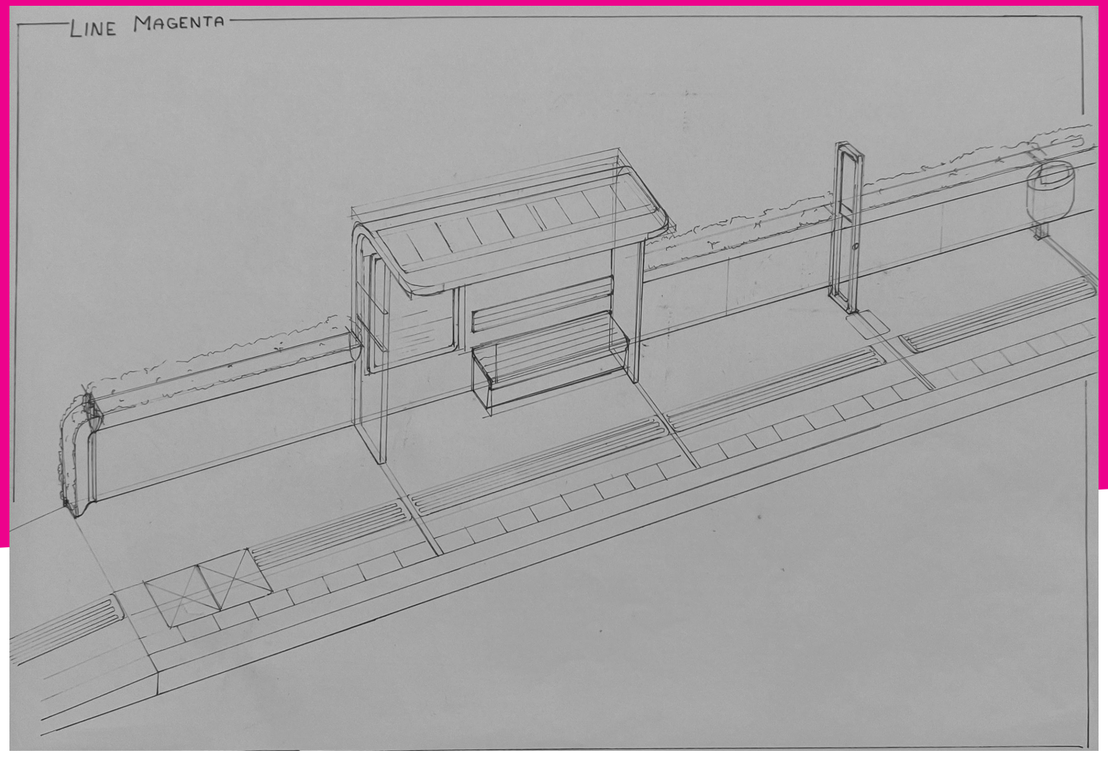
Line Cyan

This concept is based on current scaffolding. The inside of the platform has a scaffolding-like skeleton. This reduces the weight and the amount of contact points with the surface. The legs of the scaffolding can be adjusted in height adjust to uneven terrain. On top of the skeleton, the floor is rolled into place. The floor is fastened by placing the furniture on top. The furniture is locked into place via a cam lock system within the scaffolding legs.

The fences omits light through its panels in the form of a visual of a cityscape. This is done by casting light from underneath the panel. The acrylic panel conducts the light through the visual, with the help of a foil in shape of the visual. People are able to interact with that city scape with a simple touch, giving them the feel of extra control. Energy for the fence and DRIS is supplied via batteries and a solar panel on the roof of the abri. The batteries can be exchanged during maintenance.



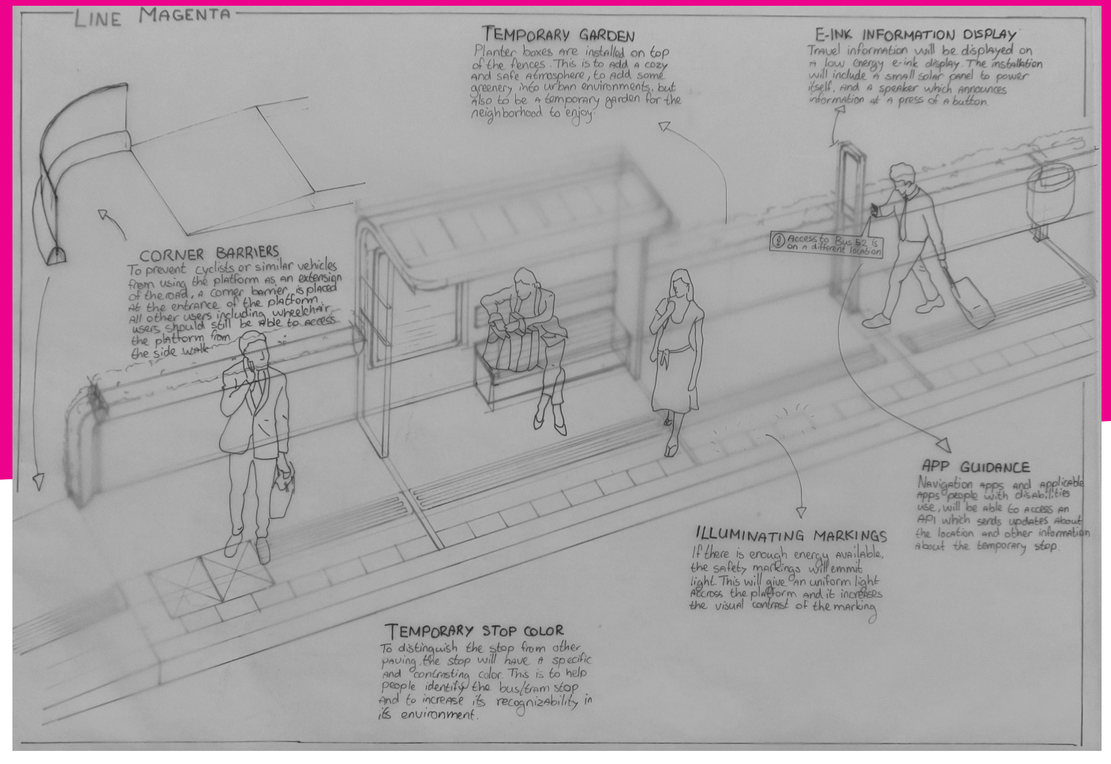


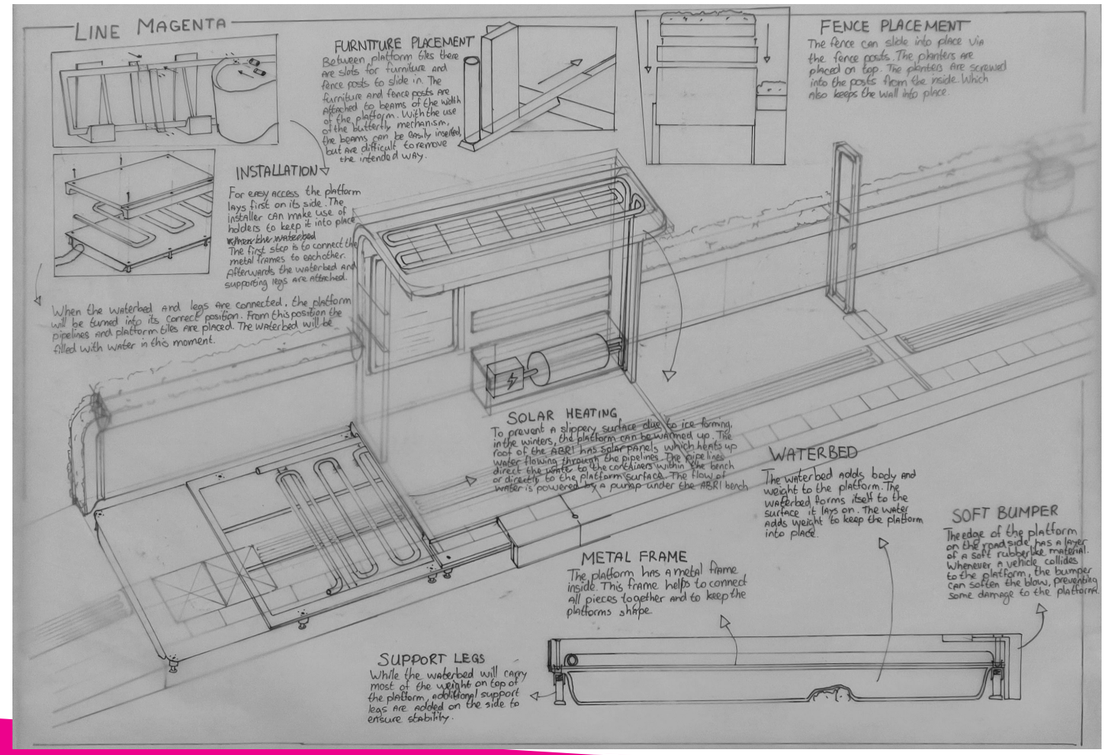


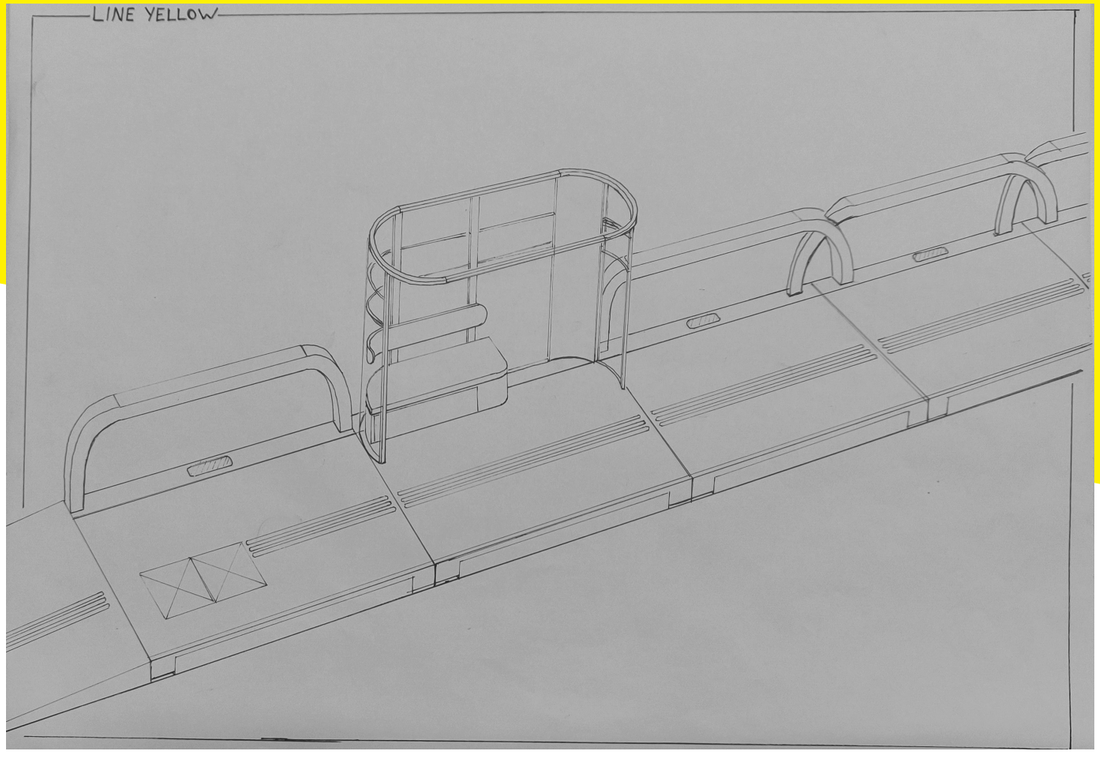
Line Magenta

Line Magenta uses a water bed as a base. The water bed forms itself to the surface requiring no evening out of the surface. The water also adds extra weight to the platform, without increasing the weight of individual parts, and thus preventing heavy workloads during installation. To prevent the platform from wobbling, some support legs are placed at the ends. At the road side of the platform, there is a rubber barrier. If there is any collisions, the barrier should prevent some of the damage. Furniture is attached by shoving them sideways into the designated slots in the platform. To keep the surface from being slippery, the platforms floor has a solar heating system. Via solar panels on the abri's roof, water is being heated. The heated water flows through the platform, to keep the platform warm, preventing ice from forming.

To make the temporary stop feel more pleasant, the fencing will have plants on top of them. Creating a little garden for the travelers and neighborhood to enjoy. The stop will have a corner barrier at the wheelchair slope, this is to block cyclists from using the stop as an extension of the road.



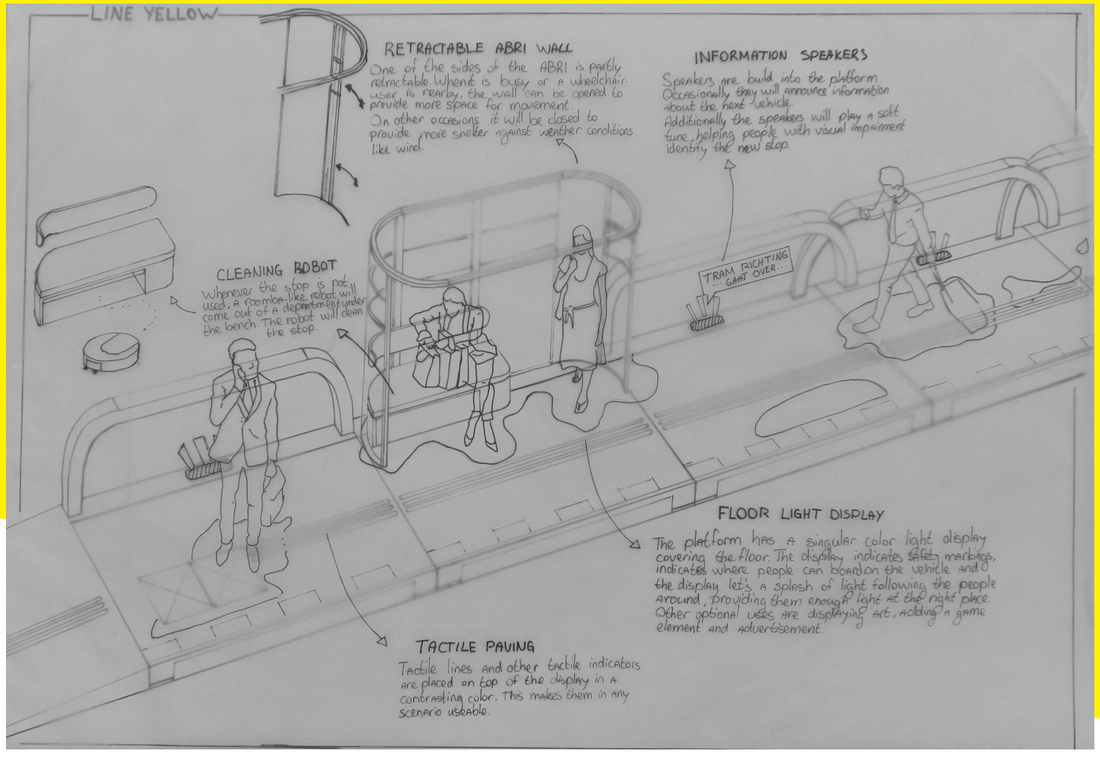


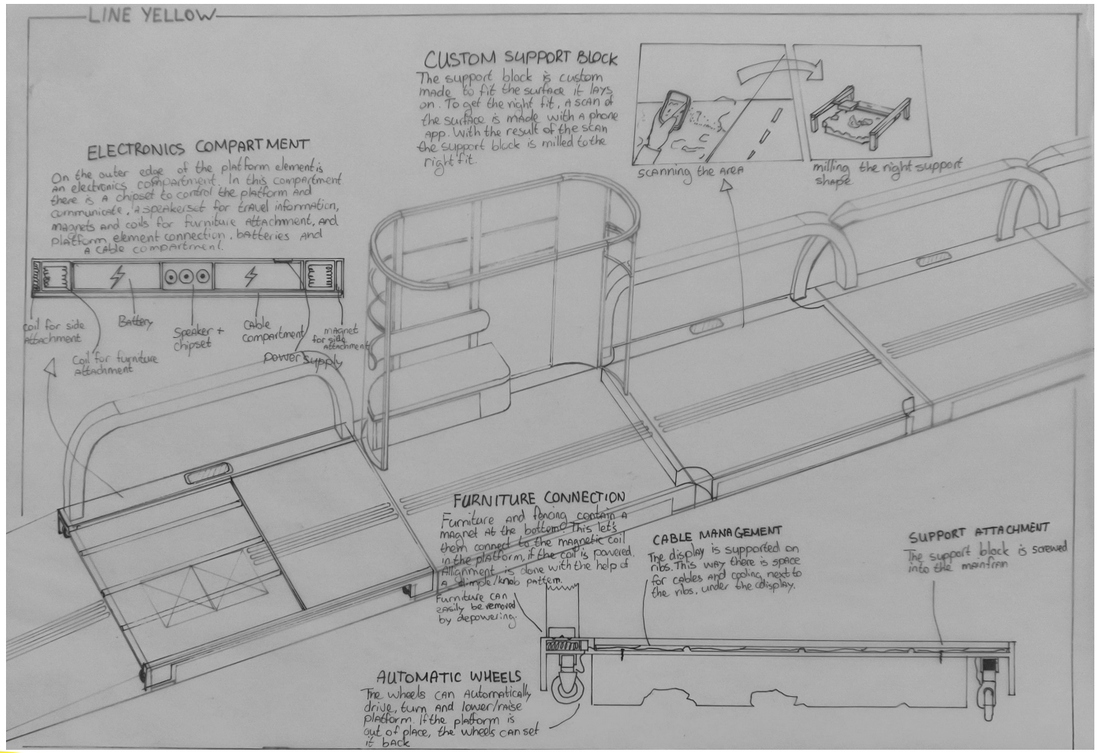


Line Yellow

Line Yellow was made with the idea of making it as technologically advanced as possible. The platform consists of multiple separate segments. Each platform has a set of wheels that can retract if needed. With the wheels the platform is able to adjust themselves into the right place. This is useful during installation and after collisions, where it can auto-correct any displacements caused by the collisions. The segments are magnetically connected to each other with the use of coils. Furniture is connected in a similar way. To make up for uneven terrain, the base of the segment is a custom made block. The dimensions of the custom made block are defined by making a scan of the area.

The entire floor of the stop is a light display, creating a visual spectacle for everyone to enjoy. The lights can follow people around to give them the needed light. It can also be used to visualize important areas like boarding. When the stop is busy or when a wheelchair user is around, one of the walls of the abri is able to retract, creating more space for everyone to move around.





10. Concept Decision

For each concept I looked how it would fulfill the focus points defined in the Design Brief [Chapter 5] [Appendix A25]. Additionally I asked for the Stadsingenieurs feedback [Appendix A24]. With the concept review and the feedback in mind, the best elements of each concept were chosen.

Result

The chosen concept was Line Cyan. Though some aspects of the other concepts were used instead and some other aspects were slightly adjusted. The chosen concept consists of the following elements:

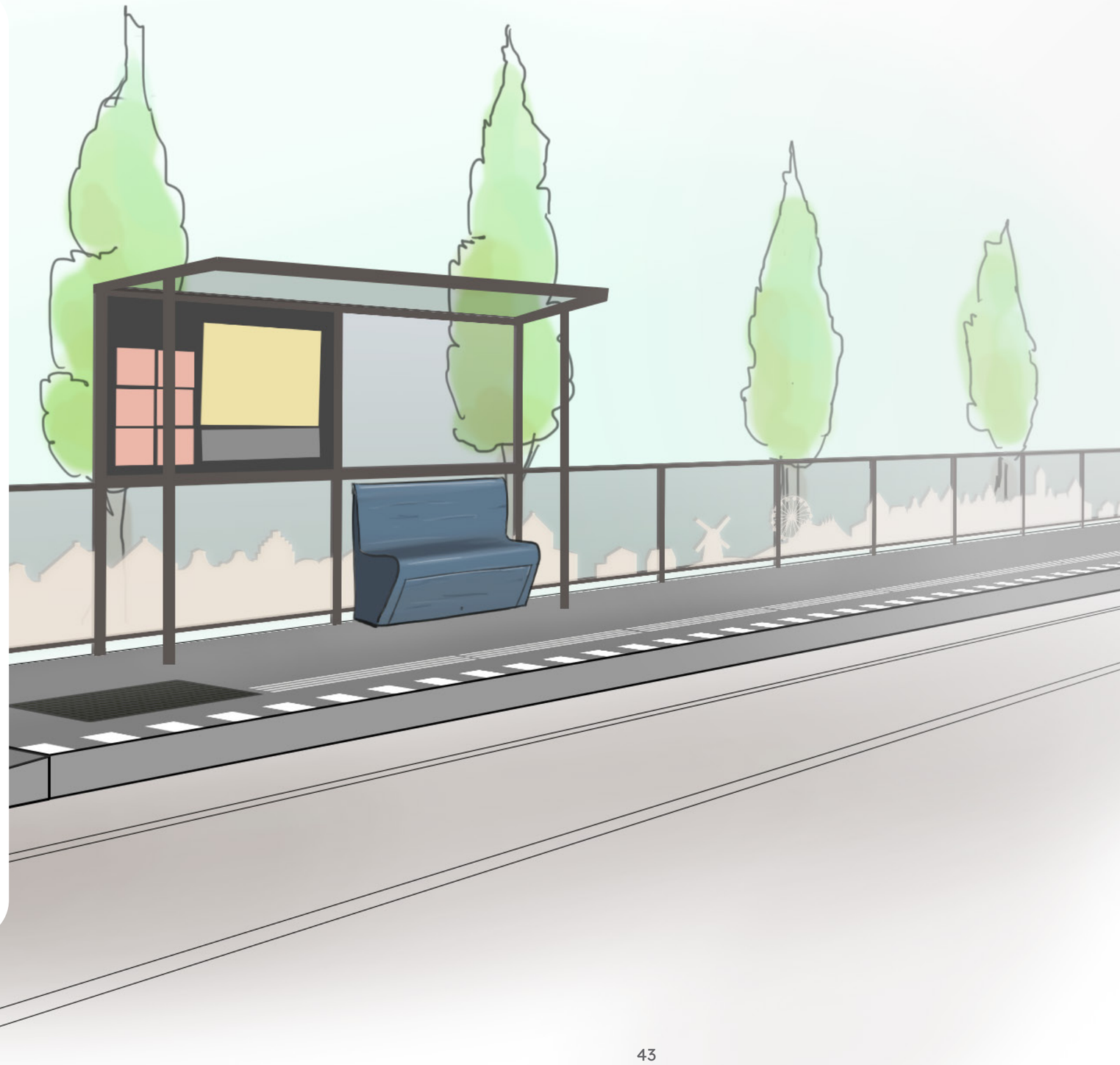
The base of the platform will be Line Cyan's platform skeleton. The wedges of the ring lock system will be slightly adjusted, so it will be easier to remove them. The adjustable feet are included in the design. Furniture and fences are locked via a cam lock mechanism within the legs.

To prevent the impact of collisions, the sides of the platform on the road side have a soft bumper out of rubber. Additionally water containers can be added to the skeleton to add extra weight to prevent any displacement.

The cityscape fence will be used as a form of light and visual appeal of the temporary stop. The visual will end at the same height at each panel so the panels don't have to be placed in a matching order. The fence will be powered via the solar panel roof or batteries under the bench. The temporary stop will also have a visual DRIS, which also accesses energy from the solar panel roof.

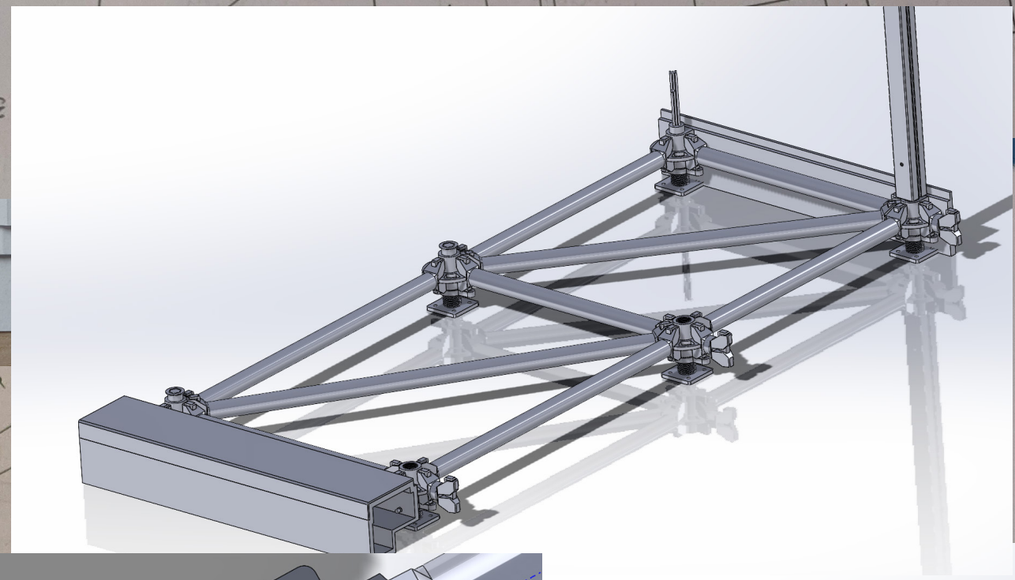
To prevent cyclists from entering the stop, a corner barrier will be placed. This makes it more difficult for cyclists to directly entering the stop, while not having a negative impact on wheelchair users.

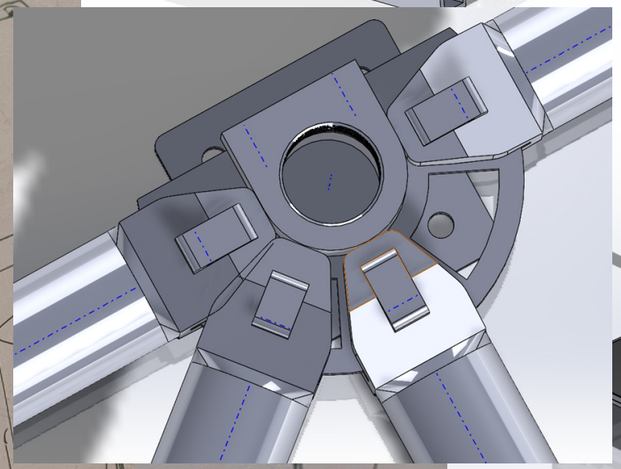
The stop will contain of separate segments, making repairment and adjustments easy to do. All the complex elements will be added in one section. This will be the section with the abri.



