COMMISSION FOR SUSTAINABLE CONSTRUCTION AT THE GERMAN ENVIRONMENT AGENCY (KNBau)
// DECEMBER 2018 //

Protecting natural resources by creating material cycles in the construction sector

Legal notice

This is a scientific opinion paper from the KNBau.
The opinions outlined herein do not necessarily correspond with those of the German Environment Agency.

Commission for Sustainable Construction Agency (KNBau)

Business office:
German Environment Agency
Section III 1.4
PO box 1406
06813 Dessau-Roßlau
Tel: +49 340-2103-0
info@umweltbundesamt.de
Internet: www.umweltbundesamt.de

/umweltbundesamt.de
/umweltbundesamt
/umweltbundesamt
/umweltbundesamt

Authors:
Claus Asam (Qualified Engineer), Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR)

Architect Theresa Keilhacker (Qualified Engineer)

KAZANSKI . KEILHACKER – URBAN DESIGN . ARCHITECTURE

Teaching Prof Anette Müller (Qualified Engineer), IAB – INSTITUT FÜR ANGEWANDTE BAUFORSCHUNG [Institute for applied construction research] non-profit limited liability company

Dr Dirk Schwede (PhD), University of Stuttgart

Editor:
Til Bolland, German Environment Agency

Composition and layout:
Atelier Hauer + Dörfler GmbH

Publications as PDF:
www.umweltbundesamt.de/publikationen

Image sources:
Title image as well as images on p. 11: Anette Müller, IAB Weimar gGmbH,
images on p. 12 and 13: Andreas Kaschadt, Mittelsdorf EAR Breitungen
Version: December 2018

COMMISSION FOR SUSTAINABLE CONSTRUCTION AT THE GERMAN ENVIRONMENT AGENCY (KNBau)

// DECEMBER 2018 //

Protecting natural resources by creating material cycles in the construction sector

Contents

Key Messages

1

A large share of the material flows from the dismantling and demolition of existing structures is already recycled today. However, the technical level of this should be improved by innovations. At the same time, the economic efficiency, the necessary logistics and the acceptance among construction professionals must be effectively promoted.

2

In order to achieve a fundamental change in construction practice, resource-conserving construction must be taught as absolutely necessary to all manufactures of construction materials and planners, creators, operators and dismantlers of structures. Corresponding educational contents must be introduced and taught in training and further education institutes, as well as in specialist and mainstream presentations.

3

To implement resource-conserving construction, the local and national construction authorities must be strengthened in terms of personnel in order to effectively monitor demolition plans and their execution. Furthermore, the term „resource-conserving construction" should be added to job advertisements for construction officials and the existing personnel should be offered further training accordingly. Helpful information materials for the implementation of this key demand are the „Recycling working aids" from the Federal Government, the „Brandenburg guideline for dismantling buildings" or the current book „Recycling construction materials", currently only available in German language.

4

Demolition work must be notified and approved. Concepts and plans for resource-conserving dismantling must be developed and presented. Specific requirements for material fractions and their collection and recovery must be introduced.

5

Those involved in the planning, creation, operation and dismantling for resource-conserving construction must be reimbursed sufficiently for their additional efforts. The fee structures and acquisition guidelines must be adapted accordingly.

6

In a timely manner, it should be studied which support measures and/or sanctions (charges, taxes, quotas, financial support) are effective to introduce and support resource-conserving construction on the market. Similar to energy-efficient construction, an effective legal and technical support policy should be created.

7

Methods and principles for evaluating the recyclability of construction materials and structures must be further developed and made available and communicated to construction professionals in a generally applicable manner. Procedures and documentation (e. g. within the BNB system) must be specified in this sense. Basic data shall be provided centrally and by an independent body, for example in the WECOBIS database.

8

Aspects of recyclability – during construction and at the end of the use phase – shall be regarded as equal as technical, economic and ecological aspects in the development of new construction materials and components. In the future, aspects of recyclability should also be regarded during the technical approval of construction products in accordance to the basic requirement for construction works number seven (BR7) from the European Construction Products Regulation (Regulation (EU) No 305/2011, Annex I). The funding criteria for material and construction research must also be adapted in order to drive this process forward.

9

Research for the development of materials and processes for construction material recycling, which is still in its infancy compared to the established primary construction material research, must be given increased support and funding. The material flows currently recovered at a very low technical level must become the focus. In the future, funding should extend from research on recycling concrete to all other construction materials and components or systems.

10

The plants for treating construction waste in Germany are mainly at the technical level of the 1980s and 1990s today. The stagnation in introducing new processes into recycling practice must be overcome through support by means of investments in innovative technologies.

11

The development and introduction of new treatment and recycling technologies for construction waste will shift the boundaries of what is feasible in the planning of new buildings and retrofitting existing structures and offer more freedom in the design of recyclable structures.

Introduction

The concept of sustainability stands for responsible interaction with the environment and for conserving natural resources for generations to come, among other things. Up until now, the building energy consumption has been the focus of sustainable construction. In this area, effective requirements were formulated, technical solutions developed, and tools established for the evaluation of energy efficiency.

