Sara Badiali

February 2023

PFAS in Building Materials Report

Introduction

There is an overwhelming amount of information on Per-and Polyfluoroalkyl Substances (PFAS) and the related family of chemicals. They are present in air, water, and soil and seemingly permanent in the environment. Historically, the Environmental Protection Agency (EPA) allowed new PFAS to enter the market through "low volume exemptions resources" after a review process of only 30 days.[1] As a result there are hundreds of companies creating a variety of PFAS-type chemicals, and thousands of products use these chemicals. We now know they cause a terrible toll on human health.

PFAS are present in almost all modern building materials. These are most certainly being spread throughout the environment and to populations through demolition. There is no study confirming the spread of PFAS though building demolition. But there are tangential studies that make it easy to draw this conclusion, including landfill leche, atmospheric modeling, ground water contamination reports, and the presence of PFAS in the building materials themselves.

The following report is a look at what kinds of information is available after searching for over a month. There are three academic papers included that are not linked, they were personally sent to me by the authors and are not public. The

---

[1] https://www.epa.gov/chemicals-under-tsca/epa-announces-changes-prevent-unsafe-new-pfas-entering-market

footnotes are directly linked to the source for efficiency. Full citations are included under Works Cited. I have added notes on some citations to opportunities for infographics that are well designed and informative. I did not include them for purposes of brevity, in an already crowded field.

There is professional interest in studies on PFAS chemicals in building demolition from the resources I contacted. There is ample opportunity for King County to partner and provide the first-ever study into PFAS in building demolition. Contact Information is included in this report. The EPA awarded nearly $750,000 in funding to research PFAS exposure pathways in October 2022.[2] Since the subject is so vast, I think the EPA will do another round of funding.

Basic Literature & Key Points

Building Materials are a source of PFAS and their chemical family through manufacturing, function, to end of life treatment. How much, frequency, and longevity of exposure to the public is just starting to be studied. The manufacturing process can be studied through contamination of local communities measuring air quality, ground, and water pollution. Materials like carpets, furniture and coatings are being studied while in use, by measuring the air quality inside buildings.[3] The end of life of buildings are only currently being looked at as studies of landfill leche from C&D solid waste facilities.[4] These studies are often part of larger research tracking ground water contamination. In the month of researching this report, not one study on building demolition worksite PFAS contamination was apparent. In reaching out to experts from the Environmental Protection Agency, the Green Science Policy Institute and others working in studying PFAS in building materials, not one knew of any reports on building demolition sites. Feedback from these contacts is that it is a worthy subject matter to be studied and that they are interested in having information shared with them.

PFAS Chemicals in Building Materials

The following section is from the Green Science Policy Institute's study on PFAS in building materials: *BUILDING A BETTER WORLD Eliminating Unnecessary PFAS in Building Materials* (https://greensciencepolicy.org/docs/pfas-building-materials-2021.pdf).

The Green Science Policy Institute's team of researcher's methodology was to gather as much information as could from: peer reviewed literature, government and NGO reports, active U.S. patents, company websites, and transparency labels. The goal was to inspire other research in PFAS in construction material, choose alternative products without PFAS, actively develop alternative products, and motivate the construction industry to follow other industries in working on eliminating these chemicals. The Green Policy Institute provides a four-part webinar on PFAS in Building Materials and

---

[2] https://www.epa.gov/newsreleases/epa-awards-nearly-750000-funding-research-pfas-exposure-pathways
[3] https://publications.aecom.com/pfas/article/a-guide-to-atmospheric-modeling-of-pfas-emissions
[4] *Waste type, incineration, and aeration are associated with per- and polyfluoroalkyl levels in landfill leachates*

Eliminating the Unnecessary Uses of them, which is a good introduction to the subject and what information is currently available.[5]

The following provides information on the use of PFAS in different building product categories and is currently the most comprehensive information regarding prevalence of PFAS in building materials. Ranking Level of Concern is addressed after the list of materials. Individual citations and alternatives to PFAS are removed for ease of reading and can be found in the original Green Science Policy Institute's *BUILDING A BETTER WORLD Eliminating Unnecessary PFAS in Building Materials*[6], along with links to each source.

ROOFING

PFAS are used in four primary types of roofing materials: metal roofing, asphalt roofing, weatherproofing membranes for flat roofs, and textile-based roofs. A building's roof is in constant contact with the elements—UV radiation, temperature fluctuations, and precipitation can all limit a roof's lifespan. PFAS are used to resist weathering and prolong a roof's useful life while reflecting solar radiation away from the structure, keeping the interior cool.

Metal Roofing

PFAS are used as an exterior coating on metal sheet roofs, metal shingles, flashing, and roofing nails. Fluoropolymer coatings protect metal from scratching, color loss, and corrosion and can be used to restore the aesthetic value of faded or deteriorated colored metal. They may also serve to cool the structure by reflecting solar energy into the atmosphere and reducing the amount of heat entering the building. Fluoropolymer coatings applied to metal roofing components are similar to those used in other types of building materials; all of these are discussed in further detail in the section on Coatings.

