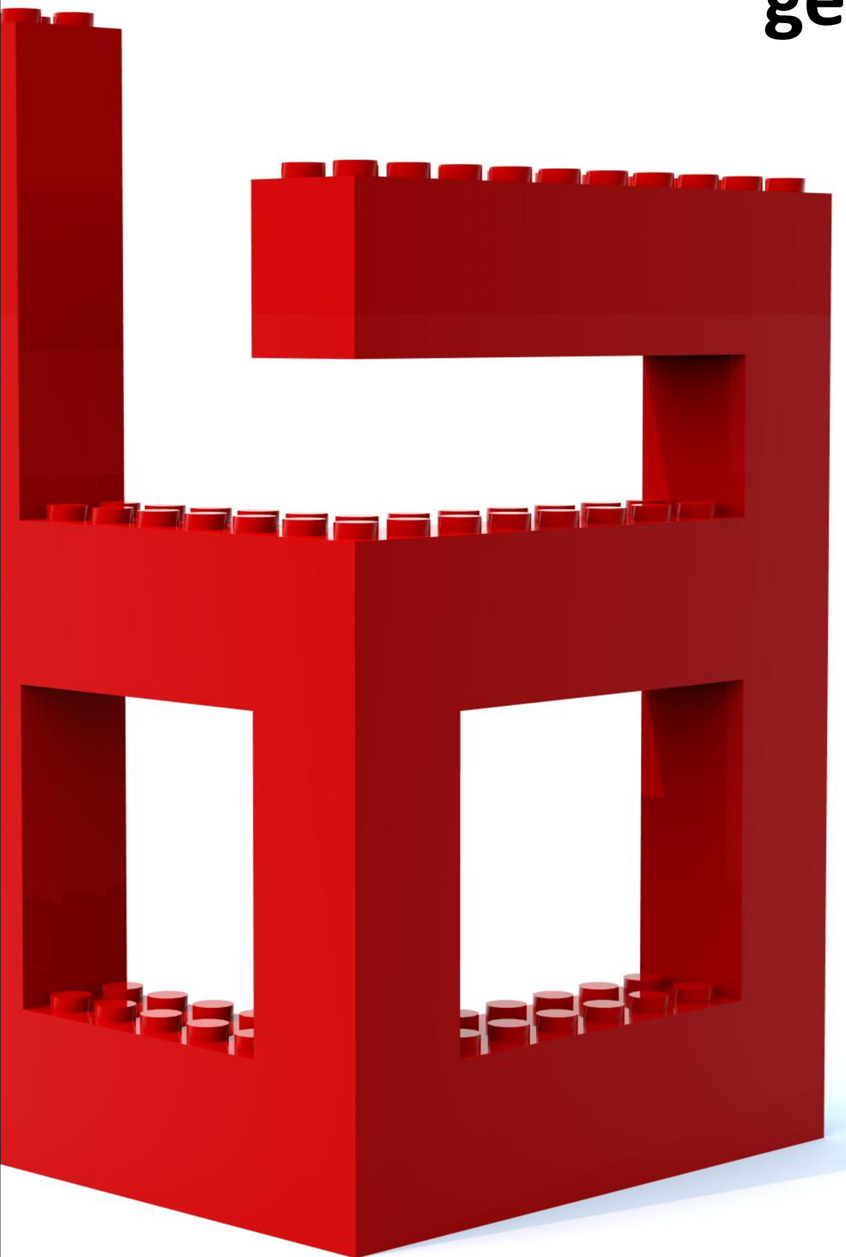
Research project
bricksapplied

Tire abrasion in german cities



1) **Classification of different dirt types in street water**
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2) **Location analysis of tire abrasion producing city areas**
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Classification of different dirt types in street water

1) Size and consequences of different particles

There are various types of particles in the street water. Those are amongst other things Leaf rests, stones, sand, wood and plastic which is present mainly as microplastic. Leaves and stones smaller than 5 millimetres, sand, small sticks and especially micropalstic enter the canalisation because it is not held back by the catchment bucket.
Sand and wood can be filtered in a sewage plant but they are not able to filter microplastic. Those particles pollute the environment and our drinking water. The most dangerous components of tire abrasion are mercaptobenzothiazol (MBT), or zincdibenzyldithiocarbamat (ZBEC). The effects of those chemicals on biology are devastating because they are so toxic. Those include toxic effects on mushrooms, seaweed, water flee and various bacteria. MBT is also very bad for the larval development of fish. It damages the cell membranes which can in the long run affect plants not being damaged directly by microplastic.