However, the construction sector also ranks first in terms of the use of raw materials and the generation of waste, and therefore has a key role to play in improving resource efficiency. Today, conserving natural resources and creating material cycles is moving more and more into the focus of sustainable construction. The aim is to reduce the volume of waste and at the same time, to conserve natural resources. While energy-efficient construction and the energy-saving renovation of existing structures was developed and introduced to the market over the last 40 years, there is still a great deal to do to implement resource-conserving construction. A clear formulation of requirements, the development of manageable evaluation and planning methods are required, as are the development of new recyclable construction materials and the further development of treatment and recovery technologies. Not least, the regulatory framework and the general acceptance of market participants must be developed in such a way that the use of recycled construction materials becomes self-evident in the future.

In this sense, two essential areas of activity must be developed in order to create material cycles in the construction sector. These are the recovery of secondary resources from existing structures and the planning of future resource-conserving and recyclable structures.

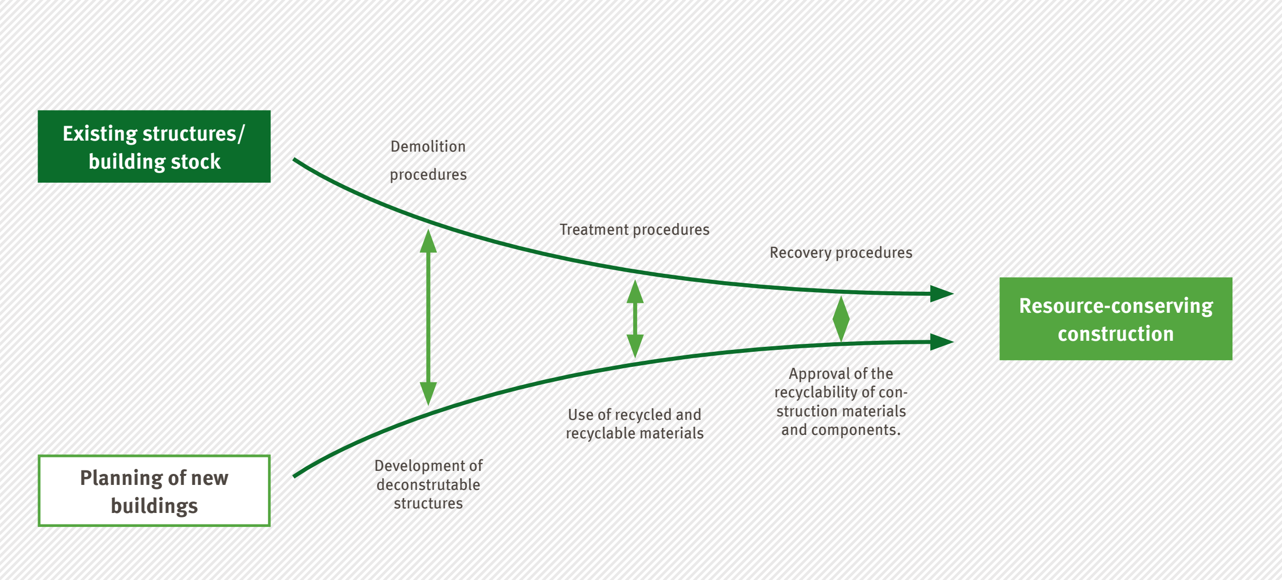
- Existing structures (building stock)
  There are limits to the selective deconstruction of existing structures. Constructional elements, construction materials and their combinations can often not be separated into material fractions pure enough for high-quality recycling during demolishing. Therefore, the development of well-performing dismantling, treatment and recovery technologies are required to retain recyclable material flows. In this way, unusable waste can be reduced as much as possible, but not avoided completely.

- Planning new buildings
  For new structures, the later recycling must already be taken into account at the planning and construction phases. Knowledge about the separability and recoverability of the construction materials shall drive the planning of deconstructable structures and a recycling-focused material selection. Additional challenges for future recycling arise from the use of new functional construction materials and composites in new buildings. The recyclability and the use of recycled materials have to become decisive criteria when developing and manufacturing new construction materials, constructional elements or systems. Certification systems for sustainable buildings, as implemented by the German Federal Government (i. e. BNB), are a first step in this direction.

These two fields of action require different approaches and involve various actors in planning and implementation. However, the development of effective deconstruction, treatment and recovery procedures for existing structures will also lead to greater freedom in planning new structures and developing new construction materials. As in the past for energy-efficient construction, technological advances in the future will be crucial for resource-conserving construction.

Figure 1

Interactions between planning new buildings and the available technologies at the utilisation end of resource-conserving structures



Source: KNBau own depiction

Recycling of the existing structure

Even if the building materials industry states high recovery rates today, a closer look at the recycling practice reveals a rather unsatisfactory picture. The recycling of building materials in quality-preserving loops is only achieved in a few cases today.

For example, recovered asphalt can be separated by type and processed specifically so that it fulfils the technical requirements for high-quality recycling. However, the recycling volume is limited by the material demand in road construction. Since road maintenance dominates over new construction and renewed surfaces may only contain a limited proportion of recycled asphalt, a stock of recovered asphalt is consequently building up.

Although waste plasterboards from demolition or plasterboard trimmings from building activities can also be separated, only a fraction of the arising quantities is fed into the production process today. At present, a considerable amount is still being disposed past the existing plants.

There are two possibilities for the recycling of crushed concrete-based construction materials: the manufacture of bearing layers in roads or the substitution of primary aggregates (i. e. gravel) in concrete production. Technical regulations and water quality requirements apply. With the available treatment technologies high-quality recycling materials can be produced. The use of these construction materials in road construction is already common. Concrete production from recycled aggregates has played just a small role in Germany compared to the overall quantities up until now. Especially for high quality aggregates the conditions are rather favourable as a dense network of recycling companies faces a large number of ready-mix manufacturers. However, at present, only a small number of construction material recyclers produce aggregates for use in concretes.

