





Booklet by
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ARCHITECTURES OF CORRESPONDENCE

Diploma ETH Zürich, HS 2023
Chair of Affective Architectures
Chair of the History and Theory of Urban Design
Chair of Circular Engineering for Architecture

Experiencing Excavated Earth

CASE STUDY WITH
TOGGENBURGER AG

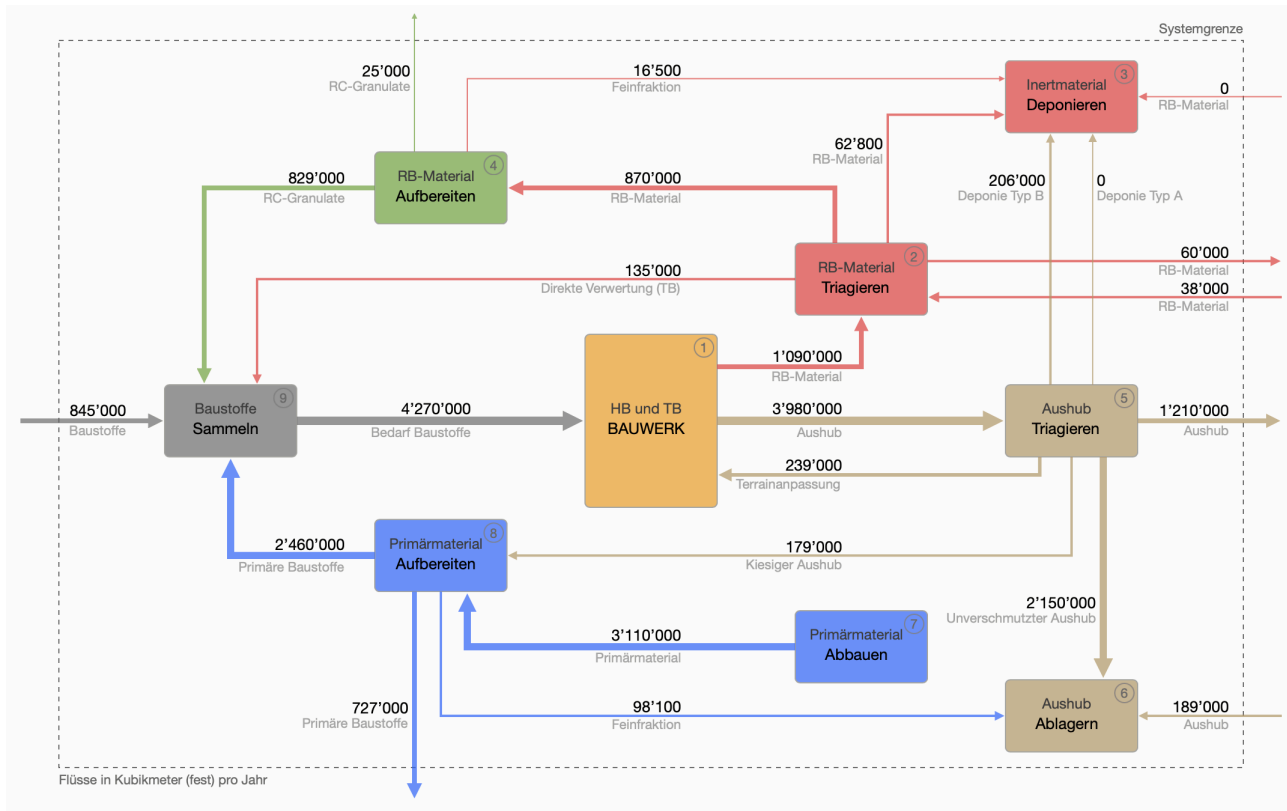
*With many thanks to Toggenburger AG,
especially to Beat Manni who kindly
organized all the visits for me.*

