FINAL REPORT

PART 2: LANDSCAPE TURFS

Investigations on outdoor sports fields with synthetic turf systems to determine wear phenomena due to fibre abrasion related to the intensity of use

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1 Initial situation

The ILOS at the Osnabrück University of Applied Sciences, together with the EMEA Synthetic Turf Council, the joint committee for synthetic turf systems (ESTC), is investigating outdoor sports facilities with synthetic turf systems throughout Europe in order to contribute to the estimation of the discharge quantities of secondary microplastics.

Following the current discussions about the ban on the marketing of primary microplastics for synthetic turf surfaces, it is to be expected that a similar discussion will also arise for secondary microplastics. In order to ensure that the discussion is not based on erroneous data, it is necessary to determine discharge quantities.

2 Method

In this study, synthetic landscape turfs are investigated. Sites in Belgium were provided as locations for synthetic landscape turf. The studies are conducted on areas in the public domain, such as playgrounds, or on facilities in the private domain, such as gardens. Again, the selection of the areas is made by the ESTC. These systems were installed between the years 2009 and 2017. The classification of the investigated turfs is based on the type of use, not on the type of product. A distinction is made between residential garden us and recreational play us.

The following general data were included for the present study, as far as they could be obtained:

- Name of the site
- Address
- Synthetic turf system
- Synthetic turf type
- Age or year of construction
- Main use
- Infill system or type
- Photo documentation

In addition, the following measurement parameters were recorded for the study, as far as they could be determined:

- Pitch dimensions in m
- Area of the pitch in m²

- Pile height above the base fabric in accordance with FIFA TM 29
- Infill height of the infill material according to FIFA TM 21
- Stich spacing in stich rows according to FIFA TM 28
- Stich row spacing in accordance with FIFA TM 28
- Number of threads per nap
- Nap weight
- Total thread length per nap by estimation

These data are kept internally at ILOS and are only used in this study if significant differences or other assertions can be proven. Complete documentation is not provided here. This also ensures that no conclusions can be drawn about products or manufacturers.

2.1 Sampling and testing in the field

Step 1: Determination of the test sites

Two measuring points were selected for the investigations of landscape turf to enable a differentiation between intensively and extensively used areas as far as possible. For this purpose, one sampling point was always chosen at the edge of the area, where the signs of wear were obviously lowest. The second sampling point was chosen where the most activity was obviously to be expected.

Step 2: Cutting off the fibre bundles

The exposed fibre bundles were cut directly above the backing fabric using nail scissors and bagged in reusable bags (see figure 1). 20 fibre bundles were taken per sampling site.

Figure 1: Fibre removal

2.2 Performance and measurement in the laboratory

The laboratory measurements were carried out for all fibre samples under constant conditions in the laboratory for soil mechanics at the Osnabrück University of Applied Sciences (see figure 2). To ensure uniform temperature and humidity, the fibres were conditioned beforehand. For this purpose, the fibres were stored in the laboratory and dried before weighing.