2) Density of particles for filtering the top layer of water

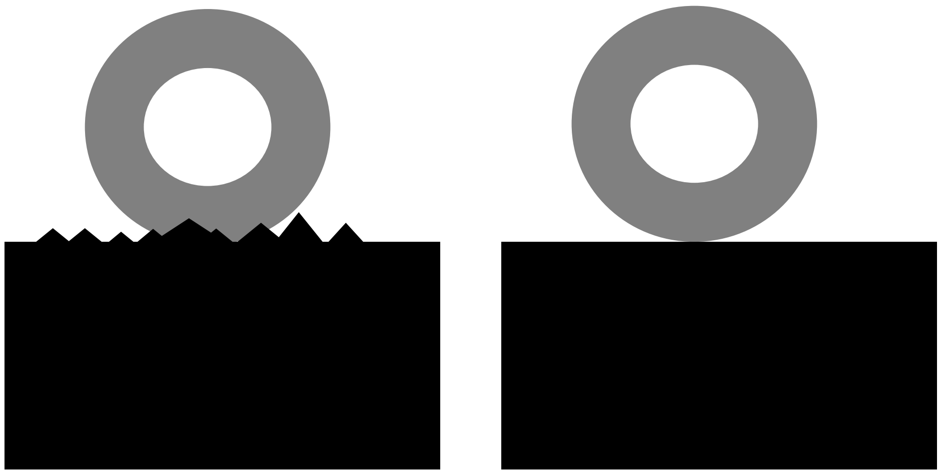
To construct a system for filtering street water with a diagonal drain it is helpful to analyse the density of the particles because this knowledge can be essential for the development of a filter system.

attribute	Leaves	Wood	Stones	Sand	Microplastics
density (kg/m³)	<1000	470-690	2000-2700	1800-2050	0,92-1,55
Size (cm²)	2-15	0,2-5	0,2-1	0,0063-0,2	0,001-0,5
occurence	Near trees	Near trees	Every where	Every where	Roundabouts, traffic lights, turns, inner cities

Location analysis of tire abrasion producing city areas

1) Number of tire particles in sewage canals of different city area

The amount of tire abrasion on a specific part of a road can differ between different city and country regions. This is dependent of the weather, the number of vehicles and the texture of the street. The amount of tire abrasion being formed on streets in good shape is different from a damaged street.



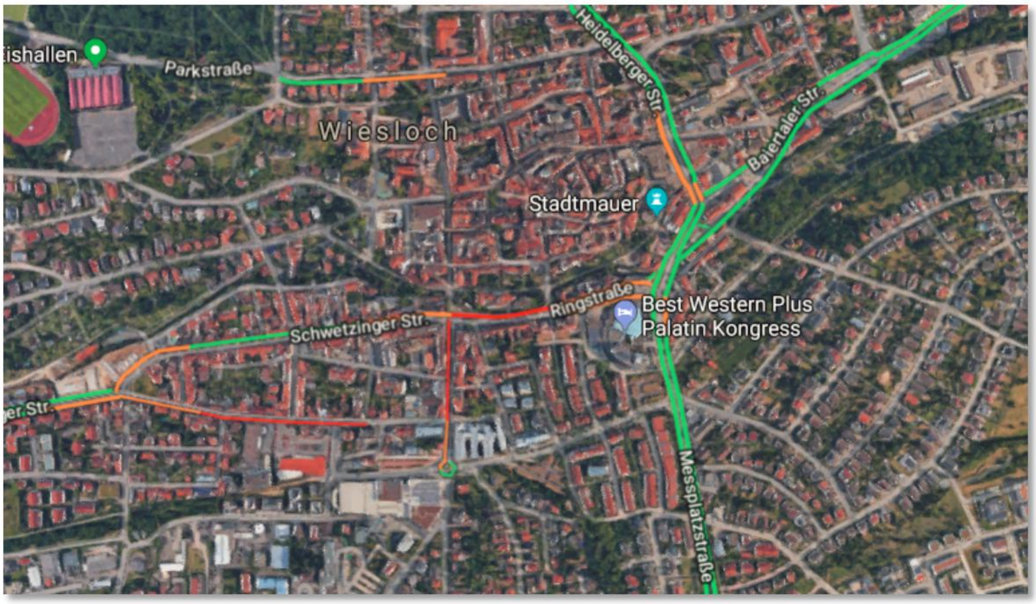
Turns also make a difference in tire abrasion bacause the wheels are exposed to a higher stress. The tire abrasion level also gets larger whenever a car breaks or picks up speed at traffic lights, crossroads and traffic jams than at a clear street. Those street parts are found mostly in large cities where the number of cars is also multiple times higher than in towns.