Ready-mix manufacturers often have reservations and a lack of confidence in the use of recycled materials in concrete formulations. Functional and ecological disadvantages, presumably stemming from less favourable processability or an increased need of binding agents (esp. cement), have been clearly refuted by research and practice. Ecological advantages such as the conservation of primary material stocks, or frequently shorter transport distances of the recycled construction materials are paid little attention. Pilot projects have shown that concrete with recycled aggregates can compete economically with conventional concrete.

Demolished masonry is very restricted in its use as recycled construction material as it is often a mixture of different wall construction materials such as bricks of differing quality, lime sandstone, lightweight concrete and aerated concrete as well as mortar and plaster. The main reason for the poor recyclability are the physical properties of the particles such as porosity, stability and frost resistance, or impurities containing sulphate. Their use is thus limited to a low level, such as for backfilling operations for wells or pits etc. on the construction site or for construction and profiling works on landfills. If the materials contain too much sulphate they are not even permitted for use in these simple applications for water management reasons. In these cases, completely new ways of treating and recovering the construction materials must be adopted.

INFOBOX 1

Demolition and selective deconstruction

Demolition is the removal of a structure without expressly considering its material content. The selective, controlled, systematic or recycling-focused deconstruction, however, is the step-by-step mechanical dismantling of a structure with the aim of obtaining as much unmixed material as possible. Today's demolition tasks generally combine demolition and selective deconstruction, depending on the type of structure, the conditions of the demolition site and the intended use. With regard to the type of structure, there are the following two opposing extremes: the demolition of traffic areas or specific engineering structures does not usually involve any selective deconstruction. However, for highly developed buildings or which have been converted several times, recyclable material fractions can only be generated by selective deconstruction.

Prior to selective deconstruction, existing building materials are registered according to type and quantity. Based on that, planning commences for the spaces for the interim storage, for the capacities for transport and for the economic utilisation. The deconstruction begins with the removal and disposal of the materials which are harmful to health and the environment to avoid contaminating large volumes of other materials.

The materials are then separated into material groups such as minerals, wood, plastics and metals so that they can be specifically recycled. However, composite materials pose technological limits to the separation of materials. They usually cannot be separated with the demolition tools used and, due to the dimensions of these tools, smaller foreign components cannot be to filtered out.

The reuse of whole building components or elements requires an increased effort compared to the extraction of single materials by deconstruction. Usable materials and components without a structural function are removed from the structure before the demolition. They are then offered to the market with the help of a supporting infrastructure such as an exchange for construction components, or specialist retailers for historic construction materials. For larger components and those with a structural function, special disassembly techniques have to be used. The economical implementation of construction component recycling requires secured and well-known component qualities. In today's conditions, the recycling of components can only rarely be implemented in an economic and organised manner. In the future, such a reuse can be supported effectively through the use of BIM-based databases and the modular planning of new buildings.

Demolition of a concrete traffic area

Demolition of a canning factory with material separation on the demolition site

INFOBOX 2

Treatment technologies

Treatment technologies have to transform demolition waste into secondary construction materials with defined compositions and particle size distributions. Crushers and screening machines are used to produce grains or aggregates from coarse demolition materials. Aggregates contain different sizes of particles up to a specified upper grain size. Grains are mixtures with narrow grain limits, for example 4 to 8 mm.

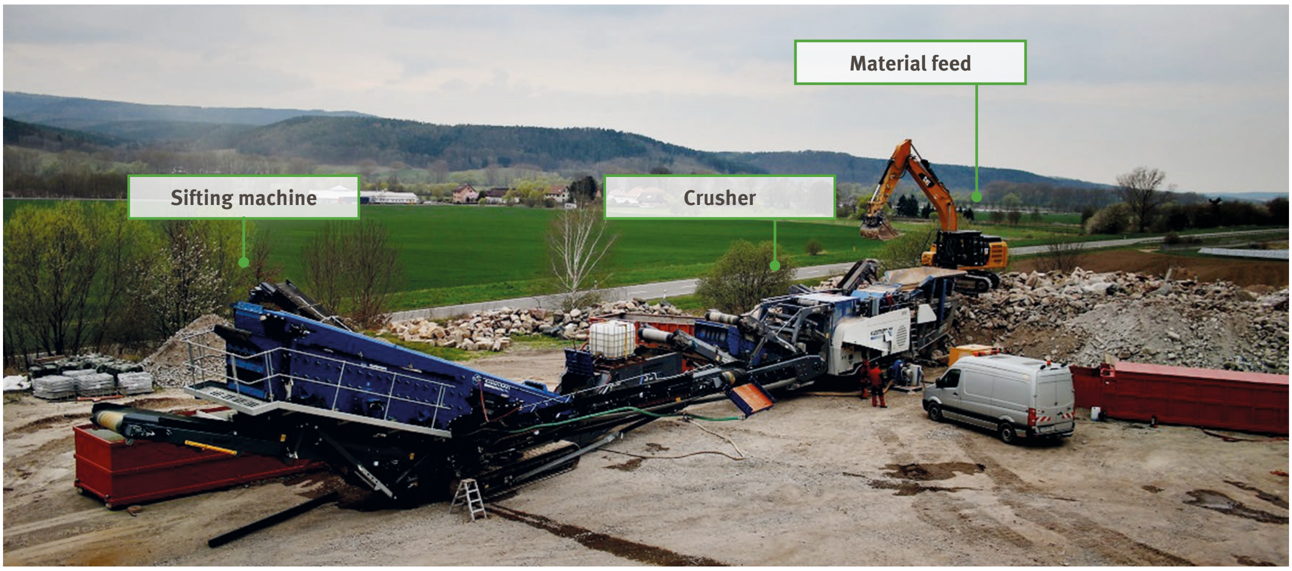
The material composition can be influenced by manual sorting or with sorting machines. A frequently used dry process is air separation where light impurities such as insulating materials, paper, foil and sometimes wood can be removed from coarse grains – usually larger than 8 mm. Wet processes can separate certain light mineral materials, too, but gypsum removal is also not possible at a reliable level. Depending on the process, draining the products and treating the process water may be necessary.