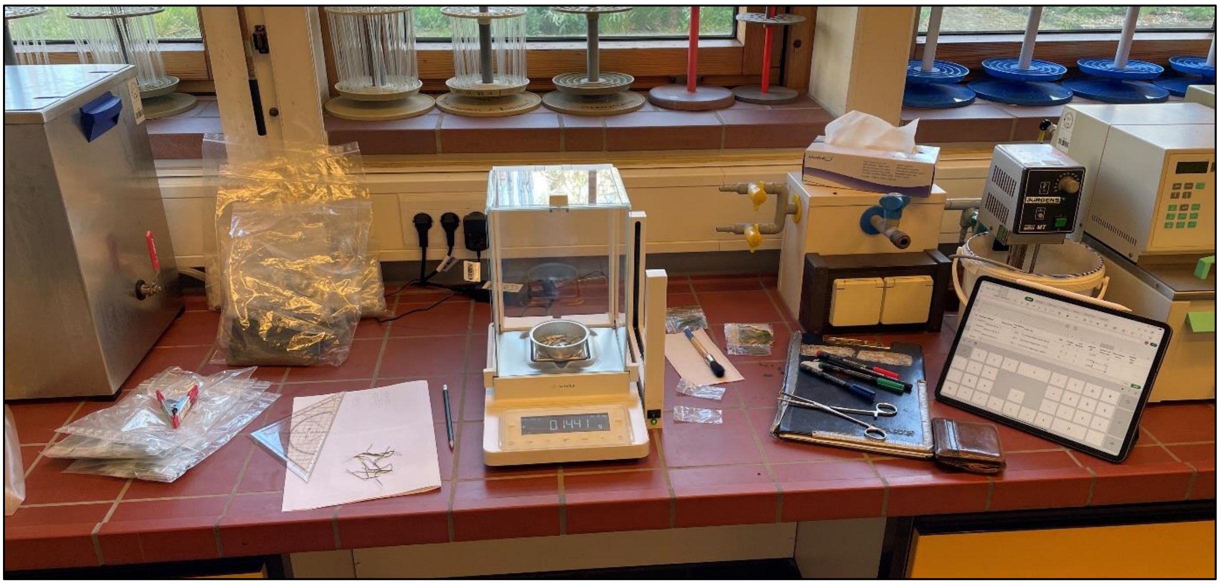

Figure 2: Work in the laboratory

Step 1: Removing the fibre

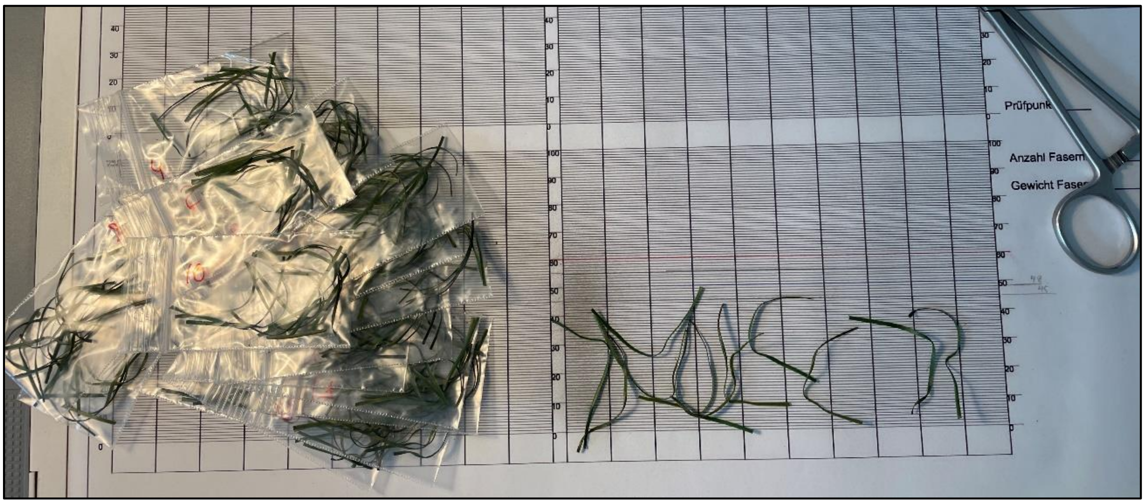

Figure 3: Removing the fibres

In the first step, the fibre bundles were removed from the reusable bags and checked for completeness (see figure 3). Subsequently, the fibres were cleaned of any residues and thus prepared for weighing.

Step 2: Weighing with an analytical balance

The cleaned and conditioned fibre bundles were weighed with an analytical balance under laboratory conditions (see figure 4) and the results were documented.