Asphalt Roofing

PFAS may be used in asphalt-based roofing materials as a component of granules. Asphalt shingles and flat roofs commonly incorporate mineral-based granules to add aesthetic appeal, improve weather protection, increase UV-resistance and solar reflectivity, and to aid in ballasting. Roofing granules consist of a core of rock or mineral covered by a pigmented ceramic coating. Specialty granules designed for high solar reflectivity can employ coatings that contain PFAS. Granules manufactured by 3M are coated with a proprietary surfactant polymer to prevent staining. It is unclear whether

---

[5] https://www.youtube.com/watch?v=bbn71Jgaet8&list=PL99Hk3l3_pxYXcQBw8KZGvXb-Wi5pJRRa&index=2&ab_channel=GreenSciencePolicyInstitute

[6] https://greensciencepolicy.org/docs/pfas-building-materials-2021.pdf

the coating contains PFAS. In addition to granules, fluoropolymer coatings may also be applied to entire shingles. Titanium dioxide-based coatings are non-PFAS alternatives for increasing solar reflectivity.

Weatherproofing Membranes

Several fluoropolymers may be used in weatherproofing membranes for flat-type roofs in residential and commercial buildings. These membranes can be made of numerous materials, including synthetic rubber, polyvinyl chloride (PVC), polyolefin, or other heavy-duty thermoplastics, and sometimes contain a fluoropolymer layer or coating. The fluoropolymers aid in moisture control and solar reflectivity, as well as conferring durability and stain resistance. These membranes may also be clear or opaque for use in greenhouses. Heating of fluoropolymers like PTFE at high temperatures releases ultrafine particles that, when inhaled, can cause a health condition known as “polymer fume fever” and lead to severe acute lung injury. Thus, installation of heat-welded roofing materials containing PFAS is a possible occupational exposure concern.

Tensile Roofing

Fluoropolymers are used to create durable and decorative textile-based roofs. PTFE or ethylene tetrafluoroethylene (ETFE) can be applied as a coating on a rigid fiberglass base or woven into strands and then made into a textile-like material. So-called tensile roofs made of these materials are touted for their strength, durability, and low maintenance, and are often used for retractable and deployable structures such as stadiums, and for shade fabrics. Notable examples of tensile roofs include the Beijing National Aquatics Center, the Minnesota Metrodome, and the Denver International Airport.

Other Roofing Materials

Fluoropolymer coatings such as Dura Coat XT-10, Kynar 500, and Hylar 5000 are applied to rain gutters to repel dirt, resist staining and allow for easier cleaning. Alternative polyester-, silicone-, and acrylic-based coatings can provide similar weather protection without PFAS. Liquid-applied fluoropolymer coatings have been proposed for concrete roofing tiles and wooden shingles to increase reflectivity, provide cooling, and resist dirt and mildew.

COATINGS

Coatings are broadly defined as exterior treatments that serve a functional purpose. PFAS are used to improve the performance of paints, metal coatings, and wood lacquers. They reportedly protect pigments, improve ease of application, increase weather resistance, and improve the finish and durability of these products. A recent study found over 100 distinct PFAS used in various paints, coatings, and finishes.

Data from the Nordic countries indicate that coatings and paints are the second highest use of PFAS by manufacturers in that region.

Paints

Fluorinated additives (both polymeric and non-polymeric) can be used in epoxy-, oil-, alkyd-, and acrylic-based paints to achieve specific finishes and durability requirements. PFAS lower the surface tension of paint, which allows for even flow, spread, and a glossy finish. Polymer and non-polymer PFAS can be added to paints to provide non-stick, “graffiti-proof”, dirt and stain resistant, oil- and water-repellent, and anti-corrosive properties. Fluoro-modified polysiloxanes are added to paints as a deaerator to decrease bubbling. PFAS are also used in paints as binders. Binders are polymeric materials that join the ingredients in the paint together, or help impregnate the substrate to decrease bubbling and peeling. Commercially available fluoropolymer binders include ZEFFLE® by Daikin Chemicals, and Lumiflon® by AGC Chemicals.

PFAS are used in powder coating—a dry finishing process in which pigmented polymer powders are melted onto metal, wood or other surfaces. Fluorinated resins used in powder coatings, such as Solvay’s HALAR® 6014, reportedly result in higher weatherability, color and gloss retention, and resistance to chemicals, impacts, flames, and corrosion. Non-fluorinated chemicals commonly used as binders in both liquid paint and powder coats include acrylics, alkyds, and epoxies. Acrylic binders are known for their durability and gloss retention, while phenolic binders are best used in humid conditions. Hybrid materials such as phenolic-alkyd binders give paint the strength of the phenolics and the color retention of the alkyds.

Metal Coatings

Many metal coating formulations employ fluoropolymer binders to increase durability. Fluorinated coatings are used as exterior finishes for large buildings, bridges, and industrial structures, in addition to high touch metal surfaces such as elevators and sanitary fixtures. The addition of PFAS reportedly protects metal building products against weathering and staining and increases corrosion resistance. PFAS-containing coatings are also used to increase the energy efficiency of metal roofs and exterior walls (by increasing reflectivity), to keep snow and ice from sticking to roofs and gutters, and even to aid in the penetration of coated roofing nails. The use of PFAS coatings on metal structures may sometimes be required by building codes, as is the case for bridges in Japan. Most PFAS-containing metal coatings are applied during manufacturing, but they can also be applied to building materials after installation as liquids or sprays. Polyvinylidene fluoride (PVDF) is the original and one of the most common fluorinated chemicals used in metal coatings, but other polymeric PFAS are also used. Brand name fluoropolymers used in metal coatings include Kynar® PVDF from Arkema, Hylar® PVDF from Solvay, Lumiflon® FEVE from AGC Chemicals, and ZEFFLE VDF/TFE copolymer from Daikin.

