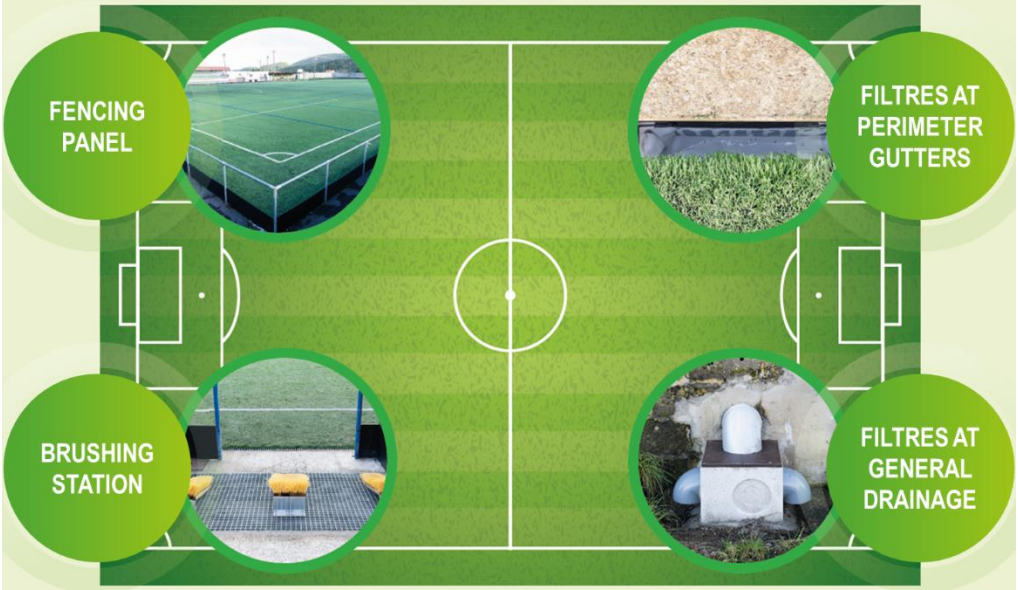
SIGNUS
SISTEMA COLECTIVO DE GESTIÓN DE NEUMÁTICOS FUERA DE USO

MONITORING OF AN ARTIFICIAL TURF FOOTBALL PITCH WITH RECYCLED ELT RUBBER INFILL

Assessment of risk management measures to prevent the release of microplastics



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April 2022

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1. BACKGROUND

The European Chemicals Agency (ECHA) is working on behalf of the EU on a new restriction proposal for intentionally-added microplastics in order to reduce their releases into the environment [1]. This restriction would, among other applications, restrict the use of polymeric infill (0.5 - 2.5 mm) in artificial turf sports surfaces as being considered microplastics (< 5 mm). End-of-life tyre rubber (hereafter ELT) as infill material provides the best playing surface and the highest level of safety for players, as well as the maintenance of such sports surfaces is done in a sustainable way.

ECHA's final opinion published in June 2021 envisages two scenarios:

a) A conditional derogation to the implementation of risk management measures to reduce the release of microplastics on artificial turf pitches. It is proposed to do this immediately for the installation of new pitches, and within 3 years from the publication of the proposal, for all existing pitches.

b) A full ban on their use with a transition period of 6 years.

The total ban on the use of rubber granulate as infill for artificial turf football pitches will have a direct impact on ELT granulation and recycling plants, on companies linked to artificial turf (manufacturers and installers) and on the sports entities that use it (mainly local councils). This is reflected in the study "Socio-economic analysis of the potential impact on the rubber granulate sector of the ECHA proposal" that SIGNUS commissioned to PricewaterhouseCoopers Asesores de Negocios, S.L. in November 2020 [2]. This study shows that, to date, there is no alternative for infill outside the definition of microplastics that can meet the same performance and safety requirements, and/or that cannot be used in all types of climate [3], and furthermore, no alternative can achieve the environmental benefits of ELT recycling. In addition, the study states that there are currently no recycling alternatives to compensate for the loss of approximately 50% of the market share of ELT-derived rubber used as infill material in the case of Spain. As a result, 77,670 tonnes of ELT (tonnes used as infill for artificial turf pitches in 2019), equivalent to 10.5 million passenger car tyres, would have to be sent for energy recovery [4], incineration or, in the worst case, long-term storage.