Figure 4: Analytical balance

2.3 Evaluation of the data

The fibre wear was determined using the weight of the individual fibre samples. Assuming that the intensity of use influences fibre wear, the following intensities of use are assigned to the sampling points of the football pitches:

Sampling point 1 → extensive use, control area

Sampling point 2 → intensive use

Point 1 was defined as a control point, based on the assumption that no use takes place within the area of sampling point 1 and consequently no fibre wear/mass loss is to be expected at this point. Accordingly, the weights determined from sampling points 2 were always compared with this point.

2.4 Error analysis

To better classify the data obtained, it is important to point out possible sources of error and their evaluation.

In a preliminary investigation, random samples of one square meter of a new, unused artificial turf were examined using the method described. In the process, 1,500 fibre bundles were weighed. The coefficient of variation of the results of this preliminary investigation is 3.4% with an outlier rate of 4.2%. The large scatter already present within a new artificial turf reduces the statistical robustness of the data obtained in this study.

The assumption that there is no abrasion at sampling point 1, which serves as the control point, is not correct. Landscape turf is very difficult to divide into extensive and intensive used areas because of the highly individualized use. Broken and worn fibres are also found at sampling point 1. Even if the missing fibres in the control point are included, the calculated mass losses are less than the actual mass losses. The actual mass loss at the control point cannot be determined by this method. Using the manufacturer's specifications as a control point is not useful because they have a tolerance of +/- 10%.

Another source of error is the cutting of the bundles above the backing fabric. Due to the dense tufting, some bundles may not be cut completely horizontally directly at the base fabric. Since this source of error is present at each sample point, it contributes to the increase in variance, but has little effect on the calculated mass losses. Alternative methods, such as drawing the fibres, have greater sources of error because the loops below the backing fabric are different. Since the pile layer is cut at a uniform height above the backing fabric during production, cutting above the backing fabric is preferable.

3 Evaluation of the synthetic landscape turfs

Figures 5 to 11 show the results for the synthetic landscape turf, which is assigned a residential use. In contrast, Figures 12 to 15 show the results for a landscape turf that serves a recreational play use. The intensively used areas (orange) are compared with the extensively used areas (green). To estimate the scatter of the results, the results are presented with the help of box plots.