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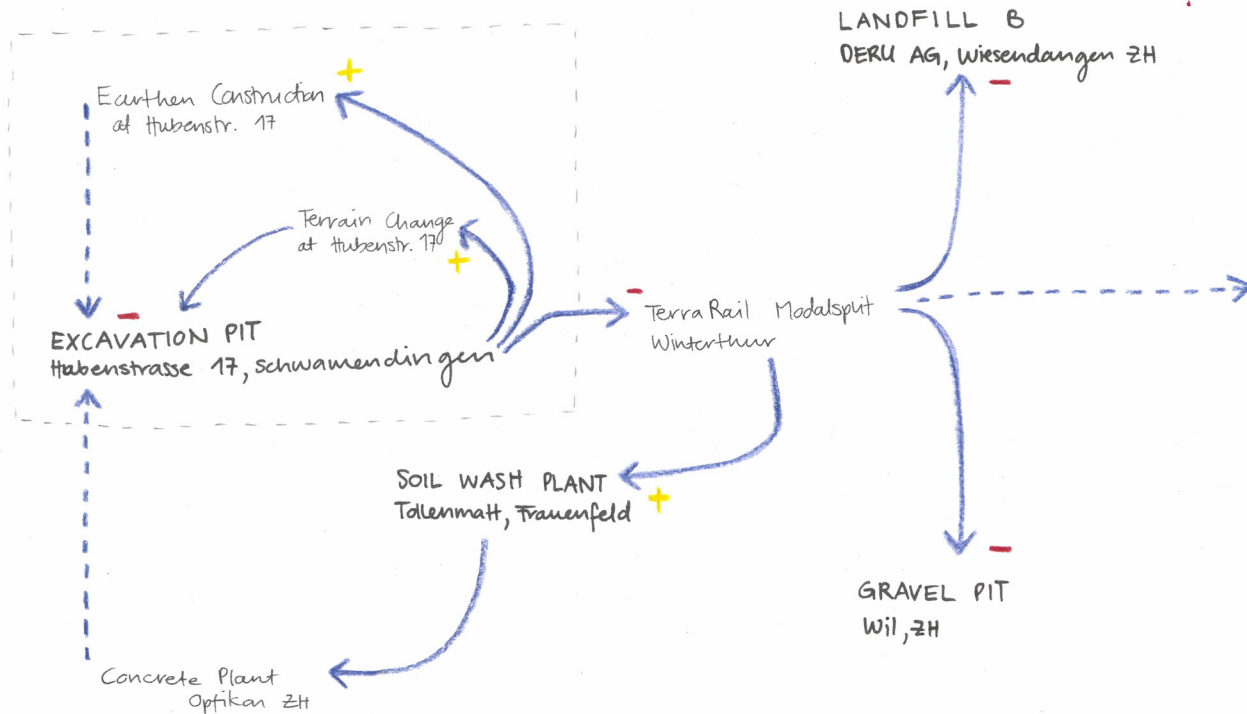
Resource Trajectory

WHERE DOES EXCAVATED EARTH GO TO?