The sensor-based sorting which was introduced in other waste management sectors years ago is very rarely encountered in the treatment of construction waste. However, it is the only process that offers the possibility of separating different types of construction material.

In addition to mineral components, construction and demolition waste also contains metals, wood and plastics. These components require fundamentally different treatment technologies and are usually passed on to appropriately equipped waste management companies.

Construction waste can be treated in mobile or stationary plants. They hardly differ in terms of equipment and performance parameters. However, if a closed water cycle is required, wet processes in mobile plants usually reach their limits.

In Germany, there are a total of about 800 stationary and 1400 mobile recycling plants for mineral construction waste. They can be parts of complex (construction) company structures with demolition, civil engineering, building construction activities and their own ready-mix concrete manufacture. Another variety are those operated in recycling centres where waste such as green waste and mixed construction and demolition waste is treated. It is also possible to combine this with the treatment of natural aggregates.



View of a mobile construction waste treatment plant

INFOBOX 3

Areas of use and recovery technologies

Recycled construction materials currently usually replace natural construction materials. In the case of backfilling, soil and earth materials are replaced by treated, or in some cases, partly untreated construction waste. In road construction, recycled construction materials or even blends from recycled aggregates, natural and/or industrially manufactured aggregates are used as frost protection layers or base layers. In the case of concrete, natural aggregates are substituted by recycled grain aggregates.

These areas of use require that the recycled materials fulfil all construction and environmental regulations. To meet these requirements, regular demolition and treatment processes may have to be adapted in some cases.

Up until now, there have only been specialized recovery processes for few types of construction waste or components. Plants with parallel drums are used for the high-quality recovery of removed asphalt. Compared to conventional production, this additional process step is required for high recycling rates. In the case of plasterboard waste, the cardboard is mechanically separated before the recovered gypsum enters the production. Mineral wool and porous concrete waste can also enter the original manufacturing process when treated accordingly.

The specific recovery process for pitch asphalt removes the pitch from the aggregate by combustion. The thermal energy can be recovered and gypsum is created as a by-product from the required flue gas desulphurisation (FGD gypsum). There exists a promising thermal treatment process for demolished masonry. Previously, this waste could only be backfilled due to its heterogeneity. The light granules produced with the new process can, however, be used in manufacturing light concrete. If the waste contains sulphates, also FGD gypsum is created as a by-product.

Some plastics used in the construction sector are already being recycled as raw materials. For others, processes are undergoing trials. These chemical processes are developed and operated in close collaboration with plastic manufacturers. The plastics are first dissolved with solvents and then, after separating the usually insoluble impurities, precipitated again. There is one commercially operated plant in Italy to recover PVC from composite materials such as cables. A pilot plant is currently being set up in the Netherlands to recycle external thermal insulation composite systems (ETICS) containing flame retardants. This plant is also based on dissolving as mentioned above. The especially problematic flame retardant, Hexabromocyclododecane (HBCDD) can also be separated out in this way.

Recycled aggregate 8/16 mm from concrete

Aggregate composition 0/45 mm

INFOBOX 4

Harmful materials and impurities in the material cycle

Construction waste can contain substances harmful for the health or the environment. They can be present as objects or as components of construction materials. Examples are asbestos, mineral wool with respirable mineral fibres, polycyclic aromatic hydrocarbons (PAH) as a component of pitch asphalt, certain wood preservatives, soot, polychlorinated biphenyls (PCB) or heavy metals. Identifiable harmful objects, materials or components must be removed selectively.

Impurities and contaminants in construction waste can, as a result of their physical or chemical properties, impair the technical construction properties and thus the recyclability of material fractions.
It is known that already smaller amounts of gypsum in recycled aggregates used in road construction can lead to rises when the gypsum gets wet. If used for manufacturing concrete, too high gypsum contents in aggregates can lead to the formation of ettringite, possibly severely damaging the concrete structure.

The emission of harmful substances from recycled construction materials or industrial side products to soil and groundwater must be avoided. Testing of these emissions via leaching and chemical analysis thus is a part of official material approval and regular quality control. These emission test results determine the recycling options within the water protection limit values. If materials have very low emissions, they may be used almost without restriction. For materials with some emissions there are recycling options where the way of installation reduces or prevents the influx of water. If the emissions exceed certain limit values, recycling is not permitted. The materials must then be landfilled

For the known recycled construction materials, the limit values for the contents of impurities are laid down in the technical construction requirements. In simple terms, the more negative the effects pollutant on the constructional properties, the lower the permissible content.