Concentration of tire abrasion	Low	Medium	High
Location	Straight low populated streets	City areas with few turns and some traffic lights	Roundabouts, traffic lights, turns, inner cities
Texture of the street	New streets	Older streets and gravel	Damaged or much used streets

2) Use of the street filter system in e.g. Wiesloch

The application of our street filter system only makes sense in areas which have a high grade of microplastic pollution

Wiesloch

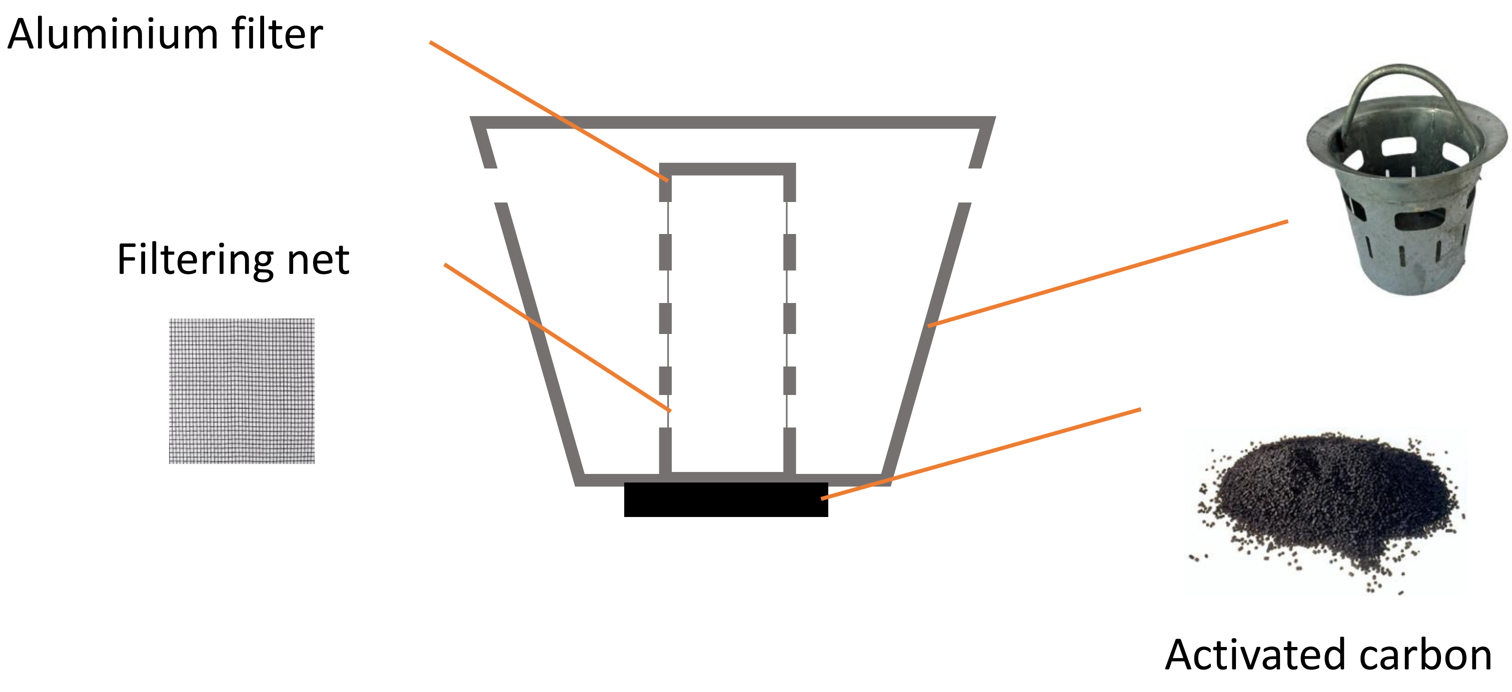


The largest streets have a high vehicle concentration and by that also a high tire abrasion. Also these streets have many traffic lights. So this area is the one where it would make sense to use our filter system:

- Heidelberger Straße
- Gerbersruhstraße
- Parkstraße
- Baiertaler Straße

Prototype with various filter layers over each other

For this filter system the street water is directed in the catchment bucket, where it rises until it flows through our holes in the perforated pipe and without bigger pollutants it is filtered by the activated carbon filter.
If leaves and mud concentrate in the bottom area of the catchment bucket, the water can still rise and flow through the filter net to prevent the filter system from being blocked.
In the rare case of a blocking and strong rain the water will rise and flows out through overflowing holes to prevent a flooding of the street.

