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Using building materials sustainably – IOER Material Cadastre Germany provides an essential basis

The construction sector is one of the world's biggest polluters. It is responsible for the enormous consumption of natural resources and the emission of large quantities of greenhouse gases. At the same time, it generates many tonnes of construction waste. If this is to change, more building materials need to be recycled and components reused. With the "Material Cadastre of Buildings in Germany", scientists at the Leibniz Institute of Ecological Urban and Regional Development (IOER) are now providing an important basis for such recycling in the construction sector. For the first time, information on the composition and distribution of building materials is now available for the entire building stock in Germany.

The construction industry accounts for almost 45 per cent of global resource consumption. It is also one of the biggest emitters of greenhouse gases such as CO_2. These are not only produced by heating or cooling buildings, but also during the production of building materials, their transport to the construction site and the construction of the buildings themselves. The proportion of these 'grey emissions' in global greenhouse gas emissions is rising continuously. It is one reason why countries such as Germany regularly fail to meet the targets of the Paris Climate Agreement in the construction sector. At the same time, buildings contain enormous quantities of materials that are generated as construction waste during demolition. In Germany, this amounted to over 200 million tonnes in 2022, more than half of the total waste generated!

"If we could manage to use building materials for longer and recycle them after buildings have been demolished, i.e. if we could build in a circular way, then the construction industry could make a significant contribution to limiting the climate change it causes, conserving resources and reducing pollution," explains Georg Schiller, Head of Research Group Anthropogenic and Natural Resources at the IOER. However, until now there has been a lack of essential basic information, such as precise information about which materials are used in buildings, in what quantities they occur and how they are distributed in the building stock.

Material Cadastre Germany closes information gap

With the IOER Material Cadastre of Buildings in Germany, the institute is now providing this central database for the first time – covering every municipality in

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Germany. The calculations for 2022 show: The 51.6 million buildings in Germany contain around 20.8 billion tonnes of building materials. With a share of 46 per cent, concrete is the dominant building material in this 'material store', followed by sand-lime brick and bricks with just under 10 per cent each. The proportion of renewable building materials such as wood, reed or straw is only around one per cent of the total. Statements can also be made about the amount of greenhouse gases produced during the manufacture of building materials. Extrapolated to the entire building stock in Germany in 2022, there are around 2.86 billion tonnes of CO_2 equivalent in the materials used – as much as Germany emits in total in four years. In conjunction with information on regional demolition and new construction activity in municipalities, the material register makes it possible to estimate what material is available for recycling when existing buildings are demolished and what material requirements could be covered for new construction and refurbishment. The quantities of expected construction waste can also be determined with the help of the material register.

From types of buildings to types and quantity of building material

3D building models of the entire German building stock, as provided by the Federal Agency for Cartography and Geodesy (BKG), form the basis for the development of the Material Cadastre. These models are enriched with information and data. Among other things, the buildings are typified according to their function. For example, residential and non-residential buildings and other subcategories can be differentiated. *"The result is a detailed picture of the German building stock. By using the 3D building models, we know the building volume and can assign a specific type – residential building or factory building, Single-family house or apartment block – to each building. This in turn tells us which materials are used in a building and in what quantities,"* explains Reinhard Schinke, who played a key role in creating the national Material Cadastre.

This is because material indicators can be assigned to the individual building types. These type-related material indicators are the result of many years of research at the IOER. *"We analysed the typical construction of a building type, for example a factory building. From the foundations and walls to the ceilings and roofs – the type and quantity of materials usually used are determined for each component. We differentiate between a total of 44 building material groups,"* explains Georg Schiller.

Depending on the type of building, sometimes more concrete is used, such as in factory buildings or high-rise office blocks, or more brick and wood, such as in residential buildings. This typical composition of different buildings is reflected in the material indicators developed. They can be accessed via the IOER's "Information System Built Environment (ISBE)" – and they form a crucial basis for the informative value of the national Material Cadastre. The Cadastre itself, which links geodata with material indicators, is available as a dataset in IOER's new data repository "ioerDATA".

In its current form, the IOER Material Cadastre of Buildings in Germany is based on analyses carried out on a building-by-building basis. The information provided is therefore very valuable, as it provides reference values for typical building material compositions of comparable buildings. This already offers potential – especially at a strategic level – for the expansion of regional material cycles when planning circular cities. *"In combination with information on demolition and construction activity, it would be possible, for example, for local authorities to realistically examine what contribution the recycling of demolished concrete can make to covering local raw material requirements and what possibilities for the sensible orientation of municipal policy control instruments result from this,"* Georg Schiller describes an exemplary application of the information from the Material Cadastre. In principle, the IOER Material Cadastre of Buildings in Germany offers basic information for a wide range of planning tasks relating to the efficient management of existing material stocks in the building stock, thus reducing the costs of data procurement. The construction method of individual buildings necessarily remains blurred. *"The type-based approach neglects individual characteristics. It is therefore not possible to provide exact information on the actual material composition of a specific building at building level,"* explains Schiller.

The data can be used by local authorities, architectural firms and owners of larger building stocks as well as by consulting firms and start-ups in the field of circular construction. They can use the information directly or enrich it with their own, more detailed data in order to derive business models from it, such as the development of building passports or the creation of sustainable demolition and reuse concepts as part of so-called "pre-demolition audits". The data is also of interest to recycling companies, as it helps them to better estimate future demolition material and build business models on this basis.

Refinement of the database, further development of methods

"At the IOER, we have been researching the foundations for the Material Cadastre Germany for well over ten years and the work is far from complete," explains Georg Schiller. Work is continuing on further developing the methods and refining the data in order to expand the range of applications. "*For example, further differentiation of the buildings, for example by taking their age into account, would bring greater accuracy. After all, an apartment block from the Wilhelminian era is made of significantly different building materials than one that was built after the end of the war in the 1950s. An assessment of pollutant risks could also be based on this,"* says the scientist. As with previous research, the IOER continues to work with a wide range of circular building stakeholders in planning offices, authorities and industry, to whom the data is directed.

IOER Material Cadastre of Buildings in Germany | at the repository "ioerDATA": https://doi.org/10.71830/V2STEU

Material indicators | at the IOER Information System Built Environment (ISBE): https://ioer-isbe.de/en/resources/what-kind-of-materials-are-used-

in-our-buildings

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Further reading

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Schwarz, Steffen; Gruhler, Karin; Schiller, Georg: **Mapping building material stocks in cities: regional material cadastres. Guideline.** Berlin: BMWK, 2023.
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