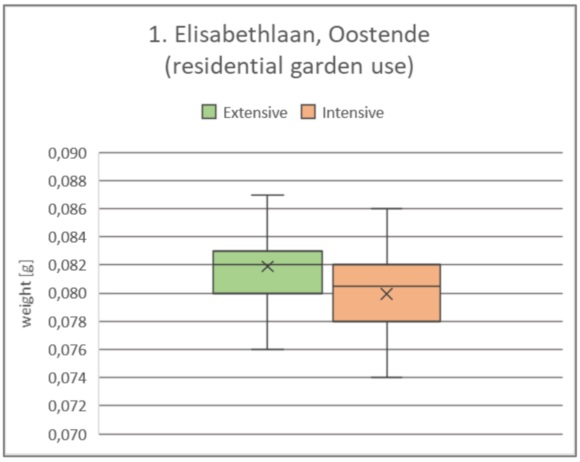

Figure 5: Distribution of the determined fibre bundle weights Belgium 1

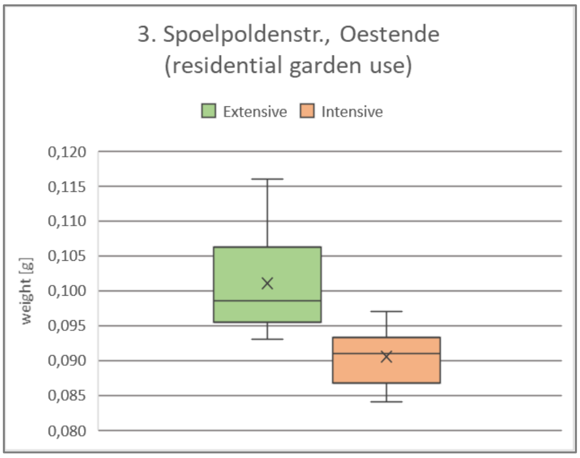

Figure 6: Distribution of the determined fibre bundle weights Belgium 3

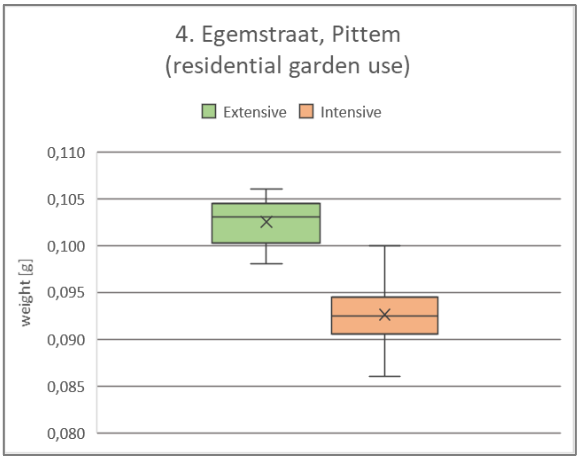

Figure 7: Distribution of the determined fibre bundle weights Belgium 4

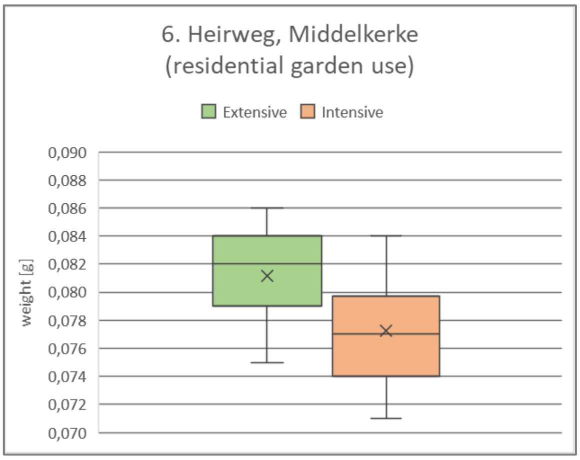

Figure 8: Distribution of the determined fibre bundle weights Belgium 6

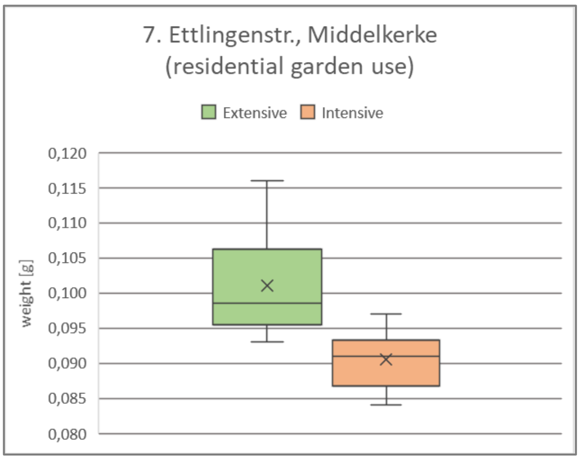

