

**ENVIRONMENTAL AND HEALTH RISKS OF RUBBER
INFILL**

rubber crumb from car tyres as infill on artificial turf

summary

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SUMMARY

Because of a discussion on the environmental and health aspects of rubber infill from shredded car tyres a research was conducted, of which the results are reported here. The research was conducted independently and was guided by a committee with all parties concerned involved.

The aim of the investigation was to generate independent data and to formulate conclusions based on these data on the potential environmental and health risks of the use of rubber infill from shredded car tyres on artificial turf.

Work plan

The investigation consists of a literature research supplemented with experimental research to fill the gaps in the knowledge and to verify already existent data.

For the literature research 17 research reports and 13 supplementary sources were investigated, In addition to that use was made if Dutch and European legislation and guidelines.

Additionally a separate literature research was conducted to allergies caused by skin contact with rubber products.

For the experimental investigation samples were taken on 3 production plants of rubber infill and samples were taken on 14 artificial turf pitches according to a FIFA protocol.

For the experimental environmental investigation rubber infill samples were analyzed of the composition and also on the leaching of several parameters. In these analyses samples fresh samples from production plants, samples from 1 year old pitches and samples from 3 year old pitches were investigated. Also laboratory weathering tests were used and the leaching of 1 year old and 3 year old infill samples was investigated. The data on the content and the leaching were compared with limit values from Dutch regulations and with ecotoxicological limit values for soil and surface water.

The experimental investigation on health aspects was aimed on the uptake of polycyclic aromatic hydrocarbons (PAH's) through skin contact with rubber infill. A laboratory model migration test was performed on the migration of PAH's to massage oil and vaseline. Additionally with football players the presence of PAH metabolites in the urine was measured after they had intensive skin contact with rubber crumb on an artificial field pitch. The results from both tests have been compared with internationally accepted health limit values for PAH's.

Composition of the rubber crumb

The potentially dangerous substances in the rubber infill, that are found in the literature are primarily heavy metals (especially zinc), volatile components (nitrosamines, xylenes), benzothiazoles, secondary amines and polycyclic aromatic hydrocarbons (PAH's). The zinc is due to zinc oxide, that used as a vulcanisation aid in the rubber production process. The PAH 's are due to the high-aromatic

oil, that are used in car tyres. Xylene is a solvent. Benzothiazoles are accelerators in the vulcanization process and the secondary amines are antioxidants for the rubber.

Environmental risks

The environmental investigation was focussed on the parameters for which there are limit values in the Dutch Building Materials Decree.

- **air**

Based on the literature investigation we conclude that the emission to air does not pose an environmental risk. This conclusion is supported by our investigation of the composition of rubber infill, where we find only very limited amounts of volatile components.

- **soil and groundwater**

For the assessment of the environmental risks use was made of the risk assessment method of the Building Materials decree, which formally only applies to stony building materials, such as sand and gravel. The Building Materials Decree will be succeeded in 2007 by the Decree on Soil Quality. The limit values in the Decree on Soil Quality have not yet been decided on.

From the content analyses on organic components according to the Building Materials Decree it is shown that all parameters comply with the limit values with the exception of one production sample, which exceeds the limit for xylenes.

From the leaching analyses according to the Building Materials Decree it is shown that all parameters comply with the limit values with the exception of the leaching of zinc. The amount of zinc oxide in rubber crumb from truck car tyres is higher than in rubber crumb from passenger car tyres.

the leaching of zinc increases by weathering of the rubber infill. This is determined by comparing the leaching of zinc from samples from used fields with fresh samples and by laboratory weathering tests.

In a formal assessment using limit values from the Building Materials Decree and the Decree on soil Quality the leaching of zinc from the rubber infill does not comply with the limit values. In a more realistic test, in which realistic values of density and layer thickness were taken into account, the leaching of zinc was assessed using the immission limit value from the Building Materials Decree and the calculated immission limit value from the Decree on Soil Quality

- Scenario 1 uses realistic application parameters and does not take into account the life time of the infill (it is not renewed in 100 years)
- Scenario 2 also uses realistic application parameters and assumes a final life-time of the infill (it is renewed every 10 years).