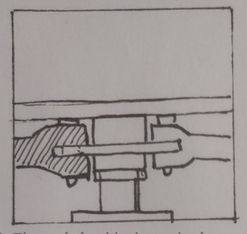
11. Design Iterations

After the concept decision, the concept got through some changes. While visualizing the concept in 2D and 3D, some things didn't feel right. With some ideation and discussions, the concept gained a different form than originally envisioned. The main changes are listed in the next two pages.

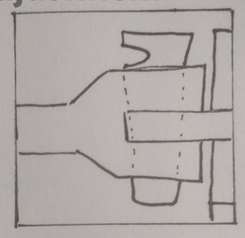




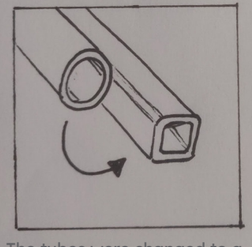
Ledgers Readjustment



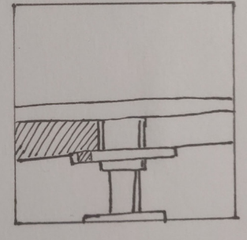
1. The original ledger design was based on a ring lock mechanism. A downside was that it took away a lot of vertical space.



2. To get the wedges out easier, an indents was added to the wedges.

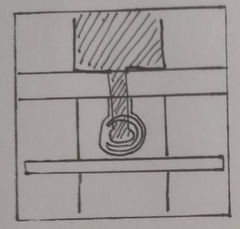


3. The tubes were changed to a square shape so the plate could rest on it.

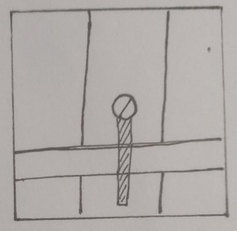


4. The ring lock design got replaced by a much simpler design. This takes a lot less time to install and gains vertical space.

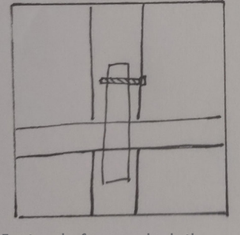
Cam Lock Design



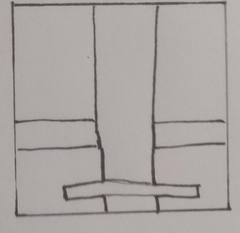
1. To lock furniture, a cam lock design was used. Because the lock was under the platform, it was hard to reach.



2. The cam lock was moved upward for better reach.

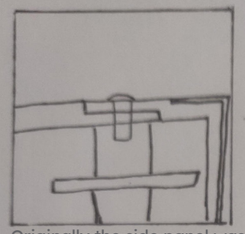


3. Instead of a cam lock the furniture would be screwed into together. This would be more reliable than cam locks.

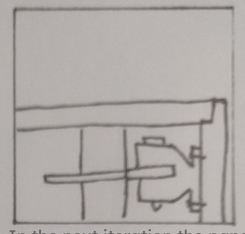


4. The furniture is directly attached to the legs, removing installation steps and removing vulnerabilities.

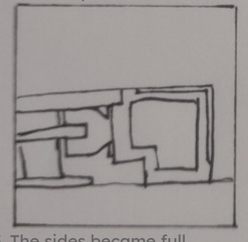
Side Panel Attachment



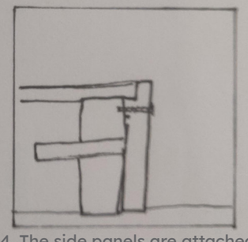
1. Originally the side panel was attached via the top of the skeletons leg. This would be pretty difficult to integrate with a sandwich panel.



2. In the next iteration the panels were attached via the ring lock mechanism.

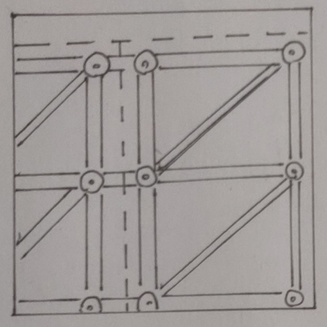


3. The sides became full blocks. These blocks could be interchanged. A Combiband could be used for example.

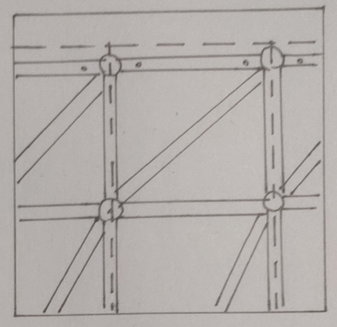


4. The side panels are attached to the ledgers. This removes any critical areas of the previous iterations.

Plate Placement



1.At first the plates were attached via the legs. The downside was that this would require an extra set of legs for the plate to rest on.



2. With the change of the ledgers, the plate is able to be attached to the ledgers. This eliminates the need of an extra set of legs.

12. Final Design

Accessibility

With the final design, people with disabilities are able to use the stop without any outward assistance. The stop can be set level with the vehicles. It includes a slope for wheelchair users and people with strollers. Tactile paving(figure 12-1) even lighting and clear contrast are used to guide people with an visual impairment. And an abri with a bench is placed for people who need to rest.

Maintenance

Replacing or repairing parts are easy to do with its modular and segmented design. If there is damage to the stop, the damage part can be replaced without readjusting the whole stop. With the waste bin, there is an opportunity for travelers to dispose their waste. Even when trash falls into the stop, it won't bunch up due to its open fence walls.

Sustainability

The stops gains power for its lighting and information system via a solar panel on the abris roof. Making it self-sustainable. With its scaffolding design, the stop does not have to make any damages to the surroundings.

Durability

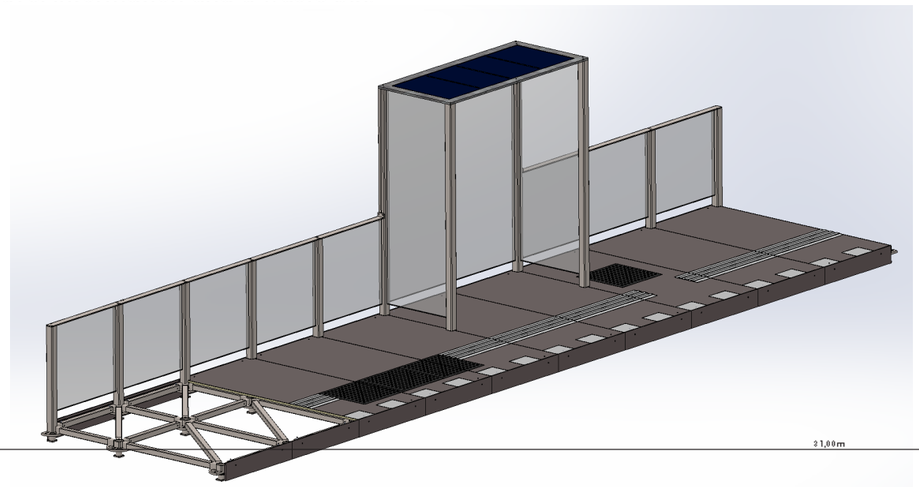
Unlike current temporary stops, this design can be reused multiple times. Parts can also get easily replaced with its modular design. The skeleton is made out of stainless steel just like scaffolding, making it durable against the elements and it keeps the construction sturdy.

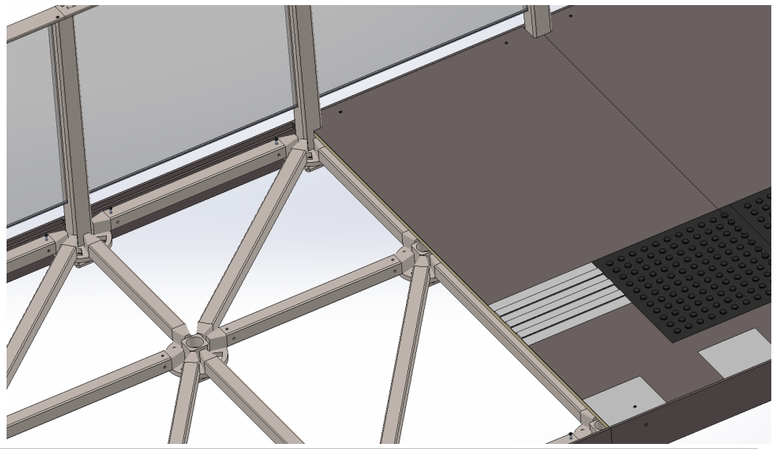
Traveler Experience

With its cityscape fencing, the stop is very inviting to the traveler. The stop is well lit and includes facilities as an abri with bench, digital travel information and a waste bin.

Installation / Deinstallation

With its scaffolding-like design, the stop can be set up very quickly. The material to set up the stop is light weight enough to move around. The surface plates are made of a lightweight sandwich construction [Appendix A26]. Maintaining an ergonomically sound work environment for the personnel.





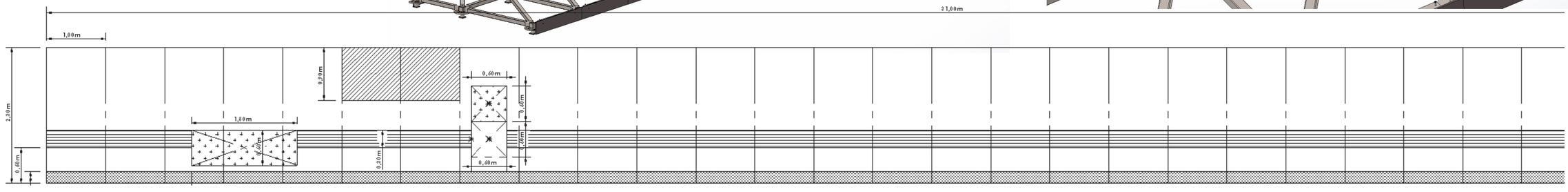
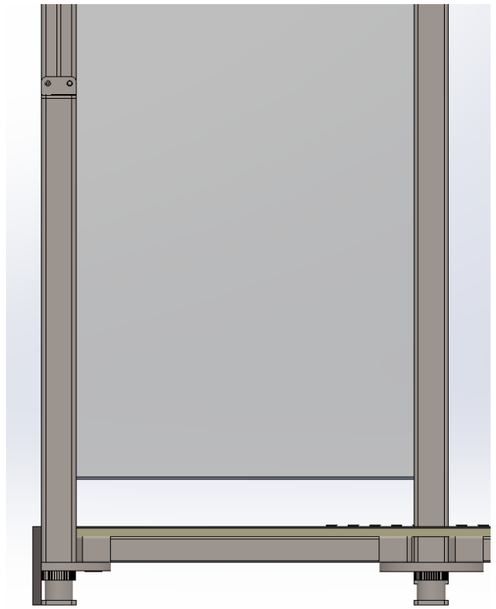


FIGURE 12-1 Layout of tactile paving at the stop.

Implementation in Surrounding Area

With its cityscape fencing, the stop brings a bit of the city within the area. The stop acts as a little exposition. Because of the scaffolding construction, the area is not being damaged with the installation, and the quick set up reduces any obstructions. The stop contains its own solar panel, reducing the need to be attached to the electricity network. If the solar panel is not enough, the battery under the bench can be replaced.



Safety

With its see through and lighted panels, the stop creates a sense of natural surveillance. Additionally the stop also keeps people safe with the inclusion of safety markings and fencing. If the stop is being used as a cycling route, corner barriers can be used to block of the cyclists. To prevent people from slipping, the surface has anti slip tiles (Coba Europe, n.d.).

13. Recommendations

While plenty has been done for this project, there is still a lot of to do for this subject. If this project gets a continuation, here are a few recommendation on how to go forward.

Space behind the stop

At a discussion with the Stadsingenieurs it was mentioned that every stop needs to have some open space behind its fences. The reason why should be investigated and how the design is going to meet the needs.

Test installation time

The design will safe installation time in comparison with the old temporary stops, but the amount of time is not quantified. A test should be held to get a grasp on the impact of the installation of the new design.

Calculations and in practice

I made calculations for the bending of the plate [Appendix A26] and needed weight of the stop at a collision [Appendix A27]. While the weight calculation sheet was finished, it has not been used. The calculations can be used to see if the stop needs additional weight. In that case, a variation of the waterbed idea of the magenta concept can be put into use.

Though calculations are a nice starting point, the results may differ with what happens in practice. It is recommended to validate the results in practice.

Way finding

During the first observations [Appendix A15], some people were not able to find the stop. There is no wayfinding at the old stop and websites like GVB.nl doesn't always update. This is inconvenient for people who have trouble finding their way and for some people with disabilities who get easily stressed.

Surroundings

According to Casper of Cliëntenbelang Amsterdam [Appendix A19], is the surrounding area of a stop not always accessible. If the surrounding area is not accessible to people with disabilities, it is not mentioned. More research can be made on how people with disabilities can be warned about these inaccessible surroundings or how these surroundings can be made accessible.

Awareness of ability to use transport

Lots of people with disabilities don't use public transport because they don't know they are able to use it [Appendix A19] [Appendix A20]. Especially with the current trends in transport, more and more transport is accessible for the now. How can they be made aware of this?

Manual of temporary stop

With the set-up of a temporary stop, many processes are involved. Permits needs to be requested, personnel needs to be hired. Time and place needs to be booked. Also the personnel needs to know how they should set up the stop. All this can be written in a manual.

Boarding Indications

Boarding indications are not the best at the municipality of Amsterdam. There are some boarding indications as tactile paving, but these are very wide to compensate for multiple vehicles, losing its function [R3.32. + R3.33.]. For the wheelchair entrance, there is no indication while they need it to prepare their boarding [Appendix A19].

Costs and comparison

The costs of the stop is not indicated yet. With the cost it can be compared to other temporary or even permanent stops. And does its modular design save money in the long run?

Soft bumper

The soft bumper was initially in the design, but later removed. The effectiveness of it is questionable, but still an interesting direction to research in.

Solar roof

The solar roof still leaves a few questions. Like how is the electronics connected? Are specialists needed to install it? How is the roof placed with the Arbowet in mind? And is a permit needed to install the solar roof and battery? A good start is to talk with a specialist about this.

14. References

Abenoza, R. F., Ceccato, V., Susilo, Y. O., & Cats, O. (2018). Individual, Travel, and Bus Stop Characteristics Influencing Travelers' Safety Perceptions. Transportation Research Record. Retrieved from https://doi.org/10.1177/0361198118758677

Amsterdam Rainproof. (n.d.). Rainproof abri in tramhaltes Amsterdam. Retrieved from rainproof.nl: https://www.rainproof.nl/project/groeneabri

Bakker, P. (2018). De Keuze van de Reiziger. den Haag: Kennisinstituut voor Mobiliteitsbeleid (KiM).

Berkhout, A. (2021, 10 13). 10086: Weteringsschans West: Fietsomleiding. Amsterdam: Gemeente Amsterdam.

Braille Institute. (n.d.). White Cane Safety Day. Retrieved from brailleinstitute.org: https://brailleinstitute.org/white-cane-day

CBS. (2021, 9 3). Mentale gezondheid in eerste helft 2021 op dieptepunt. Retrieved from cbs.nl: https://www.cbs.nl/nl-nl/nieuws/2021/35/mentale-gezondheid-in-eerste-helft-2021-op-dieptepunt

CBS. (2023, June 9). Gezondheid en zorggebruik; persoonskenmerken.

CirculinQ. (n.d.). Maak kennis met de infrastructuur van morgen. Retrieved from circulinq.nl: https://circulinq.com/

Clientenbelang Amsterdam. (n.d.). Missie en Visie. Retrieved from clientenbelangamsterdam.nl: https://www.clientenbelangamsterdam.nl/over-ons/missie-en-visie

Coba Europe. (n.d.). COBAGRiP® Light Anti Slip. Retrieved from cobaeurope.com: https://www.cobaeurope.com/flooring/product/cobagrip-light

CROW. (2014). Richtlijn Toegankelijkheid. CROW.

CROW. (2019, 03 25). Looproutes: 1. Checklist richtlijnen en aanbevelingen. Retrieved from crow.nl: https://kennisbank.crow.nl/kennismodule/detail/64034

de Klerk, M., Fernee, H., Woittiez, I., & Ras, M. (2012). Factsheet: Mensen met lichamelijke of verstandelijke beperkingen. Sociaal en Cultureel Planbureau.

Digital Society School. (n.d.). WWWWWH. Retrieved from Design Method Toolkit: https://toolkits.dss.cloud/design/method-card/wwwwwh-2/

Fabrique. (n.d.). Tijdloze abri voor Haaglanden. Retrieved from fabrique3d.nl: https://www.fabrique3d.nl/portfolio/haltevoorziening/haaglanden-abri/

Gemeente Amsterdam. (2023). Deelvervoer. Retrieved from amsterdam.nl: https://www.amsterdam.nl/deelvervoer/

Gemeente Amsterdam. (n.d.). Handboek Zo Werken Wij In Amsterdam. Amsterdam.

Gibson, L. (2016, October 14). 17. Sandwich Panels. Retrieved from MIT OpenCourseWare: https://www.youtube.com/watch?v=4zpQwirFsbk

Gran Studio. (2019). MOBJECTS. Retrieved from granstudio.com: https://www.granstudio.com/mobjects

Groene Bouwhekken. (n.d.). Groene Bouwhekken. Retrieved from groenebouwhekken.nl: https://www.groenebouwhekken.nl/

GVB. (2019, January 30). Met een rolstoel het openbaar vervoer in. Retrieved from GVB: https://over.gvb.nl/nieuws/met-een-rolstoel-het-openbaar-vervoer-in/

GVB. (n.d.). Organisatiestructuur. Retrieved from Werken bij GVB: https://werkenbijgvb.nl/organisatiestructuur/

GVB. (n.d.). OV-domein en taken. Retrieved from gvb.nl: https://over.gvb.nl/organisatie/ov-domein-en-taken/

GVB. (n.d.). Strategische doelen. Retrieved from werkenbijgvb.nl: https://werkenbijgvb.nl/gvb-als-werkgever/missie-visie-en-strategie/

GVB. (n.d.). Tourist guide. Retrieved from gvb.nl: https://www.gvb.nl/bezoek-amsterdam/tourist-guide

Havik, E. M., & Melis-Dankers, B. J. (n.d.). Shared spaces for blind and partially sighted people: a challenge for designers. Retrieved from eccolo.nl: http://www.eccolo.nl/shared-space/english/#/home/

Hoogland, R., & van Baar, S. (2021). Integraal Programma van Eisen Operationeel Systeem Tram Gemeente Amsterdam. Amsterdam.

Ieder(in). (n.d.). Over Ieder(in). Retrieved from iederin.nl: https://iederin.nl/over-iederin/

Light Rail Advies. (2019). Rekenblad Halteverhoging.

Ministerie van Sociale Zaken en Werkgelegenheid. (2023). Hoeveel mag een werknemer tillen? Retrieved from Arboportaal: https://www.arboportaal.nl/onderwerpen/tillen-en-dragen/vraag-en-antwoord/hoeveel-mag-een-werknemer-tillen

Oogfonds. (n.d.). Kleurenblind. Retrieved from oogfonds.nl: https://oogfonds.nl/oogklacht/kleurenblind

Oogvereniging. (2022). Internationale Dag van de Witte Stok 2022: Regionale Acties. Retrieved from oogvereniging.nl: https://www.oogvereniging.nl/internationale-dag-van-de-witte-stok-2022/internationale-dag-van-de-witte-stok-2022-regionale-acties/

Oogvereniging. (n.d.). Standpunten. Retrieved from oogvereniging.nl: https://www.oogvereniging.nl/standpunten/

OV Magazine. (2022, December 2). Drie vervoerders en opdrachtgever innoveren samen. Retrieved from ovmagazine.nl: https://www.ovmagazine.nl/vakartikel/drie-vervoerders-en-opdrachtgever-innoveren-samen

Overheid. (2015). Besluit toegankelijkheid van het openbaar vervoer. Retrieved from https://wetten.overheid.nl/BWBR0029974/2015-01-01/#Hoofdstuk3

PBTconsult BV. (2013). Routegeleiding, tactiele routegeleiding voor mensen met een visuele beperking. Utrecht: PBTconsult BV.

Pellington, P. (2022, April 20). The 5 Pillars of CPTED: Natural Surveillance. Retrieved from deepsentinel.com: https://www.deepsentinel.com/blogs/crime-prevention-through-environmental-design-natural-surveillance/

RailAlert. (2018). Voorschrift Veilig Werken Tram (VVW-Tram). Amsterdam.

Rijksoverheid. (2022). Bestuursakkoord Toegankelijkheid Openbaar Vervoer 2022-2032 Eindversie. Retrieved from https://www.rijksoverheid.nl/documenten/rapporten/2022/11/07/bijlage-bestuursakkoord-toegankelijkheid

Rijksoverheid. (n.d.). Arbobeleid. Retrieved 9 30, 2023, from Rijksoverheid.nl: https://www.rijksoverheid.nl/onderwerpen/arbeidsomstandigheden/arbobeleid

Rijksoverheid. (n.d.). Taken van de Rijksoverheid. Retrieved from Rijksoverheid.nl: https://www.rijksoverheid.nl/onderwerpen/rijksoverheid/taken-van-de-rijksoverheid

Roozenburg, N., & Eekels, J. (1998). Productontwerpen, structuur en methoden.

Studio Bus Sala. (n.d.). Pop-up bushalte. Retrieved from bassala.com: https://www.bassala.com/pop-up-bushalte

United Nations. (2008). Convention on the Rights of Persons with Disabilities., (pp. 9-10). New York.

Vervoerregio Amsterdam. (2013). Aangepaste Concessie Amsterdam 2012. Amsterdam.

Vervoerregio Amsterdam. (2017). Blad gemeenschappelijke regeling van Vervoerregio Amsterdam. Amsterdam: Vervoerregio Amsterdam. Retrieved from https://zoek.officielebekendmakingen.nl/bgr-2017-685.html#:~:text=Er%20zijn%20al,de%20fysieke%20infrastructuur.

Vervoerregio Amsterdam. (2020). Beleidskader Inclusieve Mobiliteit. Amsterdam.

Zedde, P. v. (2020). Leidraad Centrale Verkeerscommissie. Amsterdam: Centrale Verkeerscommissie.

APPENDIX

A15. First Exploration Amsterdam

As an introduction to the project, I went to a walk through Amsterdam together with the Stadsingenieurs. The goal of the walk would be to give a better understanding about the context surrounding the problem.

FIGURE 15-1 A newly placed tram stop. The entrance is missing tactile lines.

Set-up

With Ron from the Stadsingenieurs I will visit the following places: a big work terrain, two temporary stops and a new stop.

Some focus points in exploring the environment of temporary tram stops were:

- How is the accessibility for people with disabilities?
- How is the clarity?
- How does the current traffic handle the situation?
- How do the travelers handle the situation?
- How does a temporary stop differ from a fixed stop?

FIGURE 15-2 With a button press, audio is played with the current travel information.

Results

Work Terrain

The first visit was at a construction work terrain. The most interesting part was how people were being redirected. The area was mostly closed off with fences. Cars were being redirected by traffic controllers and signs, yet still some issues appeared, like cars driving to closed ends or facing each other on a one way street. The cycle route was limited, where cyclists ended up riding the walkway.

New Stop

New tram-stops have a standard design. The stop at Paleisstraat is a good example of that(figure 15-1). The tram contains the following elements:

- A sloped entrance, so people with a wheelchair can enter.
- Indicators for the visual impaired: Guideline along length, indicator for tram information sign, indicator for entrance, indicator for end of stop when they need to turn around.
- An abri with bench, a map and travel information.
- Tram information monitor. The monitor also has a button, when pressed an audio segment will be played with the information on the monitor(figure 15-2).
- Advertisement
- Trashcan
- Fence to segment itself off from traffic.
- Line indication to stand behind

One interesting interaction with the stop was a truck trying to make a turn. During that turn he was riding over the stop. This could damage the stop pretty badly.

Temporary Stop

I've visited two temporary tram stops; Eerste Marnixdwarsstraat and Rijksmuseum. Both of the tram stops had concrete plates as a floor. The height of the flooring matched the trams well. The state of the plates were less desirable. There were many cracks, holes(figure 15-3) and the plates were misaligned(figure 15-6). The misalignment most likely happened from unintended use, like cars riding on or against it. Misalignment like this also happens normal stops, but due to temporary nature of the observed stops, reparation does not have a priority.

Both stops also had slopes for wheelchairs. These were made out of cold asphalt. The Rijksmuseum had slopes on both ends of the stop, while the stop at Eerste Marnixdwarsstraat only had one slope. The slopes were used by cyclists to ride on the stop at the Rijksmuseum. Since the height of the flooring was level with the tram, it is easy for people in wheelchairs or people with strollers to enter. The tram itself also has a retractable slope to cover the gap(figure 15-4). This is activated by pressing the wheelchair button on the outside of the tram.

While the Rijksmuseum stop is being used more, the Eerste Marnixdwarsstraat had more facilities. It included an Abri, tram-information sign, trashcan and a fence separating the stop from the bicycle lane. The stop at the Rijksmuseum only had an tram-information sign. The Eerste Marnixdwarsstraat most likely has more facilities as it stays longer than the temporary stop at the Rijksmuseum.

Both tram stops had guiding lines for visually impaired people. These were across the length of the stop. However they were in an unusable state(figure 15-5). Due to the misalignment of the tiles, the lines were misaligned as well. There were many spots were the lines were deteriorated or there were tiles where there were no guide lines at all. There was no line or indication at the entrance of the stop. And there are no indications for boarding, information or end of the stop. Since the tram-information sign was not digital, there was no audio information. While the tram stops had a guiding line, it didn't have a warning marking at the edge of the stop.

At the stop of the Rijksmuseum two tourists asked for the location of the tram stop to a construction worker. The tram-information signs are yellow, which is a good indication for Dutch people what the tram station is. This is more difficult to figure out as a foreigner. On the apps and websites like Google Maps, 9292 and GVB, the given location of the stop is at its old location. The website of GVB should have the updated location, even for temporary stops, but it didn't have for this one.

Temporary stops like these two, take about 2 to 3 days to set up. A stop could block traffic, solutions to that are to let traffic make use of the tram lane or to redirect the traffic entirely.

TAKEAWAYS

- The stop at the Rijksmuseum is a good spot for further observations, due to the volume of people.
- The current concrete flooring at the temporary stops are not good enough, due to cracks, holes and misalignment
- With the slopes and ramps from the tram, wheelchair users were able to use the temporary tram stop.
- Visual impaired people would have difficulties using the station due to bad marking and no indications where the stop would be.
- A current stop takes 2 to 3 days to set up.