Figure 9: Distribution of the determined fibre bundle weights Belgium 7

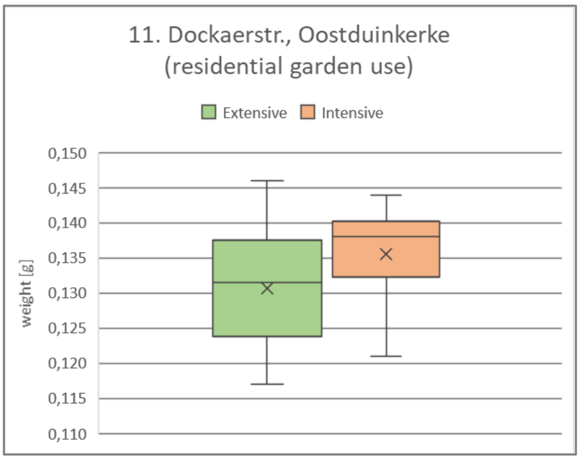

Figure 10: Distribution of the determined fibre bundle weights Belgium 11

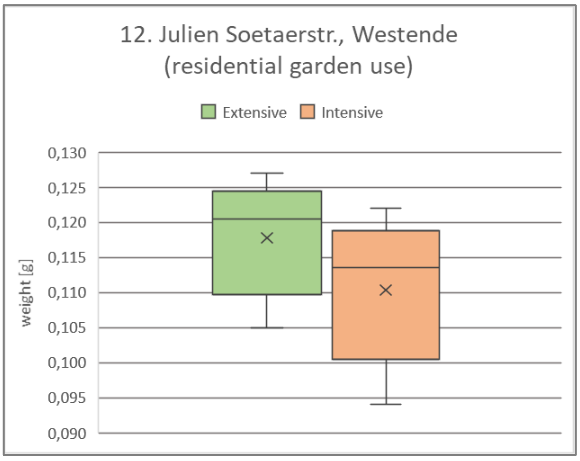

Figure 11: Distribution of the determined fibre bundle weights Belgium 12

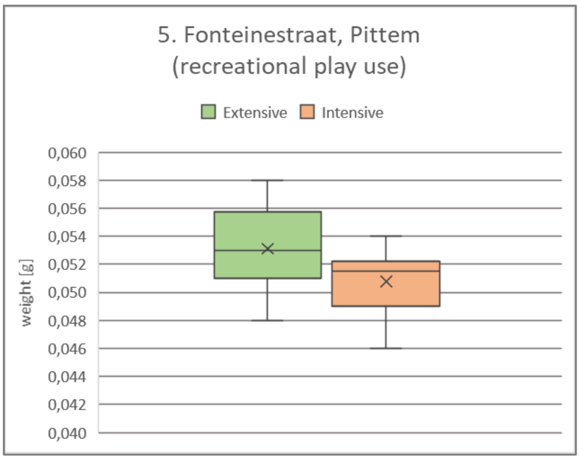

Figure 12: Distribution of the determined fibre bundle weighst Belgium 5

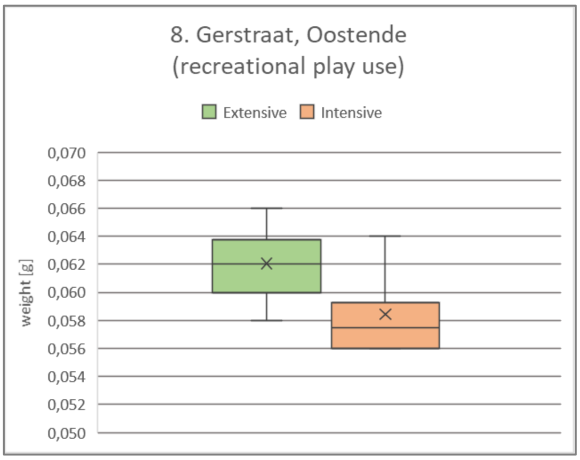

Figure 13: Distribution of the determined fibre bundle weighst Belgium 8