Metal entrances, doors, and door components (hinges, frames, latches, handles, locks, etc) may be coated with PFAS to enhance durability and thermal protection. PTFE is used in door operators that help open and close doors in commercial buildings, although the function is unclear.

Wood Lacquers

PFAS are added to wood lacquers and sealers as wetting agents and to enhance oil and water repellency and stain resistance. They may also be used in sealers to increase the dimensional stability of wood and as matting agents in factory applied finishes for wooden products including cabinetry. Chemical treatments such as acetylation can increase dimensional stability and rot resistance. Plastic-wood hybrids such as Trex® come with increased durability and have high recycled content (which may or may not contain PFAS or other chemicals of concern).

Plastic Coatings

PFAS can be applied to plastic surfaces for a variety of applications. For instance, some dry erase boards utilize PFAS-containing coatings. Fluoropolymer coatings can be applied on structural plastics that are used instead of glass or ceramic in items like windows, bathtubs, counters, shower stalls, and doors.

FLOORING

Carpets and Rugs

PFAS have been used extensively as stain, soil, and water repellents in carpets and rugs. Fluorinated chemicals reportedly prevent soiling and staining of the carpet fibers, protecting the carpet from discoloration and wear. PFAS can be applied to carpets and rugs during the fiber manufacturing process, during the manufacturing of the carpets and rugs themselves, or as aftermarket treatments. In recent years most carpet manufacturers employed a type of PFAS called side-chain fluorinated polymers. These polymers are attached to the carpet fibers, but they also contain non-polymer PFAS, including manufacturing residuals, impurities, and degradation products, that can migrate out of carpets and rugs. Studies have linked carpeted floors to higher PFAS levels in indoor dust and on interior surfaces. Once PFAS is in dust, it can be inhaled and consumed by adults, children, and pets.

Treated carpets and rugs may be a major source of PFAS exposure for young children, who have higher rates of hand-to-mouth contact and spend more time on the floor.

Aftermarket stain protectors and carpet cleaners can also contain PFAS. The original and most well-known fluorinated product is Scotchgard Carpet Protector. These products are applied after the carpet has been manufactured, by professional carpet cleaners, custodians, or do-it-yourselfers. One study found that frequent use of an after-market stain protector in a home resulted in elevated levels of PFAS in carpet, dust, and the blood of residents.

Resilient and Hard Flooring

PFAS are sometimes used to add stain and soil repellency to resilient flooring. In 2003 Mannington Mills advertised that its resilient flooring products would contain TeflonTM. More recently, flooring manufacturer Congoleum advertises the use of ScotchgardTM Protector and a patent from Armstrong Flooring, Inc. mentions the use of various fluoropolymers in its stain-resistant coating. Overall, PFAS appears to be used less frequently in the manufacturing of resilient flooring than in carpet.

A more widespread use of PFAS related to resilient and hard flooring is in after-market floor protectors, finishes, waxes, and polishes. By the early 1990s, fluorosurfactants had reportedly "been universally adopted in both household and institutional floor polish systems." Fluorosurfactants continue to be used in these types of products as levelling and wetting agents. Examples include NovecTM from 3M, Masurf® FS-120A from Mason Chemicals, and Capstone FS-65 from Chemours. Fluoropolymers like PTFE are also sold to manufacturers of floor coatings and polishes as product additives.

SEALANTS AND ADHESIVES

Fluorinated sealants are used to create a grease-resistant and water-resistant barrier that protects building materials from stains, mold, and physical damage. Grout, tile, and concrete sealers are applied to these materials to provide a clear, durable finish. Caulks are used to fill gaps and crevices, creating a waterproof seal. O-rings are used to create durable seals in plumbing applications. Adhesives, which are used to bond two materials together, sometimes contain PFAS to increase adhesion strength. Grout, tile, stone, and concrete sealers Porous materials such as stone, grout, unglazed tile, and concrete are often treated with a sealer or lacquer to create a smooth, water-resistant protective barrier. Sealers are used routinely in indoor applications including stone countertops, kitchen and bathroom tilework, and stone, tile, or concrete flooring. Sealers are also used in exterior applications including patios, staircases, foundations, and parking garages. PFAS are added to sealers to increase resistance to oil, water, stains, and (for exterior surfaces) snow, ice, and graffiti. In the case of grout, PFAS-containing sealer is sometimes included as a component in the grout mix or paste.

In 2005, dozens of cases of respiratory problems, dizziness, and disorientation were linked to Stand'n Seal Grout Sealer, a spray product sold in major home improvement stores. It was later determined that the aerosolized fluoropolymer resins in the grout sealer were the likely cause of these health problems. This led the U.S. Consumer Product Safety Commission to announce a voluntary recall of the product. Due to the health hazards, legal troubles, and bad press, the sealer never returned to shelves.

Caulks

Caulks are used to fill gaps and prevent the entry of water or other elements that may degrade a structure. PFAS are added to caulk formulations to increase durability and chemical resistance while maintaining a strong bond between materials. One patent also claims that the addition of PFAS reduces dust accumulation on the caulk. Fluorinated caulks are used in the construction of building facings, elevators, and furniture. Caulks based on urethane, silicone, polysulfide, and acrylic chemistries are used in both do-it-yourself and commercial applications and may be PFAS-free alternatives. Some caulks based on these other chemistries may also contain PFAS.