FIGURE 15-3 Damaged concrete flooring at a temporary stop.

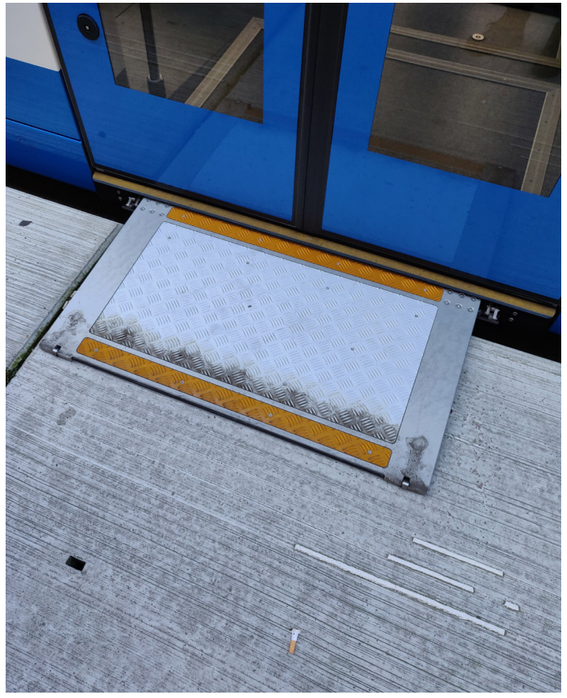


FIGURE 15-4 Retractable ramp from tram.

FIGURE 15-5 No tactile lines at a segment of the temporary stop.

FIGURE 15-6 Uneven concrete flooring at a temporary stop.

A16. Observing Use of Temporary Tram Stop

From chapter A15. First Exploration Amsterdam, two interesting things were observed at the Rijksmuseum tram stop: a cyclist was cycling on the tram stop and two tourists were not able to find the tram stop. Those two things were found in an only 5 minute visit. This inspired me to observe the stop a bit more, to see if there are any more interesting interactions.

Setup

The observation was done in two sessions on the 5th and the 6th of October at the temporary tram stop at the Rijksmuseum. Both sessions were about 2 hours long. The first observation was done during the afternoon at around 15:30 till 17:30. The second around lunch from 12:00 till 14:00. Interesting moments were written down on a notebook. Pictures and videos were taken on a phone. On the second day I filmed via a camera on a tripod.

Specific things I've been looking out for are:

- How do travelers navigate to the tram stop and to the tram? Are they using apps or using the information sign?
- What is the behavior of surrounding traffic?
- How are people with disabilities using it?
- Is there any unexpected behavior?
- Where do people wait?
- How many people are using it?

Results

Bicycle problem

Bicycles ride on the stop. This can lead to dangerous situations and decreases the passenger experience. During the observation people were forced to wait outside the stop because cyclists were cycling constantly over the stop. During boarding and offboarding of the trams, there were some almost collisions with the passengers and the cyclists(figure 16-1).

There were a few reasons why there were so many cyclists on the tram stop. The tram stop was installed on top of the cycling lane. There was a detour for cyclists, but the detour was quite long and cyclists even had to go the opposite direction first (Berkhout, 2021). And the slopes at both ends of the tram stop made it very easy for cyclists to cycle on top of it.

Travel information

There were some people who had trouble finding the right travel information. People had some trouble deciphering the schedule on the travel information sign(figure 16-4). In some cases it led to people asking the tram driver instead. The sign itself didn't tell what station it was, instead it said "temporary station". The schedule was written in small text, and part of the schedule was on the other side of the sign, though the sign had no indication of different sides. Most of the travelers did not look at the sign at all, the people who do had often trouble with it.

Resting outside the stop

Often people were waiting on the walkway outside of the tram stop (figure 16-3). Even during the moments were cyclists didn't ride on the stop. Sometimes they were sitting on the stairs of the nearby buildings or leaning on the walls (figure 16-2). The stop itself has no seats or alternatives for people to rest on. At one instance a person with a walking cane waited a bit for the tram, but walked away later. They had no place to rest.

FIGURE 16-1 Cyclist almost colliding with passengers

FIGURE 16-2 People resting on the stops curb.

FIGURE 16-3 People waiting outside the stop as a result of cyclists.

FIGURE 16-4 A couple trying to decipher the given travel information

TAKEAWAYS

- Stop needs to be unattractive for bicycle traffic.
- Travel information should be easier to understand.
- Travel information should be written in larger text.
- There needs to be places for people to rest on.

A17. Interview with Rik from the Oogvereniging

On the 15th of October was White Cane Safety Day, that day was founded to raise awareness for visually impaired people. (Braille Institute, n.d.) At the station of Leiden people from the Oogvereniging and Gehandicapten Platvorm Leiden stood there to inform people about blindness in public transport for people who are interested. (Oogvereniging, 2022) There I had a conversation with Rik Wouters of the Oogvereniging on how his visual impairment affects his travel experience.

FIGURE 17-1 Example of a metal flooring. This can get too slippery for guiding dogs.

Set-up

For preparation I've formed a small selection of questions:

- How do you navigate during a construction?
- In which aspects can public transport change to improve accessibility for visual impaired people?
- Any tips to look out for when designing a temporary stop?

The amount of questions is limited due to the situation where this conversation takes place. Interesting findings will be noted into a notebook.

Results

Most blind people are not completely blind. They still can see a little bit. Things like contrasting colors can be noticeable. When it is dark the visual impairment is worse, good lighting improves their vision significantly.

Rik uses the OVinfo app for real time information of nearby public transport. The app detects the location of the user and shows a timeline of departing transport nearby. Rik has his phone set up that a voice tells what's on display on the OVinfo app.

The CROW Kennisbank is the norm, when it comes to designing for people with a visual disability.

Tactile paving is in two widths: 30 and 60cm. The 60cm version is an older variant. In current designs only the 30 cm width tactile paving is used.

It helps a lot for blind people if the floor of the tram/bus is level with the stop. This is because they cannot see the height difference. The unknown height difference might cause them to trip over.

Some tactile paving include a sound tile. This is a hollow tile, giving a different acoustic feedback when going over with a probing cane. These sound tiles are used to indicate things like supposed vehicle entrances.

During construction, walkways are sometimes made of metal. This can be problematic as metal is slippery, which causes trouble for guide dogs. Metal flooring is being used as it is easy to install and it is easy to attach tactile paving on top of it(figure 3-1).

During construction Rik uses the construction fences as guidelines. The concrete segments to keep the fences up, obstruct the way and blind people can trip over it.

Blind people decide plans in their travels on a basis of habits. Change like constructions can be confusing to them.

TAKEAWAYS

- Visual impaired people often can see contrasting colors.
- Good lighting improves visibility significantly during the dark.
- Apps like OVinfo are being used to navigate.
- Kennisbank CROW is the norm.
- Height differences and objects on the floor can cause visually impaired people to trip over.
- Sound tiles can be used as an indication.
- Floors shouldn't be slippery for guiding dogs.
- Blind people mostly base their travels on habits

A18. Creative Session: Context

Stadsingenieurs have worked a lot in this field, so they have a lot of knowledge. This session is meant to use that knowledge to get a better overview of the context. With the session I will gain some preliminary ideas. And lastly, the session is meant to have a better understanding between the parties. (Student vs Stadsingenieurs) The student will know where everyone's interest lies. The company will have a better view of the project the student is working on.

Set-up

Preparation

Materials: Thick markers, A3 paper(for 635 and drawing lesson), A1 paper roll(for WWWWWH), whiteboard + markers, post-its, refreshments and lunch.

Location: Stadsingenieurs office and the meeting room near the office

Participants: Wouter (Has to leave for the final hour), Freek, Ron, Yonas (Was not able to join) and Ad.

Planning

11:00 – Explanation session

To give an expectation of what will happen during the session, why there is an session and talk about the basic rules, like: there is no bad idea.

11:05 – Icebreaker

Talk about bad personal experiences with public transport. Warm up and make the subject more relatable. Not much warm up will be needed as everyone knows each other.

11:10 – WWWWWH (Digital Society School, n.d.)

Ask the questions: Who? What? When? Where? Why? and How? for the context of a temporary bus/tram stop. Which gives a better insight of the context and prepares for the next few subjects.

11:40 – Debate

A debate about a few controversial subjects. Participants get 5 minutes to think of arguments and then 10 minutes to debate against each other. Use 2 subjects. Subjects can be:

- It is not needed to take people with disabilities into account.
- During construction it is ok to walk to the next stop instead.
- A phone is enough travel information.

12:15 – Lunch

Lunch will be provided by Stadsingenieurs, one of them need to bring the lunch and will be out of the session for a while.

12:35 – Drawing Lesson

A small lesson on how to draw an easy character. Meant to warm up everyone for drawing ideas and not feel people limited by their drawing skills.

12:45 – H2's

Writing down different H2's in context of designing a new temporary tram/bus stop.

13:00 – Choosing H2's

The participants chose their favorite H2's, which will be used to think more ideas for.

13:05 – 635

The 635 method will be used to think of ideas for the chosen H2's. Every participant has a paper with one H2 written on. They will draw/write three ideas on that paper within 5 minutes. When the 5 minutes are over the papers will be rotated and the participants will draw/write 3 new ideas within 5 minutes.

13:30 – Break

A break will be placed after the 635, as a breather. 635 can be a bit much and needs some time to recover afterwards.

13:35 – If there is some time left: Fun idea session like: Criminal Intent or Worst Case Scenario.

A fun session to have some final crazy ideas and end on a fun note. This is only done if there is enough time.

13:40 – Favorite ideas

As a small converging moment, everyone's favorite ideas will be discussed.

13:50 – Discussion

A discussion on how everyone felt how the session went. And space for some questions.

Post session – Leftover H2's

After the session a few leftover H2's will be written down on the whiteboard in the Stadsingenieurs office. The Stadsingenieurs can add their ideas over time. The H2's will be exchanged over time to keep it fresh.

Timeline

Icebreaker

Before the icebreaker I started with a short explanation about the session and the rule that no idea is a bad idea.

For the icebreaker the participants were asked to talk about their bad experiences on tram/bus stops. Instead the participants started to write down what's bad about temporary tram/bus stops. I didn't stop them, instead I asked some participants specifically with the question.

Results

Problems and bad experiences on tram/bus stops stated by participants(figure 18-1):

- No guiding lines
- No travel information
- Stop is too small for wheelchairs
- Stop is not level with the trams/busses
- No connection with the surrounding area,
- Stop is not recognizable as tram/bus stop
- No space for an abri
- Lack of lighting
- The ground is not stable
- The ground plates are often loose.

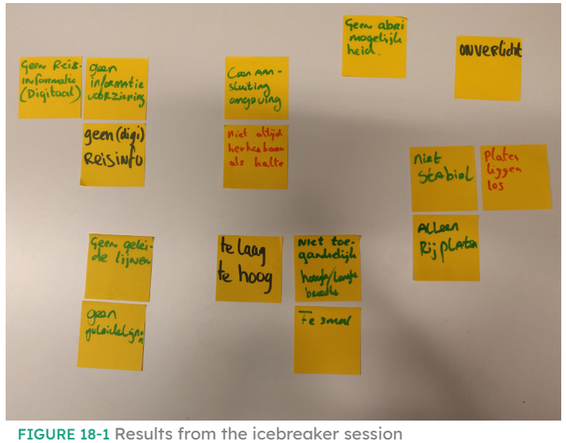


FIGURE 18-1 Results from the icebreaker session

Debate

A debate was held on the statement; "It is not needed to take into account for people with disabilities when creating a temporary stop."

It was placed before the WWWWWH, because it feels more like an icebreaker and some people need to go for a few minutes and take the lunch. That can better be done during WWWWWH instead of the debate. People were hesitant at first to be the bad guy in this statement, but some offered to take the stance. Instead of doing another subject to debate on, I decided to let people think for ideas on how to facilitate people if the temporary stop can't be accessible for people with disabilities. This ended up being a good closer for the debate.

Results

Arguments for the statement(figure 18-2):

- It is a very small group.
- The costs to change the stop to include them is very high.
- Changing trains to include them costs a lot too.
- Many people with disabilities are not able to get to the stop due to poor surrounding infrastructure.
- There are already alternative transit concepts for them.

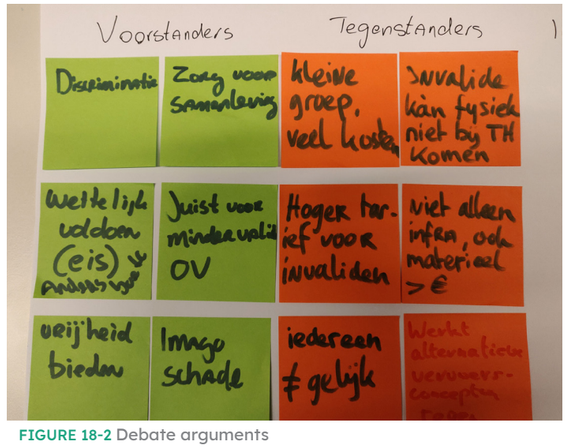


FIGURE 18-2 Debate arguments

Arguments against the statement:

- Not including them is discrimination.
- We should care for each other.
- This is a requirement by law.
- The ability to use public transport gives people with disabilities more freedom.
- Not offering public transport to people with disabilities leaves a bad image.

Idea-generation: "How can we still help people with disabilities if it is not possible to facilitate for them in a temporary stop?"(figure 18-3)

- Higher tariff for people with disabilities.
- People with disabilities need to go to the next stop.
- Taxi-service.
- Adjust wheelchair.
- Boarding help app.
- A display to help them.

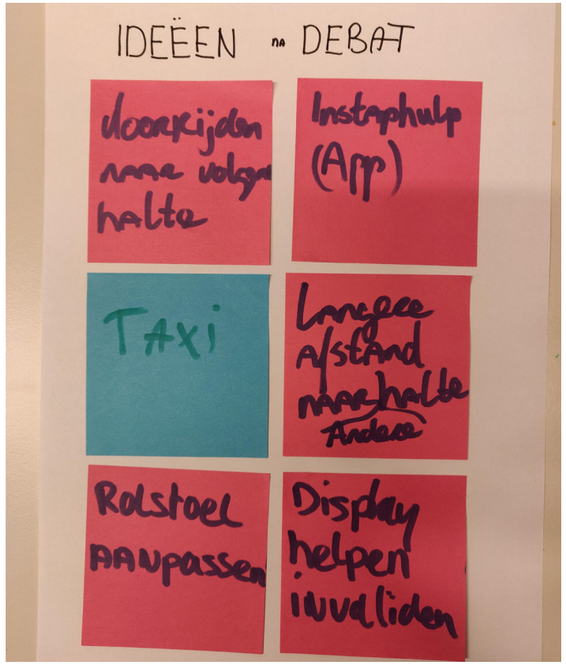


FIGURE 18-3 Ideas resulting from debate

WWWWWH

To gain a better overview of the context, the group went through the following questions:

- Who are involved around the temporary stop?
- What happens at a temporary stop?
- When is the temporary stop being used?
- Where is the temporary stop?
- Why do we need a temporary stop?
- How is a temporary stop placed?

The initial idea was to write these on a whiteboard, but since the room with whiteboard was not yet available, I decided to write them down on an A1 roll instead. This ended up being a great addition. The roll allowed to let the whole WWWWWH be one a single rollable page.

Results

Who are involved around the temporary stop? (figure 18-5)

- Passengers
  - Transfer passengers
  - Students
  - Party goers
  - Workers
- People with disabilities
  - Senior citizens with walkers
  - Children's carriage
  - Deaf people
  - Wheelchair users
  - Visual impaired people
- Surrounding
  - Cyclists
  - Nearby residents
  - Homeless
  - Emergency services
  - Surrounding traffic
  - Pests
- Set-up and maintenance
  - Rail cleaner (bvl wagon, lubrication service truck)
  - Cleaners public space
  - Abri advertisement/JCDecaux
  - Daily maintenance by GVB
  - Garbage collector
  - Contractor who places/removes the stop.

What happens at a temporary stop? (figure 18-6)

- Passengers
  - On and off boarding
  - Entering and leaving stop
  - Waiting
  - Using phone (Calling/playing a game/browsing)
  - Reading book
  - Sitting and resting
  - Reading travel information
  - Discarding trash
  - Parking bicycle
  - Take shelter
- Orienting themselves
- Maintenance
  - Cleaning
  - Sweeping
  - Removing cigarette ends
  - Collecting garbage
  - Changing advertisement
  - Lay salt in winter
  - Setting up the stop
  - Removing the stop
- Other
  - Halting of the tram/bus
  - Firetruck facility

FIGURE 18-5 Who

FIGURE 18-6 What

When is the stop being used? (figure 18-7)

- Between 1:00 – 5:00 there is no tram.
- Rush hours
- Night bus
- Maintenance is during 7:00 and 17:00.
- Holidays (Kings day)
- Events
- Day and night (light and dark)

Where is the stop? (figure 18-8)

- Public space
- Inner city; shopping district, squares
- Near a point of interest
- Next to construction
- Placed on a bicycle lane/green stroke/ parking spot/car lane/walkway
- Next to the tramline/bus lane
- Green strokes (grass)
- Next to car lane/bicycle lane/walkway
- Near a pedestrian crossing place
- 400 meter radius of another stop

Why do we need a temporary stop? (figure 18-9)

- Accessibility
- Safety
- Requirement from Vervoerregio Amsterdam
- Customer satisfaction
- Retaining customers

How is a temporary stop placed? (figure 18-9)

- Tram lane plates
- Sometimes not at all
- Entrance/exit from a street
- With or without abri/trash can
- Tram/bus stop sign
- With or without wayfinding
- Stelcon plates
- Cold mix asphalt ramp

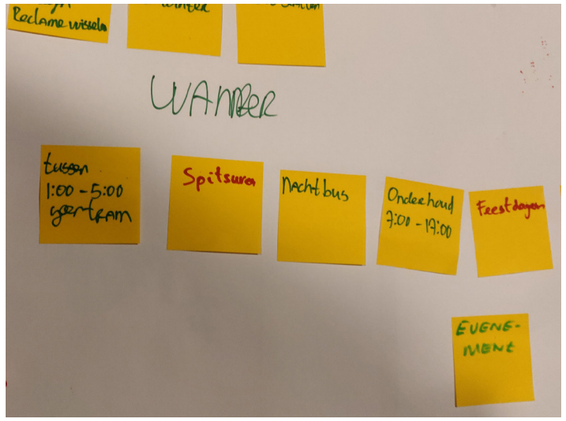


FIGURE 18-7 When

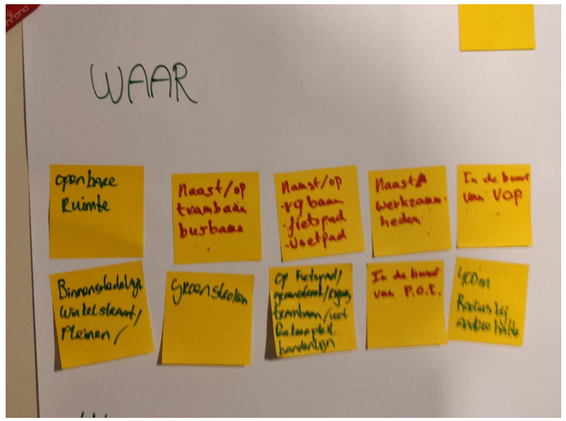


FIGURE 18-8 Where

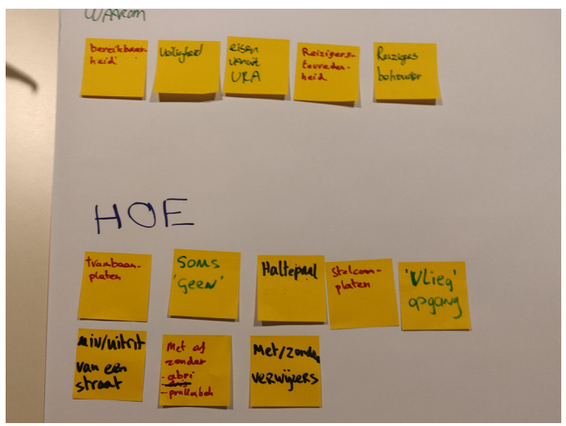


FIGURE 18-9 Why and how

H2's

After the lunchbreak the group made some H2(How to...) statements. These are in preparation for the 635 method later on. This part went quite smoothly, the participants thought of quite a lot and even one started sorting them out. After this they were tasked to select the most important H2's. These would be used for later.

Results

- Assemblage
  - H2 assemble a temporary stop?
  - H2 easily disassemble a temporary stop?
  - H2 assemble/disassemble a stop quickly?
  - H2 place a temporary stop?
  - H2 lift segments of a temporary stop?
  - H2 move a temporary stop?
  - H2 store a temporary stop?
  - H2 place a temporary stop on an uneven ground?
  - H2 secure the temporary stop on the ground?
  - H2 adjust the width and length of the temporary stop?
  - H2 adjust the height of the temporary stop?
  - H2 keep a temporary stop stable?
- Traveler experience
  - H2 convey digital travel information?
  - H2 make a stop recognizable?
  - H2 create an accessible entrance?
  - H2 create shelter?
  - H2 convey information to the travelers?
  - H2 let users discard of waste?
  - H2 make a temporary stop accessible for people with disabilities?
- Safety
  - H2 light up a temporary stop?
  - H2 guarantee safety?
  - H2 prevent slipping of the travelers?
  - H2 close off the sides of a temporary stop?
  - H2 prevent falling/tripping of the travelers?
- Other
  - H2 clean a temporary stop?
  - H2 profit from a temporary stop?
  - H2 produce a temporary stop?
  - H2 prevent collision of a car/ truck against a stop?
  - H2 make a stop sustainable?
  - H2 make a temporary stop vandal proof?

Most important selected H2's(figure 18-11):

- H2 guarantee safety?
- H2 make a temporary stop sustainable?
- H2 make a temporary stop accessible for people with disabilities?
- H2 keep a temporary stop stable?
- H2 display travel information at a temporary stop?
- H2 assemble/disassemble a stop quickly?
- H2 make a temporary stop vandal proof?

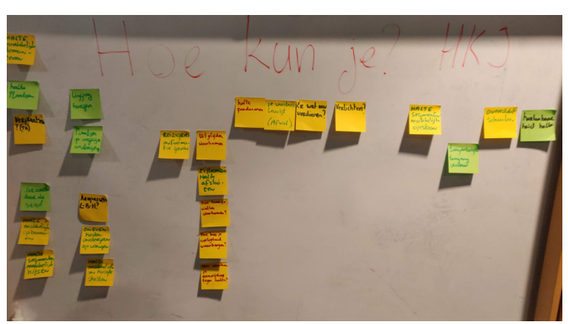


FIGURE 18-10 Sorting process of H2's

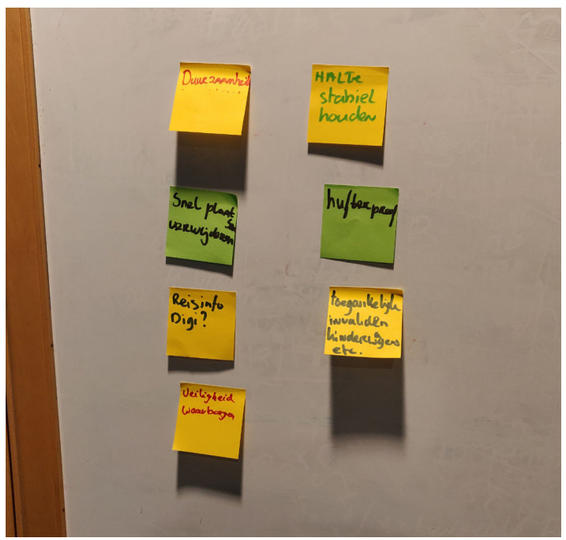


FIGURE 18-11 Chosen H2's

635

Just before starting with the 635, I gave a little drawing lesson on how to draw a very rudimental person. This is included because non-designers are often reluctant to draw ideas instead of writing. It didn't go that well, and could have been prepared a bit better, but it also gave the impression that it is ok to draw badly. In that regard it was successful.

With a selection of the most important H2's the group followed the 635 method. 635 stands for 6 people, 3 ideas and 5 minutes. The idea is that everyone has a paper with a H2 on it, they get 5 minutes to think of 3 ideas. After the 5 minutes everyone gives their paper to next person clockwise. There the participants will think of 3 additional ideas. This will be repeated until the original query is back to the original participant. This method gives a great idea output, lets people iterate on other ideas and works great for problems with multiple aspects like this one.

During the 635 one of the participants had to leave, so I decided to join in. This way there are still enough people for this method. It also gives an opportunity to show that silly ideas are allowed. Sadly no crazy ideas were generated by the rest of the participants.

After the session, every person presented their paper with ideas and we had a small discussion about each. Because people went pretty thorough with this discussion, the favorite idea selection, which was planned in later ended up obsolete.

Results

H2 guarantee safety?

1. Place a fence on the edge.
2. Make the ground of non-slip material.
3. Don't make the ground uneven so people won't be able to trip.
4. Lighten up the stop.
5. Use signs for wayfinding and indicating for unsafe situations like slippery surface.
6. Marking for places where people may not enter from.
7. Guidelines for people with visual impairments.
8. Mind your step announcements.
9. Lighting strips on the floor.
10. Placing camera's.
11. Adding security.
12. Make use of a WhatsApp neighborhood group.
13. Add an alarm button.

H2 make a temporary stop sustainable?

1. Use solar panels as abri roof. a. Place a windmill
2. Use ocean plastic as building material.
3. Reuse previous stops.
4. Use existing concepts like plastic road segments.
5. Moving it electrically.
6. Return leftover energy to power grid.
   a. Make available to travelers for charging phone or bicycle.
7. Entrance fee by recycling bottles.
8. Let travelers generate energy with a bicycle.
9. Information sign about how people can be more sustainable.
10. Separated waste bin.

H2 make a temporary stop accessible for people with disabilities?

1. Make the height at 24 cm, level with the public transport.
2. Have a maximum of 5% slope at the entrance.
3. Add marking for people with visual impairment.
4. Let trams have ramps for wheelchair users.
5. Add a lift to the tram stop.
6. Have someone at the tram who carries people into the tram.
7. Set up a taxi service for people with disabilities.
8. Lower the tram track instead of increasing the height of the stop.

H2 keep a temporary stop stable?

1. Leveling feet adjustable from the top.
2. Fill in the body of the stop with water for added weight.
3. Link segments of a stop against each other.
4. Flexible links due to uneven ground.
5. Flexible linking material for when shrinkage happens.
6. Memory foam like material which adjust on unstable ground.
7. Hang up the stop, so it is not dependent on the floor.
8. Make the stop a big sandbox.
9. Make the base out of sand and place the stop on top.