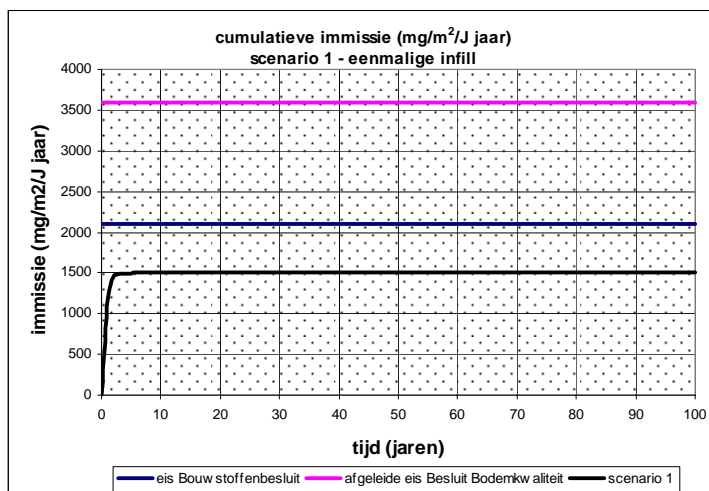


Figure 1: Scenario 1, no renewal of the infill

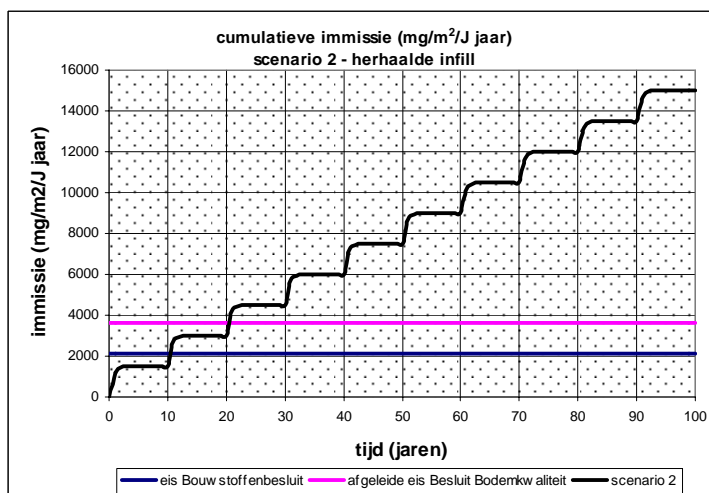


Figure 2: Scenario 2, renewal every 10 years

In scenario 2 the limit values of the Building Materials Decree are exceeded after 11 years. After 20 years the limit values from the Decree on Soil Quality are exceeded. The actual leaching can either be higher or lower. It can be lower due to a lower leaching in the filed situation than in the column test. It can be higher due to the fact that the weathering of the rubber crumb is only partly been incorporated in the assessment. In a scenario in which maximum effect of the weathering is included after 3 to 4 years the limit values are exceeded. Further investigations might resolve this issue.

The potential exceeding of the limit values is not so high that it might result in a potential case of soil contamination of the soil beneath an artificial turf field at the level of the intervention values for soil. It concerns an exceeding of the environmental policy standards.

In addition to the leaching there might be a potential environmental risk in the spreading of rubber crumb around the fields. In case of inaccurate housekeeping the amount of zinc and PAH's in the soil may increase because the soil is contaminated with rubber crumb.

- **surface water**

When drainage water is transported to surface water the ecotoxicological limit values for dissolved zinc in surface water are exceeded. In practice this will not occur completely because Dutch artificial turf fields have an open drainage system and at least a part of the excess rain water goes into the soil. Only on heavy soil (clay grounds) will the surplus rain water be transported 100 % to the surface water.