On average, mixed material flows contain low contents of harmful materials and impurities. Selective deconstruction can – in addition to generating recyclable material flows – also concentrate those unwanted contents in separate material flows for specific treatment. They are thus channelled out of the material cycle and can be disposed of in an environmentally-friendly manner or, in the best-case scenario, be recovered themselves.

Construction for future recycling

In its basic requirement no. 7 „Sustainable use of natural resources“, the current EU Construction Products Regulation demands that buildings in the future be „designed, built and demolished in such a way that the use of natural resources is sustainable“. This means that a strategic and life-cycle related view on resource-conserving planning of new structures will become the task and obligation for planning and executing professions in the construction sector.

Meaningful and manageable evaluation methods are needed to support the targeted optimisation of designs under a resource-conserving planning of new buildings. The holistic planning and assessment approach under the German, federal „Assessment System for Sustainable Building“ (BNB), or its spiritual sister, the assessment system of the German Sustainable Building Council (DGNB), offers a suitable framework for the now commencing development and implementation of these methods. Those approaches should be taken into account in funding decisions, e. g. in future KfW programmes.

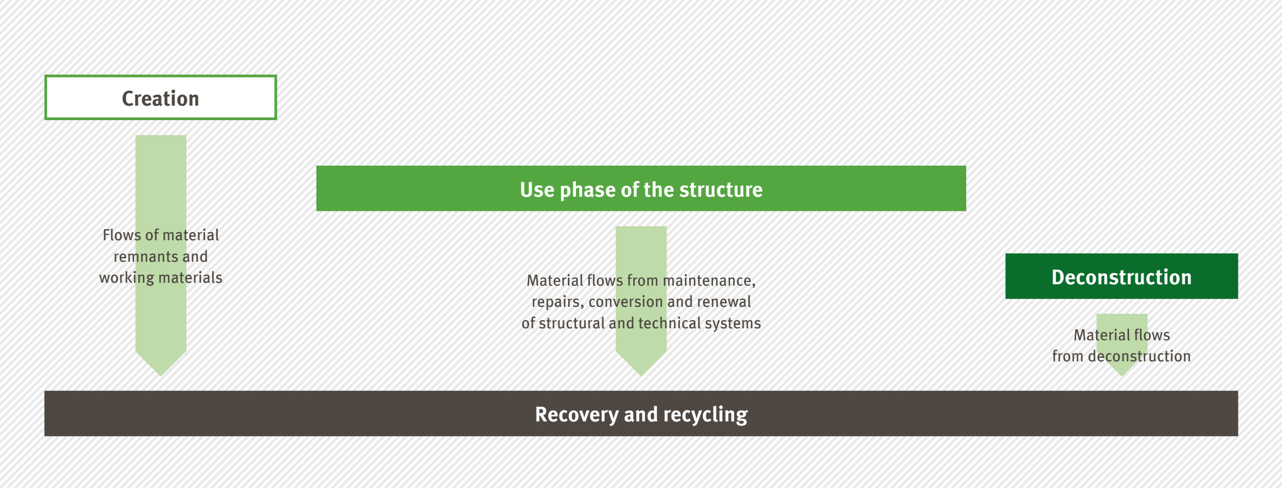
INFOBOX 5

Take-back systems

Voluntary or mandatory take-back systems are playing an increasing role in resource-conserving construction. Here, manufacturers (or manufacturing associations) return dismantled products to the production processes after use and thus close the material cycle. Take-back systems like these group together the economic interest and technical competence in one hand, opening up potential for innovation. Today, take-back systems exist for photovoltaic systems, electronic devices, mineral wool, PVC windows, floor coverings, roof coverings and aerated concrete, for example. The construction material retailers should be given a central role here for the necessary logistics of take-back systems.

Figure 2

Material flows in the life cycle of structures



Source: KNBau own depiction

INFOBOX 6

Resource-conserving construction

The fundamental principles of recyclable construction are: the choice of recyclable and recoverable materials, the planning with separable connections and the planning of recovery clusters and modular structural elements which can be safely removed from the structure and treated separately (replaced, repaired). Structural parts which require servicing or which have shorter lifespans must also be accessible or not closed in by fixed components. Both demolition planning and creating a recyclable new construction plan require expert knowledge from the planners and increased planning effort.

However, the optimisation of building planning already provides economic and organisational advantages for the servicing, maintenance and conversion of the building, meaning that the increased planning effort is matched by a direct benefit.

Recyclable construction implicates planning with material qualities in mind which allow high contents of secondary raw materials, sustainably closing material cycles. Today, this is often not the case. For example, in spite of a generally high recyclability of glass, high-quality glazing systems cannot be manufactured from dismantled sheet glass. Recycled glass is used for other products with lower quality requirements such as container glass, profiled glass, expanded glass or foam glass.

Composite materials and integrated structures shall only be used if processes, infrastructures and, if applicable, take-back systems exist which can ensure later recovery. In a few cases, the manufacturers of construction products (carpets, plasterboard, heating pumps) are interested in having their own products returned to them, as their parts still have the required quality. In the event of a foreseen scarcity or rise in cost of primary raw materials, old products are an interesting source of raw materials for the manufacturers for their new production, without expensive treatment.

However, the materials used must be labelled or documented so that they can be identified during dismantling without costly analysis and can be reused or recycled as single-variety materials. For example, this can be done by comprehensive construction documentation within BIM approaches. Since it can be expected that such documentation will not be continuously maintained and will not be available in an up-to-date form at the end of the life cycle, it is expedient to design more obvious and simpler structures and to plan with a reduced diversity of simpler materials.