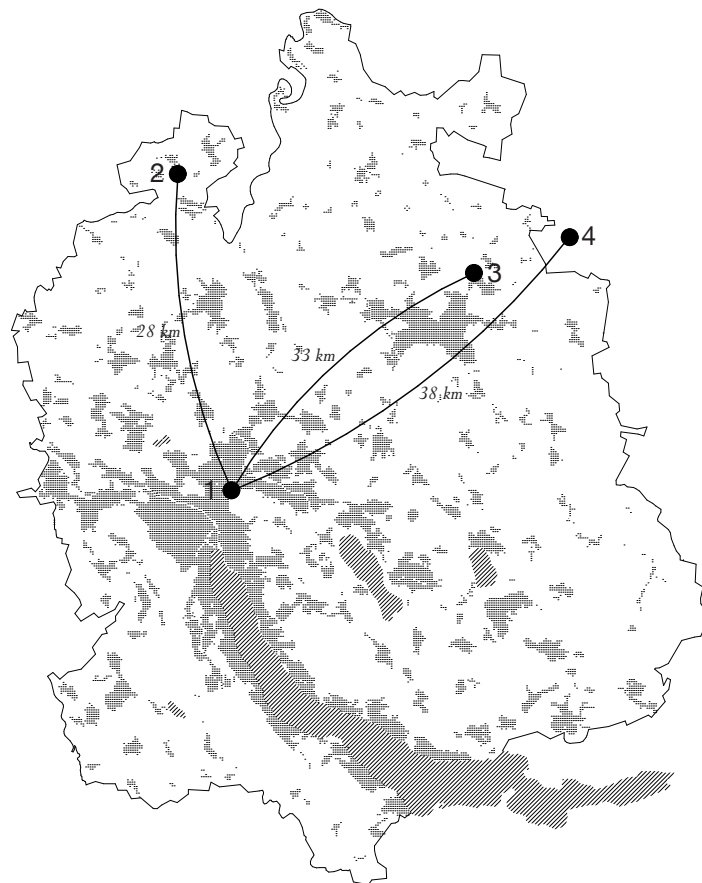


Static KAR model of the material flow system in Zurich in 2020; arrow thickness corresponds to the value of the material flow

Energie- und Ressourcen-Management GmbH, 2020, http://www.kar-modell.ch/resultat_statMod.html (visited 04.09.2023).



Trajectory of the Earth from Hubenstrasse 17



SITE VISITS

5

- 1 Excavation at Hubenstrasse 17, Schwamendingen ZH
- 2 Gravel Pit Backfill in Wil ZH
- 3 Landfill DERU AG, Wiesendangen ZH
- 4 Soil Washing Plant Tollenmatt, Frauenfeld TG



Toggenburger



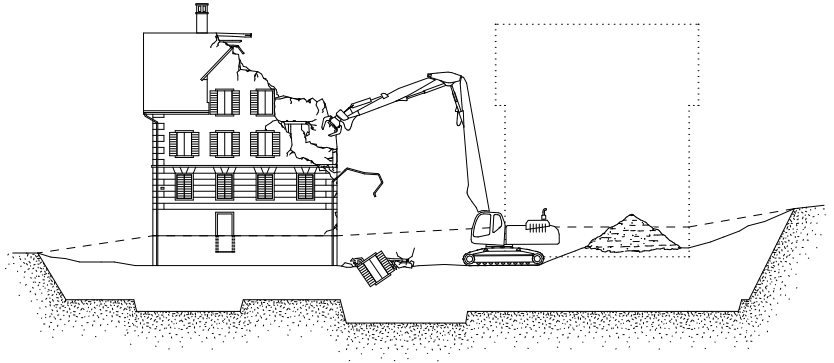
Monday
18.09.2023

CONSTRUCTION SITE HUBENSTRASSE 17

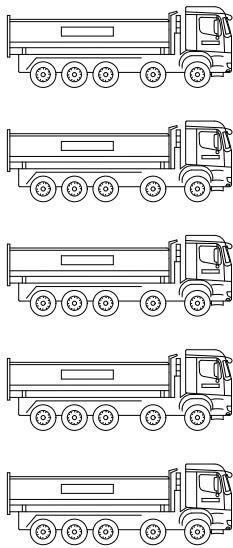


Site Plan of the Project at Hubenstrasse 17

Uster AG, <https://hubengarten.ch> (visited 15.09.2023).



At Hubenstrasse 17 in Schwamendingen, two houses from the 1940s were deconstructed, and around 100m^3 material (5 full-loaded trucks) with mineral contamination was removed and transported partially to the landfill and partially to the soil washing plant. Especially in the fill wedge, contaminated material such as brick fragments were found. In Zurich, from 200m^3 of contaminated material, at least 50% of it must be recycled - this means, for example, that the material must be washed in a soil washing plant to obtain secondary building materials such as gravel for recycling. It is only possible to wash excavated earth when there are maximal 30% fine particles.