The recycling and end-of-life tyre management industry is strongly in favour of controlling the release of microplastics on artificial turf sports fields to reduce their impact on the environment. The release can be effectively prevented, both in terms of technical implementation and costs. The implementation of risk management measures on artificial turf pitches, such as those included in the technical report CEN/TR 17519 [5], will not only control 97% of the microplastics released into the environment [6], but also further contribute to the objectives of the European Green Deal, the Circular Economy Action Plan and Sustainability, as it is the main application of ELT rubber granulate to date [7].

However, there are doubts about the effectiveness of these risk management measures. In order to obtain more information on this, SIGNUS has launched a project to monitor an artificial turf pitch in order to evaluate the effectiveness of such measures.

The success of this project will generate relevant information that will help to clarify the existing doubts about the impact of the use of rubber granulate as infill material on the environment.

2. OBJETIVES

The aim of the project is to **evaluate the effectiveness of risk management measures (RMM) to prevent the release of infill material from artificial turf football pitches into the environment**.

For this purpose, two artificial turf pitches are being monitored, one on which risk management measures have been implemented (study pitch) and one on which no modifications have been made and which serves as a reference (control pitch). This will **determine the amount of infill that is typically lost from artificial turf football pitches**, as well as the amount that is prevented from being released into the environment due to the risk management measures implemented.

The project has been carried out in collaboration with the *Instituto de Biomecánica de Valencia* (IBV) and *Oziona Soluciones de Entretenimiento, S.L.* (Oziona). Work began in June 2021 and is scheduled for completion in November 2022, with a 10-month duration for monitoring pitch.

3. RISK MANAGEMENT MEASURES IMPLEMENTED

3.1. Selection of the pitches

The criteria considered for the selection of the artificial turf pitches for the study are:

- Location in adverse weather conditions (rain and wind).
- Federated eleven-a-side football pitches
- Recently constructed pitches

According to these criteria, two artificial turf eleven-a-side football pitches have been selected in Galicia:

- *A Guía* (Carreira, Ribeira) built in 2017, where the RMM have been implemented (**study pitch**).
- *Manuel Regueiro* (La Estrada) built in 2020, which is taken as a pitch reference without RMM (**control pitch**).

Image 1: Location of the study football pitch.

3.2. Identification of RMM and estimation of implementation costs

An exhaustive analysis of the studies carried out so far was carried out in order to identify and implement the tasks and measures required for the execution of this study. For the identification and definition of the RMM, the study carried out by Ecoloop in Sweden [8] was taken as a reference, focusing on the monitoring of the infill material collected by these measures.

The RMM have been defined taking into account the following points of loss of infill material:

1. Players
2. Water drainage systems
3. Pitch perimeter

In addition, maintenance machinery has been identified as one of the elements contributing to the release of infill material outside the perimeter of the pitch. Although this measurement is not considered in this study, as it is not a question of quantifying the effect of a RMM but rather a recommendation of good practice in the equipment cleaning, the necessary instructions have been given to the technicians to clean the machinery and equipment after maintenance tasks.

The implementation of the measures has been carried out by Oziona, an artificial turf installation company.

The approximate implementation costs of this study are shown below.

Table 1: Approximate implementation costs of the RMM.

RMM measure	Approximate cost (€)
Brushing station	5,300
Water drainage system filters*	3,600
Fencing panels (~160 m)	14,000

*It includes the filters of the drainage gutter manholes around the pitch and the general drainage (manhole + filters).

In this case, the total cost of the RMM undertaken is approximately 23,000 €, which is substantially lower than the cost associated with the installation of a new pitch. According to the socio-economic analysis report prepared by PricewaterhouseCoopers [2] this is between 100,000 and 200,000 €, depending on the size and configuration of the pitch.

It should be noted that, in the case of Spain, there are currently no specialised companies offering the implementation of this type of measures, so these costs should be taken as a guideline and may be reduced. Furthermore, these costs depend on various parameters (materials, market in different countries, labour cost, etc.), above all related to the level of specialisation of the sector.

3.3. Description of the RMM implemented

The RMM implemented in the pitch of A Guía (Carreira, Ribeira) are detailed below.

3.3.1. Brushing station

A brushing station for boot cleaning has been implemented at the entrance-exit of the pitch, consisting of a pit with a lining made up of a metal grid with 4 brushes fixed to the ground. Barriers have also been placed on the sides of the pit to prevent the loss of material during boot cleaning.

Image 2: Brushing station at the entrance-exit of the pitch.

3.3.2. Water drainage system

The infill material can be carried away by rainwater or irrigation water. The following is a description of the RMM implemented in the drainage system:

- **Drainage gutter manholes**: these are the manholes that are located in the perimeter gutters of the pitch. In total there are 10 manholes with filter to retain particles larger than 100 µm.