H2 display travel information at a temporary stop?

1. Let the traveler use their phone.
2. Use speakers.
3. A dynamic information display.
4. A statical information display.
5. Person who tells/announces the information.
6. Information signs in the abri.
7. Projection information display on the floor.
8. Statical information painted on the floor.

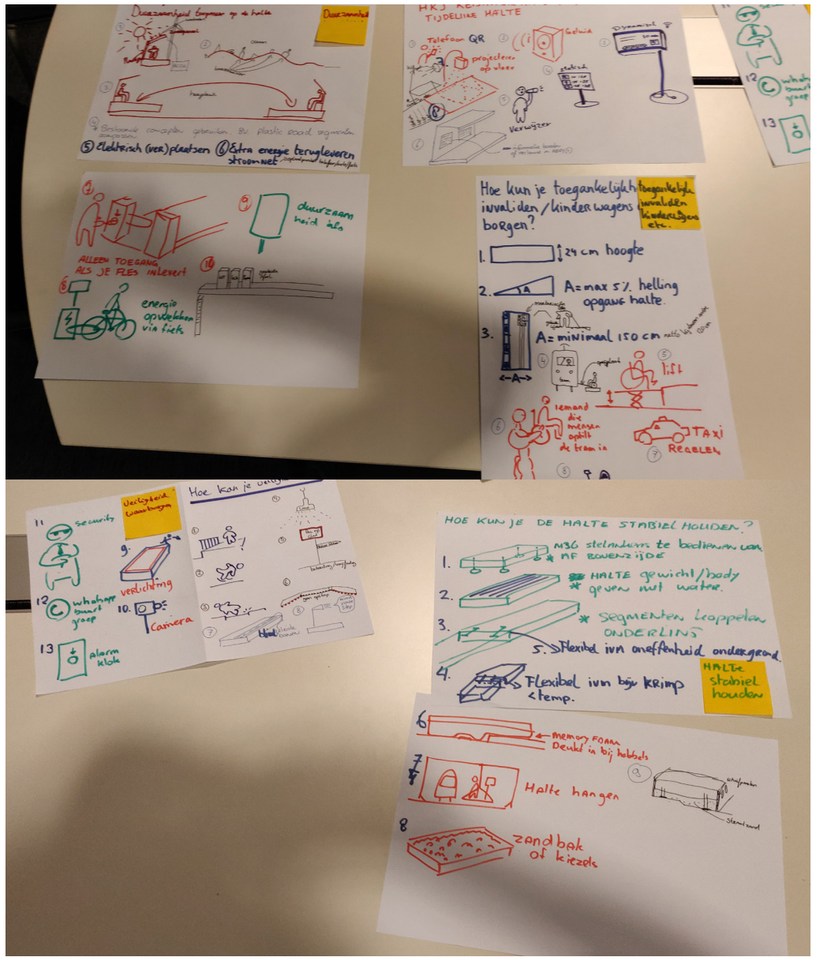


FIGURE 18-12 Ideas from 635

Final idea session

With time for one more idea session, I decided to go for the Criminal Intent method. With the Criminal Intent, the participants think about the worst and most evil kind of solutions to the problem. Afterwards a few ideas are being selected. From the selected ideas situation, the participants will think about new good ideas.

During the session it was noticeable that a lot of criminal ideas were based on actual situations, which the participants found improper.

Results

What would be the most evil temporary stop? (figure 18-13)

- No stop at all.
- Make the stop only 40cm wide.
- No slope for wheelchairs.
- The stop is just a sign.
- The stop is on the middle of the road.
- The stop is a mud pool.
- It is very dark.
- The stop contains the wrong information.
- The information is written on a tiny piece of paper.
- Traffic being blocked due to the stop.
- Next to a fire extinguisher.
- Stop were tram is unable to stop.
- Stop is blocking a loading/unloading area.
- Stop is inaccessible for pedestrians.
- Stop is in the middle of a construction area.

What if the stop was just a sign?(figure 18-14)

- Use cordon tape to indicate the stop.
- Make use of existing elements of the surrounding.

What if the wrong information is displayed?

- Communicate to the tram/bus driver. They can announce the right information.
- Put a person at a stop to tell the right information.

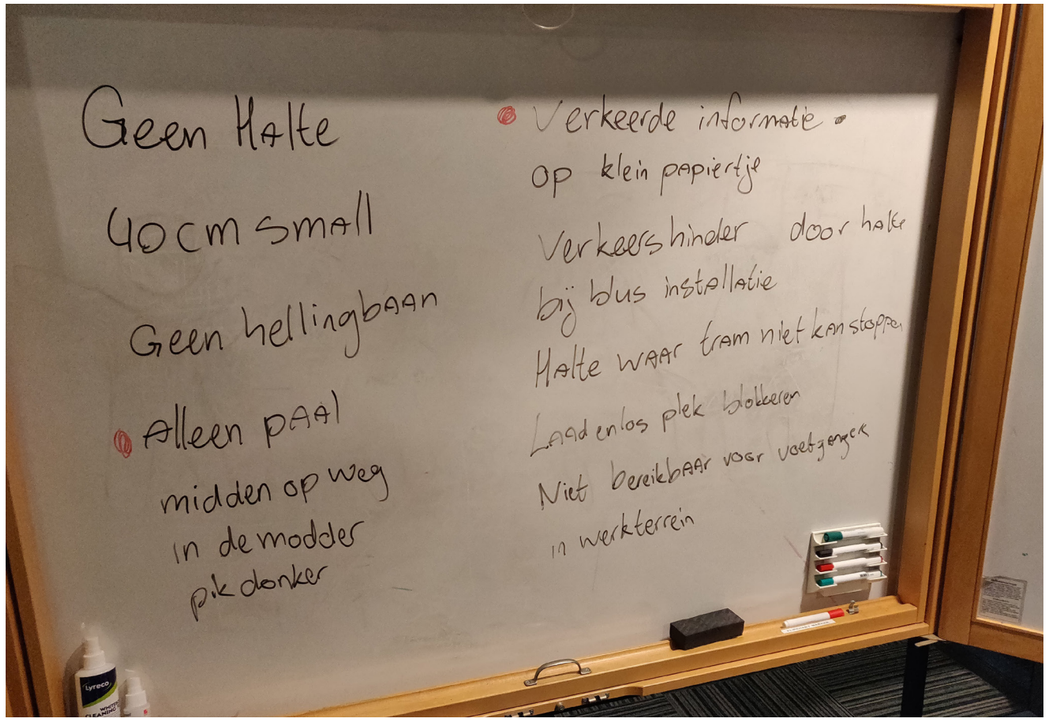


FIGURE 18-13 Some evil ideas

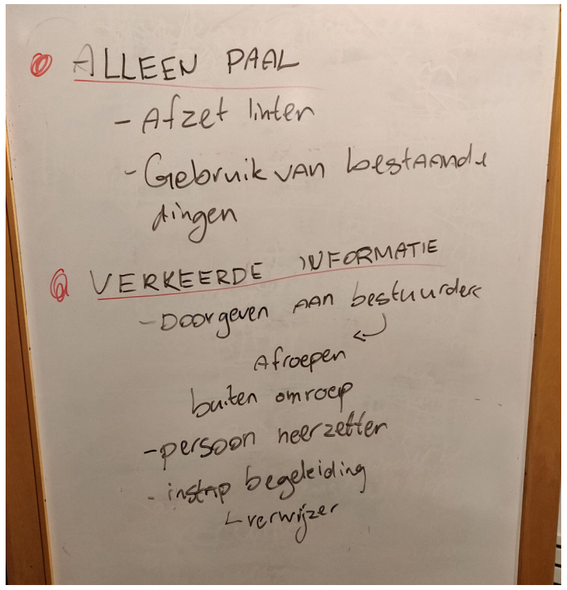


FIGURE 18-14 Solutions to evil ideas

Discussion

As a closer to the session the group had a short discussion how the session went. The session was well liked, especially the planning and structure was perceived as good. The group didn't want some H2's go to waste. Luckily I had a plan for these. During the discussion I also explained where I am in the project and how the session fits into the project.

Post session

After the session I wrote a H2 statement on the whiteboard for people to generate ideas on. Some ideas were added over time. People also added some H2's to it. (figure 18-15)

FIGURE 18-15 Post session idea board

A19. Interview with Casper from Cliëntenbelang Amsterdam

To gain a better understanding how people with disabilities experience public transport, I had an interview with Casper, an experience expert from Cliëntenbelang Amsterdam. The focus of the interview mainly lays in his experience as a wheelchair user and the insights he has gotten as an experience expert. These insights will be used to redefine the design brief and program of requirements.

Set-up

The interview will be semi structured with a length of about 50 to 60 minutes. The structure of the interview is defined in an interview guide. The interview will be recorded. The recording will be transcribed via a transcribing software. Any errors of the transcription software will be corrected by hand. The interview was held in person at Caspers home.

Interview Guide

Preparation

- Location and refreshments
- Charged recording device
- Notepad and pen
- Printed out interview guide
- Images of temporary stop

Introduction:

Thanks for coming

Drinks + Food

Ask to record the conversation.

I'm Jasper, working on my graduation thesis in Industrial Design via Stadsingenieurs. I want to create a better experience for all people in public transit.

No wrong or right answers

Questions:

1. Tell me something about yourself?

   Name, Occupation, Disability

2. In which situations do you use public transport?

   How much do you want to use public transport?

   What's limiting it?

3. Can you think of a moment where you hit a problem with your disability while using the tram or bus?
4. How did you know what to do when using public transport for the first time as person with disability?

   Which resources did you use?

5. Walkthrough of taking public transport, can you tell me how you go through it and what kind of problems you face on each step?:
   a. Decision making destination, route and mode of transport
      - Use of any apps and why?
   b. Travelling to stop/station
   c. Using the station
      - What do you do?
      - Do you use any of the facilities
      - Rest
      - Travel Information
   d. Boarding
   e. Travel
   f. Off-boarding
   g. Exit stop/station
   h. Move to destination
6. Did you have any experience of times when a tram or bus stop was temporary moved due to something like construction or an event?
   a. Where you able to use public transport as usual?
   b. Did they facilitate for your disability?
      - Where they successful?
   c. How could they improve?

((SHOW PICTURES OF TEMPORARY STOP))

7. I'm planning to experience the situation by myself. Do you have any tips navigating as a person with the disability?
8. Are there any things that designers often forget when designing for people with disabilities?
9.

Wrap Up:

Thanks for your time and help

Reach out for later?

Subscribe to project update?

Reflection

The interview was held at Caspers house. It took about an hour to finish the interview, which was close to the estimation. From the interview I've gained a lot of information. Though the subject went quite often to problems Casper experienced at bigger NS stations, rather than tram or bus stops. For the preparation of the interview I had a step by step walkthrough planned. This was not really needed as most of it was told already. Listening back, I noticed that I stumbled a lot on forming sentences, sometimes even leaving them unfinished. This made some questions more difficult to understand. It made me sound unprofessional and under prepared, while this was not the case. A solution might be is to say the questions out loud beforehand to practice. The results had not been affected much by it, as Casper managed to understand each of them.

Results

About Casper

Casper makes use of a wheelchair in his daily live. With his insights as a wheelchair user, Casper is an experience expert for public transport at Clientenbelang Amsterdam. He is also a member of the Reizigers Adviesraad in Amsterdam. One of his goals as an experience expert is that newly placed public facilities in Amsterdam are made with accessibility in mind before construction, rather than it needs to be adjusted afterwards. Which would be much more difficult to adjust.

Autonomy and self-reliance is very important for people with disabilities. The UN goal for accessibility in public transport is way too late according to Casper. Everything should have been accessible already.

Planning of travel

When a person with a disability wants to make use of public transport, they have to carefully plan ahead most of the time, making spontaneous decisions rarely possible to make. If planning beforehand is needed, the needed timeframe between planning and transport can vary between an hour to a day, depending on the transport provider. Travel decisions are made based on the accessibility of the starting and end point.

The accessibility of a stop is often shown on the website or app of the transport provider. The accessibility indication on the app/website is split into different kind of accessibilities, like wheelchair accessible and accessible for people with visual impairment. There is no differentiation between different levels of wheelchair accessibility. The information provided to the website or apps is not always correct as it doesn't not take the environment outside the stop into account. In one case Casper couldn't exit the stop as the walkway was too small, while the app of GVB indicated that the stop was wheelchair accessible. Constructions on the route will add extra difficulties to the planning, as alternative facilitation or routes are not always accessible and changes are not communicated well. Casper pointed out that people with visual impairment are often overlooked. One of the problems they have with public transport is, when one vehicle delays and the other is coming in first, it is difficult for them to notice. Preferably this should be announced via audio.

For some public transport providers, a person with a disability need to schedule in their boarding. At NS the user needs to schedule an hour beforehand to get boarding assistance. In some cases the assistance won't show up. Then they are dependent on the conductor, which is not allowed to assist officially. Alternatively they need to rebook, which delays their journey for an hour. Booking is not needed for using the tram, bus and metro at Gemeente Amsterdam. The conductor or driver should be able to assist the traveler.

Stops in Amsterdam

Accessibility of transport in Amsterdam vary from stop to stop. One stop/station can be accessible, to even the point where no appointment needs to be made for assistance, but that doesn't take into account the stops along the way of the route, which can lead to dangerous or tricky situations. There are some stops in Amsterdam you absolutely don't want to use as a wheelchair user. Like some metro stops and some very small tram stops in the centrum, where there is not room left for the extendable ramp.

There has been cases where the lights in the metro stations were not working or when the elevators were out of service, leaving people unable to make use of public transport, or unable to exit at their destination. GVB does not communicate about these issues when they happen, leaving people with disabilities in some difficult situations, even when they plan their route carefully. If there are changes in accessibility, people are dependent on broadcast messages, at the stop or in the bus/tram. This is mostly not done at all.

A new tramline in Amsterdam (15G to Amstelveen), the stops were made too low for use without extendable ramp, but when the extendable ramp is used, the ramp would hit the edge of the drainage system of the stop. This had to be adjusted after the fact. This is something they could have prevented by hiring an experience expert like Casper. At the Amstelveen-lijn, some stops were too high. The height made the bus/tram wheelchair ramps unusable. The stops needed to be fully readjusted. Problems like these happen frequently, while they are preventable.

Casper recognized the bicycle problem I observed at the Rijksmuseum stop. It seems to be something that is happening frequently at other stops as well. Even at the metro stations. According to Casper the people of Amsterdam specifically have an anarchist mentality. Casper already send a complain of the bicycle problem towards GVB. Casper points out that if you design something against the bicyclists, it can also have a negative impact towards wheelchair users.

On stops and stations in Amsterdam, a lot of people smoke. Nearby smokers prevents Casper from using facilities of the stop, like waste-bins or ABRIs.

Beyond the stop

Construction can make a route towards the stop more difficult. Their alternative walkways are not always wheelchair compatible. The paving of the street towards the stop needs to be well connected. And the paving should be smooth enough for people with sport wheelchairs to use. These wheelchairs have skateboard-like wheels.

Curbs are often a frustration, there are curb cuts, but often they are difficult to get through due to height difference. It is still often expected that wheelchair users use these.

Boarding Assistance

When boarding busses, wheelchair users require assistance of the bus driver. Cliëntenbelang Amsterdam provides a mandatory training for drivers and conductors to give the right assistance. Some drivers will assist the wheelchair user, some are not in the mood and will think of an excuse to keep driving. For bus drivers, assisting wheelchair users is too much of a hassle. If the extendable plank needs to be placed manually, the driver complains about back problems. Automatic extendable planks are prone to malfunctioning, due to the lack of maintenance. If the ramp is able to extend out but not in anymore, it would affect the other travelers.

At one of the guidance videos of GVB, it is explained to raise your hand if you want to board (GVB, 2019). According to Casper this is just the usual indication of a bus or tram needs to stop or not. Casper always makes sure to raise his hand so the driver can mentally prepare to it as well.

Casper had an experience where the ramp broke at a bus when he was on it. He ended up wounded, but despite that he can't just stop using public transport. Because there are very few wheelchair users making use of public transport, the ramps are not properly maintained.

People with manual wheelchairs, like people with starting MS, have difficulties with entering the bus/tram as it costs a lot of energy. They often have to ask the driver or fellow passengers to help them enter the vehicle. This reduces the persons autonomy and freedom of mobility.

NS has now a Mobility SE Service via Qarin, where you can go everywhere with public service with the assistance of a 'Halte Buddy'. Which is most likely based on Amsterdam's OV Coach. You can request the service at any public transport stop by pressing a button, then you will be able to get assistance with the next passing vehicle.

Awareness

Not many wheelchair users make use of public transit. This is often because they don't know it is for them possible to use. They don't know if there is a ramp inside a bus or tramp. It is not visible for them that it might be usable. When Casper first had his disability he had no knowledge of how to use public transport with his disability. He was unaware he could use public transport. Public transport vehicles used to be inaccessible, which set expectations for Casper he was not able to use it at all. He started to get aware he was able to use public transportation after he got asked by GVB to give the personnel training about assisting people with disabilities. Since then he started to make use of public transportation.

There are not many sources available to make people aware they are able to use public transportation. There used to be a campaign from OV coach, but Casper does not know if that had much reach to the people currently making use of an AOV bus. The AOV bus is a taxi service within Amsterdam. for people with disabilities, provided by Gemeente Amsterdam. To make use of it, the traveler needs to book it at least an hour before departure. People can also make use of the Valys service to travel to nearby regions outside of the Amsterdam region in a similar way. Booking the Valys needs to be done a day ahead. The municipality is trying to reduce the amount of AOV users as a way to reduce costs.

It would be ideal when planning for public transport, that there is a link directing to information for people with a mobility problem. Preferably with small videos to show how easy it actually is. Casper made similar videos with GVB as example (GVB, 2019).

There is no general source/guide for people with disabilities, on how to deal with their disability and what resources are available to them. Cliëntenbelang is a place for these people to ask any questions, but most of them don't know about Cliëntenbelang and what it can do for them.

Design of stop

Casper has been in situations where a temporary stop was used. He didn't encounter any problems. As long if there is a ramp and if the stop is at the right height, or the busses/trams have a wheelchair ramp, it should be usable. It is also important to include the facilities for people with other disabilities. When shown the pictures of current temporary stops, he didn't think it as that bad. 1m10 is an acceptable width to move around. At the picture of the Rijksmuseum stop he noticed that stop is too low. In that case the conductor needs to retract the wheelchair ramp. The ramp inside the tram at the Rijksmuseum is a manual one.

Boarding is an important factor to take into consideration. Bus and tram doors should not end up in front of an ABRI, tree, trashcan or any other obstruction. There should be enough space in front of the doors for a wheelchair user to maneuver around. The boarding should be as level as possible. The maximum distance is 5 cm of levelness, but 1 to 3 cm is more preferred. Then both electrical and manual wheelchair users are able to get inside without much trouble. Also it should be taken into account the doors are still able to open to the outside

Some bus stops only have a ramp on one side. This is frustrating when you are coming from the other side. A stop should be reachable from both sides. An example is Amstel station. The ramp is almost always at the opposite side of where the bus/tram stops. When it is busy, Casper needs to pass through the mass at the stop to reach the vehicle. Sometimes people refuse to move aside for him.

At the new tram line in Utrecht there are wheelchair markings at the stop, indicating the exact location where wheelchair users can board. This works great and makes boarding a lot easier. Amsterdam also has some markings, but in practice the vehicles mostly do not align with the markings. This is dependent on the driver.

TAKEAWAYS

- Autonomy and self-reliance is very important for people with disabilities.
- People with disabilities need reliable and up to date information about accessibility and changes before and during their journey.
- The accessibility of a stop is also influenced on how accessible the environment beyond the stop is.
- Dependency on assistance is not preferred, as assistance is not always provided reliably.
- Designs that prevent cyclists from entering, can negatively impact the experience of wheelchair users.
- When designing for wheelchair users, keep race-wheelchairs in mind. These have smaller skate-board like wheels.
- Many people with disabilities are not aware they are able to use public transport.
- There should be enough maneuver space in front of a bus or trams doors.
- Having the vehicles entrance level with the platform is a great help. It should preferably be level within 1 to 3 cm.
- Wheelchair entrances of the stop should preferably at both sides.
- Indications of boarding entrances are very helpful.

A20. Conference: Bereikbaarheid voor Iedereen

On the 6th of March of 2023, I went to the conference “Bereikbaarheid Voor Iedereen” in Amersfoort. The focus of this conferences was mobility for everyone in the Netherlands. in this conference many experts and public transport users had a chance to talk about their work or experience.

Tim, an MBO student and wheelchair user, told his story about his use with public transport. According to him, the wheelchair entrances of public transport are often unpredictable. He also had trouble finding a good place to sit during rush hours.

According to Vivianne Heijnen, State Secretary for Infrastructure and Water Management, mobility is a human right. When people are secluded from public transport it increase the chance of isolation and loneliness.

Intermission: Public transport is not as reliable for people with disabilities than as for people without.

Bianca is a wheelchair user because of the chronical pains she has. When she has an appointment she needs to do a lot of planning to make use of public transport. Things like, which facilities are offered and if there are any defects, is not always as clear, making planning difficult to her. Bianca indicates that high bus platforms are important. In Barcelona basic Stelcon plates are being used, there are already very effective. A gap between the bus and the platform can lead to some trouble. This is also a problem for people with visual impairments and people with dementia.

Jeroen Bastiaanssen is a researcher in transport. He speaks about transport-poverty. When there is no public transport available, people with no alternative transport are secluded from work, facilities and social connections.

FIGURE 20-1 Impression of the conference.

Not everyone is able to use a bicycle. According to Melanie van de Horst, chair of Vervoerregio Amsterdam, 25% of gen z is not able to use a bicycle. In Amsterdam, many are afraid to use a bicycle. To help people make use of public transportation in Amsterdam, there is an OV-coach project. An OV coach guides people on how they can travel with public transport. More than 70% of these people use public transport on their own after the guidance. More than half of the residents of Amsterdam do not have a car. For elderly to be able to use public transport, the maximum range of a stop/station should not be more than 500m.

Someone from the audience tells that they have trouble using digital services, which is often used for solutions. They also say that it would be better to remove barriers than teach people to move around them.

Roy Geers, alderman of the municipality of den Bosch, tells that their residents are not aware on some public transport possibilities. Den Bosch tries to make people aware via a brochure, website, a telephone support line and a support desk. Thanks to the support services people have been asking more questions.

Ms Knolle is an elderly person who likes to go to the Mobility café. The Mobility café is an initiative by the Ouderenfonds, it is an event where multiple stakeholders sit together to map problems that elderly encounter during transport, and if possible think of solutions to these problems.

TAKEAWAYS

- Predictability in public transport is important for travelers with disabilities.
- Reducing the gap between vehicle and platform is a big help for people with disabilities.
- Lack of public transport leads to isolation and decreases opportunities for a group of people.
- The maximum range of a stop should be 500m.
- People are not aware of all the facilities that are being offered.
- Digital services do not reach everyone.

A21. Meeting with Vervoerregio Amsterdam

On the 21st of February me and the Stadsingenieurs had a meeting with Vervoerregio Amsterdam. There we had a meeting about the temporary stop project and about Vervoerregio Amsterdam being a potential client.

I gave a presentation where I explained what we are doing, what we find important in our future design and why. The presentation started with an introduction to the problem/opportunity. It showed a animation of our vision of a temporary stop, followed by images of current temporary stops and some of its unintended uses. From there the initial design brief was shown, with 8 focus points. Lastly an drawing was added of a possible solution.

The 8 focus points that are up for discussion are:

- Accesibility
- Maintenance
- Installation
- Sustainability
- Durability
- Reachability
- Traveler Experience
- Implementation in surrounding area

Vervoerregio Amsterdam is interested in investing in this project, but does want to know the business case of the product first. The people of Vervoerregio Amsterdam liked and agreed with the focus points set up in the presentation. One addition they wanted to be included was the physical safety.

Additional tips were to make decisions based on available material, check about APV exemptions for battery equipment and to discuss the design with Verkeer en Openbare Ruimte and with the Puccini test agency.

FIGURE 22-1 Stadsingenieurs making models of their ideas.

A22. Creative Session: Ideation

In the first creative session, the Stadsingenieurs took a look at the context around the temporary stop. Even though there was a little bit of time for ideation, it was not the main focus. This session is a continuation of that previous session. With the context set in mind, the Stadsingenieurs will ideate and reflect on their ideas in this session.

The goal of this session is to gain a lot of inspiring ideas to use and to involve the Stadsingenieurs more into the project.

Set-up

Planning

13:00 – Idea generation

Make use of prompts like H2's, Codename cards and challenges.
Start with codename cards, as they are a bit more crazy.

13:50 – Sorting ideas

Let the group cluster the ideas.

14:00 – Choosing ideas

Each person gets two stickers.
One sticker you think would work best.
One sticker you personally really like.

14:05 – Making idea presentation

Split the group into two smaller ones.
Each choose one idea to work out.
They will have tools available like cardboard, paper, pens etc.

14:40 – Presenting

Each of the group will present their idea.

14:50 – Reflection

Ask how they felt how the session went. What could improve.

14:55 – Clean-up

The area is rented for 2 hours. Need to leave it clean afterwards.

Preparation

Materials:

- Post-its
- Small stickers (Can also make from post-its)
- Markers
- A4
- Flipboard
- Crafting supplies
  - Scissors
  - Carton
  - Paper
  - Glue
  - Tape

Location:

- The Gem large meeting room

Participants:

- 5 From Stadsingenieurs

Timeline

Idea Generation

Since the subject is well known by the Stadsingenieurs and in the previous session the context was more defined, I decided to start right away with the idea generation in this session.

To assist the group in the idea generation I gave some prompts for them to continue on. The prompts can be categorized into three groups; Random words, H2's and Challenges. Random words were selected with the help from the game Codenames. Codenames has a stack of cards with each a random word on it. During the session I choose a few of the cards and make a prompt using that card. The H2's generated in the previous session were being used as possible prompts in this session. Lastly, I generated some challenges for people the ideate on. All prompts can be found in the appendix.

To let the group know that crazy ideas are allowed, I started with some Codename prompts as a warm up. Later I used a mix of H2's and challenges.

The idea generation went different than I expected. The table was too big, making it difficult for people to interact with each other, even when putting them closer together. This also made it so that the people at the ends were more secluded from the group. By asking them specific questions I tried to bring them back into the group.

Sorting and Choosing Ideas

Because the interaction between each other was less than expected, I decided to let people put their ideas on a whiteboard and take a look at each other's ideas and see if they find something interesting. From there on out I let them chose which ideas they want to continue on.