O-Rings

O-rings used for high-pressure, high-stress, and high-temperature applications can be made of PFAS. Fluoroelastomer O-rings (such as Viton®) are available for sanitary washers, fittings for medium to large PVC pipe, and potable water appurtenances such as water heaters and hose bibs. Some of these products may also contain Teflon-coated washers. While O-rings are a common component of plumbing systems, it is unclear how often high-performance PFAS-containing O-rings are used in residential and commercial structures.

Adhesives

Adhesives are used in many applications in building construction, including adhering tiles, flooring, drywall, ceiling, wood-related materials and molded structures. PFAS are added to adhesives to increase the strength of the bond adhering materials together. There are two mechanisms for this increased adhesion. One is that PFAS enhance the penetration of adhesives into their substrates. Another is that they increase the adhesive's wettability, allowing for greater spread and increased contact area between the adhesive and adhered materials. Examples of PFAS advertised for use in adhesives include Capstone FS-30 and FS-31.152 Limited evidence from a patent suggests that fluorocarbon-based synthetic rubbers, known as fluoroelastomers, may be used in adhesives as well. Many adhesive formulations are made from non-fluorinated chemicals.

GLASS

Fluorinated chemicals are used in a variety of glass building materials such as windows, doors, and mirrors. PFAS increase the durability of glass and limit the buildup of dust and debris on glass surfaces. This makes PFAS-treated glass useful in hard-to-access locations, such as building facades and solar panels on roofs. PFAS are often applied to glass surfaces as coatings, but in some instances the PFAS can comprise a separate layer within the glass panel.

Windows, Doors, and Other Glass & Ceramic Fixtures

Common building materials such as windows, mirrors, shower doors, bathtubs and toilets may be treated with PFAS. Fluorinated coatings are used to make glass and ceramic surfaces more durable and resistant to heat and abrasion, to prevent soiling and grime, and to provide 'easy to clean' and anti-smudge characteristics. Examples of PFAS advertised for use as glass and ceramic coatings include SURECO™ 232081 and the Easy Clean Coatings series. Fluoropolymer-glass composites have also been patented for use in fire-resistant applications.

Most PFAS-containing glass treatments appear to be marketed to product manufacturers rather than do-ityourselfers (DIY). It is not clear whether products for the DIY market contain PFAS.

Lightbulbs

Fluoropolymer coatings are applied to "shatterproof" light bulbs advertised for laboratory, medical, and consumer uses. PTFE coatings reportedly increase the durability of the bulbs and impart nonstick and easy-clean characteristics without changing the color, temperature, or shading of the light. Fluoropolymers are also used in electroluminescent lamps such as safety exit signs in commercial buildings. PFAS coatings on light bulbs have been known to cause respiratory distress and death in birds, including poultry.

FABRICS

PFAS are added to fabrics used in furniture, curtains, etc., for their stain-, soil-, and water-repellent properties. Fluorinated treatments can be applied to individual fibers or finished fabrics during manufacturing, or after-sale in the form of sprays. Several brand name PFAS-containing treatments include Teflon®, Nanosphere®, Scotchgard®, Capstone®, Crypton®, Crypton® Green, Nanotex®, Nanotex® + Durablock®, and GreenShield®.

Fabric awnings used in front of commercial and residential spaces may be treated with PFAS for water- and stain proofing. Four of five acrylic awnings measured in a German study contained fluorotelomer alcohols and perfluorocarboxylates at levels that indicate the use of side-chain fluoropolymers.

WIRES AND CABLES

Electrical wires and cables (groups of wires) are typically insulated with a non-conductive plastic sheath, often made of PFAS. The insulating properties of fluoropolymers allow for the use of thinner insulating sheaths that are flexible, durable, and stand up to high temperatures. This makes them useful for applications such as air conditioner units, computers, light fixtures, and radiant heated flooring. The NFPA 70 (Electrical Code) lists PTFE and ETFE as suitable for insulated wiring for all purposes, and ethylene chlorotrifluoroethylene (ECTFE), perfluoro-alkoxy, PTFE, and ETFE as suitable for building fixtures. Several large chemical manufacturers sell PFAS-containing formulations for coating wires, including Tefzel from Chemours and Halar from Solvay. PFAS are also used in electrical tapes in air ducts, which are covered in the ‘Tape’ section.

TAPE

PFAS-containing tape is used in electrical work, plumbing, sealing, and many other applications. One of the most well known uses of PFAS in building projects is Teflon plumber’s tape, also known as threadseal tape, which is used to seal pipe connections and other threaded fittings. It works by filling the spaces between interlocking pipe threads to create a seal and prevent leaking. Plumber’s tape is made of 100% PTFE film, which reduces friction and prevents rust.

Liquid/paste pipe thread sealant can also contain PTFE. PTFE tape can contain residual amounts of non-polymer PFAS that have the potential to leach into drinking water. PFOA, for instance, has been used to manufacture PTFE and has also been detected in PTFE tape. PTFE tape is normally in contact only with pipe threads and not with flowing water. However, if installed incorrectly it can tear and enter the interior of a pipe system where the potential for leaching is greater.

Fluorinated fiberglass and film tapes are used in electrical applications in drop ceilings and other open-air spaces, for example, to wrap bundles of wires that run between separate floors of commercial buildings. These tapes are composed of a PTFE-impregnated plastic or a fiberglass base with an adhesive layer. PTFE or other fluoropolymers serve as an insulator and strengthening agent and help prevent abrasion. These taped bundles can be surrounded by a layer of PVDF, which, in addition to the PTFE in the wire sheath, acts as a flame retardant and protectant from corrosion and water damage.