In the city of Zurich, all topsoil is contaminated. Based on the plans, the geological report, and the expert opinion, the excavation company writes a disposal concept based on experience. This serves as the basis for the disposal certificate after completion of the excavation. From the signing of the contract between the client and the excavation company, the building ground risk lies with the client and the excavated material belongs to the excavation company.

The site at Hubenstrasse 17 is ready for excavation. First, drillings will be made to build the girder pile walls (Rühlwand). Since there is often not enough space on inner-city construction sites to make embankments for the excavation pit, the soil is often supported by means of girder pile walls (Rühlwänden).

In general, we should aim to reuse/recycle 75% of the excavated material and should only deposit 25% because the longer we have less and less space in landfills and want to strive for a material cycle to counteract the exploitation of raw materials.





Thursday
21.09.2023

CONSTRUCTION SITE HUBENSTRASSE 17





They are drilling holes for the girder pile wall to fix the earth from the neighboring plots. When drilling earth from some meters below is coming out that helps you analyze the quality of the construction ground. At the north-eastern part of the plot there was very viscous sandy material coming out what could be a risk for groundbreaking. But since it was only a thin layer it is nothing to worry about in this case. On the eastern side they added two extra h-beams to create a third storage place for construction containers since the plot is quite small and there is not much space to store things during the construction. They will start with excavating next week and including the first concrete slab it should be finished by the end of November.



Next week I can join the construction meeting on Tuesday and afterwards I can experience the path of the excavated earth by sitting in a truck loaded with excavated earth and we go to unload it directly in the gravel pit of Wil. There we load gravel, take it to a construction site and come back to load earth at Hubenstrasse. Best it to load a truck directly but sometimes you have to store it on a pile on the construction site, mostly when you excavate at the back part of the plot where you don't have any street access.

The logistics behind the transport are very complex and empty runs have to be avoided. That's why Toggenburger AG has two dispatchers who take turns on a daily basis to coordinate and control everything. Approximately 180 trucks drive per day and circulate the materials - excavated earth, mixed demolition material and gravel. Toggenburger AG has two gravel pits in the north of Zurich, in Wil and in Marthalen. The dispatchers decide which gravel pit is to be used for depositing the excavated material. The degree of filling of the gravel pit and the composition of the earth are decisive, since one wants to have as different components as possible.









Tuesday
26.09.2023

CONSTRUCTION SITE HUBENSTRASSE 17

TRUCK RIDE

GRAVEL PIT BACKFILL WIL ZH





Arriving at Hubenstrasse 17 this morning, it changed a lot. Already a big change in the topography, a shifting of earth from here to there is visible. At the construction meeting (Bausitzung) they discussed the process and that the disposal certificate of the demolition of the two buildings has to be done as soon as possible. All the contamination that was found has to be included such as slag, bricks, wood, mixed demolition etc. The excavation will happen in the next 2-3 weeks. Next week the geometer will take zero point measurements for the terrain model. In total, around 3'000-4'000 m³ earth, equivalent to 150-200 trucks, will be excavated at Hubenstrasse 17. The earth is continuously picked up by trucks passing by.











I had the chance to enter a truck and to accompany the excavated earth to the gravel pit in Wil. It was an incredible experience to join this invisible path. A truck (Schlepper) can carry around 23m^3 material what is a maximum weight of the loaded truck of 40t (with a tolerance of +/- 1300kg). During the ride Tiago explained me different possible routes he has to make. We now went from the construction site at Hubenstrasse 17 with 25'300kg excavated earth to backfill the gravel pit in Wil. There we loaded underlay sand which we brought to a construction site in Regensdorf and with an empty truck ready to be reloaded we went back to Hubenstrasse 17.

Another frequent occasion is the transport of excavated material to the soil washing plant Tollenmatt in Frauenfeld, from there the filter cake (Filterkuchen) of the washing plant to the cement plant Tännlimoos (Baar) or Biberist (Solothurn), where it is used for cement production.