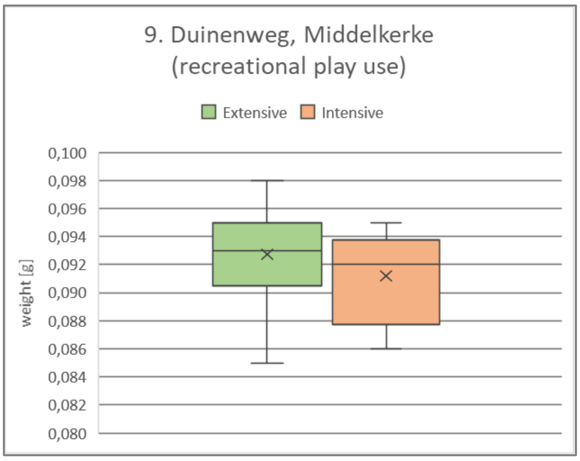

Figure 14: Distribution of the determined fibre bundle weighst Belgium 9

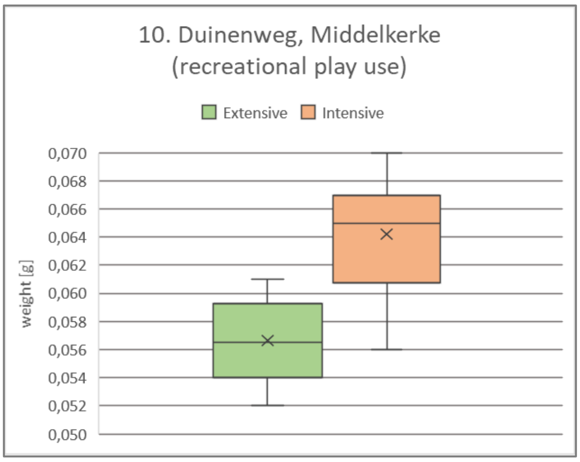

Figure 15: Distribution of the determined fibre bundle weighst Belgium 10

The following figure shows the differences of the average masses between intensively and extensively assigned test points. On the y-axis the difference is given as mass loss in %. On the x-axis the age of the turfs. A distinction was made between residential garden use (blue) and recreational play use (orange).