The total zinc load from rubber infill on artificial turf fields to surface water is a small contribution to the total zinc load from all sources in the Netherlands. It amounts to 0,08 %. In the future this might increase to 0,5% because the amount of fields might increase from 370 to 2500 fields.

- **conclusion on environment risks**

The leaching of zinc is the most relevant parameter. After a number of years in use the immission of zinc in the soil from an artificial turf field with rubber infill from car tyres will probably exceed the environmental limit values. There is however no risk for new cases of soil contamination due to the use of the rubber infill.

For the other components from the Building Materials Decree, no exceeding of environmental limit values was determined.

Health risks

Rubber crumbs contain a number of substances that might lead to health risk at excessive levels of exposure. The question is whether these excessive levels of exposure actually occur when football players use the artificial turf pitches. The exposure might occur by swallowing, by inhalation and by skin contact. For several substances in the rubber crumbs there are known levels of exposure from other sources. The background exposure to PAH's from food is 4 ng PAH's per kg body weight (bw).

- **swallowing**

The content of heavy metals in rubber infill complies with the European toy directive and we therefore expect that heavy metals do not present a health risk to the football player. The same applies to phthalates. Based on the literature the swallowing of rubber infill for organic compounds is not assessed to pose a relevant exposure scenario.

- **inhalation**

In indoor and outdoor applications of rubber infill in literature at levels also found in this investigation, no health risks were assessed for sportsmen and others. In the indoor application the ventilation should be sufficient to limit the fine dust.

In literature calculations are presented implying that the daily uptake of PAH's by inhalation of fine dust in an indoor hall by an adult, who is training for 20 hours a week during the winter season, is not more than is taken up from other diffuse sources.

- **skin contact**

In investigations on the potential health risk by skin contact especially the exposure to organic components in the rubber is relevant, because they may migrate from the rubber crumb to the skin.

The PAH-components that have attracted attention to rubber crumb from car tyres due to the reduction of highly aromatic oils in car tyres, are found in the rubber infill in amounts of 20 to 40 mg/kg. In a migration investigation in the laboratory it was determined to how much PAH's football players on an artificial turf pitch are exposed by skin contact

In an exposure scenario for a professional football player a maximum average daily uptake was calculated of 0,12 ng/kg bw benzo[a]pyrene. Benzo[a]pyrene is a carcinogenic PAH-component, which is often used as a marker for the total PAH uptake. The advised limit value for marginal risk is 1 ng/kg bw. The calculated daily uptake is therefore lower than the advise limit value for marginal risk.

In addition to the laboratory investigation fields tests were performed. In this investigation football players had an intensive skin contact with rubber infill during a field training on the artificial turf pitch . The urine of the players was investigated before and after the training on the concentration of 1-hydroxypyrene, a metabolite of pyrene, a PAH-component. The uptake of PAH during the training on an artificial turf pitch could not be determined unambiguously, although there had been an intensive skin contact with the rubber infill. If an uptake of PAH had taken place, it did fall in the range of uptake of PAH from other sources in the environment and food.

Rubber infill appears to contain a number of substances that might cause allergic reactions to user groups that are already sensitized. Especially the aromatic amines in the rubber are suspected. The chances that substances in the rubber cause skin irritation to non-sensitized persons is estimated to be low. Possibly persons can be sensitized by exposure to rubber infill. How intensive the skin contact must be to cause sensitizing is not known. Experimental research can give more insight in the potential of sensitizing persons during activities on rubber infill.

If persons show skin disorders after contact with rubber infill it is recommended to analyze whether this might be related to oversensitivity to sensitizing substances in rubber. This can be done by using the patch-test with "black rubber mix".

- **conclusions on health risks**

Based on the available literature on exposure to rubber crumb by swallowing, inhalation and skin contact and our experimental investigations on skin contact we conclude, that there is not a significant health risk due to the presence of rubber infill for football players on an artificial turf pitch with rubber infill from used car tyres.