Image 3: Filters of 100 µm installed in the perimeter gutters.

- **General drainage manifold:** outside the pitch facilities at the general drainage, a manhole with metal filters to retain particles larger than 100 µm has been built. At this point all the drainage lines of the pitch come together and the water is discharged into the external sewage system. The reason for using metal filters is to prevent the water pressure from damaging the sieves.

Image 4: Manhole and filters of 100 µm at the general drainage.

As mentioned below, the general drainage is being redesigned in order to increase its draining capacity, which has been reduced by the installation and clogging of filters.

3.3.3. Fencing panels

A 50 cm high polyethylene fencing panel has been installed along the entire pitch perimeter, properly sealed in the area in contact with the ground. This fence will prevent the loss of material to the outside due to the effect of rain and wind.

Image 5: Fencing panels installed on the pitch perimeter.

3.3.4. Changing room containers

A container has been placed in each of the changing rooms for the collection of particles that may be placed inside players' boots and clothing.

Image 6: Container in the changing room for the collection of particles placed inside players' boots and clothing.

3.4. User awareness actions

In order to communicate and raise awareness of the project, two informative posters have been prepared and placed at the entrance to the facilities and at the entrance to the changing rooms.

Image 7: Project information poster at the entrance to the facilities.

Image 8: Project information poster at the entrance to the changing rooms.

4. MONITORING PITCH PROCEDURE

The sampling plan and the analysis of the samples are described below.

4.1. Quantification of the infill material release

For both pitches, the control pitch (without RMM) and the study pitch (with RMM), sampling has been carried out in different points of the pitch (specifically 5, corresponding to the test points of the FIFA handbook) with the aim of quantifying the mass of infill material per square metre present in the pitch at the beginning and at the end of the study.

Therefore, the average in kg/m^2 of infill material for the points studied is obtained by quantifying the released infill as:

$$\mathbf{Infill_{released}} = \mathbf{Infill_{initial}} + \mathbf{Infill_{refill}} - \mathbf{Infill_{final}} - \mathbf{Infill_{retained}}$$

where:

- **Infill$_{initial}$**: the estimate of the total infill material present in the pitch at the start of the project based on the rubber granulate extracted in the sampling carried out.
- **Infill$_{refill}$**: the total amount of infill material that is added into the pitch as refill during the project.
- **Infill$_{final}$**: the estimate of the total infill material present in the pitch at the end of the project based on the rubber granulate extracted during the sampling.
- **Infill$_{retained}$**: the total amount of infill material retained in the risk management measures during the project.

4.2. Monitoring pitch

The monitoring study has a duration of 10 months (January – October 2022). During this period, samples will be taken and data will be recorded in terms of weather and playing hours as explained below:

- **Weather conditions will be registered** during the project in order to have accurate information on rainfall and wind conditions.
- **Registration sheets** have been made available to the pitch personnel to quantify the hours of use of the pitch, to record the maintenance operations carried out and, if necessary, to report the cleaning operations.
- **Routine sample collection:** samples shall be taken at a frequency of **once a month** at the following points.

Table 2: Routine sample collection.

	Sampling point		Sampling frequency
1	Brushing station		Once per month (10 samples in total)
2	Drainage gutter manholes		
3	General drainage manifold		
4	Changing room containers		Once during the 10 months

- **Occasional sample collection**: during certain **training sessions**, samples are collected in the brushing station and in particular containers placed in the changing rooms, registering the pitch conditions (dry, wet – irrigation, or wet – rain).

- **Pitch perimeter**: the loss of material prevented by the fencing panels **will not be directly quantified**. Some of this material will end up in the gutters (and therefore be collected in the different filtering systems) and the rest will return to the pitch (as it is contained within the playing area).

4.3. Sample characterisation

The **characterisation process of the samples** is as follows:

1. Weighing of the total dry mass of the initial sample.
2. Separation and quantification of the artificial turf fibres present in the sample.
3. Weighing of the total dry mass of the sample after removal of the artificial turf fibres.
4. Separation of larger impurities from the rubber infill.
5. Washing of the rubber infill sample to remove small impurities and sand.
6. Drying of the rubber infill sample in an oven at 70ºC ± 5ºC until a mass reduction of the sample of not greater than 1 ± 0,1 g has been achieved.
7. Weighing of the total dry mass of the rubber infill sample.
8. Particle size distribution analysis of the rubber infill sample[1]: particle size distribution curve and percentage retained on each sieve.