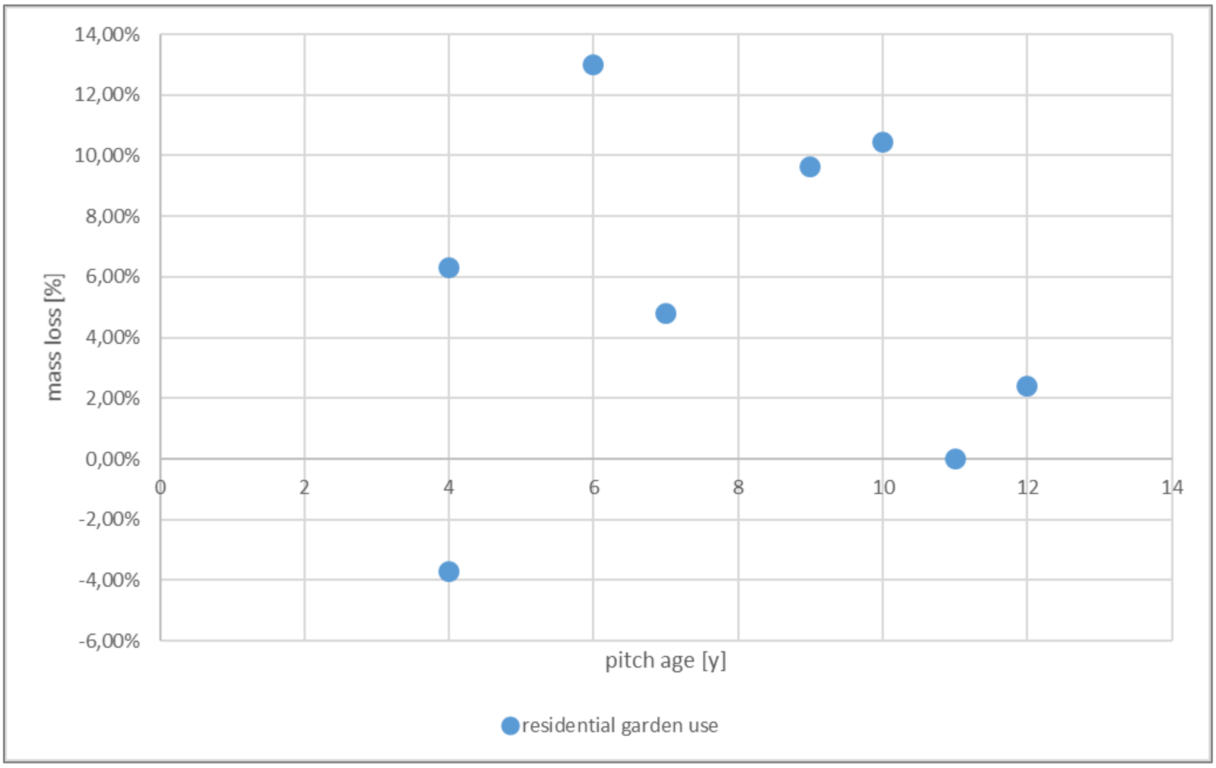

Figure 16: Total fibre wear on areas of synthetic landscape turf (residential garden use)

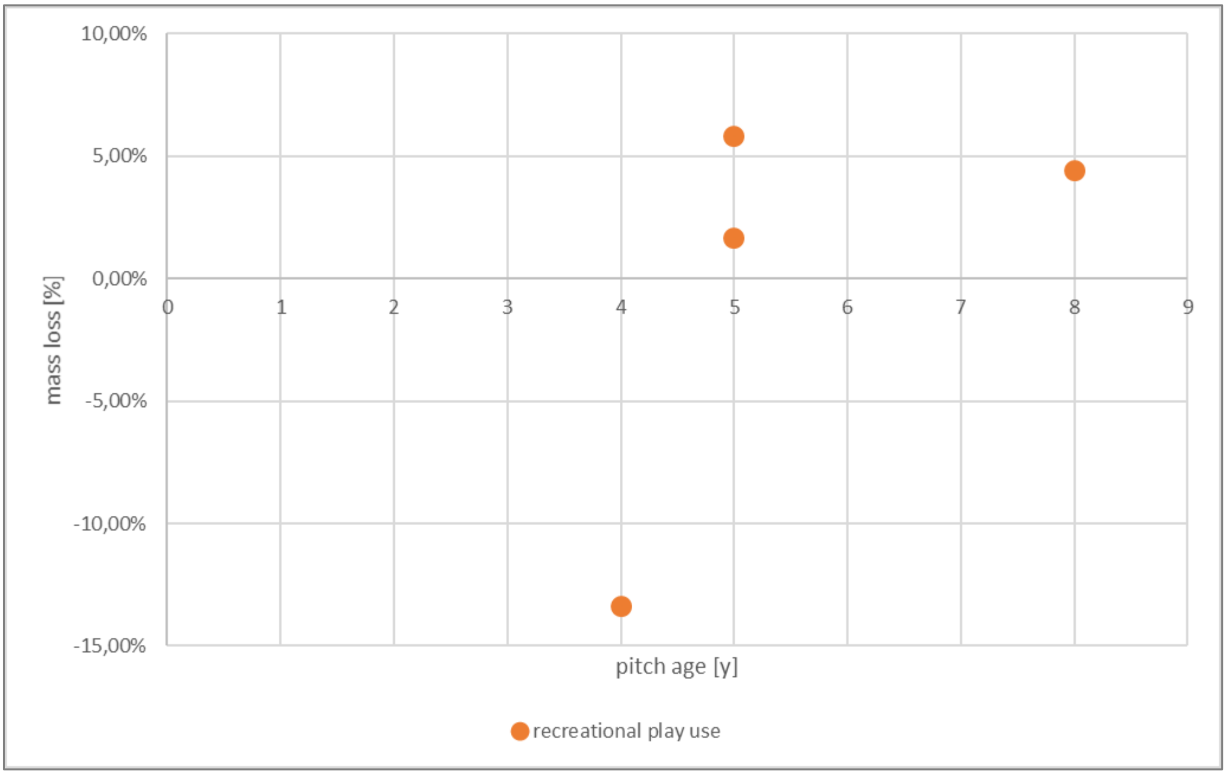

Figure 17: Total fibre wear on areas of synthetic landscape turf (recreational play use)