Fluorinated tape is also used inside conduits so that bundles of wires can be easily removed or inserted. PTFE tape is used in the manufacturing and installation of windows, doors, vents, skylights and other structural openings. During manufacturing, fluorinated tape is employed to hold PVC frames together and prevent physical deformities during welding. Some windows and skylights may still have this tape holding the frame together up until installation or be installed into the structure with the tape. Flashing tape used to seal the frame of a door, window, or other opening to the wooden frame of a building may also contain PFAS.

PFAS-containing tape can also be used in flooring applications to adhere carpet and resilient flooring to the underlay or subfloor. Fluoropolymers are used in the release liners (covers that protect adhesive tape before application) and are thrown away after use.

TIMBER-DERIVED PRODUCTS

Evidence suggests that PFAS may be used in composite wooden sheets like oriented strand boards (OSB), medium and high-density fiberboard (MDF and HDF), and plywood. A study of European building products detected small amounts of PFOA and other PFAS in 14 samples of OSB and other composite wood materials. The source of the PFAS may have been adhesives used during manufacturing. A separate study reported that adding PFAS to a urea-formaldehyde resin used in particleboard improved the properties of the board. The same study that detected PFAS in composite wood sheets found similar levels in two samples of wood fiber insulation, which is marketed as an eco-friendly alternative.

PFAS levels in both the wood sheets and wood fiber insulation were relatively low and could have resulted from unintentional background contamination.

SOLAR PANELS

Numerous uses of PFAS are documented in solar panels. Fluoropolymer coatings or films may be incorporated into the glass top layer of panels, the encapsulant film that surrounds the solar cells, and the backsheet. Fluoropolymers reportedly increase durability, transparency, UV-resistance, heat-resistance, mechanical strength, dirt-repellency and energy production, and they are lightweight. Halar® (ECTFE) and Tefzel® (ETFE), as well as polyvinyl fluoride (PVF) and PVDF, are among the fluoropolymers used for solar panels.9,218 Rechargeable batteries that are increasingly used to store the energy captured by solar panels also contain PFAS. Reported uses of fluoropolymers in lithium-ion batteries and supercapacitors include enhancing chemical resistance and adhesion properties and strengthening the ionic conductivity.

ARTIFICIAL TURF

Artificial or synthetic turf is used as a water- and maintenance-saving alternative to live grass landscaping. Its popularity is growing, and as of 2015 there were 11,000 artificial turf fields in the U.S. and 13,000 in Europe. Synthetic turf is made up of artificial fibers resembling blades of grass that are woven into a backing material. The grass-like fibers are generally made from nylon, polypropylene, or polyethylene. Granular material, known as infill, is often used to fill in space between the blades and stabilize the turf surface. Recent reporting indicates that both the backing and the blades of artificial turf can contain PFAS. One study reported measurable levels of total fluorine in blades from eight samples of artificial turf, suggesting that PFAS may be used as polymer processing aids during manufacture of the blades. Fluoroelastomer- or fluoropolymer-based processing aides can be added to melted plastic during extrusion to keep the equipment operating smoothly and prevent defects in the finished plastic pieces. Such processing aids would still be present in the final turf blades or backing. The same study detected very low levels of non-polymer PFASs in two samples of artificial turf backing, 1,000 to 1,000,000 times lower than concentrations reported in fibers from new carpet.

Cost-effective alternatives to fluorinated processing aides include thermoplastic polyurethane-based elastomers. Artificial turf infill is often made from recycled tires, which may be another source of PFAS. Polymeric pellets manufactured specifically as infill are also available, and patents indicate that these materials may contain PFAS as well. The infill associated with artificial turf can cling to textiles such as shoes, clothes, and athletic equipment, leading to human exposure on the field, in the car, and at home. Data on PFAS concentrations in artificial turf are scarce, so it is difficult to know the magnitude of this potential exposure pathway.

SEISMIC DAMPING SYSTEMS

PFAS are employed in seismic dampers used to make large buildings and bridges resilient to earthquakes. PTFE pads or discs are used in a variety of ways within structural skeletons and foundations to allow structures to remain standing. In some cases, PTFE bearings are required by California state law in bridge construction.[7]

Prevalence and Level of Concern

According to the U.S. Department of Energy, PFAS are a class of over 9,000 man-made fluorinated chemicals used since the 1940s in many industrial processes and in a wide array of commercial and consumer products.[8] PFAS is generally used for the same group of chemicals once referred to as PFC (perfluorinated chemicals). There is no official definition of either PFAS or PFC, and various definitions can significantly affect what is and is not considered a PFAS.[9]

---

[7] https://greensciencepolicy.org/docs/pfas-building-materials-2021.pdf

[8] https://www.energy.gov/sites/default/files/2022-11/DOE%20Initial%20PFAS%20Assessment%20-508.pdf

[9] https://onlinelibrary.wiley.com/doi/full/10.1002/ajim.23362

The presence of PFAS chemicals in construction materials historically resembles lead paint or asbestos. Like lead paint or lead-based sealants, the coatings can be on anything and everywhere. And like asbestos, the applications were widely used. However, PFAS and their chemical family do not have clear markers to indicate their presence and are even more widely used than lead or asbestos.