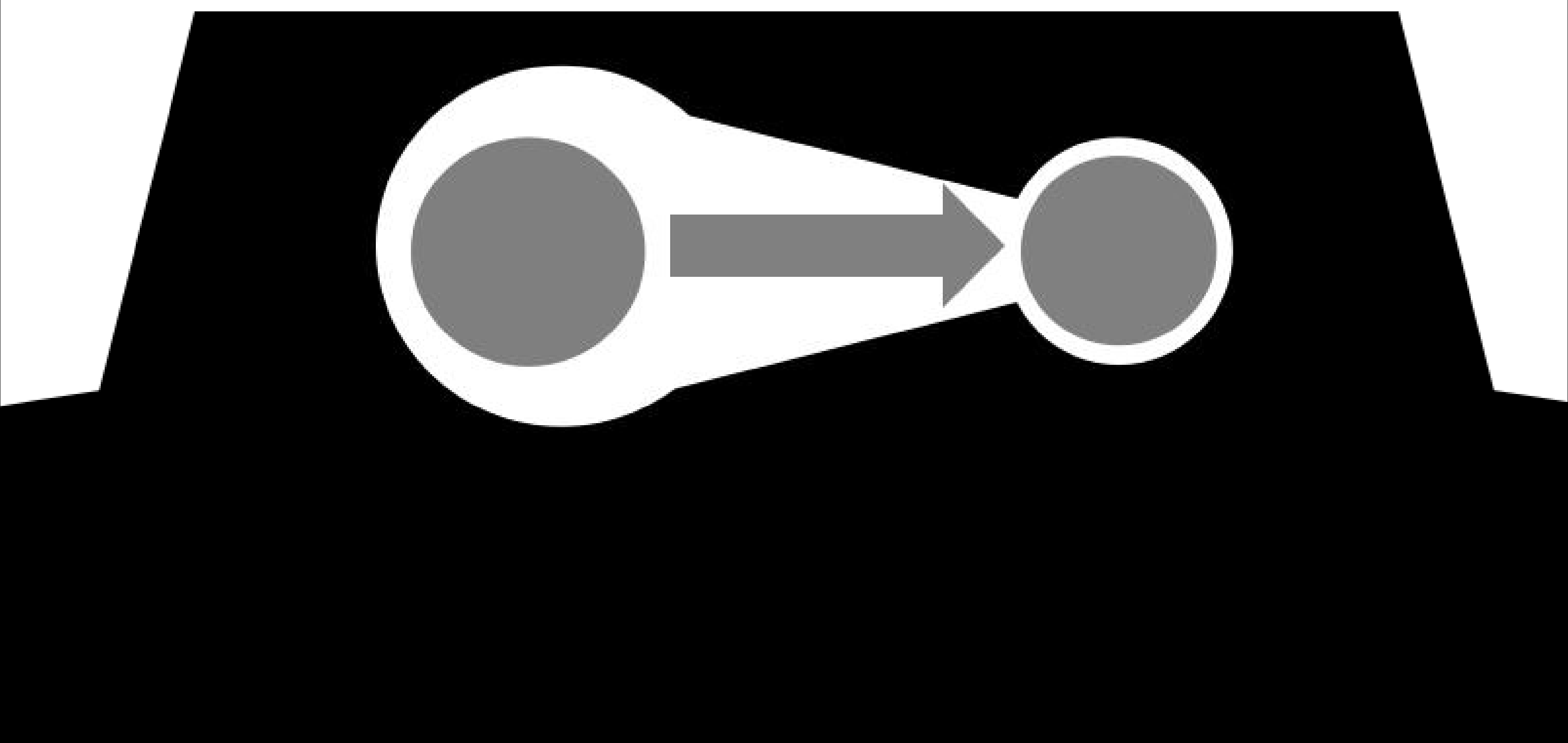


1) Activated carbon workmanship

To have the speed of water flow as high as possible you need to make the pressure larger or enhance the surface of the filter. This is why we use activated carbon filers which has up to 2000 m² of surface. Because of that the speed of drainage is high enough.

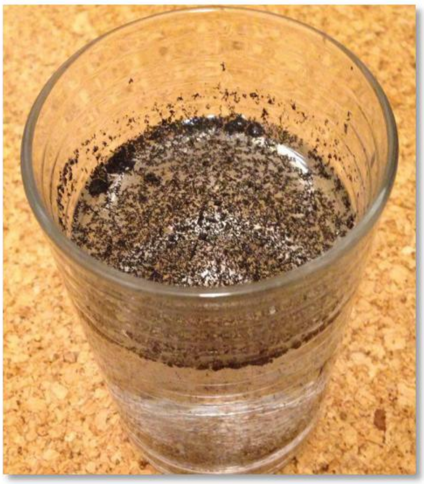
2) Easy hooking system

The cleaning of the filter is very easy because of the special hooking system for the activated carbon filter that we have developed. The filter is just pressed to the bottom of the mud fang bucket and fixated by a short turn.