Transporteur	Fahrzeugart	Kennzahl
2000000002 Toggenburger AG	Bestellt: Kipper Alle Geliefert: Schlepper	TG 198
Bezeichnung		
Deviposition:		
* Aushub- und Ausbruchmaterial, unverschmutzt		
Charge:	VeVA Code	
Tara: 15 480 * kg Brutto: 40 780 kg Netto: 25 300 kg		
Zuschläge / Sonderleistungen: 10764 Energiekosten- und Treibstoffzuschlag		
Bemerkungen:		
Bemerkung Kunde:		
Bemerkung Chauffeur: Kunde nicht verfügbar. Keine Kundenunterschrift.		
Übernommen:		Lie



On the way, we passed the Nadelbändli gravel pit in Glattfelden (Eberhard & Toggenburger), which already looked giant and impressive. Arriving at the gravel pit in Wil (Hastag & Toggenburger, next to Holcim), I felt like I was on another planet. It is scenically very alien and impressive and huge in dimension. There are unnaturally perfect shapes and lines describing the landscape and lots of trucks coming in and out. The 25.3t of earth that were loaded suddenly looked like very little dumped at the gravel pit. It is the relation of things in its context that makes them and defines them. The dumped earth from Hubenstrasse 17 formed a small pile next to other piles dumped just before. They were all different in color and grain size. I wondered where the other soil came from. Here organisms from different places meet and possibly feel strange in the new environment.

It is exciting and fascinating to see the different realities behind the excavation earth.







Back on the construction site I could make my first try to dig earth with the big digger. It is crazy how soft and light it feels to shift earth with the digger. It was a completely different experience with earth than the one I had in the summer school where the work with earth felt very heavy and tiring. Of course, it was all manually and without the help of such a machine.

On my way from home to Hubenstrasse 17 I crossed the Irchel Park. Knowing that it is a constructed landscape out of excavated earth is impressive and showing another possible reality of excavated earth.

Clash of Realities

CHANGING PERCEPTION DEPENDING ON THE CONTEXT













«For life on earth to carry on, and to flourish, we need to learn to attend to the world around us, and to respond with sensitivity and judgement.»

- Tim Ingold, Correspondences, p. 3.

«Reciprocal Landscapes stems from a desire to think of construction materials [...] as continuous with the landscapes they come from, and with the people that shape them [...] to understand materials as fragments of other landscapes;»

- Jane Hutton, Reciprocal Landscapes, p. 5.

«There are lines in the landscape because every landscape is forged in movement, and because this movement leaves material traces along the manifold paths of its proceeding.»

«The question is: are any of these lines really there, or do they exist only in the mind's eye? In drawing them, are you merely following a graphic convention [...] or are you participating - in the roaming of your eyes and corresponding gestures of the hand - in the formative process of the landscape itself?»

- Tim Ingold, Correspondences, p. 169, 165.





Thursday
28.09.2023

CONSTRUCTION SITE HUBENSTRASSE 17

CONSTRUCTION SITE RAIL LOAD DELTASTRASSE WINTERTHUR

LANDFILL DERU AG WIESENDANGEN

SOIL WASHING PLANT TOLLENMATT FRAUENFELD





At the Hubenstrasse they started preparing the concrete spraying machine to concrete the construction pit walls. While excavating the pit an old oil tank appeared. They have to test if it has been cleaned and have to dispose it in scrap iron. I observed the loading of a truck and counted the “shovels” – 9 shovels of the digger is one full loaded truck, what means around 23m^3 (25t) of earth. The total amount of earth excavated at Hubenstrasse will proximately be around $3'000\text{--}4'000\text{m}^3$. Therefore, it is still allowed to transport the material by truck. The train duty is only when you have more than $25'000\text{m}^3$ material.