Mapping how much PFAS is in a material or product is difficult to almost impossible in the current legal environment. Like other chemicals, many PFAS are used in such a way that their use is a trade secret, or there is no requirement that their use be stated in a specific application.[10]

Elizaveta Zvereva is an Earth Science graduate student at the University of Toronto. She is in her second year of researching PFAS's in building materials. In my interview with her she explained why there is an absence of information on prevalence of PFAS chemicals in building materials. Currently manufacturers don't have to disclose how much PFAS chemicals per unit they produce. They only have to disclose that their industry creates PFAS's if it's more than 100lbs in production. The variety of PFAS type of chemicals is difficult to test for. The process uses a mass spectrometer that measures gasses and maps markers. There are variations on PFAS's chemicals that exist in products, but the markers are not known outside of the company that creates them. Getting these markers means asking the company to disclose chemicals that are currently unregulated and most likely unknown to the EPA.

> Great strides have been taken in recent decades in understanding the fate, mobility, toxicity, and remediation of PFAS, there are still considerable management concerns across the life cycle of these persistent chemicals. The study of emerging compounds is complicated by the confidential nature of many PFAS chemistries, manufacturing processes, industrial by-products, and applications. Furthermore, the diversity and complexity of affected media are difficult to capture in laboratory studies.[11]

In an attempt to mimic the functionality of regulated PFAS's, companies create other closely chemically related compounds. These "solutions" can be as bad as the original PFAS, but are unknown, and cannot be monitored. The GenX compounds are an example. Scientists are attempting to get PFAS chemicals and closely related compounds to be regulated as a group. Which would open up their ability to get these markers for testing products. Companies are lobbying to get PFAS chemicals and related compounds to be individually regulated. That means each new chemical compound would have to go through a regulation process, in the meantime companies can use them. Dow Chemical and 3M were the original companies that made PFAS and PFOS compounds. There are now hundreds of companies that make these kinds of chemicals and variations on them.[12]

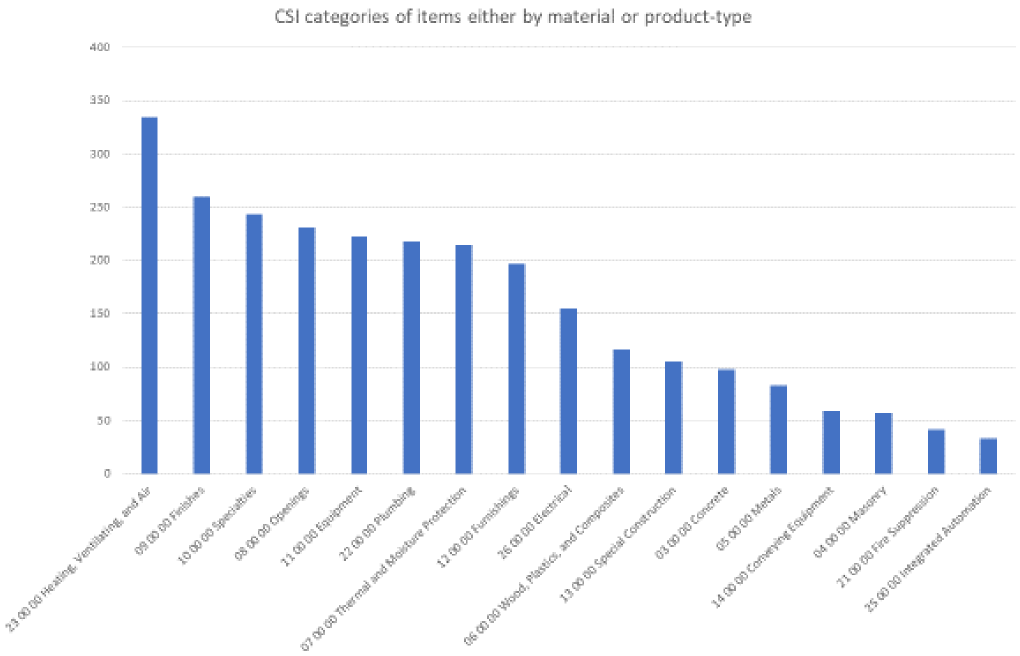
---

[10] https://onlinelibrary.wiley.com/doi/full/10.1002/ajim.23362

[11] *Per- and polyfluoroalkyl substances in the environment.* PDF

[12] Zvereva, Elizaveta, Masters of Earth Science, focus PFAS in Building Materials, University of Toronto, Zoom interview, January 20, 2023.

The variety and scope of construction materials is vast. There are thousands of products, and companies that make them. Brad Guy, professor of Sustainable Architecture at the University of Florida, created a list of potential building materials using the Construction Specifications Institute format (CSI). Based on his assessment a common building could have up to 2,668 discrete products in its construction. He provided his findings in a slide, however he does have a spreadsheet he indicated that he would share. I did not include it in this report.



> "I came up with potentially 2,668 different products could be used in a typ. commercial building using CSI format. Not by mass or $ value however by number of distinct types of products. For example, Heating, Ventilation and Air has many discrete types of products of which many will be used, whereas there are fewer types of Concrete products. The point was to see how many potential different producers might be contributing to a category or product, or else the complexity in each category when trying to ascertain the composition of the entire building. It will be easier to figure out the Concrete composition than the composition of the Finishes given more different types of Finishes than concrete. And of course, HVAC systems are complex, period," Brad Guy.[13]

There may be as many types of PFAS chemicals currently being used as there are individual construction products. In the paper *An overview of the uses of per- and polyfluoroalkyl substances (PFAS)†*[14] published by the Royal Society of Chemistry, the authors identify more than 200 use categories and subcategories with more than 1400 individual PFAS. It provides more categories than construction materials (including items like guitar strings), while also stating that it is an

---

[13] Brad Guy Architect, NCARB, AIA, professor of Sustainable Architecture at the University of Florida

[14] An overview of the uses of per- and polyfluoroalkyl substances (PFAS)†, Royal Society of Chemistry

incomplete list. The study also provides a list of the identified PFAS per use category, including their "exact masses" for future analytical studies aiming to identify additional PFAS. The paper also points out the difficulty of measuring exact PFAS in materials as sometimes the chemicals are present in the creation process and only trace amounts are found in the actual product.