Experiments with the activated carbon filter

1) Filtering tire abrasion



Material: Glass of water, tire abrasion, bowl, activated carbon filter

Structure: Fill the tire abrasion in the glass of water. Put the activated carbon filter over the bowl to catch the water.

Execution: Let the water with tire abrasion flow through the filter and catch the water after filtering.

Observation: The majority of tire abrasion get caught in the activated carbon filter. After the experiment the water is viewable cleaner.

Interpretation: Based on the turbidity of the water we found out that our filter filters 85% of the microplastic.

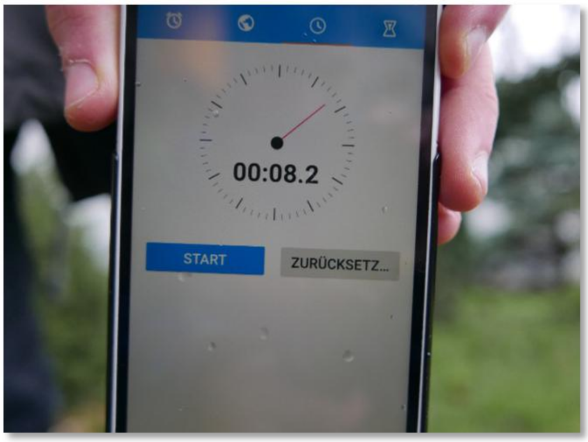
Experiments with the activated carbon filter

2) Pollution and cleaning intervals

Material:	Prototype with activated carbon filter, street
Structure:	Place the prototype in a drain
Execution:	Wait for a week and let the rain do its work
Observation:	In one week of use 50g of dirt were accumulated in the mud fang bucket.
Interpretation:	So we concluded that 2.6kg of dirt will be accumulated each year in one mud fang bucket. With the capacity of the prototype we calculated a useful maintenance rate of about 6 months. Also the activated carbon filter has to be cleaned after this time.

Experiments with the activated carbon filter

3) Flow rate



Material: Can with 1 litre of water, activated carbon filter, bowl

Structure: Place the activated carbon filter over the bowl and take the can of water.

Execution: Pour the water into the activated carbon filter and measured the time the water need to flow through.

Observation: We measured that the water needed 8.2 seconds.

Interpretation: So we concluded that the flow rate of our activated carbon filter is 7.3 litres per minute

Calculations:

Filter efficiency: ≈ 85%
Filter application: ≈ 20% of catchment buckets

→ Only appreciable ones (downtown, freeways,...)

Total efficiency: >17%

Starting from 110.000 tons on german streets we would filter 19.000 tons absolutely even we modify only 20% catchment buckets. And because they are in areas with a higher tire abrasion concentration you can assume a higher amount anyway.

Costs for whole country (Germany):

About 15,000 catchment buckets would have to be replaced in Germany. Every replacement would cost about 70 euros so it would cost only about one million euros for a nation wide replacement. Every filter reactivation costs 10 cents so the yearly costs would only be 1500 euros.

The costs of all anti microplastic street filters are in contrast to a new sewage plant **2 to 3 times more efficient**.

Calculations

Costs for Wiesloch:

To replace the filters in the city we live in (25,000 habitants/ 30 squarekilometer) about 120 catchment buckets would have to be replaced. So the cost would be 8400 euros. The total reactivation costs are only 24 euros.

Conclusion

Our filter system is the cheapest, easiest to build and most practical system possible. By using this Analysis you can employ the anti microplastic street filter systems as effective as possible. The drainage system is useful to stop floods. The filter also has the optimal cost-efficiency proportion, which enables a mass production and a large-area insertion. This a huge advantage over expensive experimental sewage plants and other solutions. Besides his solid design and well-thought-out drain system reduce the maintenance rate and effort. To make the system more popular we also programmed our own website about the street filter.

In Cooperation with:

- Mister Dallinger (highways department Heidelberg)
- Mister Kleemann (public services Wiesloch)
- Mister Venghaus (Technical University of Berlin)
- Mister Ronellenfitsch (timber yard Wiesloch
- Mister Harder (Carbon Tech AC GmbH)