Making Model

For this phase the group was split into two. I joined one of the groups to make the amount of people even. With the help of various crafting supplies the groups were able to make a model based on their ideas.

One of the groups was very enthusiastic and even brought in their own material for the model. The other group had more trouble to get a concrete presentable product.

Results

In the session many different ideas were generated. Afterwards I've categorized them by subject. The ideas were either used for the concepts or as inspiration for later ideation.

The Stadsingenieurs ended up with a nice presentable model of a potential stop.

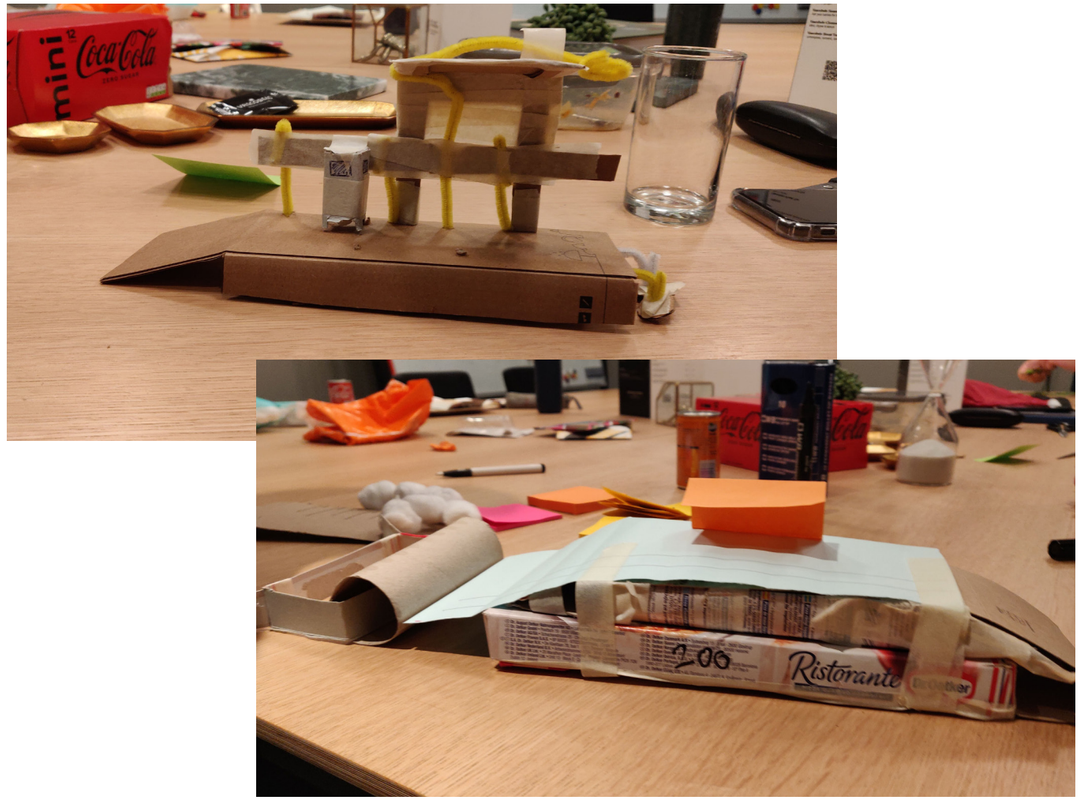
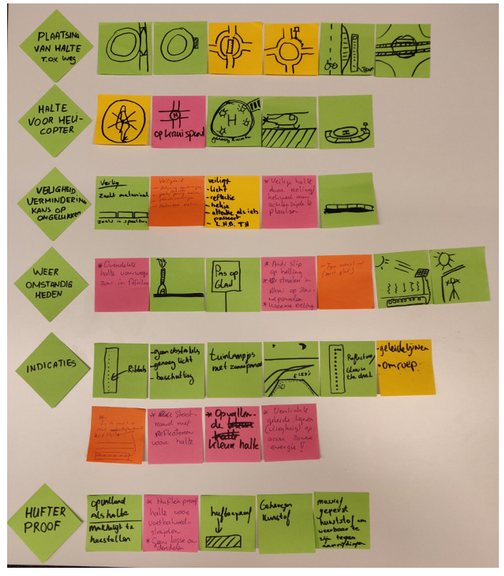


FIGURE 22-2 Models made by the Stadsingenieurs



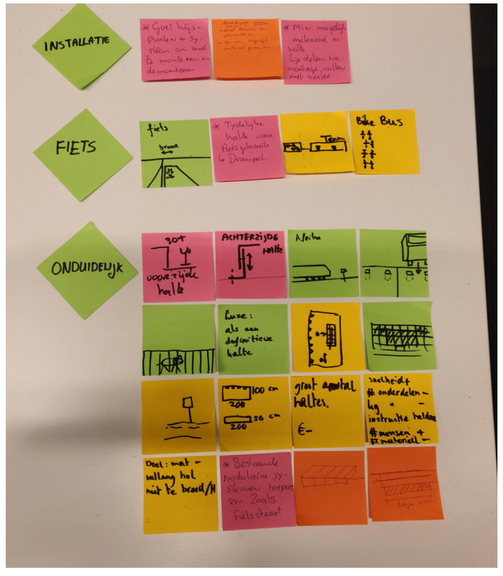


FIGURE 22-3 Ideas generated by the Stadsingenieurs.

A23. Concept Descriptions

Line Cyan

Cityscape Lighting

The bus/tram-stop's fence functions as a source of uniform lighting. It also adds some extra decoration to the stop. The panels are made of a transparent material, with an opaque light diffusing layer in the shape of a cityscape. Via an LED strip on the bottom of the panel, the light will travel through the opaque layer, creating an enlightened cityscape. Displaying different art than cityscapes is also a possibility.

Drawing with Light

With a touch to the fence, the color of that part of the fence-LED will change. This way the traveler can leave their mark to the stop without being destructive or inappropriate.

Sign at Old Location

To ensure travelers are able to find the location, as sign redirecting to the new location is placed at the former location. Additionally, floor markers are installed, directing to the new location.

LED Display

Just like the current bus/tram-stops, travel information is displayed via an LED screen. This element will also have a speaker to announce travel information, which can be activated by a press of a button.

Tram/Bus Indicator on Ramp

The ramp will have a visual indicating that people are entering a bus/tram-stop. This can be in the form of a logo or text showing "Tram" or "Bus". The purpose is to prevent unintended users like bicyclists from entering the stop, while also increasing visibility of the stop for users to find.

Visible Repairs

A tram/bus-stop gets often damaged due to unintended use. When repairing the stop, instead of masking the repair job, the repair job will be made intentionally visible. Similarly to 'Kintsugi', a Japanese tradition where porcelain is mended with golden adhesive. The visibility of the past damage should raise awareness to the travelers that the stop is not indestructible.

Discard Waste in the Floor

Waste deposits are build flush into the floor. Whenever the traveler wants to discard their waste, they can place their foot on a pedal to open the deposit. By placing the waste deposit under the floor, it allows the deposit to be bigger than usual, which reduces the frequency needed to empty the deposit.

Fence Construction

The fence consists of pillars, panels and top bars. The pillars are attached to the platform, similar to other furniture. Each pillar has slits where the panel can slide into. To secure the panels in place, a bar is screwed on top of the pillars. The bottom of the panels has an LED-strip. The LED-strips are connected to each other through the pillars. ABRI's have a similar construction as the fences.

Solar Roof

Energy is gained via a solar panel on top of the ABRI's roof. Excess energy is stored in a battery under the bench. The battery can be accessed for maintenance or replacement.

Floor Roll

The platform floor is of one length consisting of smaller panels of full width attached to long flexible strips. It can be stored by rolling up. Installation can be done quickly and conveniently by rolling out.

Surface Material

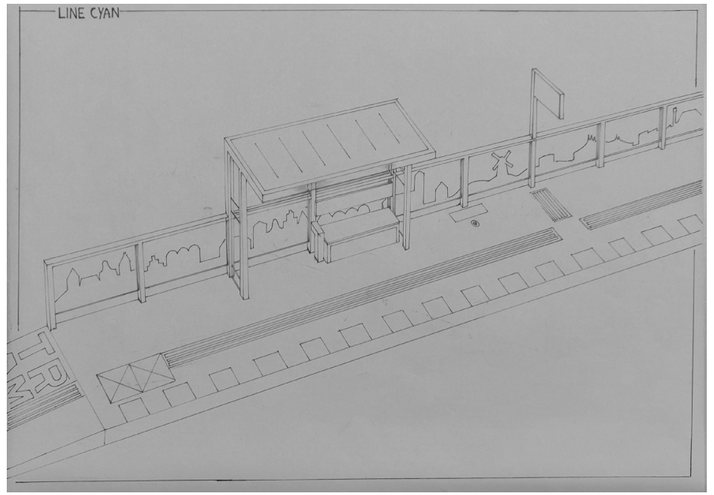
The surface of the platform is made of porous material. During rain the porous material acts as drainage. The floor also has an extra texture to create more friction, preventing people from slipping.

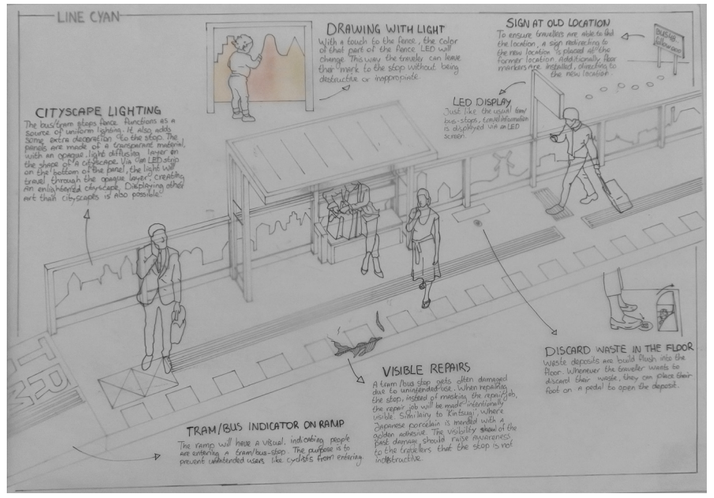
Adjustable Feet

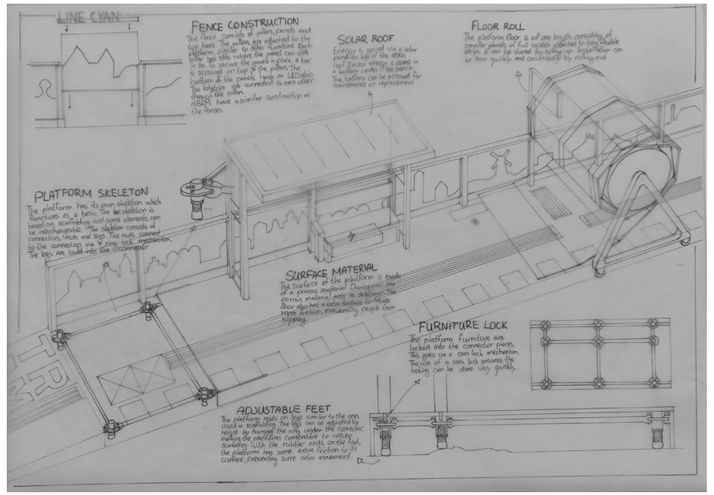
The platform rests on legs similar to the ones used in scaffolding. The legs can be adjusted by height by turning the ring under the connector, making the platform compatible to uneven surfaces. With the rubber ends on the feet, the platform has some extra friction to its surface, preventing some unwanted movements.

Furniture Lock

The platform furniture are locked into the connector pieces. This goes via a cam lock mechanism. The use of a cam lock ensures the locking can be done very quickly.







Line Magenta

Corner Barriers

To prevent bicyclists from using the platform as an extension of the road, a corner barrier is placed at the entrance of the platform. All other users including wheelchair users should still be able to access the platform from the sidewalk.

Temporary Garden

Plater boxes are installed on top of the fences. This is to add a temporary garden for the neighborhood to enjoy, to add some greenery into urban environments and to add a cozy and safe atmosphere to the stop.

E-Ink Information Display

Travel information will be displayed on a low energy e-ink display. The installation will include a small solar panel to power itself and a speaker which announces information at a press of a button.

Temporary Stop Color

To distinguish the stop from other paving, the stop will have a specific and contrasting color. This helps people to identify the tram/bus-stop and to increase its recognizability in its environment.

Illuminating Markings

If there is enough energy available, the safety markings will emit light. This will give an uniform light across the platform and it increases the visual contrast of the markings.

App Guidance

Navigation apps and applicable apps, people with disabilities use, will be able to access an API which sends updates about the location and other important information/changes about the temporary stop.

Installation

For easy access, the platform lays first on its side. The installer can make use of holders to keep it into place. The first step is to connect the metal frames to each other. Afterwards, the waterbed and supporting legs are attached.

When the waterbed and legs are connected, the platform will be turned into its correct position. From this position the pipelines and platform tiles are placed. The waterbed will be filled with water in this moment.

Furniture Placement

Between platform tiles there are slots for furniture and fence posts to slide in. The furniture and fence posts are attached o beams of the width of the platform. With the use of the butterfly mechanism the beams can be inserted, but are difficult to remove the intended way.

Fence Placement

The fence can slide into place via fence posts. The planters are placed on top. The planters are screwed into the posts from the inside, which also keeps the wall into place.

Solar Heating

To prevent a slippery surface due to ice forming in the winters, the platform can be warmed up. The roof of the ABRI has solar panels which heats up water flowing through the pipelines. The pipelines direct the water to the container within the bench or directly to the platforms surface. The flow of water is powered by a pump under the ABRI bench.

Support Legs

While the waterbed will carry most of the weight on top of the platform, additional support legs are added on the side to ensure stability.

Metal Frame

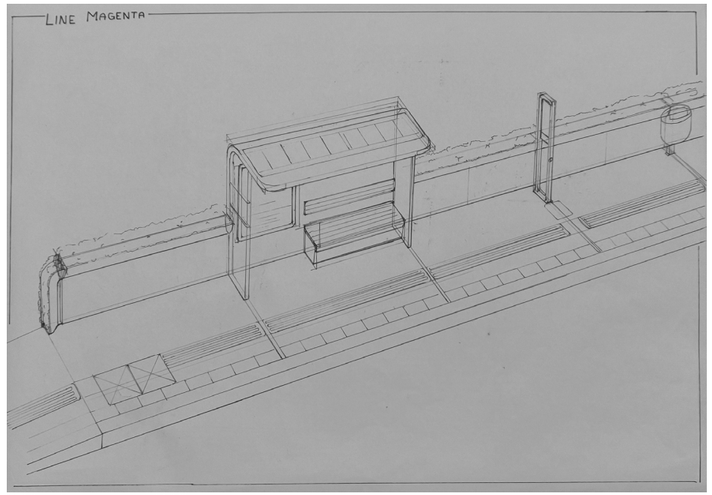
The platform has a metal frame inside. This frame helps to connect all pieces together and keeps the platform in shape.

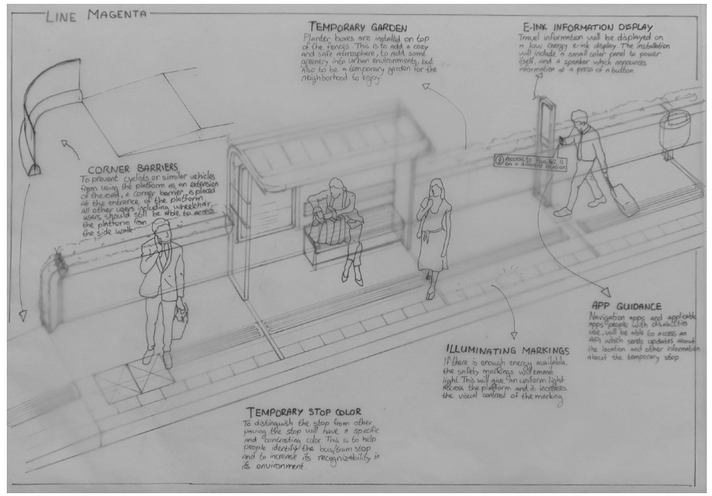
Waterbed

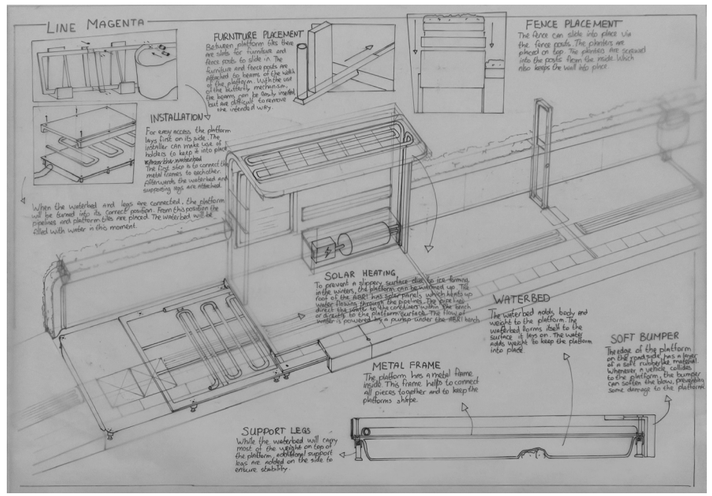
The waterbed adds body and weight to the platform. The waterbed forms itself to the surface it lays on. The water adds weight to keep the platform into place.

Soft Bumper

The edge of the platform on the road side has a layer of a soft rubberlike material. Whenever a vehicle collides to the platform, the bumper can soften the blow, preventing some damage to the platform.







Line Yellow

Cleaning Robot

Whenever the stop is not used, a Roomba-like robot will come out of a department under the bench. The robot will clean the stop

Retractable ABRI Wall

One of the sides of the ABRI is partly retractable. When it is busy or a wheelchair user is nearby, the wall can be opened to provide more space for movement.

On other occasions it will be closed to provide more shelter against weather conditions like wind.

Information Speakers

Speakers are build into the platform. Occasionally they will announce information about the next vehicle. Additionally the speakers will play a soft tune, helping people with visual impairment to identify the new stop.

Floor Light Display

The platform has a singular color light display covering the floor. The display indicates safety markings, it indicates where people can board on the vehicle and the display lets out a splash of light following the people around. This provides the users enough light at the right places. Other optional uses are displaying art, adding game elements or add advertising.

Tactile lines and other tactile indicators are placed on top of the display in a contrasting color. This way they are still able to provide the tactile feedback.

Electronic Compartment

On the outer edge of the platform element is an electronics compartment. In this compartment there is a chipset to control the platform, speakers for the travel information, batteries, a cable compartment and magnets and coils for furniture attachment and connection between platform elements.

Custom Support Block

The support block is custom made to fit the surface it lays on. To get the right fit, a scan of the surface is made with a phone app. With the result of the scan, the support block is milled to the right fit.

Furniture Connection

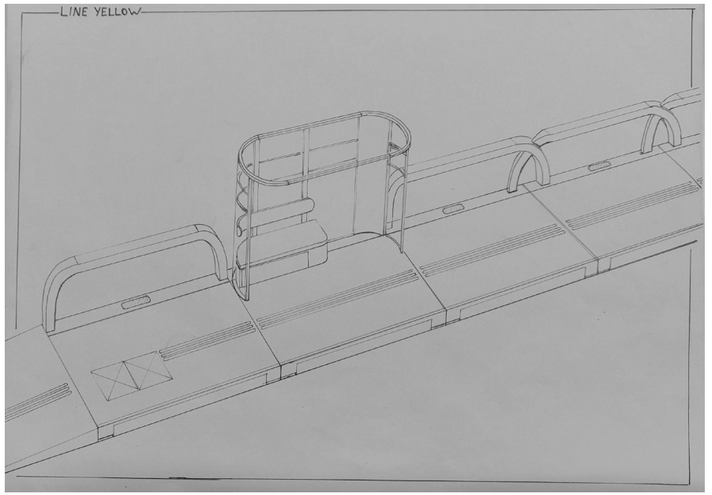
Furniture and fences contain a magnet at the bottom. This lets them connect to the magnetic coil in the platform if the coil is powered. Alignment is done with the help of a dimple/knob pattern. Furniture can easily be removed by depowering.

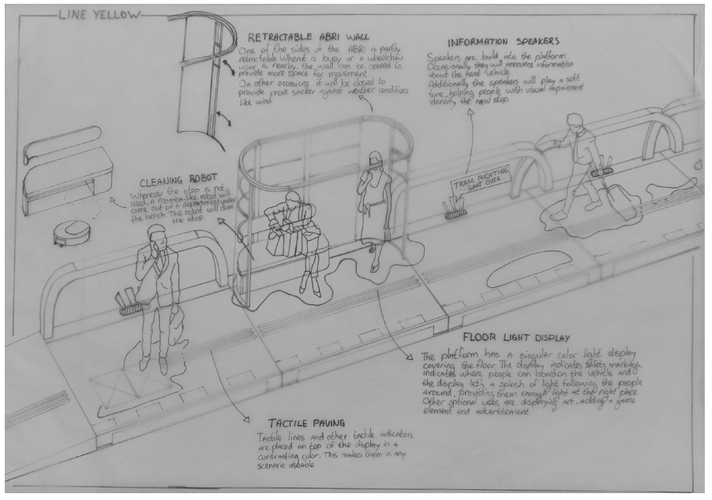
Automatic Wheels

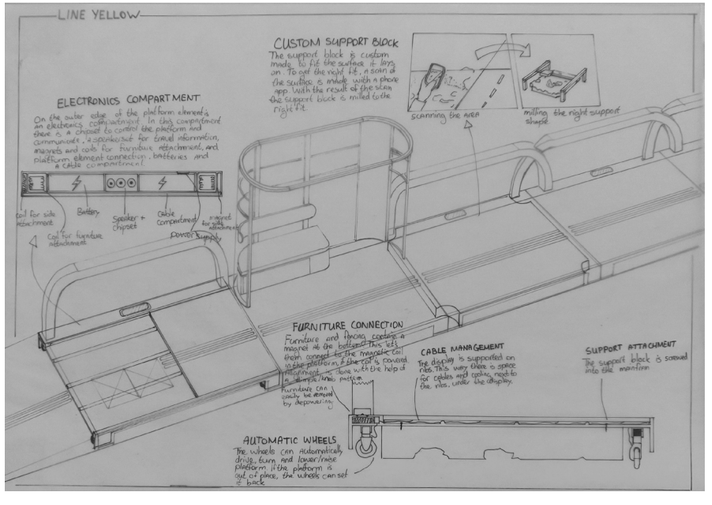
The wheels can automatically drive, turn and lower/raise the platform. If the platform is out of place, the wheels can self-correct the platform to its original position.

Cable Management

The display is supported on ribs. This way there is space for cables and cooling for the display.







A24. Feedback Stadsingenieurs

Additional Ideas / Remarks

Ideas

During the feedback the Stadsingenieurs came with a few ideas. The first one was a misconception of one of the drawings. The idea is to be able to change the height of the platform legs in Magenta and Cyan from the top, when the floor plates are already placed.

The Stadsingenieurs really liked the idea of modular sections as it makes it easier to make adjustments or reparations. A possible connection between these sections was a zigzag connection. In the middle of the connection would be a pin to secure it. Another idea to make optimal use of the modular sections is to place all the complex parts into one section. An example was to attach the DRIS and wastebin to the ABRI.

To reduce weight of the platform, the Stadsingenieurs thought about using plastic like PVC as material. A downside might be extra slip due to rain. This could be prevented with different textures or coating.

At the magenta idea, the bicycles are being redirected via a corner piece. It is also possible to redirect busses. This can be done by installing ribs on the floor. These give enough feedback for the driver to adjust their vehicle to the correct position.

Remarks

At two of the concepts light is casted from the bottom. The Stadsingenieurs were wondering if the lights still have effect from that position. There might be in need of an additional top view light source, possibly from the ABRI.

The Stadsingenieurs want to know more about storage possibilities and how it will be done for the temporary stop. The concepts had some ideas for it, but not on a detailed level.

At some construction areas, art is already being displayed. An example is the bridges at Oranjeloper.

Magenta

The waterbed has some technical concerns according to the Stadsingenieurs. Because the different kinds of deformities of the surface, the waterbed needs to adjust. Resulting the waterbed having excess space when placed on flat surfaces. After considering the possibilities, this should not result into the expected problem, the waterbag might need more water to reach the desired level. However, the variable water levels require more careful planning getting the platform to the right height during installation.

In the concept the waterbed has the size of the full length of the platform. This is a considerable size taking 30 to 60 meters. With that size, the waterbed can get too heavy, even without water.

When deinstalling the water of the waterbed needs to be drained out. One concern were the water will flow into. There is plenty of places to drain water to, as most places in the Netherlands is designed to redirect excess water to the right places. There might be some rare cases were this causes issues. It is good to think how the water can be taken out in these cases.

The final concern is for when the platform is installed on a sloping surface like a bridge. The water will flow with gravity towards the bottom, resulting into the platform not being perpendicular of the surface. This will cause problems during boarding as the bus or tram entrance is perpendicular to the surface.

Despite these issues, the Stadsingenieurs liked to idea of using water. Using the water is an easy way to create extra weight to keep the platform into place. A suggested adjustment was to split the reservoir into multiple compartments. This will remove the weight problem and it would reduce the slope issue. Another suggestion leave out the function of being an object for the platform to rest on to, by turning the waterbed into a water compartment.

The rubber bumper was an element the Stadsingenieurs would love to see on any stop. One of the Stadsingenieurs had a concern about the wear and tear of the rubber and if the material would be able to stay connected to the other elements.

The heated floor seemed a bit unnecessary by the Stadsingenieurs. A possible cheaper alternative would be to make use of an electric mat instead of a water system. This would still be considered too much for a temporary stop. It would be something to consider for a permanent stop though.

Issues:

- Water bed without water is heavy due to its size.
- Slopes changes water distribution affecting the angle of the platform.
- Deformities in surface require different amount of water to reach the right height.
- When deinstalling there needs to be facilities ready to drain the water out.
- Rubber can wear and tear when combined with different material.
- Heated floor is too situational.

Suggestions:

- Split waterbed into multiple sections.
- Turn waterbed into a water compartment only used to add extra weight.

Likes:

- Use water to add extra weight to the build.
- Using a rubber bumper to prevent some damages.

Cyan

According to the Stadsingenieurs the concept is missing weight for it to be secured enough into place. Rubber ends at the legs are not enough to compensate for it. A solution is to drill the platform to the surface. However, this will leave damage to the environment. The Stadsingenieurs prefer to keep the road intact.