Unlike mercury thermometers or arsenic in treated lumber, no data exists of exactly how much PFAS chemicals are in individual building materials. Therefore there is currently no way to rank them according to prevalence or individual toxicity. Until laws change and companies are forced to disclose this level of information, or scientists are privy to the chemical markers to be able to test individual materials, the toxicity is present but unmeasurable.

Other Factors Making it hard to Rank Level of Concern

The age, distribution, maintenance, and degradation are key factors as to how much chemical is in a building material. If the product containing PFAS's was applied properly, maintained, reapplied as needed, in a place that weathered or degraded it, are all factors as to how much is still in the material. Newer and larger buildings will have more potential products with PFAS's in them. Buildings with more composite materials like OSB board or new windows will too. Dow Chemical and 3M used more PFAS's in products as they developed them. Older buildings will have less due to materials not being invented yet, or engineered as much (lumber over OSB, etc.). Older buildings will also have less if they were left to degrade naturally and were not subject to maintenance using products containing PFAS. For example, a metal roof from a building built before 1970 could be free of PFAS type chemicals because it never had them, they washed off over time, or they were applied incorrectly (too cold for adhesive to work properly).[15]

Embodied Toxicity

"Embedded Toxicity" is a concept that looks at chemicals in building materials from the procurement of resources to make a product, to the end-of-life treatment. This measurement is best known in "Embedded Carbon", where it is standard to measure carbon emissions from the earliest efforts to create a product, to the waste it creates when it is no longer in use. The authors of *Introducing "Embedded Toxicity": A Necessary Metric for the Sound Management of Building Materials* argue that the measurement of how toxic a building material is, should start at the extraction of resources.[16]

> Despite its centrality to the Sustainable Development Goals, the embedded toxicity of chemicals in building materials has not received the same attention as that of the embedded energy, water, and

---

[15] Zvereva, Elizaveta, Masters of Earth Science, focus PFAS in Building Materials, University of Toronto, Zoom interview, January 20, 2023.

[16] https://pubs.acs.org/doi/full/10.1021/acs.est.2c03128

> greenhouse gas emissions. We draw attention to the concept of "embedded toxicity" to aid in the sound management of building materials, as a needed addition to "embedded carbon".[17]

To capture all the related chemicals in the process of making building materials requires a wider scope than just what is currently in the material in the built environment. The upstream and downstream lifecycle of chemicals in building materials must be treated and therefore should be included in measurement of material toxicity.

Building Demolition and PFAS Exposure

PFAS are present in almost all modern building materials and most likely many older buildings were treated with products containing them. Building demolition is uniquely suited to spread the contaminates of PFAS chemicals on the jobsite, to populations directly adjacent to the project, for miles that the materials are moved for disposal, and ultimately in the landfill even if the landfill is lined. In demolition the mechanical action of crushing creates particulates of dust from the building's materials. These particulates enter the air and spread throughout the environment. Machines repeatedly driving over the worksite further circulate these particulates. Atmospheric conditions like wind can exacerbate the spread of dust.[18]

> Small-scale changes in air and surface water velocities can disperse contaminants in multiple directions, contributing to rapid vertical mixing of PFAS and cross-media transport (for example, surface water to sediment and deposition from air to surface soil). In air and water, molecules moving in response to a concentration gradient is known as diffusion. In surface water and air, mixing caused by turbulence is also referred to as eddy diffusion.[19]

Demolition is a main source in diffusing PFAS's into the environment. The common practice of spraying water over a building while it's being demolished further saturates the ground and eventually water table with particulates. Workers, vehicles, and containers leaving demolition sites all spread dust and particulates offsite and would be considered a secondary source of contamination.[20] These workers then spread the dust into places like their homes. The presence of PFAS in dust particulates have been measured indoors and found "once PFAS is in dust, it can be inhaled and consumed by adults, children, and pets."[21]

The majority of construction and demolition waste goes to landfills. More than 1,500 construction and demolition debris (CDD) landfills operate in the United States (U.S.), and U.S. federal regulations do not require containment features such

---

[17] https://pubs.acs.org/doi/full/10.1021/acs.est.2c03128

[18] http://www.reclamationadministration.com/2016/07/22/deconstruction-vs-demolition-portland-oregons-potential-for-groundbreaking-health-and-safety-studies-in-building-demolition-by-sara-badiali/

[19] https://pfas-1.itrcweb.org/wp-content/uploads/2022/09/FT_PFAS_Fact_Sheet_083122_508.pdf

[20] https://pfas-1.itrcweb.org/wp-content/uploads/2022/09/SiteChar_PFAS_Fact_Sheet_082522_508.pdf

[21] https://greensciencepolicy.org/docs/pfas-building-materials-2021.pdf

as low-permeability liners and leachate collection systems for these facilities.[22] The materials containing PFAS's leach the chemicals into groundwater over many years.