At the construction site where a lot of contaminated soil is excavated, we met the geologist and the environmental technician. They were debating what to do with which triage. They piled up different triages to distinguish the different soils where the geologist can take samples to analyze the earth for contamination. Some were much darker than others – the color and the smell mostly are already identifiers of contamination. The recycling rule (Verwertungsregel) prescribes that 50% has to be recycled/reused and only maximal 50% can be deposited on landfills. E-material has to be deposited on landfills, T-material can be washed and recycled.





Approaching the landfill DERU AG by car you can perceive the dam already from distance. It serves on the edge of the landfill as visual protection to satisfy the neighbor. The process of initializing this landfill in Wiesendangen started in 1999 and the first deposit was in 2021. There were three federal court decisions because of objections by neighbors. There are five stages where maximum two can be open at the same time. It is planned to fill and recultivate the landfill until 2038. The landfill volume is approx. $830'000\text{m}^3$ on $110'000\text{m}^2$ where approx. $50'000\text{m}^3$ are filled up annually.

The DERU AG is a landfill type B which means that only low and slightly contaminated mineral waste from demolition and excavation consisting of at least 95% rock-like components is landfilled. The material deposit costs 52.-/t.

source: PDF 'Informationen für die Einwohner von Wiesendangen und Rickenbach zur Deponie DERU AG' (deruag.ch).









Gestaltungsplanerimeter

Deponieplanerimeter

WD 4396

WD 4388

Quasileite (ASTRA)

Einbauelemente:
 Asphalt 1 Material
 (g > 3")
 Wasserdicht
 min. 100 mm
 max. 1% Prozeßdruck

Einbauelemente:
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[illegible]

Basisaufbau 1:50

Abzählende Abfolge - Typ B
in Schichten eingebaut

Entwässerungsschicht 4,80 mm
Material gemäss VVEA Anhang 3, Ziffer 2.3
 $K_f \geq 10^6 \text{ m/s}$, Schicht 0,30 bis 0,50 m

Entwässerungsschicht
Sauberes Geröl 16/32 mm
 $K_f \geq 10^6 \text{ m/s}$, Schicht 0,05 m
 $1 \text{ m}^3 / \text{km}$

Entwässerungsschicht
PE 100-S21 dn 250 mm
Stärke 11 / PN 10 / 160 geklebt

Gewegewebe
Hot 6-Bändergewebe
150 g/m²

Basisschichtung
Stärker aus mineralischem Material
gemäss VVEA Anhang 3, Ziffer 1
 $K_f \leq 1 \times 10^4 \text{ m/s}$, Schicht 0,30 m
ansteigende Moräne,
verwehrt (aufgelockert)

The construction is reminiscent of a “fillet in dough”. It is dug down about 2.5m, where the topsoil (A) and subsoil (B) are temporarily relocated to be reused. Then a 40cm thick landfill brine is made, which is covered with a filter mat and 40cm of seepage material (4/8 gravel). In the landfill brine are installed seepage pipes to drain the landfill. On the landfill bottom the waste material is deposited, up to the desired height and finally sealed on the top with material of leachate level 10^{-8} , this can be for example filter cake of the soil washing plant. Finally, the temporarily stored subsoil and topsoil is placed on top so that the area can be returned to agriculture.

The final design is a flat area (max. 12% slope) for agricultural use with near-natural slopes on the edges. The highest point will be 8m higher than the highway next by and the appearance will be like a “nice green meadow”.

ilu AG, 2021, DERU AG.



ilu AG, 2021, DERU AG.









The Tollenmatt soil washing plant in Frauenfeld has been in operation for 13 years. The idea is to recover a product from waste. Since there is the rule that 50% of contaminated material has to be recycled, it is a good way to do so. They aim for 2024 to recycle around 75%. Economically worthy is it when there are maximal 30% fine particles in the soil. But today they wash soils with up to 45% fine particles. They wash around 50t/h and aim to wash around 100'000t per year.

The washing plant is located on a 200m by 100m area next to the train track, which allows the railroad deposit. 300m further to the east you have access to the free loading. The biggest challenge is the spatial capacity because you need a lot of space. Next by is a residential and commercial zone where people aren't very happy with the noise and the dust. In exchange they clean once a year all their windows with their lifting platform.