The basic principles of resource-conserving planning of new buildings are

- the ability to separate connections,
- the compatibility of materials and
- the minimization of harmful substances and impurities in the selected materials.

In view of long service lives, the preservation of information about structures (deconstructability, fasteners) and about the use of materials in a way still understandable in 80+ years must be considered. Today, various approaches are being discussed, for example the introduction of a building passport or comprehensive resource registers. However, structures need also to be simplified, through modularisation, less diversity of materials and minimal content of potentially harmful substances and impurities. The development of new technologies for surveying and documenting buildings also plays a central role. These must already be carried out in new planning and building construction, forced by new rules on material labelling and digital building information systems. Alongside such approaches, more innovative methods for dismantling, collecting and treating materials in all life cycle phases of the construction should be introduced.

From the beginning, construction, the material systems used and their range of functions evolved together. New material systems have also regularly brought with them new recycling requirements. Clay bricks – easy to process and to shape into new bricks – were replaced by fired bricks. Unreinforced concrete was replaced by reinforced concrete. New developments which make it possible to save resources by using slimmer components are currently being tested.

The physical and functional requirements for building structures have significantly increased, not least due to the energy standards required today. Layer structures and bonded material layers are frequently used for insulation and producing an airtight building envelope. The same applies for material systems and coatings for moisture protection and for sealing the structure. The materials in a standard component of a current building envelope are diverse and some are inseparable. Small parts such as dowels, supporting rails and additives such as adhesive and levelling layers are also contained in considerable quantities. Many of these material systems can therefore not be economically recycled.

Architectural and constructive objectives also lead to the use of new materials and material combinations. As opposed to conventional reinforced concrete, steel fibre concrete can only be separated by finely disintegrating the concrete matrix. Only a small part of the emerging fractions can be recycled, e. g. concrete grains > 2 mm.

Current construction and material research tends to the development of more composite construction materials, such as concrete and mortar reinforced with carbon, steel, plastic or glass fibres. Hard to separate composites of organic and inorganic materials such as cement-bound particle boards or wood-polymer concrete beams which are developed by research institutes require new treatment processes.

Innovative materials and resource-conserving construction can go hand in hand. This is achieved by regarding the construction phase, the use phase and the end-of-life phase as equally important when developing new construction materials. Material design has to consider technical, economic and ecological aspects of all life cycle phases. The objectives and the funding criteria for material and construction research must be adapted accordingly.

The scope of recycling examinations usually ends with the dismantling of composite materials. In the future, the recyclability must be examined over the entire material life cycle. A system for this should be developed from the requirements of classic primary raw material processing and the requirements of the recycling sector. In the future, the right treatment solutions must be developed and supported alongside newly developed construction materials. For every innovative construction material being disposed, adequate treatment and recovery processes must exist. As a consequence, the necessary recycling capacities must be built up to match the rising waste quantities.

INFOBOX 7

Evaluation systems for resource-conserving construction

Today, there are different processes to evaluate the dismantling and recycling-friendliness of structures. They can also be used to optimise structures in the sense of resource-conserving construction. In most processes, evaluations are first carried out at a component level followed by the evaluation of the entire building. Up until now, the processes in accordance with IBO, BNB and DGNB only referred to the building structure (DIN 276, cost category (KG) 300). The technical building systems (KG 400) have not yet been evaluated at present. The latter is overdue.

The IBO (Österreichisches Institut für Bauen und Ökologie – Austrian Institute for Building and Ecology) is place the longest time. Over the course of a comprehensive lifecycle observation, a waste disposal indicator „Entsorgungsindikator EI" is determined for the structure. Here, three possible disposal routes for individual components – recycling, incineration and depositing – are evaluated on a scale. The values are then weighted according to volume and potential use to determine the disposal indicator for the entire component structure. The process is documented in an online component catalogue (see section: Further sources). The ability to separate joints, material compatibilities and the presence of impurities are currently not taken into account in the IBO process.

In the current procedure according to the German evaluation system for sustainable building (BNB), the layers of the construction elements with a total of at least 80 % of the mass of the building (KG 300) are evaluated with regard to their dismantlability, their grade of purity and their recyclability. The point value for the BNB certification is calculated from this. An Excel spreadsheet is available for carrying out the procedure. Corresponding functions are also available in the eLCA online tool (see section: Further Sources), so that deconstruction, separation and recyclability can also be assessed in the course of the life cycle analysis. The procedure according to the BNB is currently being extensively revised.

The criterion TEC1.6 „Deconstruction and recycling-friendliness" from the German Sustainable Building Council (DGNB) currently has the most comprehensive procedure. Its sub indicators „selection of recycling-friendly construction materials", „deconstructable building structure" and „deconstructability, convertibility and recycling-friendliness in the design" address three essential levels of resource-conserving construction. The procedure considers all materials in standard components, including, for example, fasteners, dyes and adhesives which may only be present in very small quantities. In the case of e. g. paints, adhesives or admixtures, the recyclability has be confirmed by a recycling company and the materials need proof to not cause harm to the local environment (criterion ENV1.2 „Risks to the local environment"). Furthermore, the avoidance of some components, e. g. of coatings through the suitable selection of materials, is rated positively. A list of problematic standard components should also be submitted to the client during the planning stage, so that recycling, conversion and dismantling concepts can inform the design decisions.