> Diffusion in groundwater is often ignored because diffusion rates are slow relative to advection. However, diffusion of contaminant mass into lower permeability soils or site materials such as clays, bedrock, and concrete may enhance the long-term persistence of PFAS in groundwater.[23]

Even if the C&D has a liner, like those in Florida, the leachate is pumped from tanks and sent to wastewater treatment plants, which are another contamination source.[24]

Lead and asbestos in building materials and the harm they cause resulted in educational campaigns and laws to ensure materials are disposed of in hazardous waste facilities. The prevalence of lead in dust particulates inspired experts to recommend expanding demolition notification to at least 400 feet away from single-family housing demolition and not just adjacent properties.[25] PFAS's need to be treated with more stringent laws than lead and asbestos have in building materials. Building demolition should be looked at as a primary source of PFAS chemicals released into the environment.

The EPA released a memorandum to states that provides direction on how to use the nation's bedrock clean water permitting program to protect against per- and polyfluoroalkyl substances (PFAS). The guidance outlines how states can monitor for PFAS discharges and take steps to reduce them where they are detected.[26] The use of water in demolition may be a way to move forward in creating awareness and eventually legislation creating safer demolitions or eliminating them altogether.

Conclusion

PFAS chemicals in building materials are in the very early stages of being studied. The data is limited due to a variety of issues including proprietary information and sheer volume of products to be investigated. There are no known studies of PFAS exposure in building demolition. There are tangential findings that indicate a strong case for building demolition to be a powerful candidate for PFAS contamination.

The Environmental Protection Agency's integrated approach to PFAS is focused on three central directives:

- Research. Invest in research, development, and innovation to increase understanding of PFAS exposures and toxicities, human health and ecological effects, and effective interventions that incorporate the best available science.

---

[22] https://pubs.acs.org/doi/10.1021/acs.est.5b01368
[23] https://pfas-1.itrcweb.org/wp-content/uploads/2022/09/FT_PFAS_Fact_Sheet_083122_508.pdf
[24] https://ncpolicywatch.com/2020/04/16/your-discarded-carpet-is-poisoning-the-earth-with-pfas/
[25] https://journals.sagepub.com/doi/10.1177/003335491312800605
[26] https://www.epa.gov/newsreleases/epa-issues-guidance-states-reduce-harmful-pfas-pollution

- Restrict. Pursue a comprehensive approach to proactively prevent PFAS from entering air, land, and water at levels that can adversely impact human health and the environment.

- Remediate. Broaden and accelerate the cleanup of PFAS contamination to protect human health and ecological systems.[27]

Building materials fall into the EPA's call for Research, Restrict and Remediate directives. Building demolition should be analyzed and acted on immediately.

There are many existing sources for the adverse health effects of PFAS's and their related chemicals. There are also more detailed descriptions of measurements in parts-per-million and the chemical history. For brevity sake, I have included links to sources. An enlightening and easy overview would be to watch the movie *Dark Waters,* which tells the story of the first related PFAS litigation against DuPont.[28] Then review the Works Cited index.

Building Material Reuse

As a Building Material Reuse expert, the presence of PFAS in materials opens up even more arguments for deconstructing buildings and reusing stock. Green Science Policy Institute is "hungry for alternatives" to building materials without PFAS's to offer the public. If older buildings have less PFAS or by some miracle none, then this is a good initiative for deconstructing and reusing them. PFAS are so prevalent and long lasting that they will persist through recycling of products.

The variation of building materials with PFAS chemical family (including PFOA, etc.) might be better measured through individual buildings, instead of general building stock. Buildings are constantly evolving though repairs, maintenance, remodeling and updating. But older buildings would have started with less PFAS and materials inherently made with them. The authors of Embedded Toxicity address recycling and waste and recommend building audits before demolition. "At end-of-life, predemolition audits, a quality control mechanism before the building is torn down, are advisable. These should test for chemicals of particular concern, such as PCBs and asbestos, to inform the demolition team and subsequent waste managers (including recyclers) where special precautions should be taken." Building reuse professionals have been advocating for audits like this for years, but for opportunities to reclaim materials. A combination of purposes to reclaim materials, and to isolate chemical hazards may prove effective enough to boost existing building deconstruction laws. Or even tip the scales to create new reuse legislation where there is none. Something worthy should come out of this disaster and there is opportunity to create meaningful change here.

---

[27] https://www.epa.gov/system/files/documents/2021-10/pfas-roadmap_final-508.pdf

[28] https://en.wikipedia.org/wiki/Dark_Waters_(2019_film)

Sara Badiali is a consultant for municipalities, businesses, and nonprofit organizations on how to create circular economies from recycling buildings. She is the creator of [Reclamation Administration.Com](), a building material reuse news and innovation databank available free to the public since 2011.

Sara has provided Portland, Oregon, Baltimore, Maryland, and Senator Laura Acasio, of the State of Hawaii with data and research products. She is the author of seven articles on building deconstruction practices, material reuse, and hazardous construction materials. Sara created the Demolition Health Hazards infographic.

Sara advised the groundbreaking creation of the City of Portland’s Building Deconstruction Ordinance. She provided her expertise on the City of Baltimore’s ReBUILD ACT, building deconstruction policy legislation. She was board chair for the national nonprofit Building Material Reuse Association. .

Sara has a master’s degree in Public Administration from Portland State University, an undergrad degree in Health Education, and trained and worked as a construction welder in 2002, for architect Paolo Soleri at Arcosanti in Cordez Junction, Arizona.

Sara Badiali
(503) 320-2535
6205 SE Flavel St
Portland, OR 97206
Sara.Badiali@Gmail.com