The use of existing scaffolding elements is something the Stadsingenieurs liked. Especially because the costs can be reduced by reducing the amount of custom parts.

With the waste bin, the Stadsingenieurs were wondering how it would be cleaned out or maintained. It would seem like a more difficult task than a normal bin.

The cityscape light panels were seen as a nice addition to the stop. To make the installation a bit easier, the illustrations should on each panel, start and end on the same height. Then the panels won't have to be installed at the right order.

The Stadsingenieurs were not sold on the roll idea. They were wondering if it would be able to last over time, specifically when sand or dust enters the cavities. The construction also looked very heavy and clunky.

Closing of the sides of the platform is difficult to do with uneven surfaces. One idea of the Stadsingenieurs was to be able to create adjustable side platform panels by letting them shove in and out with gravity.

Issues:

- Platform is not fixed secure enough to the surface.
- Maintenance of waste bin seems difficult to perform.
- Floor roll seems to heavy, clunky and prone to defects.

Suggestions:

- Have a fixed height at the ends of the panel illustrations.
- Change the side panels of the platform that they can fall down to the right height.

Likes:

- The cityscape fencing.
- Using existing elements in the design.

Yellow

The concept was seen as being on the expensive side, considering the energy usage and custom parts. The screens use a lot of energy, which besides the costs also require a permanent energy source. This is not always available. The custom mill-able block seemed like an expensive and unsustainable option. Other options were to make use 3D printing were a honeycomb structure can be used to reduce material, or to make use of sand instead.

Despite the costs, they thought a concept like this would fit well into some popular areas for tourists. An example given was the Rembrandtplein in Amsterdam.

The screen surface might be able to remove contrast of the tactile paving. The light should not overlap with the tactile paving to prevent this.

People would prefer to see travel information than hear them through speakers. People are able to retrieve information much quicker and at their own pace, if the information is displayed visually. Headphone users and people with hearing impairment would also be impacted negatively.

Due to the moving parts of the retractable door, there were concerns if it would be prone to technical difficulties.

The use of magnets were seen as an interesting potential solution. An issue was to maintain the connection, the coils needs to stay powered at all time. Instead of using the coils, the Stadsingenieurs were wondering if magnets could be used on both sides, were a barrier can close or open the connection. The Stadsingenieurs also wanted to know if the magnets can create a connection that is strong enough.

Issues:

- Concept seems expensive.
- Requires a permanent energy source.
- Custom mill-able block is a waste for a temporary stop.
- Light can remove contrast of the tactile paving.
- Information through speakers is not convenient to most users.
- Retractable door is prone to defects.
- Unclear if the magnet connection is strong enough.

Suggestions:

- Instead of powering coils, make an on/off connection between two magnets.

Likes:

- The stop would fit well in areas with a lot of tourists.
- Screens are a new selling point.

A25. Concepts Review

Cyan

Accessibility

The waste bin is flush with the floor when closed. This creates some extra maneuver space at the stop, which benefits wheelchair users. Though with the foot pedal, making use of the wastebin might be a challenge for wheelchair users.

The measurements used for the tram/bus-stop are according to the current guidelines set by Amsterdam. These measurements ensures wheelchair users still have enough space to maneuver around. The platform will be at the same height as the vehicles stopping at the stop, for ease of access for people with a mobility or visual impairment. The concept will include a ramp for wheelchair users to reach those heights.

The stop includes an ABRI with a bench for people to rest to. The compartment under the bench makes it more difficult to stand up, as the feet can't be put back much to stand up via the legs.

The whole stop will be lighted uniformly with the use of the cityscape fencing. Increasing visibility for people with visual impairment when it is dark outside.

Across the stop will be tactile paving to guide people with visual impairment. The stop will also have an anti-slip floor preventing guidance dogs from tripping and keeping them focused on their job.

The LED screen is similar to current information displays, following the guidelines already set into place. LED panels are able to visualize information in good contrast, increasing the readability of important information. For people who are not able to read the information on the display, there is the option to let a speaker announce the information with a press of a button.

A change of stop can be stressful to some people. To make them feel at ease there are some ways to guide them to the right place. At the old location of the stop will be a sign redirecting the traveler to the new location. The traveler can follow a path on the floor marked by a trial of stickers. There will also be a tram or bus indication on the ramp, to increase the visibility of the stop from a distance. These options are only visual indications.

Maintenance

The stop will need regular visitation for maintenance. On a regular basis a cleaning person will have to visit it to empty the waste bin and clean up the rest of the stop. Under the floor is plenty of space for a bigger container for waste than usual. This can reduce the needed cleaning frequency. The fences and ABRI walls are raised a little so any litter can flow through instead of piling up.

The battery can be reached by opening the compartment inside the bench. The compartment can only be opened with a key owned by the mechanic. The battery should be easily replaceable from there on.

Whenever there is damage to the stop, visible repairs are made to the stop. This might require some extra planning and preparation at first.

Installation / Deinstallation

The skeleton of the platform is made from existing mechanics seen in scaffolding. This makes it easy and quick to install without much need for extra training. The ring lock connection will make it a bit more difficult to deinstall. This is because there is not much space under the skeleton to hammer the locks out. Similarly to scaffolding, the legs can be adjusted in height by screwing a ring to the right position.

The floor is placed by rolling out over the stop in one go. The process should be done very quickly. Due to the size of the stop, the complete roll might be very heavy.

Furniture are rooted inside the skeletons legs. In here they can be locked via a cam lock mechanism. This method is very quick and easy to do and adds the possibility to make use of custom keys. The position of the cam lock might make the installation uncomfortable to perform.

The fence and ABRI are done very quickly by shoving in the elements. If the visual on the panels end at the same height, there is no need to take the panel order into consideration.

Sustainability

The platform uses the electricity generated from its solar panel roof. Excess energy will be stored in a battery, so the platform will no run out of energy when the panels are not generating electricity. While the energy usage during its use is very sustainable, it will need components like batteries and solar panels to provide them.

Some parts, especially in the skeleton, are already used in other constructions. This gives the possibility to reuse parts from different constructions. But even when the parts are bought new, there is no need to make new molds.

Durability

Repairs made to the stop are made in such a way they are visible. Visible repairs should raise awareness to the people around, that the stop is not indestructible. That awareness could reduce the amount of damages to the stop over time.

To keep water from flooding the floor, water is being drained through the porous floor.

Traveler Experience

The cityscape lighted fence adds a form of art to the stop. By either looking or interacting with the fence, the traveler has a way to ease the pain of waiting for a bit. The interaction also gives the user a way to leave their mark to the stop, giving them some feeling of control.

The stop will contain an Abri with bench. The Abri provides shelter from weather. The bench provides a place to rest.

To display travel information an LED panel similarly to current DRIS systems is used. This visualizes clearly the information and travelers are familiar to the system.

With the sign at old location and guidance trial, the traveler is directed to the new stop. This should make the switch up more convenient.

Instead of a throwing waste into a normal bin, travelers will throw it into a deposit in the floor. The change should be minimal, but if used, should be tested to be sure.

Implementation in Surrounding Area

The platform stays into place due to the rubber feet. The rubber adds extra friction between the feet and the surface to prevent movement. This prevents the need for drilling into the ground.

With the use of solar panels, the platform is not dependent on a connection to the electricity network. If the area is able to facilitate such connection, the platform can be connected to use the network as a backup.

With the Cityscape fence, the stop creates a connection between the stop and the city it is placed in. It can also act as a piece of art for the neighborhood to enjoy.

Safety

Bicyclists driving on tram/bus-stops can cause dangerous situations. To prevent it, a tram or bus visual is placed on the ramp. This should differentiate the stop clearly from the road.

To separate the travelers from other traffic, fences are placed at the end of the stop. This also prevents them from falling because of platform height difference in comparison to the surface. For separation of the travelers from the trams, the usual safety markings are used.

To prevent people from falling on the platform, a floor is used with more friction. During winter the surface needs to be salted to prevent ice forming.

Transparent panels and uniform lighting are able to facilitate better natural surveillance, keeping the travelers feel more safe. The use of art should make the travelers feel more comfortable as well.

Magenta

Accessibility

The measurements used for the tram/bus-stop are according to the current guidelines set by Amsterdam. These measurements ensures wheelchair users still have enough space to maneuver around. The platform will be at the same height as the vehicles stopping at the stop, for ease of access for people with a mobility or visual impairment. The concept will include a ramp for wheelchair users to reach those heights.

The stop includes an ABRI with a bench for people to rest to. The compartment under the bench makes it more difficult to stand up, as the feet can't be put back much to stand up via the legs.

With the use of illuminating safety markings, the stop will be lighted uniformly. This will increase the visibility of the stop for people with visual impairment for when it is dark. It also adds an extra contrast to the safety markings, therefor increasing its visibility for people with visual impairment. One thing to look into is the direction of the light. It is cast from the bottom instead of the top, this might cause the lighting to be a bit less efficient.

Across the stop will be tactile paving to guide people with visual impairment.

The color of the stop will be of a distinct color from its environment. This will increase the visibility of the stop for people with visual impairment. The distinct color will also increases the recognizability at a quick glance for all travelers, making it easier to find for people who have difficulties adapting to new situations.

Additionally with the use of an API system for apps, people with disabilities are able to prepare better for their travels and are not met with any unwanted surprises on their way.

Maintenance

The stop will need regular cleaning maintenance. The waste bin is similar to bins used at normal stops, therefor the cleaning process does not have to change for the temporary stop.

Under the bench is a compartment with the pump, battery and water reservoir for the heating. The compartment can be reached with a key owned by the mechanic. If necessary, the mechanic can replace or maintain the parts.

Most of the repairing can be done easily as elements like the floor and bumper consists of multiple sections. The damaged section can be removed and replaced.

The plants needs to be maintained once every two weeks.

During cold winter days, there is no need to salt the surface to prevent ice forming. The heated floor is able to take over this task.

Installation / Deinstallation

The parts of the installation are of lightweight, to increase the ergonomics and speed to set it up. With the use of the metal frames at the start, the platform has a structure early on in the process. The parts are screwed into each other, which is a familiar process to the installer. With the use of water, the weight is added to the platform at the end of the process. The water also automatically let the platform adjust to the shape of the surface it lays on. The water can be transferred via a mobile water tank, requiring minimal effort. During deinstallation the water can be drained out to a nearby drainage system. Because the platform is very long, some lightweight parts might get heavy due to their size. These parts include the water bag and metal frame when connected. This might increase the difficulty of assembling.

Furniture and fence posts are connected to beams which can be shoved into the platform. The furniture is already placed into the beams, which saving time on location. It will require space behind the stop to align the beam.
The fence panels are shoved into the posts afterwards. Over these panels the planters are screwed into the fence posts, setting the panels in place as well.

Sustainability

With the temporary garden, plant life is being added to urban environments. This adds a place for insects to thrive. The plants also contribute to cleaning the air.

Solar energy is being used to heat the floor during cold times, requiring no additional energy. However, it will need components like solar panels, pump, battery and reservoir to provide the heated floor.

The information panel uses minimal amount of energy with its e-ink display. It will have its own solar panels to provide the energy.

Durability
The bumper is placed to soften collisions with the platform, reducing the amount of damage the platform takes. If any damage happens, the floor and bumper consists of multiple panels. The damaged panel can be replaced without having to adjust the other panels.

By making the platform slightly slanted, rainwater is redirected towards the road. Preventing pools forming on the platform.

Traveler Experience
With the use of plants on fences, a temporary garden is created for travelers to enjoy. The garden should add a cozy atmosphere and over time, travelers are able to perceive new growth.

With the use of the safety marking lights, the stop is always well lighted. Which increases everyone's visibility when it is dark.

The stop will contain an Abri with bench. The Abri provides shelter from weather. The bench provides a place to rest.

For up to date travel information is an e-ink information display placed. The display will be able to show basic information, but not as detailed as the usual displays. For more detailed information, people can consult their favorite navigation app. The apps can access specific APIs to get real time information of the stop and any location changes due to the temporary stop placement.

The discarding waste process will be very familiar for the traveler. In this concept, the usual waste bin is being used.

Implementation in Surrounding Area
With the weight of the waterbed, the platform will not be able to moved easily. This removes the need to drill the platform into the surface, preventing any damage. The waterbed is dependent on a nearby drainage system to drain itself out during disassembling. In the Netherlands, this should not cause a problem.

The stop will have a contrasting color from its surroundings. This will increase the visibility of it. It might be seen as unpleasing to the neighborhood. The garden however, will improve the scenery. It is visually pleasing for the neighborhood, but it will also improve its natural ecosystem, especially in urban environments.

The stop uses solar energy. The solar energy is mostly used for the heating of the floor, meaning that for the lighting the stop is preferably connected to the electricity net. This is not always provided by the surrounding area, or difficult to organize.

Safety
The stop is always prepared for the cold winter days with its heated floor. The heated floor prevents the forming of ice, which prevents any accidents due to ice.

On temporary stops, it can happen that bicyclists start to ride on it. This can cause dangerous situations, especially during boarding. To stop bicyclists and other unintended traffic from entering the stop, a physical corner barrier is placed. This blocks the entrance for bicyclists, while travelers are still able to access via the sidewalk. To separate the travelers from other traffic, fences are placed at the end of the stop. This also prevents them from falling because of platform height difference in comparison to the surface. For separation of the travelers from the trams, the usual safety markings are used.

The safety markings will have extra contrast for travelers to see, due to them casting light as well. The light also helps to facilitate a better natural surveillance, keeping the travelers feel more safe. The use of the temporary garden should make the travelers feel more comfortable as well.

Yellow
Accessibility
The measurements used for the tram/bus-stop are according to the current guidelines set by Amsterdam. These measurements ensures wheelchair users still have enough space to maneuver around. The platform will be at the same height as the vehicles stopping at the stop, for ease of access for people with a mobility or visual impairment. The concept will include a ramp for wheelchair users to reach those heights.

The stop includes an ABRI with a bench for people to rest to. The compartment under the bench makes it more difficult to stand up, as the feet can't be put back much to stand up via the legs. The ABRI wall is retractable, allowing wheelchair users to maneuver more easily through the platform, and letting them be able to make use of the ABRI. The retractable wall is opened automatically when a wheelchair user is in sight according to its sensors.

The stop will be lighted with the use of the lighted floor. Travelers, boarding areas and abris, will have more light surrounding them. The extra emphasis helps people with visual impairment to see and identify the important elements in a stop. This will be at a cost of more uniform light.

Tactile paving is placed on top of the light display, to still give the tactile feedback. For the paving to work optimally, the light should avoid the paving as much as possible. This will ensure the contrast in color of the lines.

Travel information is conveyed by announcing it through speakers at certain intervals. Allowing people with visual impairment to be up to date with their travels. Additionally the speakers will emit a soft tune for people to identify the stop. While it will enhance the experience for people with a visual impairment, it will leave out people with a hearing impairment.

Maintenance
The stop will be cleaned with a Roomba-like robot. Robot needs to be emptied on a regular basis. To prevent unnecessary visits, the robot is able to communicate how full its container is. The fences are raised so any litter can flow through instead of piling up.

Whenever there is damage, a section can be replaced with a new section. The damaged section can be repaired at the warehouse.

Installation / Deinstallation
With this concept the goal is to do as few work as possible at the location. To make the platform match to the surface area, the platform contains a custom support block. To create the support block, a scan of the area is made first. This will be done via a phone app. With that scan, the support block will be milled to a shape, fitting the area. Creating the support block will take more time than adjusting the platform on location, but it will save time at the location. Once the support block is made, it can be attached to the rest of the platform.

From there on the platform sections can be loaded on the carrier. They can drive on it by themselves or be carried into it. The same goes with the unloading. At the location, each platform section is able to move to their designated location and put themselves into place. The sections will be connected to each other via a magnet to spool connection. This connection can be powered on and off automatically depending on the occasion.

The fences and abri are also connected via a magnet to spool connection to the platform. To align them correctly into place with the platform, there is a dimple/knob pattern on both the furniture and platform. The whole process on site requires minimal physical effort and can be done very quickly.

Sustainability
This concept requires energy from the electricity net to work. The energy required is also more than the other concepts. Making the carbon footprint much higher.

The custom support blocks are not reusable and need to be remade every time.

The floor display can be used to convey messages related to sustainability.

Durability
When a collision happens, each platform section is able to self-correct them back to their original place. When there is actual damage, only the damaged section needs to be replaced.

By making the platform slightly slanted, rainwater is redirected towards the road. Preventing pools forming on the platform.

Traveler Experience
The floor light display creates a display of art for travelers to enjoy. It follows the traveler around to give the traveler a sense of control. Interacting with the installation is a way to reduce the pain of waiting. It enlightens the stop when it is dark. And it can provide information like boarding indications.

Besides the boarding indications on the floor, the traveler is made aware of travel information by the speakers. Downsides of the speakers are they don't give information directly to the traveler and it is not hearable when a traveler wears headphones.

The stop will contain an Abri with bench. The Abri provides shelter from weather. The bench provides a place to rest.

Waste will be cleaned by the Roomba-like robot when it is quiet. This will keep the stop clean, but it does not provide a clear place for travelers to deposit their waste.

Implementation in Surrounding Area
The stop adds a temporary display of art into the area for the neighborhood to enjoy. The display of art is especially beneficial in touristy area.

Due to the use of the self-correcting wheels, the platform does not need to be drilled into the surface, preventing any damage to the surface.

The platform does need to be connected to the electricity net. Meaning that the surrounding area needs to provide the facilities for it. While each section has some batteries, it will not be enough to maintain it for long. They are beneficial when self-adjustment is needed.

Safety
The stop looks more expensive on purpose. It will give a clear separation of the road and indicates that car drivers and bicyclists need to be more careful around it.

To separate the travelers from other traffic, fences are placed at the end of the stop. This also prevents them from falling because of platform height difference in comparison to the surface. For separation of the travelers from the trams, the usual safety markings are used.

Transparent panels and tracking lighting are able to facilitate better natural surveillance, keeping the travelers feel more safe. The use of art should make the travelers feel more comfortable as well.

A26. Bending

To decide material for the plates, I made calculations of the maximum bending of these plates. Formulas are gained from a MIT course video (Gibson, 2016). The calculations were made in Maple. The Maple document can be read at [Appendix A28]. The output were documented in an excel document which can be read at the end of this chapter.

Sandwich material

The crucial part of a plate in bending is the outer sides. In a sandwich construction, the outer sides, also called faces, are of a material more resistant to the bending, while the core of the material is a lighter and/or cheaper material.

Assumptions

The maximum bending happens in the form of a 3 point bend, where the force is applied in the middle (figure 26-1).

The plate is simplified to act as a beam.

The weight of the plate does not have a significant enough impact on the bending.

The maximum bending length is an overestimation.

The normal stress in the face is a constance.

Shear stress does not vary significantly over the width.

Debonding and indentations are not taken into account.

Input

Plate thickness: The thickness of both the core and face material can be adjusted. A thinner plate is more preferable because that would create more space for adjustable legs.

Space between legs: The maximum possible space between legs is used. The dimensions are based on one of the earlier design iterations.

Load weight: The weight on the plate. In the calculations 300kg is used as load.

Plate material: Both the core and face material can be adjusted.

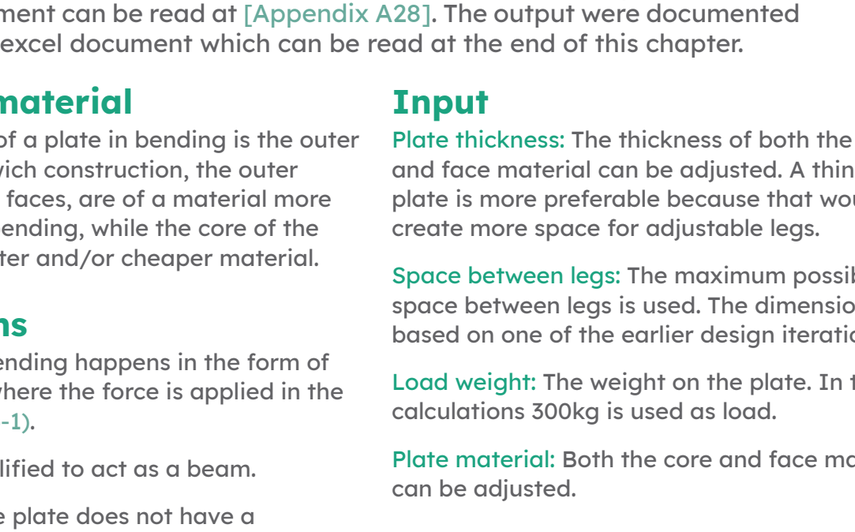


FIGURE 26-1 Free Body Diagram with shear force and bending moment diagrams.

Output

Yield failure

The material will yield when the normal stress is bigger than the materials yield strength. With a sandwich material, the face-material is the most critical element against yielding.

Shear failure

The material will shear when the shear stress is bigger than the materials shear strength. With a sandwich material, the core-material is the most critical element against shearing.

Buckle wrinkle failure

The core and face material can buckle/wrinkle from each other when the buckling stress is smaller than the normal stress in the face-material. The buckling stress is dependent on both the Young's moduli of the core and face materials.

Bending

The maximum deflection is a combination of shear and bend deflection. Bend deflection is mostly dependent on the yield modulus of the face material. Shear deflection is mostly dependent on the shear modulus of the core material. The maximum allowable deflection is 5mm this is based on requirement R1.5.

Weight

Antil slip panels of 1 by 2m are about 13.5kg (Coba Europe, n.d.). The maximum amount a person is allowed to carry according to the Arbowet is 23kg, see also requirement R6.3. This leaves 9.5kg for the sandwich material per panel or 4.25kg per m².

Price

The price will also be part of the outcome, which can be used to decide materials if they pass the other categories.

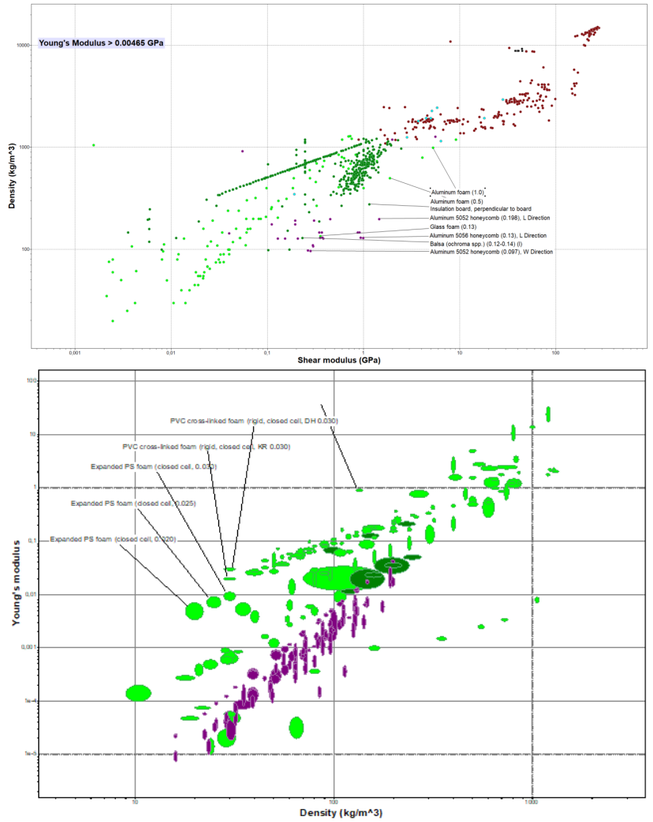


FIGURE 26-2 Material selection via Granta.

Material Selection

Via Granta I made a selection of core and face materials. See (figure 26-2) of some of the selections.

Results

The chosen materials for the plate are PVC cross-linked foam (rigid, closed cell, DH 0.075) for the core and Carbon fibers, very high modulus (5 micron, f) for the faces. The core will be 19.6mm thick, the faces 0.2mm per face. The weight is well within range with 2.23kg/m² and the price is €66.53 per m².