At present, all procedures lack the basic data for a reliable evaluation of the relevant criteria. Similar to the basic data provided by ÖKOBAUDAT for the life cycle assessment, databases with characteristic values of construction materials must be made available for the assessment of resource conservation.

Necessary developments

Creating prerequisites and legal requirements

The actors concerned still lack the knowledge for broadly using resource-conserving construction methods. For decades, recycled construction materials have primarily been regarded in terms of their harmful contents. This has lastingly damaged their reputation as construction materials. For this reason, information, guidelines, regulations and requirements must be provided to counter the prejudice and to support the various parties in resource-conserving construction:

- In the future, statistics on recycling rates should differentiate between the areas of use and the qualities of the recycled materials in more detail. A careful resource management needs to know which material flows go to backfilling, agriculture and road construction and which go to high-quality areas of use, for example recycled concrete or take-back systems.

- Information on demolition, treatment and recovery technologies for specific construction materials and components must be provided to the relevant agents. This should not only be a list of the best available technologies, but also show the regional capacities (as a register of recycling firms), and specifics for the logistics of the materials. This information should be freely available online for all material groups, e. g. integrated into the WECOBIS database.

- Standards, directives and technical approvals for construction materials are to be formulated in such a way that recycled materials and primary materials are interchangeable if equally suitable.

- To support construction professionals and to ensure that resource-conserving construction is implemented, sample tender texts for recycling-oriented demolition work, recycling-oriented planning of new buildings, conversion and repairs should be made available. They should address the use of recycled materials.

- In the future, the contribution made by structures, construction products and construction materials for conserving resources should be assessed at regular intervals and have a significant influence on the corresponding development and selection processes, e. g. in procurement. Methods for assessing the conservation of resources must be provided to the parties concerned, tailored to their respective use. Both simplified instruments such as product labelling for DIY markets and complex approaches, e. g. for the development of construction material systems and the approval of new construction materials have their place. Information on recyclability at a material and product level can already be provided voluntarily today via EPD (environmental product declarations). However, this path is not sufficient, as still too few companies provide the relevant information and there are problems with comparability and verification. Rather, a legally binding quality assurance instrument is required.

- Resource-conserving planning and construction should be incorporated into the training and further education of all construction professionals. Corresponding curricula for architecture, engineering and skilled worker apprenticeships should be developed.

- Based on the tasks of an „energy consultant“ in energy-efficient construction, a service profile of a „recycling consultant“ is to be introduced. As in ÖNORM B3151, mandatory recycling consulting should be included in the planning and execution phase of deconstruction projects above a minimum size or expected material flow. In ÖNORM B3151 defines thresholds values of 3500 m³ of enclosed space or 100 t of dismantled material. In the planning of new buildings, the „recycling consultant“ should give advice on recyclable construction and the selection of recyclable and recycled materials.

- An officially standardised terminology for resource-conserving construction is currently still lacking and needs to be introduced. It is a prerequisite for the development of the field of activity and to reliably formulate targets in practice and in research.

Support and funding

The recycling of construction materials must be advanced by targeted support and funding measures:

- Compared to established primary material research, research on the recycling of construction materials is still in its infancy and is insufficiently funded. The development of recyclable construction materials and components as well as technologies for demolition, treatment and recovery must be supported and funded in a targeted manner. This should also include material flows which up until now have only been recycled on a small scale, or those made of complex material composites to obtain a high technical functionality.

- Most of the stationary recycling plants operating today were set up in the 1980s and 90s. This stagnation in introducing new processes in the recycling practice must be overcome by supporting investments in innovative technologies such as sensor-assisted sorting or thermal processes. Such support would lead to high-quality material flows and a better use of the resource potentials in construction. The transfer of the laboratory-scale technologies into practice must also be supported.

- In many cases, the high-quality use of recycled construction materials is not yet economical today when compared to the use of primary materials. In these cases, targeted and temporary support measures, such as tax reliefs for the production and use of recycled building materials, should support the increased use of these materials and thus develop the market. Further measures could be: taxation of landfilling of construction and demolishing waste, transport levies, or the prescription of a minimum recycled content in construction materials and for building planning. The impact of such measures should be investigated by studies in a timely manner and made available for decision making.

Further sources

EXISTING STRUCTURE

ÖNORM B 3151: 2014 12 01, „Dismantling of buildings as a standard method for demolition“, Austrian Standards Institute

KrWG (2012), „Gesetz zur Förderung der Kreislaufwirtschaft und Sicherung der umweltverträglichen Bewirtschaftung von Abfällen“ [Legislation on the advancement of the recycling economy and securing environmentally-friendly waste disposal], online: http://www.gesetze-im-internet.de/krwg/

DIN 18007: 2000 05 „Demolition works – Concepts, procedures, fields of application“, Beuth Verlag

VDI 6210 Sheet 1: 2016 02 „Demolition of civil construction and technical facilities“, Beuth Verlag

VDI/GVSS 6202 Sheet 1: 2013 10 „Contaminated buildings and technical installations – Demolition, refurbishing and maintenance“, Beuth Verlag

EU Commission (2018), „Guidelines for the waste audits before demolition and renovation works of buildings“ online: https://ec.europa.eu/docsroom/documents/29203/attachments/1/translations/en/renditions/native