They wash chemically contaminated excavated material of contamination grade T, B and E as well as hazardous waste. The products obtained are sand (0/2 and 2/4) and gravel (4/8, 8/16, 16/32 and 32/80) in different sizes. Up to pollution T the gravel is „clean“ for concrete production. The slurry is washed out, as well as light materials such as slag, wood, coal, bricks, etc., anything lighter than stone. This is disposed of in a landfill and the filter cake is often taken to the cement plant as a raw meal substitute, from which cement is made by burning processes or it is used for the construction of the landfill soils.

They have two dewatering systems. One is an interceptor from which the water flows to the wastewater treatment plant (ARA). The other is a basin where residual gravel and sand is removed by settling and the water goes back into the cycle as process water. If they have too little water, they add roof water to the circuit. It circulates 300m³ of water per hour.



Since last week they have solar panels on the roof, which should cover 20% of the electricity demand. In addition, they are currently building an optical sorting plant to sort the gravel even further, according to color for example, to produce and offer high-quality products.





The pollutants mostly adhere to the smallest particles, they are consequently washed out with the sludge. The idea is to separate mud, sand and gravel from each other. This is done in the following way.

The contaminated material is tipped with a wheel loader into the vibro-bar sizer, where the largest lumps are sorted out. Parts smaller than 8 cm fall through another bar sizer directly onto the conveyor belt into the washing plant. The larger pieces are collected and broken into smaller pieces by a dredge crusher.

Entering the washing plant, the soil is first washed in a turbo washer, which can already wash out light material such as wood. A hydrocyclone separates sand, gravel and sludge. The gravel goes directly down to the settling machine, where lighter ones float on top and the heavy ones sink. This is the density sorting for the gravel. The sand is still completely separated from the sludge with a flat bottom cyclone, which is removed as a filter cake. This is pressed in the chamber filter press to get as much water out as possible to avoid paying unnecessary weight. Filter cakes, if containing heavy metals, are deposited in a landfill C, otherwise used as raw meal substitute in the cement factory (only when organically contaminated) or form the landfill brine. Heavily contaminated filter cakes, such as those containing mercury, are exported.





Density sorting of sand is done by means of a spiral sheath. The light particles go outside and are disposed of as light material, the heavy ones stay inside and are recovered as product. The middle ones are let through again until they can make up their minds. The final sorting of gravel and sand is done by sieving. In case of heavy contamination, the gravel/sand is still mixed in the attrition, where further contaminants can be washed out by friction. This step is only done if necessary.

Every 500t the material is analyzed to make sure that it is no longer contaminated. Then it is decided whether it can be used as a secondary building material or whether it will be sent to the cement plant.

The whole washing plant is controlled on a monitor. It can be switched on with only 4 clicks and switched off with one click. A total of 4-5 people are present and working on the plant.





Thursday
12.10.2023

CONSTRUCTION SITE HUBENSTRASSE 17

TESTING THE SOIL





A lot has happened at Hubenstrasse 17 since two weeks ago, when I was last here. The excavation pit already looks much bigger and deeper and the concrete wall (Rühlwand) is already half sprayed. Now they are digging continuously and spraying in stages to stabilize the excavation pit. As they excavate, they encounter different layers of soil - from earthy, to loamy, to very sandy. It is impressive that in such a small space, the earth beneath the surface is so varied. You can see the different layers well and feel the difference strongly when you take the earth in your hand.

I took soil samples of as different material as possible and tested the soil. From the tests, I would conclude that it tends to be very sandy-silty soil with little clay. To build with the excavated soil from Hubenstrasse 17, you would probably have to mix in more clay.