Material Core	Thickness Core[mm]	Material Face	Thickness Face [mm]	Deflection [mm]	Bend Deflection [mm]	Shear Deflection [mm]	Yield Fail	Normal Stress [MPa]	Yield Strength Face [MPa]	Shear Fail	Shear Stress [MPa]	Shear Strength Core [MPa]	Buckle Fail	Normal Stress [MPa]	Buckling Stress [MPa]	Price [EUR]	Price Faces [EUR]	Price Cores [EUR]	Weight [kg/m2]	Weight Face [kg/m2]	Weight Core [kg/m2]
`Aluminum 5052 honeycomb (0.07)`	20.00	`Aluminum alloy, wrought ((	5.00	0.80	0.72	0.08	FALSE	7.71	126.00	FALSE	0.11	2.24	FALSE	7.71	19.25	€ 73.50	€ 47.70	€ 25.80	28.49	27.1	1.39
`PVC cross-linked foam (rigid, closed cell, DH 0.060)`	28.00	`PP (50% long glass fiber)`	1.00	17.53	16.27	1.26	FALSE	27.53	27.53	FALSE	0.08	0.40	FALSE	27.53	190.52	€ 29.51	€ 6.46	€ 23.04	4.34	2.66	2.66
`PVC cross-linked foam (rigid, closed cell, DH 0.060)`	20.00	`PP (50% long glass fiber)`	5.00	6.17	4.41	1.76	FALSE	7.71	119.00	FALSE	0.11	0.40	FALSE	7.71	190.52	€ 48.78	€ 32.32	€ 16.46	14.50	13.3	1.20
`PVC cross-linked foam (rigid, closed cell, DH 0.060)`	28.00	`Magnesium alloys`	1.00	5.43	4.18	1.26	FALSE	27.53	153.00	FALSE	0.08	0.40	FALSE	27.53	301.52	€ 32.35	€ 9.30	€ 23.04	5.30	3.62	1.68
`PVC cross-linked foam (rigid, closed cell, DH 0.060)`	26.00	`Magnesium alloys`	2.00	3.60	2.24	1.35	FALSE	14.82	153.00	FALSE	0.08	0.40	FALSE	14.82	301.52	€ 40.00	€ 18.61	€ 21.40	8.80	7.24	1.56
`PVC cross-linked foam (rigid, closed cell, DH 0.060)`	25.00	`Magnesium alloys`	2.50	3.27	1.86	1.41	FALSE	12.33	153.00	FALSE	0.08	0.40	FALSE	12.33	301.52	€ 43.83	€ 23.26	€ 20.58	10.55	9.05	1.50
`PVC cross-linked foam (rigid, closed cell, DH 0.060)`	28.00	`Stainless steel`	1.00	2.18	0.92	1.26	FALSE	27.53	541.00	FALSE	0.08	0.40	FALSE	27.53	499.46	€ 61.59	€ 38.55	€ 23.04	17.16	15.48	1.68
`PVC cross-linked foam (rigid, closed cell, DH 0.060)`	29.20	`Stainless steel`	0.40	3.42	2.21	1.21	FALSE	65.99	541.00	FALSE	0.07	0.40	FALSE	65.99	499.46	€ 39.45	€ 15.42	€ 24.03	7.94	6.192	1.75
`PVC cross-linked foam (rigid, closed cell, DH 0.060)`	29.00	`Stainless steel`	0.50	2.99	1.78	1.21	FALSE	53.16	541.00	FALSE	0.07	0.40	FALSE	53.16	499.46	€ 43.14	€ 19.27	€ 23.87	9.48	7.74	1.74
`Expanded PS foam (closed cell, 0.020)`	29.20	`Stainless steel`	0.40	12.99	2.22	10.77	FALSE	65.99	541.00	TRUE	0.07	0.07	FALSE	65.99	95.90	€ 16.86	€ 15.42	€ 1.44	6.77	6.192	0.58
`Expanded PS foam (closed cell, 0.050)`	29.20	`Stainless steel`	0.40	5.17	2.21	2.95	FALSE	65.99	541.00	FALSE	0.07	0.45	FALSE	65.99	302.96	€ 19.04	€ 15.42	€ 3.62	7.65	6.192	1.46
`PP foam (structural, 0.6)`	29.20	`Stainless steel`	0.40	2.24	2.15	0.10	FALSE	65.99	541.00	FALSE	0.07	6.48	FALSE	65.99	2232.23	€ 43.95	€ 15.42	€ 28.53	23.71	6.192	17.52
`PP foam (structural, 0.6)`	19.20	`Stainless steel`	0.40	5.10	4.95	0.15	FALSE	100.36	541.00	FALSE	0.11	6.48	FALSE	100.36	2232.23	€ 34.18	€ 15.42	€ 18.76	17.71	6.192	11.52
`Phenolic foam (closed cell, 0.160)`	29.20	`Stainless steel`	0.40	2.77	2.20	0.56	FALSE	65.99	541.00	FALSE	0.07	0.33	FALSE	65.99	797.40	€ 43.42	€ 15.42	€ 28.00	10.86	6.192	4.67
`Phenolic foam (closed cell, 0.120)`	29.20	`Stainless steel`	0.40	3.24	2.21	1.03	FALSE	65.99	541.00	FALSE	0.07	0.22	FALSE	65.99	535.01	€ 36.41	€ 15.42	€ 20.99	9.70	6.192	3.50
`Polyethylene terephthalate foam (closed cell, 0.108)`	29.20	`Stainless steel`	0.40	3.32	2.21	1.11	FALSE	65.99	541.00	FALSE	0.07	0.98	FALSE	65.99	515.41	€ 44.21	€ 15.42	€ 28.79	9.35	6.192	3.15
`Styrene acrylonitrile foam (closed cell, 0.068)`	29.20	`Stainless steel`	0.40	3.32	2.21	1.11	FALSE	65.99	541.00	FALSE	0.07	0.74	FALSE	65.99	536.67	€ 38.19	€ 15.42	€ 22.78	8.18	6.192	1.99
`Polymethacrylimide foam (rigid, 0.051)`	29.20	`Stainless steel`	0.40	3.44	2.21	1.23	FALSE	65.99	541.00	FALSE	0.07	0.69	FALSE	65.99	579.58	€ 123.75	€ 15.42	€ 108.33	7.71	6.192	1.52
`PVC cross-linked foam (rigid, closed cell, DH 0.045)`	29.20	`Stainless steel`	0.40	3.60	2.21	1.39	FALSE	65.99	541.00	FALSE	0.07	0.30	FALSE	65.99	415.45	€ 33.41	€ 15.42	€ 17.99	7.51	6.192	1.31
`Polyetherimide foam, (closed cell, 0.06)`	29.20	`Stainless steel`	0.40	3.69	2.21	1.47	FALSE	65.99	541.00	FALSE	0.07	0.83	FALSE	65.99	439.65	€ 129.01	€ 15.42	€ 113.59	7.94	6.192	1.75
`Styrene acrylonitrile foam (closed cell, 0.055)`	29.20	`Stainless steel`	0.40	3.60	2.21	1.39	FALSE	65.99	541.00	FALSE	0.07	0.50	FALSE	65.99	459.02	€ 33.84	€ 15.42	€ 18.43	7.80	6.192	1.61
`PVC cross-linked foam (rigid, closed cell, DH 0.075)`	29.20	`Stainless steel`	0.40	3.04	2.21	0.83	FALSE	65.99	541.00	FALSE	0.07	0.68	FALSE	65.99	576.37	€ 45.20	€ 15.42	€ 29.78	8.38	6.192	2.18
`Aluminum 5052 honeycomb (0.07)`	29.20	`Stainless steel`	0.40	2.27	2.22	0.06	FALSE	65.99	541.00	FALSE	0.07	2.24	TRUE	65.99	27.54	€ 53.09	€ 15.42	€ 37.67	8.22	6.192	2.03
`PVC cross-linked foam (rigid, closed cell, DH 0.030)`	29.20	`Stainless steel`	0.40	4.10	2.21	1.89	FALSE	65.99	541.00	FALSE	0.07	0.15	FALSE	65.99	321.12	€ 27.39	€ 15.42	€ 11.97	7.07	6.192	0.87
`Polymethacrylimide foam (rigid, 0.071)`	29.20	`Stainless steel`	0.40	2.96	2.20	0.76	FALSE	65.99	541.00	FALSE	0.07	1.25	FALSE	65.99	709.99	€ 150.03	€ 15.42	€ 134.61	7.99	6.192	1.80
`Aluminum 5052 honeycomb (0.085), W Direction`	29.20	`Stainless steel`	0.40	2.32	2.22	0.11	FALSE	65.99	541.00	FALSE	0.07	1.88	FALSE	65.99	74.03	€ 61.26	€ 15.42	€ 45.84	8.67	6.192	2.48
`Polymethacrylimide foam (rigid, 0.110)`	29.20	`Stainless steel`	0.40	2.64	2.20	0.45	FALSE	65.99	541.00	FALSE	0.07	2.24	FALSE	65.99	998.73	€ 174.56	€ 15.42	€ 159.14	9.40	6.192	3.21
`Aluminum 3003 honeycomb (0.083), W Direction`	29.20	`Stainless steel`	0.40	2.34	2.22	0.12	FALSE	65.99	541.00	FALSE	0.07	1.49	FALSE	65.99	68.72	€ 44.59	€ 15.42	€ 29.17	8.62	6.192	2.43
`Aluminum 3003 honeycomb (0.083), W Direction`	29.20	`Carbon fibers, very high mc	0.40	0.92	0.80	0.12	FALSE	65.99	1840.00	FALSE	0.07	1.49	FALSE	65.99	96.51	€ 122.25	€ 93.08	€ 29.17	3.97	1.536	2.43
`Aluminum 3003 honeycomb (0.083), W Direction`	29.20	`Carbon fibers, high strengtl	0.40	1.95	1.83	0.12	FALSE	65.99	3870.00	FALSE	0.07	1.49	FALSE	65.99	73.23	€ 65.28	€ 36.11	€ 29.17	3.89	1.456	2.43
`Aluminum 3003 honeycomb (0.083), W Direction`	29.60	`Carbon fibers, very high mc	0.20	1.70	1.58	0.12	FALSE	130.20	1840.00	FALSE	0.07	1.49	TRUE	130.20	96.51	€ 76.11	€ 46.54	€ 29.57	3.23	0.768	2.46
`Balsa (ochroma spp.) (0.12-0.14) (l)`	29.60	`Carbon fibers, very high mc	0.20	1.50	1.39	0.11	FALSE	130.20	1840.00	FALSE	0.07	2.44	FALSE	130.20	9931.55	€ 74.34	€ 46.54	€ 27.79	4.62	0.768	3.85
`Balsa (ochroma spp.) (0.12-0.14) (l)`	19.60	`Carbon fibers, very high mc	0.20	3.46	3.29	0.17	FALSE	196.63	1840.00	FALSE	0.11	2.44	FALSE	196.63	9931.55	€ 64.95	€ 46.54	€ 18.40	3.32	0.768	2.55
`Balsa (ochroma spp.) (0.12-0.14) (l)`	24.60	`Carbon fibers, very high mc	0.20	2.19	2.05	0.14	FALSE	156.66	1840.00	FALSE	0.09	2.44	FALSE	156.66	9931.55	€ 69.64	€ 46.54	€ 23.10	3.97	0.768	3.20
`Balsa (ochroma spp.) (0.12-0.14) (l)`	24.80	`Carbon fibers, very high mc	0.10	3.82	3.68	0.14	FALSE	310.80	1840.00	FALSE	0.08	2.44	FALSE	310.80	9931.55	€ 46.56	€ 23.27	€ 23.29	3.61	0.384	3.22
`Balsa (ochroma spp.) (0.12-0.14) (l)`	29.80	`Carbon fibers, very high mc	0.10	2.57	2.46	0.11	FALSE	258.65	1840.00	FALSE	0.07	2.44	FALSE	258.65	9931.55	€ 51.25	€ 23.27	€ 27.98	4.26	0.384	3.87
`Balsa (ochroma spp.) (0.12-0.14) (l)`	19.80	`Carbon fibers, very high mc	0.10	6.16	5.99	0.17	FALSE	389.29	1840.00	FALSE	0.11	2.44	FALSE	389.29	9931.55	€ 41.86	€ 23.27	€ 18.59	2.96	0.384	2.57
`Balsa (ochroma spp.) (0.09-0.11) (l)`	19.80	`Carbon fibers, very high mc	0.10	6.47	6.24	0.23	FALSE	389.29	1840.00	FALSE	0.11	1.89	FALSE	389.29	8133.33	€ 37.51	€ 23.27	€ 14.24	2.35	0.384	1.97
`Balsa (ochroma spp.) (0.09-0.11) (l)`	24.80	`Carbon fibers, very high mc	0.10	4.05	3.87	0.18	FALSE	310.80	1840.00	FALSE	0.08	1.89	FALSE	310.80	8133.33	€ 41.10	€ 23.27	€ 17.83	2.85	0.384	2.47
`Balsa (ochroma spp.) (0.09-0.11) (l)`	19.60	`Carbon fibers, very high mc	0.20	3.59	3.36	0.23	FALSE	196.63	1840.00	FALSE	0.11	1.89	FALSE	196.63	8133.33	€ 60.63	€ 46.54	€ 14.09	2.72	0.768	1.95
`Balsa (ochroma spp.) (0.09-0.11) (l)`	19.80	`Carbon fibers, ultra high m	0.10	4.95	4.72	0.23	FALSE	389.29	1830.00	FALSE	0.11	1.89	FALSE	389.29	9025.34	€ 64.64	€ 50.40	€ 14.24	2.39	0.42	1.97
`Polymethacrylimide foam (rigid, 0.071)`	19.80	`Carbon fibers, ultra high m	0.10	6.28	5.16	1.12	FALSE	389.29	1830.00	FALSE	0.11	1.25	FALSE	389.29	1106.48	€ 141.68	€ 50.40	€ 91.28	1.64	0.42	1.22
`PVC cross-linked foam (rigid, closed cell, DH 0.075)`	19.80	`Carbon fibers, ultra high m	0.10	6.39	5.17	1.22	FALSE	389.2857	1830.00	FALSE	0.11	0.68	FALSE	389.29	898.24	€ 70.60	€ 50.40	€ 20.20	1.90	0.42	1.48
`PVC cross-linked foam (rigid, closed cell, DH 0.075)`	19.60	`Carbon fibers, very high mc	0.20	4.80	3.57	1.23	FALSE	196.629	1840.00	FALSE	0.11	0.68	FALSE	196.63	809.46	€ 66.53	€ 46.54	€ 19.99	2.23	0.768	1.47
`PVC cross-linked foam (rigid, closed cell, DH 0.075)`	24.80	`Carbon fibers, very high mc	0.10	5.48	4.50	0.97	FALSE	310.8007	1840.00	FALSE	0.08	0.68	FALSE	310.80	809.46	€ 48.57	€ 23.27	€ 25.30	2.24	0.384	1.86
`PVC cross-linked foam (rigid, closed cell, AC 0.090)`	19.60	`Carbon fibers, very high mc	0.20	4.56	3.57	0.99	FALSE	196.629	1840.00	FALSE	0.11	0.83	FALSE	196.63	897.19	€ 70.65	€ 46.54	€ 24.11	2.53	0.768	1.76
`PVC cross-linked foam (rigid, closed cell, AC 0.090)`	24.80	`Carbon fibers, very high mc	0.10	5.28	4.50	0.78	FALSE	310.8007	1840.00	FALSE	0.08	0.83	FALSE	310.80	897.19	€ 53.77	€ 23.27	€ 30.50	2.61	0.384	2.23
`PVC cross-linked foam (rigid, closed cell, AC 0.090)`	19.80	`Carbon fibers, ultra high m	0.10	6.14	5.17	0.98	FALSE	389.2857	1830.00	FALSE	0.11	0.83	FALSE	389.29	995.59	€ 74.75	€ 50.40	€ 24.35	2.20	0.42	1.78

A27. Impact Car

To decide if the stop needs added weight, I made calculations in the case of a car collision with the stop. The calculations were made in Maple. The Maple document can be read at [Appendix A28].

Calculations

The assumed situation is described in a free body diagram (figure 27-1).

With the calculations there are two possible situations. The first one is when the car is able to climb the platform. The other one is when the car collides to the platform. The situation is determined at first. Afterwards the collision force is calculated. Which in turn determines the needed weight for the platform.

Input

Wheelsize of the car: The wheelsize decides the angle of the impact and if the care is able to climb the platform.

Speed of the car: What the speed of the car is just before collision.

Weight of the car: What the total weight of the car is.

Surface friction: The friction between the platforms legs and the surface it stands on.

Dimensions platform: Specifically the height of the platform has an impact.

Output

The output of the calculations is the needed weight for the stop to not move when there is a collision.

Results

Due to time constraints, no weight calculations has been made of the stop yet.

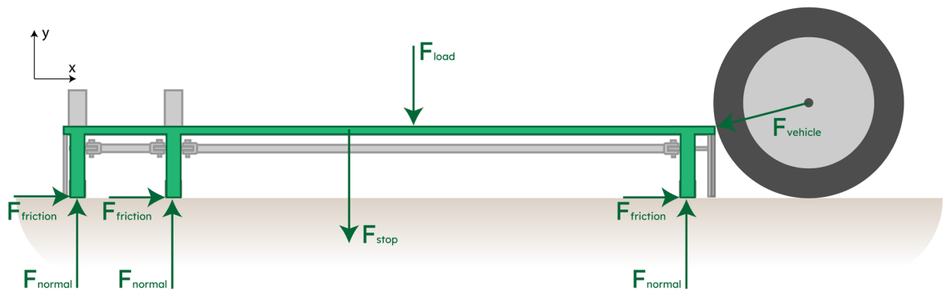


FIGURE 27-1 Free Body Diagram of the car collision

A28. Maple Calculations

Startup

```
> restart:
> with(Units):
Automatically loading the Units[Simple] subpackage

> AddUnit(euro, context = EU, abbreviations = EUR, conversion = 1.3061 * USD);
>
```

Variables

General

Dimensions Platform
Width of platform (R1.9)
2.3m for quiet stop, 2.8m for busy

```
> widthPlatform := 2.3 m:
```

Width of object free space (R1.8)
1.2m for quiet stop, 1.8m for busy

```
> widthObjectFree := 1.3 m:
```

Height of platform (R1.13)
Busses 18cm, trams 24cm.

```
> heightPlatform := 0.24m:
```

Diameter abri leg
To calculate from center of abri leg

```
> widthAbriLeg := 0.1 m:
```

Distance from the center of the front leg to the front

```
> distLeg3ToFront := 0.3 m:
```

Distance between the centers of the supporting legs accross the length

```
> distLegsLength := 1.1 m:
```

Other

Gravity Acceleration

> $G := 9.81 \frac{m}{s^2}$:

Bending

Material Database

Material Sandwich Plate Core

Database Core Material

> *DBmaterialPlateCore* :=
> *Import*("C:/Users/jaspe/OneDrive - Stadsingenieurs B. V/Documenten/Graduation/Other/Calculations/DBmaterialPlateCore.xlsx") :
> *DBmaterialPlateCore*;

	Young's Modulus (GPa)	*Shear Modulus*
Aluminum 3003 honeycomb (0.022)	0.0000191	0.0917
Aluminum 5052 honeycomb (0.016)	7.32×10^{-6}	0.0786
Aluminum 5052 honeycomb (0.07)	0.000751	0.465
Aramid paper/phenolic honeycomb (0.024)	0.0000101	0.016
Para-aramid paper/phenolic honeycomb (0.03)	0.0000267	0.063
Glass/phenolic honeycomb, ±45° fabric (0.032)	0.0000342	0.0983
Glass/polymide honeycomb, ±45° fabric (0.051)	0.000332	0.124
Glass/phenolic honeycomb, 0°/90° fabric (0.035)	0.0000812	0.039
Impregnated paper honeycomb (0.025)	0.0000267	0.0275
Impregnated paper honeycomb (0.05)	0.000211	0.0637
⋮	⋮	⋮

Material Selection Core

> *materialPlateCore* := 37 : *RowLabels*(*DBmaterialPlateCore*, *materialPlateCore*);
> PVC cross-linked foam (rigid, closed cell, AC 0.090) **(2.2.1.1.1)**

Material Sandwich Plate Face

Database Face Material

> *DBmaterialPlateFace* :=
> *Import*("C:/Users/jaspe/OneDrive - Stadsingenieurs B. V/Documenten/Graduation/Other/Calculations/DBmaterialPlateFace.xlsx") :
> *DBmaterialPlateFace*;

	Young's Modulus (GPa)	*Shear Modulus (GI*
Aluminum alloy, wrought (6061, T4)	68.3	26.2
Plywood parallel to board	6.9	0.14
Dense concrete	13.5	6.5
PPE+PS alloy (30% glass fiber)	7.86	2.89
Carbon fibers, very high modulus (5 micron, f)	554.0	235.0
Redwood (sequoia sempervirens (old)) (l)	10.1	0.746
Particleboard parallel to board	2.37	0.245
Polypropylene (PP)	0.917	0.343
PP (50% long glass fiber)	11.1	4.1
Magnesium alloys	44.0	17.0
⋮	⋮	⋮

Material Selection Face

> *materialPlateFace* := 13 : *RowLabels*(*DBmaterialPlateFace*, *materialPlateFace*);
> Carbon fibers, ultra high modulus (10 micron, f) **(2.2.1.2.1)**

Material Solid Plate

Database Solid Material

> *DBmaterialPlateSolid* :=
> *Import*("C:/Users/jaspe/OneDrive - Stadsingenieurs B. V/Documenten/Graduation/Other/Calculations/DBmaterialPlateSolid.xlsx") :
> *DBmaterialPlateSolid*;

[[, *Young's Modulus (GPa)*, *Shear Modulus (GPa)*, *Yield Strength (MPa)*, *Density (kg)*, *Price per kg(EUR/kg)*], **(2.2.1.3.1.1)**
[*Aluminum alloy, wrought* , 66.6, 25.6, 110.0, 2690.0, 1.66],
[*Plywood parallel to board* , 6.9, 0.14, 9.0, 700.0, 0.469],
[*Dense concrete*, 13.5, 6.5, 1.0, 2000.0, 0.0341],
[*Redwood (sequoia sempervirens (old)) (l)*, 10.1, 0.746, 40.8, 443.0, 0.808]]

Material Selection Solid

> *materialPlateSolid* := 4 : *RowLabels*(*DBmaterialPlateSolid*, *materialPlateSolid*);
> Redwood (sequoia sempervirens (old)) (l) **(2.2.1.3.1)**

Load on Platform

Load on platform

> *loadPlatform* := 300 kg :

Platform Plate Solid

Thickness platform plate

> *thicknessPlatformPlate* := 0.03 m :

Platform Plate Sandwich

Sandwich Measurements of Core and Face

> *thicknessCore* := 0.0198 m :
> *thicknessFace* := 0.0001 m :

Friction

Colliding Vehicle

Diameter wheel of vehicle

> *diaWheel* := 0.5m :

Mass of vehicle

> *massVehicle* := 2000kg :

Crumple zone of vehicle

> *crumpleZoneVehicle* := 0.6 m :

Bumper height from ground of vehicle

> *bumperHeightVehicle* := 0.2 m :

Speed of vehicle

> *velocityVehicle* := $30 \frac{km}{h}$:

Other Variables
Load on platform
> *loadPlatformFriction* := 80 kg :

Friction coefficient
Rubber - Asphalt https://www.engineersedge.com/coeffients_of_friction.htm
> *μFriction* := 0.9 :

Bending

Assumptions

- The maximum bending happens in the form of a 3 point bend, where the force is applied in the middle. (fig 1)

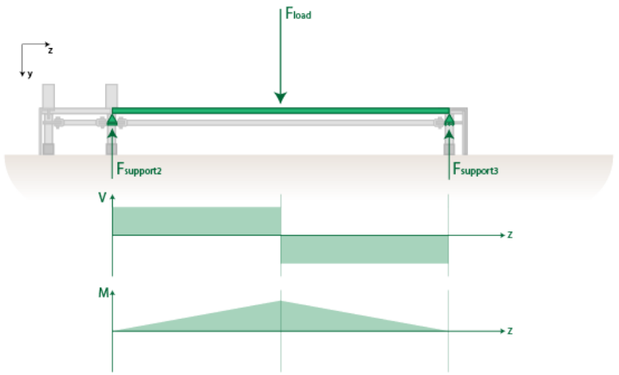


fig 1 - Free Body Diagram with shear force and bending moment diagrams.

- The plate is simplified to act as a beam.
- The weight of the plate does not have a significant enough impact on the bending.
- The maximum bending length is an overestimation.
- The normal stress in the face is a constance.
- Shear stress does not vary significantly over the width.
- Debonding and indentations are not taken into account.

Outcome

Yield failure
The material will yield when the normal stress is bigger than the materials yield strength.
- With a sandwich material, the face-material is the most critical element against yielding.

Shear failure
The material will shear when the shear stress is bigger than the materials shear strength.
- With a sandwich material, the core-material is the most critical element against shearing.

Buckle/wrinkle (Sandwich)
The core and face material can buckle/wrinkle from each other when the buckling stress is smaller than the normal stress in the face-material.

Bending
The maximum deflection is a combination of shear and bend deflection. The total deflection can not be more than 5 mm (Requirement 1.5).

Weight
The panels should be as light and big as possible. A panel should preferably be able to be carried by one person without assistant.
The maximum weight of such panel is 23 kg (Requirement R6.3).

Price
The price should be as cheap as possible

Back-end

Maximum bendable width
> $maxBendWidth := widthObjectFree + \frac{widthAbriLeg}{2} - distLeg3ToFront$:

Deciding what the longest bendable length is in the plate, accross the length or width.
> if *maxBendWidth* > *distLegsLength*
then *bendLength* := *maxBendWidth*;
sectionWidth := *distLegsLength*;
else *bendLength* := *distLegsLength*;
sectionWidth := *maxBendWidth*;
end if:

Simplification on variables to make formulas easier to read.
> *b* := *sectionWidth* :
> *L* := *bendLength* :

Simplification Solid
> *h* := *thicknessPlatformPlate* :

Simplicication Sandwich
> *c* := *thicknessCore* :
> *t* := *thicknessFace* :

Force on plate. Force in from a single point in the middle of the plate.
> *P* := *loadPlatform*·*G* :

Distance from neutral axis
> *y* := 0 :

Largest shear force
> $V := \frac{P}{2}$:

Maximum momentum.
> $Mmax := \frac{P \cdot L}{4}$:

Solid *Plate*

Chosen Material
> *materialSolid* := *RowLabels*(*DBmaterialPlateSolid*, *materialPlateSolid*) :

Youngs modulus material
> *E* := *DBmaterialPlateSolid*[*materialPlateSolid*, 1]GPa :

Shear modulus material

> $shearModulus := DBmaterialPlateSolid[materialPlateSolid, 2]\,\mathrm{GPa}$:

Yield strength material

> $yieldStrengthSolid := DBmaterialPlateSolid[materialPlateSolid, 3]\,\mathrm{MPa}$:

Shear strength material

> $shearStrengthSolid := convert(0.5 \cdot yieldStrengthSolid, 'units', MPa)$:

Moment of Inertia

> $mI := \frac{b \cdot h^3}{12}$:

First moment of Area

> $Q := \frac{b}{2} \cdot \left(\frac{h^2}{4} - y^2 \right)$:

Normal stress https://youtu.be/2F4A79hlH-0
Flexure Formula. Maximum normal stress is at the outer edge (h/2)

> $normalStress := convert\left(\frac{Mmax \cdot \left(\frac{h}{2} \right)}{mI}, 'units', MPa \right)$:

Shear Stress

> $shearStress := convert\left(\frac{V \cdot Q}{mI \cdot b}, 'units', MPa \right)$:

Deflection
Maximum bending in y direction
https://mechanicalc.com/reference/beam-deflection-tables

> $bendDeflection := \frac{P \cdot L^3}{48 \cdot E \cdot mI}$:

Shear Deflection https://www.roymech.co.uk/Useful_Tables/Beams/Shear_stress.html

> $shearDeflection := \frac{P \cdot L}{4 \cdot shearModulus \cdot c \cdot b}$:

Total deflection

> $deflectionTotal := convert(shearDeflection + bendDeflection, 'units', mm)$:

Failure Test
Will the material yield?

> if $normalStress > yieldStrengthSolid$
> then $canYieldSolid := true$;
> else $canYieldSolid := false$;
> end if:

Will the material fail in shear?