Table 1: Comparison of the determined fibre wear on areas of synthetic turf in Belgium

No.	Place	Age [y]	Loss [%]	Loss per year [%/y]	Coefficient of variation [%]
	residential garden use				
B1	Elisabethlaan 366 8400 Oostende	12	2,38%	0,20%	3,40%
B2	Dockaerstraat 31 Nieuwport	11	-	-	-
B3	Spoelpolderstraat 1 8400 Oostende	10	10,46%	1,05%	5,60%
B4	Egemstraat 92b 8740 Pittem	9	9,63%	1,07%	3,20%
B6	Heirweg 23-24 8430 Middelkerke	7	4,81%	0,69%	4,10%
B7	Ettlingenstraat 9 8430 Middelkerke	6	13,00%	2,17%	11,50%
B11	Dockaertstraat 39 8670 Oostduinkerke	4	-3,72%	-0,93%	5,40%
B12	Julien soetaertstraat 4 8434 Westende	4	6,32%	1,58%	7,20%
	recreational play use				
B5	Fonteinestraat 20 8740 pittem	8	4,42%	0,55%	4,70%
B8	Gerststraat 109 8400 Oostende	5	5,84%	1,17%	4,10%
B9	duinenweg 509 8430 Middelkerke	5	1,64%	0,33%	3,80%
B10	duinenweg 509 8430 Middelkerke	4	-13,37%	-4,46%	5,20%

4 Discussion of the results

The synthetic turf B2 in Nieuwport was not considered in the evaluation because it is a clear outlier with a coefficient of variation of > 40 % and a mass difference of about 50 %. In total, eleven surfaces were evaluated.

The measured fibre masses from the intensive areas are, with two exceptions, lower compared to the fibre masses from the extensive areas. From this observation, a use-intensity-dependent mass loss can be concluded. The observed masses within a measuring point scatter strongly. They show coefficients of variation comparable to those observed on sports pitches (cf. Part 1: sport fields). The percentage mass loss is slightly higher than on synthetic turf systems for football. This is not necessarily to be expected due to the low intensity of use, but can probably be attributed to the higher tuft density combined with lower yarn weight and less infill. No major differences can be observed in the comparison between residential garden use and recreational play use. In general, no statistically reliable statements can be made about factors influencing mass loss. Due to the small number of sites and their high dispersion, no tendencies are recognizable. For this reason, a regression curve is not used in the evaluation, so that no erroneous impression is created.

A problem with the transfer of the method presented is the definition of the measuring points. It is difficult to define intensively and extensively used areas in a private garden. It could make sense to increase the number of measuring points and to only allocate them to different intensities of use retrospectively, when evaluating the results.

To be able to make qualified statements about influencing variables, such as the age of the site, the type of use or product-specific properties, a larger test matrix is required, with significantly more sites, which exhibit a higher variability.

5 Summary

The aim of this study was to determine the fibre wear and degradation of artificial turf systems. For this purpose, fibre samples were taken in areas with different intensity of use within the systems and weighed in the laboratory.

An average loss in mass of 5% was observed for the courses studied, without considering the two negative values.

The data obtained for landscaping turf do not suggest a relationship between mass loss and type of use, as well as age of the turf. This is due, among other things, to the small number of turfs examined, the high variation within a measuring point, and the widely differing product types.

Further investigations are necessary to be able to make valid statements.

Osnabrück, October 2023

Prof. Martin Thieme-Hack

6 Literature

Fédération Internationale de Football Association (FIFA) (Hg.) (2022): FIFA Quality Programm for Football Turf. Test Manual I – Test Methods.

Müller, Benjamin (2018): Entwicklung einer Prüfmethode zur Bestimmung des Austrags von Mikroplastik aus Kunststoffrasensystemen. Hochschule Osnabrück, Osnabrück. Fakultät Agrarwissenschaften und Landschaftsarchitektur.