After sample characterisation, the following information is obtained:

- Mass and photo of the initial sample
- Mass and photo of the rubber infill fraction
- Mass and photo of the artificial turf fibre fraction
- Particle size distribution of the rubber infill fraction
- Photo of the other impurities fraction

[1] EN 14243-2:2019 - Materials obtained from end of life tyres - Part 2: Granulates and powders - Methods for determining their dimension(s) and impurities, including free steel and free textile content.

Rubber infill

Sand

Artificial turf fibres

Small particles of artificial turf fibres

Impurities

Image 9: Separation of the sample into the different analysed components.

5. PRELIMINARY RESULTS

5.1. Initial measurement of the infill contained in the pitches

Once the risk management measures were implemented, **sampling were carried out at the end of October 2021 in both the study and control pitches**.

The steps carried out for the sampling are described below:

- Five points are selected in the pitch according to the test points given in the FIFA handbook.
- At these points, a square area of 50 cm on each side is delimited with a tape, as shown in Image 10.
- Once the area has been marked out, the rubber infill material, sand and possible impurities are vacuumed up using an industrial hoover so that the artificial turf carpet is not affected.

Image 10: Sample collection by vacuum with an industrial hoover.

A first analysis of the initial sampling suggests that the variability of the amount and proportion of rubber–sand will be greater than the possible variations due to infill release. A second sampling is planned for the middle of the monitoring period.

5.2. Resolution of incidents

After the implementation of the RMM and during these months of project, maintenance work has been carried out on the installed measures, as well as some of them have been improved: fixing and sealing the fencing panels, re-designing the general drainage manifold, etc.

Among these incidents, it is necessary to mention the clogging of the filters of the general drainage manifold, mainly due to the accumulation of fine particles of polyethylene fibres from the artificial turf, which in short periods of heavy rain causes the flooding of part of the pitch due to the lack of drainage capacity.

Image 11: Clogging of the filters of the general drainage manifold during short periods of heavy rain (left) and marking on the fencing panels of the water level reached during flooding (right).

Image 12: Clogging of the filters of the general drainage manifold mainly due to the accumulation of fine particles of polyethylene fibres from the artificial turf.

The general drainage manifold is currently being improved in order to increase its drainage capacity and to prevent microplastics from the artificial turf filament clogging the filters.

5.3. Preliminary results of sample characterisation

The results of the analysis of the samples collected in February and March are presented below.

As can be seen in the following tables, the major component is the rubber granulate used as infill, but there is also a significant amount of fine particles and polyethylene filaments from the artificial turf fibres.

Table 3: Results of the analysis of samples collected in February.

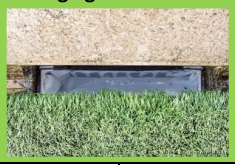
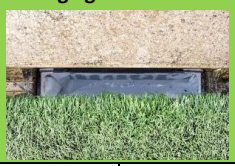
Preliminary results (February 2022)	**Drainage gutter manholes** 		**General drainage manifold** 		**Brushing station** 	
Components	**mass (g)**	**(%)**	**mass (g)**	**(%)**	**mass (g)**	**(%)**
Rubber granulate	932.5	49%	204.7	47%	422.4	60%
Artificial turf fibre (polyethylene)	348.2	18%	99.4	23%	6.1	1%
Sand	502.1	26%	110.2	25%	227.4	32%
Humidity + loss of material during the separation process	105.8	6%	15.1	3%	32.0	5%
Impurities	32.0	2%	8.3	2%	16.7	2%
Total sample mass	**1920.7**	100%	**437.7**	100%	**704.6**	100%
Total rubber granulate (1.560 g)	**59.8%**		**13.1%**		**27.1%**	
Rubber particle size distribution	(0.8-2.5) mm		(0.315-2.5) mm		(0.8-2.5) mm	

Table 4: Results of the analysis of samples collected in March.

Preliminary results (March 2022)	**Drainage gutter manholes** 		**General drainage manifold** 		**Brushing station** 	
Components	**mass (g)**	**(%)**	**mass (g)**	**(%)**	**mass (g)**	**(%)**
Rubber granulate	976.9	54%	325.7	62%	331.3	57%
Artificial turf fibre (polyethylene)	229.4	13%	12.2	2%	7.3	1%
Sand	526,0	29%	175.4	33%	196.7	34%
Humidity + loss of material during the separation process	69.6	4%	7.8	1%	32.0	5%
Impurities	18.1	1%	6.6	1%	16.1	3%
Total sample mass	**1820**	100%	**527.6**	100%	**583.4**	100%
Total rubber granulate (1.634 g)	**59.8%**		**19.9%**		**20.3%**	
Rubber particle size distribution	(1.0-2.5) mm		(1.25-2.5) mm		(0.8-3.15) mm	

In the following figure, the percentages in mass of each of the microplastic sources, i.e. rubber infill and artificial turf fibres, retained by the RMM are presented. As mentioned above, the major component is the rubber infill, but the material from the artificial turf represents in one case up to a quarter of the total microplastics collected. In order to confirm these results we have to wait for the evolution of data over the months.