> if $shearStress > shearStrengthSolid$
> then $shearFailSolid := true$;
> else $shearFailSolid := false$;
> end if:

Price per m²
Volume core

> $volumeSolid := thicknessPlatformPlate \cdot 1\mathrm{m} \cdot 1\mathrm{m}$:

Price face

> $densityMaterialSolid := DBmaterialPlateSolid[materialPlateSolid, 4]\,\frac{\mathrm{kg}}{\mathrm{m}^3}$:
> $priceKgSolid := DBmaterialPlateSolid[materialPlateSolid, 5]\,\frac{\mathrm{EUR}}{\mathrm{kg}}$:
> $priceCubeSolid := densityMaterialSolid \cdot priceKgSolid$:
> $priceSolid := convert(volumeSolid \cdot priceCubeSolid, 'units', EUR)$:

Weight per m²

> $weightSolid := volumeSolid \cdot densityMaterialSolid$:

Sandwich *Plate*

Chosen Material

> $materialCore := RowLabels(DBmaterialPlateCore, materialPlateCore)$:
> $materialFace := RowLabels(DBmaterialPlateFace, materialPlateFace)$:

Sandwich Youngs Modulus of Core and Face

> $Ecore := DBmaterialPlateCore[materialPlateCore, 1]\,\mathrm{GPa}$:
> $Eface := DBmaterialPlateFace[materialPlateFace, 1]\,\mathrm{GPa}$:

Sandwich Shear Modulus of Core

> $shearModulusCore := DBmaterialPlateCore[materialPlateCore, 2]\,\mathrm{GPa}$:

Yield strength material

> $yieldStrengthCore := DBmaterialPlateCore[materialPlateCore, 3]\,\mathrm{MPa}$:
> $yieldStrengthFace := DBmaterialPlateFace[materialPlateFace, 3]\,\mathrm{MPa}$:

Shear strength material

> $shearStrengthCore := DBmaterialPlateCore[materialPlateCore, 4]\,\mathrm{MPa}$:

Moment of Inertia Core

> $mICore := \frac{b \cdot c^3}{12}$:

First moment of Area Core

> $QCore := \frac{b}{2} \cdot \left(\frac{c^2}{4} - y^2 \right)$:

Emodulus * Moment of Inertia
https://www.youtube.com/watch?v=4zpQwirFsbk

> $EIsandwich := \frac{Ecore \cdot b \cdot c^3}{12} + \frac{Eface \cdot b \cdot t^3}{6} + \frac{(c+t)^2 \cdot Eface \cdot b \cdot t}{2}$:

Normal stress
Normal stress in face should be higher than core.

> $normalStressFace := \frac{Mmax}{b \cdot t \cdot c}$:
> $normalStressCore := \frac{Mmax}{b \cdot t \cdot c} \cdot \frac{Ecore}{Eface}$:

Shear stress in core

> $shearStressCore := \frac{V \cdot QCore}{mICore \cdot b}$:

Buckling stress

> $bucklingStress := 0.57 \cdot Eface^{\frac{1}{3}} \cdot Ecore^{\frac{2}{3}}$:
> $Eface$:
> $Ecore$:
> $bucklingStress := evalf(bucklingStress)$:

Needed Youngs modulus

> $EcoreReq := solve\left(normalStressFace = 0.57 \cdot Eface^{\frac{1}{3}} \cdot EXcore^{\frac{2}{3}}, EXcore\right)$:

> $EfaceReq := solve\left(normalStressFace = 0.57 \cdot EXface^{\frac{1}{3}} \cdot Ecore^{\frac{2}{3}}, EXface\right)$:

Deflection

Bend deflection

> $bendDeflectionSW := \frac{P \cdot L^3}{48 \cdot EIsandwich}$:

Shear Deflection https://www.roymech.co.uk/Useful_Tables/Beams/Shear_stress.html

> $shearDeflectionSW := \frac{P \cdot L}{4 \cdot shearModulusCore \cdot c \cdot b}$:

Total deflection

> $deflectionTotalSW := shearDeflectionSW + bendDeflectionSW$:

Failure Test

Will the material yield?

> if $normalStressFace > yieldStrengthFace$
> then $canYieldSW := true$;
> else $canYieldSW := false$;
> end if:

Will the material fail in shear?

> if $shearStressCore > shearStrengthCore$
> then $shearFailSW := true$;
> else $shearFailSW := false$;
> end if:

Will the material buckle/wrinkle?

> if $normalStressFace > bucklingStress$
> then $canBuckle := true$;
> else $canBuckle := false$;
> end if:

Price per m²

Volume core

> $volumeCore := thicknessCore \cdot 1m \cdot 1m$:

Volume face (2 faces)

> $volumeFace := thicknessFace \cdot 1m \cdot 1m \cdot 2$:

Price core

> $priceCubeCore := DBmaterialPlateCore[materialPlateCore, 5]\frac{EUR}{m^3}$:

> $priceCore := volumeCore \cdot priceCubeCore$:

Price face

> $densityMaterialFace := DBmaterialPlateFace[materialPlateFace, 4]\frac{kg}{m^3}$:

> $priceKgFace := DBmaterialPlateFace[materialPlateFace, 5]\frac{EUR}{kg}$:

> $priceCubeFace := densityMaterialFace \cdot priceKgFace$:

> $priceFace := volumeFace \cdot priceCubeFace$:

Total Price

> $priceSW := priceCore + priceFace$:

Weight per m²

> $densityMaterialCore := DBmaterialPlateCore[materialPlateCore, 6]\frac{kg}{m^3}$:

> $weightFace := volumeFace \cdot densityMaterialFace$:

> $weightCore := volumeCore \cdot densityMaterialCore$:

> $weightSW := weightFace + weightCore$:

Results Solid

Plate

> *materialSolid*;
> Redwood (sequoia sempervirens (old)) (l) **(3.3.1)**

> *thicknessPlatformPlate*;
> 30.00 mm **(3.3.2)**

Deflection

Total deflection in y direction

> *deflectionTotal*;
> 3.47 mm **(3.3.3)**

Failure Test

False is good // True is bad

Will the material yield? (Normal Stress > Yield Strength)

> *canYieldSolid*;
> false **(3.3.4)**

> *normalStress*;
> 5.14 MPa **(3.3.5)**

> *yieldStrengthSolid*;
> 40.8 MPa **(3.3.6)**

Shear stress

Shear strength calc unknown Currently 0.5 * Yield Strength

> *shearFailSolid*;
> false **(3.3.7)**

> *shearStress*;
> 0.07 MPa **(3.3.8)**

> *shearStrengthSolid*;
> 20.40 MPa **(3.3.9)**

Price per m²

> *priceSolid*;
> 10.74 EUR **(3.3.10)**

Weight per m²

> *weightSolid*;
> 13.29 kg **(3.3.11)**

Results Sandwich

Plate Core

> *materialCore*;
> PVC cross-linked foam (rigid, closed cell, AC 0.090) **(3.4.1)**

> *thicknessCore*;

19.80 mm (3.4.2)

Plate Face

> *materialFace*;

Carbon fibers, ultra high modulus (10 micron, f) (3.4.3)

> *thicknessFace*;

0.10 mm (3.4.4)

Deflection

Total deflection in y direction

> *deflectionTotalSW*;

6.14 mm (3.4.5)

Bend and shear deflection

> *bendDeflectionSW*;

5.17 mm (3.4.6)

> *shearDeflectionSW*;

0.98 mm (3.4.7)

Failure Test

False is good // True is bad

Will the material yield? (Normal Stress > Yield Strength)

> *canYieldSW*;

false (3.4.8)

> *normalStressFace*;

389.29 MPa (3.4.9)

> *yieldStrengthFace*;

1830.0 MPa (3.4.10)

Will the material fail in shear? (Shear Stress > Shear Strength)

> *shearFailSW*;

false (3.4.11)

> *shearStressCore*;

0.11 MPa (3.4.12)

> *shearStrengthCore*;

0.825 MPa (3.4.13)

Will the material buckle/wrinkle? (Normal Stress > Buckling Stress)

> *canBuckle*;

false (3.4.14)

> *normalStressFace*;

389.29 MPa (3.4.15)

> *bucklingStress*;

995.59 MPa (3.4.16)

If Buckle fail, required Young's Modulus

> *EcoreReq*;

2.05×10^{-2} GPa (3.4.1.1)

> *EfaceReq*;

4.53×10^{1} GPa (3.4.1.2)

Price per m²

Total price

> *priceSW*;

74.75 EUR (3.4.17)

Price of the faces (2 faces)

> *priceFace*;

50.40 EUR (3.4.18)

> *priceCore*;

24.35 EUR (3.4.19)

Weight per m²

> *weightSW*;

2.20 kg (3.4.20)

> *weightFace*;

0.42 kg (3.4.21)

> *weightCore*;

1.78 kg (3.4.22)

Friction

Assumptions

All frictions forces can be added together.
All normal forces can be added together.

The stop is a rigid body

Vehicles collides with two wheels.
Weight of vehicle is distributed equally among its wheels.

The maximum collision force is just before the moment the wheel raises.

Y Force vehicle is 0 because it is about to climb

Friction

If car is able to ride up to the platform

Equilibriums

X Forces (two wheels)

> $xForces := Ffriction + (Fcollision \cdot 2) = 0$:

Y Forces

> $yForces := Fnormal + Fload + Fstop + Fyvehicle = 0$:

Momentum equilibrium

> $Mequilibrium := Mcollision + Mweight = 0$:

Distances

Radius wheel

> $rWheel := \frac{diaWheel}{2}$:

Horizontal distance between center wheel and curb

> $distWheelCurbX := \sqrt{rWheel^2 - (rWheel - heightPlatform)^2}$:

Vertical distance between center wheel and curb

> $distWheelCurbY := rWheel - heightPlatform$:

Friction Formula

> $frictionFormula := Ffriction = \mu Friction \cdot Fnormal$:

Forces + Momentums

Force vehicle per wheel

> $Fvehicle := massVehicle \cdot G$:

> $FvehicleWheel := \frac{Fvehicle}{4}$:

Force from load on platform

> $Fload := loadPlatformFriction \cdot G$:

Momentums

Momentum of collision

> $Mcollision := Fcollision \cdot distWheelCurbY$:

Momentum of weight

> $Mweight := -FvehicleWheel \cdot distWheelCurbX$:

Forces

Vertical force Vehicle on platform

> $Fyvehicle := 0\,\mathrm{N}$:

Collision Force

> $Fcollision := -solve(Mequilibrium, Fcollision)$:

Friction Force

> $Ffriction := solve(xForces, Ffriction)$:

Normal Force

> $Fnormal := solve(frictionFormula, Fnormal)$:

Required total weight platform

> $totalWeightReqPlatformClimb := -\frac{solve(yForces, Fstop)}{G}$:

Possibility tracker

> if $distWheelCurbY \leq 0$
> then $totalWeightReqPlatformClimb := false$;
> end if:

If car cannot ride up to the platform

Work Equilibrium

> $Wcollision := FcurbX \cdot crumpleZoneVehicle = EkineticVehicle$:

Friction Formula

> $frictionFormulaCollide := FcurbX = \mu Friction \cdot FnormalPlatformCollide$:

Kinetec energy of vehicle

> $EkineticVehicle := \frac{1}{2} \cdot massVehicle \cdot velocityVehicle^2$:

Fcurb

> $FcurbX := solve(Wcollision, FcurbX)$:

Required total weight platform

> $totalWeightReqPlatformCollide := \frac{solve(frictionFormulaCollide, FnormalPlatformCollide)}{G}$:

> if $distWheelCurbY \leq 0$
> then
> $canClimb := false$;
> elif $bumperHeightVehicle \leq heightPlatform$
> then
> $canClimb := false$;
> else
> $canClimb := true$;
> end if:

> if $canClimb = false$
> then
> $totalWeightReqPlatformClimb := false$;
> $totalWeightReqPlatform := totalWeightReqPlatformCollide$;
> elif $totalWeightReqPlatformClimb < totalWeightReqPlatformCollide$
> then
> $totalWeightReqPlatform := totalWeightReqPlatformClimb$;
> else
> $totalWeightReqPlatform := totalWeightReqPlatformCollide$;
> end if:

Results

Required platform weight

> $totalWeightReqPlatform$;

13109.15627 kg **(4.3.1)**

Ability to climb on platform

> $canClimb$;

false **(4.3.2)**

Required Platform weight if climb

> $totalWeightReqPlatformClimb$;

false **(4.3.3)**

Required Platform weight if collision

> $totalWeightReqPlatformCollide$;

13109.15627 kg **(4.3.4)**

DESIGN FOR our future

TU Delft

IDE Master Graduation

Project team, Procedural checks and personal Project brief

This document contains the agreements made between student and supervisory team about the student's IDE Master Graduation Project. This document can also include the involvement of an external organisation, however, it does not cover any legal employment relationship that the student and the client (might) agree upon. Next to that, this document facilitates the required procedural checks. In this document:

- The student defines the team, what he/she is going to do/deliver and how that will come about.
- SSC E&SA (Shared Service Center, Education & Student Affairs) reports on the student's registration and study progress.
- IDE's Board of Examiners confirms if the student is allowed to start the Graduation Project.

USE ADOBE ACROBAT READER TO OPEN, EDIT AND SAVE THIS DOCUMENT
Download again and reopen in case you tried other software, such as Preview (Mac) or a webbrowser.

STUDENT DATA & MASTER PROGRAMME

Save this form according the format "IDE Master Graduation Project Brief_familyname_firstname_studentnumber_dd-mm-yyyy".
Complete all blue parts of the form and include the approved Project Brief in your Graduation Report as Appendix 1 !

family name	Kunkeler 5995
initials	JHM given name Jasper
student number	4084357
street & no.	
zipcode & city	
country	
phone	
email	

Your master programme (only select the options that apply to you):

IDE master(s): ★ IPD ○ DfI ○ SPD

2nd non-IDE master:

individual programme: - - (give date of approval)

honours programme: ○ Honours Programme Master

specialisation / annotation: ○ Medisign ○ Tech. in Sustainable Design ○ Entrepeneurship

SUPERVISORY TEAM **

Fill in the required data for the supervisory team members. Please check the instructions on the right !

** chair	Dr. ir. Hiemstra-van Mastrigt, S.	dept. / section:	DOS/MCR
** mentor	Ir. Breemen, E.J.J. van	dept. / section:	SDE/MM
2nd mentor	Hoogland, R		
	organisation: Stadsingenieurs		
	city: Amsterdam	country:	Netherlands
comments (optional)			

Chair should request the IDE Board of Examiners for approval of a non-IDE mentor, including a motivation letter and c.v..

Second mentor only applies in case the assignment is hosted by an external organisation.

Ensure a heterogeneous team. In case you wish to include two team members from the same section, please explain why.

TU Delft

Procedural Checks - IDE Master Graduation

APPROVAL PROJECT BRIEF

To be filled in by the chair of the supervisory team.

chair Dr. ir. Hiemstra-van Mastrigt, S. date 25 - 10 - 2022 signature Suzanne Hiemstra-van Mastrigt Digitaal ondertekend door Suzanne Hiemstra-van Mastrigt Datum: 2022.10.25 22:03:22 +02'00'

CHECK STUDY PROGRESS

To be filled in by the SSC E&SA (Shared Service Center, Education & Student Affairs), after approval of the project brief by the Chair.
The study progress will be checked for a 2nd time just before the green light meeting.

Master electives no. of EC accumulated in total: 24 EC

Of which, taking the conditional requirements into account, can be part of the exam programme 24 EC

List of electives obtained before the third semester without approval of the BoE

★ YES all 1st year master courses passed

○ NO missing 1st year master courses are:

name C. van der Bunt date 31 - 10 - 2022 signature C. van der Bunt Digitally signed by C. van der Bunt Date: 2022.10.31 14:00:28 +01'00'

FORMAL APPROVAL GRADUATION PROJECT

To be filled in by the Board of Examiners of IDE TU Delft. Please check the supervisory team and study the parts of the brief marked **.
Next, please assess, (dis)approve and sign this Project Brief, by using the criteria below.

- Does the project fit within the (MSc)-programme of the student (taking into account, if described, the activities done next to the obligatory MSc specific courses)?
- Is the level of the project challenging enough for a MSc IDE graduating student?
- Is the project expected to be doable within 100 working days/20 weeks ?
- Does the composition of the supervisory team comply with the regulations and fit the assignment ?

Content: ★ APPROVED ○ NOT APPROVED

Procedure: ★ APPROVED ○ NOT APPROVED

- but the project brief has been submitted late

comments

name Monique von Morgen date 14 - 11 - 2022 signature

Designing an accessible and modular temporary tram/bus stop — project title

Please state the title of your graduation project (above) and the start date and end date (below). Keep the title compact and simple. Do not use abbreviations. The remainder of this document allows you to define and clarify your graduation project.

start date 26 - 09 - 2022 — 24 - 02 - 2023 end date

INTRODUCTION **

Please describe, the context of your project, and address the main stakeholders (interests) within this context in a concise yet complete manner. Who are involved, what do they value and how do they currently operate within the given context? What are the main opportunities and limitations you are currently aware of (cultural- and social norms, resources (time, money,...), technology, ...).

Cities are always changing. New buildings arise, constructions are getting older and points of interests change over time. A city can be seen as a dynamic entity. Facilitating public transport in such a city can be quite a challenge. Bus and tram stops require to change with the city, be it for maintenance or improvement. During these changes bus and tram stops can be inaccessible for the traveler. New or temporary points of interests can also be difficult to access for the traveler due to the lack of the infrastructure. This project will take a look into designing a temporary bus and/or tram stop, or possibly a different solution, to facilitate these travelers.

The project is commissioned by the engineering firm Stadsingenieurs as a possible recommendation for Vervoerregio Amsterdam to implement. Vervoerregio Amsterdam has a goal to make every bus and tram stop accessible to everyone by 2030 (Hoogland & van Baar, 2021), which includes people with disabilities. Fixed bus and tram stops comply to that goal. Temporary stops however, do not. Next to that, the temporary bus and tramp stops lack an overall vision and uniformity, being a high contrast with the fixed stops.

With the creation and usage of the stop, many parties are involved; the public transport provider, the infrastructure maintainer, the provider of the temporary stop, the travelers/passenger, the neighborhood and the infrastructure around the station. The public transport provider, infrastructure maintainer and surrounding infrastructure, wish a swift installation of the product so it does not obstruct any traffic or transport. The provider of the temporary stops wants the installation to be swift, easy and ergonomically sound. They also want it to be reusable for other occasions. The travelers/passengers want their transport to be easily accessible. This includes accessible to people with disabilities. The travelers/passengers also want a clear guidance when using the transport and be able to feel safe during their trips. The neighborhood has the wish to have as few noise and nuisance as possible and no obstruction of their current lifestyle. Lastly, the municipality wants to be sure the solution fits in their defined streetscape (Gemeente Amsterdam, 2018), if it fits within their vision and if the needs of the citizens are met.

With so many different parties involved in this project, it can be quite a challenge to fit in all their needs. Due to the time constraint of the graduation thesis, not every need can be fulfilled in great detail. A main focus needs to be decided on. With such a broad subject, many opportunities arise as well. There is an opportunity to create a seamless experience in public transport for the traveler. There is also an opportunity to introduce a more sustainable solution and easier to install. Because a temporary bus/tram stop doesn't have a fixed location, the terrain can be a bit more difficult to work with and there is a possibility of no accessibility to an electricity source. There also needs to be taken into account for the wear and tear like the weather and large amounts of passengers.

space available for images / figures on next page

introduction (continued): space for images

image / figure 1: Example of a temporary tram stop in its current situation.

TO PLACE YOUR IMAGE IN THIS AREA:

- **SAVE THIS DOCUMENT TO YOUR COMPUTER AND OPEN IT IN ADOBE READER**
- **CLICK AREA TO PLACE IMAGE / FIGURE**

PLEASE NOTE:

- **IMAGE WILL SCALE TO FIT AUTOMATICALLY**
- **NATIVE IMAGE RATIO IS 16:10**
- **IF YOU EXPERIENCE PROBLEMS IN UPLOADING, COVERT IMAGE TO PDF AND TRY AGAIN**

image / figure 2:

PROBLEM DEFINITION **

Limit and define the scope and solution space of your project to one that is manageable within one Master Graduation Project of 30 EC (= 20 full time weeks or 100 working days) and clearly indicate what issue(s) should be addressed in this project.

Public transport is difficult to reroute to points of interests without proper pickup points for tram/ bus passengers. However, construction work, conventions, festivals, tournaments or similar events often necessitate rerouting of existing public transport. This leads to a new problem: confusion of passengers and operators alike on where to stop or queue for public transport at these points of interest. To avoid this confusion, this project aims to propose the design of a modular, temporary bus/ tram stop for such events, providing a smooth and intuitive user experience in these situations for both passengers and the employees assembling and disassembling the stop.

ASSIGNMENT **

State in 2 or 3 sentences what you are going to research, design, create and / or generate, that will solve (part of) the issue(s) pointed out in "problem definition". Then illustrate this assignment by indicating what kind of solution you expect and / or aim to deliver, for instance: a product, a product-service combination, a strategy illustrated through product or product-service combination ideas, ... In case of a Specialisation and/or Annotation, make sure the assignment reflects this/these.

" The design of a temporary tram/bus stop which allows for all passengers, to use public transport to travel to and from a temporary point of interest in a seamless and intuitive user experience. The assembly, disassembly and setup of the design should feature an equally seamless experience for the employees setting the tram/bus stops up, while the product itself should not disrupt its surroundings and daily public transport."

At the end of this project I'll deliver a design proposal where the following three subjects will be tackled.

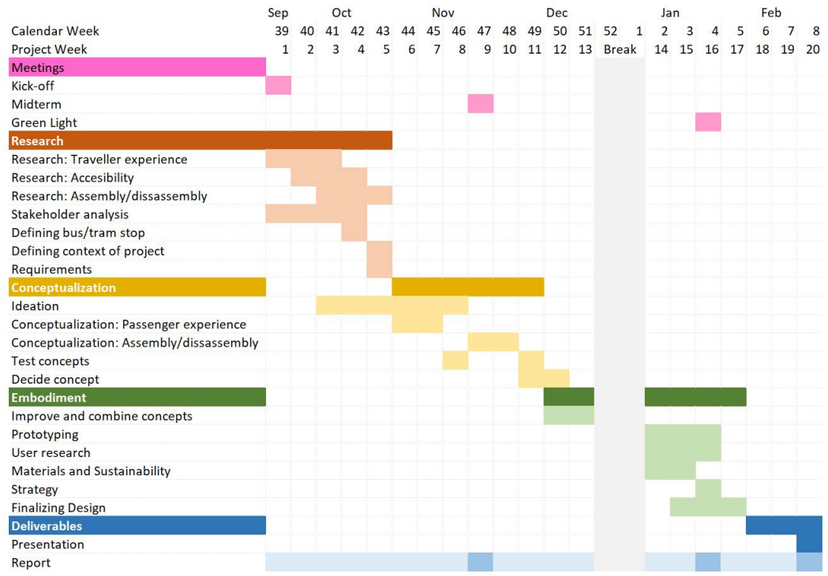
- Setting up a seamless user experience for all passengers.
- Assembling and disassembling the set-up while taking into account all the other users of the same space.
- Creating a sustainable product resistant to the wear and tear of weather and the usage.

The proposal should take into account for all stakeholders and include a strategy on how to continue.

PLANNING AND APPROACH **

Include a Gantt Chart (replace the example below - more examples can be found in Manual 2) that shows the different phases of your project, deliverables you have in mind, meetings, and how you plan to spend your time. Please note that all activities should fit within the given net time of 30 EC = 20 full time weeks or 100 working days, and your planning should include a kick-off meeting, mid-term meeting, green light meeting and graduation ceremony. Illustrate your Gantt Chart by, for instance, explaining your approach, and please indicate periods of part-time activities and/or periods of not spending time on your graduation project, if any, for instance because of holidays or parallel activities.

start date 26 - 9 - 2022 24 - 2 - 2023 end date



The project starts out with the research. There are three subjects I want to focus on, traveler experience, accessibility and assembly/disassembly. To gain the most information I want to visit the places and ask people questions about these subjects. For accessibility I want to interview people with a disability on how they go through public transport. The rest of the stakeholders will be studied in the stakeholder analysis and if possible I will see if I can reach some of them. Concluding the research the context of the project and focus of the project will be defined including requirements for a future product.

I want to start with ideation as soon as possible, during the research phase I will start out making ideas already. I will organize creative session right after the research phase if possible. Of the ideas I will make plenty of models for communication and get a better feel of the ideas. I will conceptualize and test for two subjects; the passenger experience and assembly/disassembly. If needed there will be space for iterations.

Next is the embodiment phase. Here I want to do a final test to validate the concept. And I want to finalize the concept. Here there will be a bigger focus on materials and sustainability.

As for my personal planning. I'll be at the Stadsingenieurs office every Tuesday, Wednesday and Thursday. On Mondays I would like to meet the mentor and/or chair for feedback. At the end of every Friday I will sent a weekly update. During the holidays I take a two week break.

Important dates: Week of 22 november: Midterm meeting, Week of 23 Januari: Greenlight Meeting, Week of 20 Februari: Final presentation. Reports of those meetings will be handed in a week before.

MOTIVATION AND PERSONAL AMBITIONS

Explain why you set up this project, what competences you want to prove and learn. For example: acquired competences from your MSc programme, the elective semester, extra-curricular activities (etc.) and point out the competences you have yet developed. Optionally, describe which personal learning ambitions you explicitly want to address in this project, on top of the learning objectives of the Graduation Project, such as: in depth knowledge a on specific subject, broadening your competences or experimenting with a specific tool and/or methodology, ... Stick to no more than five ambitions.

This project is very interesting as it encapsulate all aspects of design. Even though I know some aspects might be less developed than others, as the final project it is nice to be able to go through that design process fully once more. The subject about public transport seems very interesting to me, I've done the minor about Transport, Infrastructure and Logistics before, which included aspects of this. I also enjoy watching videos or reading up to about public transport or other green infrastructure. My ultimate dream goal would be to have my design being featured in such media, where it is seen as a cool urban solution.

One of the things I want to learn more as an IPD student is user experience. This project has a lot of space to learn of this subject. There are a lot of stakeholders which needs to be taken into account of and there are two different kind of user groups which make direct use of the solution, the assembler and the passenger. The passenger is especially interesting as the origin of the assignment comes from including people with disabilities. I haven't designed specifically for people with disabilities, and is something I want to have experience in.

A personal goal for myself is to learn how to not get stuck. Often I can overthink a lot or not be happy with the results of my work or writing. Instead of freezing on that moment, I should reflect and make a plan to continue. What is important in this is that I stay in contact with the people around me and make sure I have a good structure and planning to follow.

The final thing I want to improve myself on is communication. I'm not the best writer and can be a bit chaotic. Despite this I want to be able to convey myself in a professional and clear matter.

FINAL COMMENTS

In case your project brief needs final comments, please add any information you think is relevant.

Gemeente Amsterdam. (2018). Beleidskader Puccinimethode; Standaard voor het Amsterdamse straatbeeld. Amsterdam.
Hoogland, R., & van Baar, S. (2021). Integraal Programma van Eisen Operationeel Systeem Tram Gemeente Amsterdam. Amsterdam.