SEDIMENTATION TEST

The sedimentation test helps to detect the composition of the soil. The glass bottle is $\frac{1}{3}$ filled with earth and the other $\frac{2}{3}$ with water. After well shaking you let the earth settle down. The bigger grains (gravel and sand) sink faster than the smaller ones (silts and clay). The longer the water stays turbid the more clay the earth contains. Check the bottle after a while again to see how the sedimentation behaves.

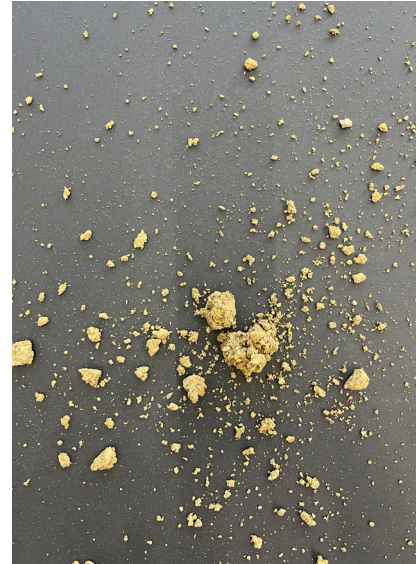




The result shows that the earth from Hubenstrasse 17 has a small clay content. The water is almost clear already after 30 minutes. After 3 hours the earthen part measures again 1/3 of the bottle.

BALL DROP TEST

Forming a ball out of the humid earth with a diameter of around 4cm and letting it fall from around 1.5m height you can observe how it breaks. Since in this case it crumbled apart into many small pieces one can assume that the earth contains only very little clay and a big amount of aggregates such as sand or gravel.





CIGAR TEST

87

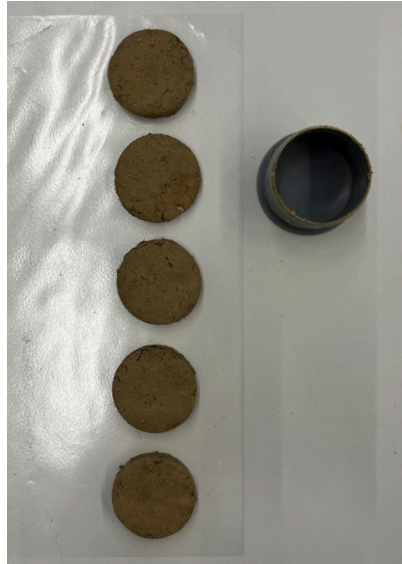
For this test the earth has to be sieved with a sieve of 4mm. Water is added to reach a plastic state of the earth where forming a cigar of 3cm diameter is possible. Push the cigar slowly towards the edge of a table. The cracked pieces should be more or less of the same length.

In this case they measure 9-13cm what signifies that the clay content is very small. To have a better cohesion you would need to add more clay.

DISK AND SHRINKAGE TEST

With the plastic earth disks are molded; 5cm in diameter and 1cm of height. After drying, you can see the shrinkage behavior and if they crack while drying. If you break a disk and it is like a cookie you can assume it is a very silty soil. If it breaks like chocolate it is a soil quite rich in clay.

To observe the shrinkage better you can form a long piece of plastic soil scratching a measure line of 10cm in it. After drying, you can measure the line again and calculate the shrinkage in percent.





SAMPLE

Working with earth it is important to test a lot and to make samples with different earth recipes to figure out the good mixture.

At the Ziegeleimuseum in Cham I had the possibility to ramm this cube. We took half clay rich soil half excavated earth and a bit of sand what we wettened a bit.

I would assume to use the earth from Hubenstrasse 17 to make rammed earth walls clay has to be added as well.



I would also like to thank Frank Denz, who took my request on the first phone call, Christoph Steiner, who spent a lot of time showing me the Tollenmatt soil washing plant, Marino and his construction site team, who always gave me a friendly welcome at Hubenstrasse, and finally Tiago for the truck trip.

All photos were taken by me, unless otherwise noted. With foreign material the source is indicated in each case.

The information in the texts is all what I was told from the various people I met, otherwise indicated.