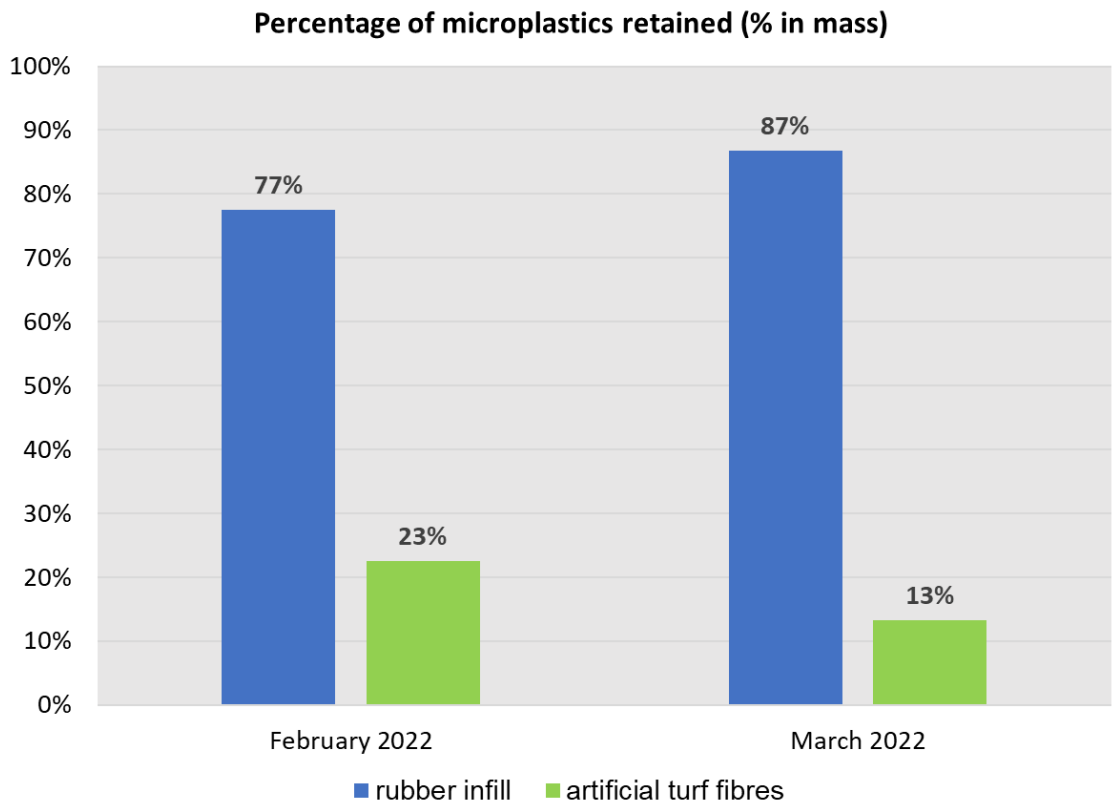


Figure 1: Rubber infill and artificial turf fibres retained by the RMM, expressed in mass percentage of the total microplastics collected in February and March.

6. PRELIMINARY CONCLUSIONS

After the first months of the project and once the risk management measures have been implemented, some technical issues have been optimised and the detected incidents have been solved.

The **monitoring pitch was launched on 9th December 2021** and the first sample collection was carried out in the second week of January 2022.

The following conclusions can be drawn so far:

- A **new source of unintentionally-added microplastics** has been identified as coming from the polyethylene filament of the artificial turf. This **reinforces the requirement to implement risk management measures to prevent the release of** both intentionally-added (rubber granulate infill) and unintentionally-added (polyethylene fibres simulating turf) **microplastics into the environment**.

- It is **difficult to find suppliers** for the different elements of the risk management measures, since this is a new market at least in Spain. As a guideline, the cost of RMM is in the order of 20,000 €, substantially below the cost of replacing it with a new pitch in the case of a ban.

- An **improved design of the drainage capacity of the general drainage manifold** is necessary, because in short periods of heavy rainfall there is clogging of the filters mainly caused by fine polyethylene particles from the artificial turf.

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