Recycling working aids, „Arbeitshilfen zum Umgang mit Bau und Abbruchabfällen sowie zum Einsatz von Recycling Baustoffen auf Liegenschaften des Bundes“ [Working aids on handling construction and demolition waste as well as on using recycled construction materials on federal properties], online: http://www.arbeitshilfen-recycling.de/links.html

Meetz M, Mettke A, Liesemeier B, Schmidt S, Verheyen F, „Brandenburger Leitfaden für den Rückbau von Gebäuden-Steigerung der Ressourceneffizienz des Recyclings von mineralischen Bau und Abbruchabfällen“ [Brandenburg guideline on the dismantling of buildings – an increase of resource-efficiency when recycling mineral construction and demolition waste], online: https://mlul.brandenburg.de/cms/media.php/lbm1.a.3310.de/Leitfaden_selektiver_Rueckbau.pdf, Ministry for Rural Development, Environment and Agriculture in the State of Brandenburg

Müller, Anette, „Baustoffrecycling: Entstehung – Aufbereitung – Verwertung“ [Construction material recycling: Emergence – treatment – recovery]; ISBN 9783658229870, Springer Vieweg

Mettke A, Heyn S, Arnold V, Faßmann J, Schmidt S (2018), „Untersuchungen zur ressourceneffizienten Kreislaufwirtschaft – Das selektierbare Bauwerk“, [Investigations of resource-efficient recycling economy – the selective structure] on behalf of the Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR) in the Federal Office for Building and Regional Planning (BBR), Edited: Brandenburg University of Technology, Faculty of Environment and Natural Sciences, Institute for Environment and Process Technology, Area of Construction Recycling, File 10.08.17.7-15.28, Bonn 2018

Figl H, Dolezal F, Thurner C (2018), „Untersuchung von gebäudegebundenen Stoffströmen in der Entsorgungsphase“ [Investigation of building-related material flows in the disposal phase], on behalf of the Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR) in the Federal Office for Building and Regional Planning (BBR), Edited: IBO – Österreichisches Institut für Bauen und Ökologie GmbH, File 10.08.17.7-16.39, Bonn 2018

PLANNING NEW BUILDINGS

Hillebrandt A, Riegler-Floors P, Rosen A, Seggewies J.A. (2018), „Recycling Atlas“, Detail Verlag, ISBN 9783955534158

BNB 4.1.4 criterion „Dismantling, Separation and Recovery“, online: https://www.bnb-nachhaltigesbauen.de/fileadmin/steckbriefe/verwaltungsgebaeude/neubau/v_2015/BNB_BN2015_414.pdf

BBSR, „eLCAv0.9.5beta“, online: http://www.bauteileditor.de/.

Österreichisches Institut für Bauen und Ökologie GmbH (2012), „EI Entsorgungsindikator: Leitfaden zur Berechnung des

Entsorgungsindikators von Baumaterialien und Gebäuden“. [DI – Disposal Indicator: Guideline for calculating the disposal indicator for construction materials and buildings]

IBO – Österreichisches Institut für Bauen und Ökologie GmbH, „IBO Passivhaus Bauteilkatalog – Ökologisch bewertete Konstruktionen“ [IBO passive house component catalogue – Ecologically assessed structures], online: http://www.baubook.at/phbtk/.

DGNB – Deutsche Gesellschaft für Nachhaltiges Bauen [German Society for Sustainable Construction], „TEC1.6 Rückbau und Recyclingfreundlichkeit“ [Dismantling and recycling compatibility], DGNB System – criteria catalogue for new buildings VERSION 2018.

BauPVO „EU Construction Products Regulation“, Regulation (EU) no. 305/2011 of the European Parliament and the Council

FURTHER INFORMATION

WECOBIS „ÖkologischesBaustoffinformationssystem“ [Ecological Construction Material Information System], online: www.wecobis.de

ÖKOBAUDAT „InformationsportalnachhaltigesBauen“ [Information portal for sustainable construction], online: www.oekobaudat.de

Institut Bauen und Umwelt e. V., „Environmental Product Declarations (EPD)“, online: https://epd-online.com/

DIN EN 15804: 2014-07: Sustainability of construction works . Environmental product declarations – Core rules for the product category of construction products. 2014.

DIN 8580: 2003-09: Manufacturing processes: Terms and definitions, division. 2003.

DIN 8593 Part 0 to 8: 2003-09: Manufacturing processes joining. 2003.

EWC waste codes, waste index in accordance with Directive 2008/98/EC of the European Parliament and the Council, online: https://www.umweltbundesamt.de/sites/default/files/medien/2503/dokumente/2014-955-eg-de.pdf

GISCodes, BGBau (Construction Industry Trade Association), online: https://www.bgbau.de/gisbau/giscodes

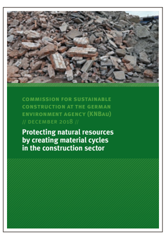
GHSCodes, Globally Harmonized System of Classification and Labelling of Chemicals (GHS), online: http://www.unece.org/trans/danger/publi/ghs/ghs_welcome_e.html

F. Kleemann, J. Lederer, J. Fellner, M. Scheibengraf (2015), „Ergebnisbericht des Projekts „Hochbauten als Wertstoffquelle““ [Findings report from the project, „Building constructions as a source of recyclable materials“], StadtbauDirektion Vienna, CD laboratory of anthropogenic resources, Vienna University of Technology, Department of Environmental Protection, online: publik.tuwien.ac.at/files/PubDat_238867.pdf

Sensitivity study on the potential of the recycling economy in building constructions (2014), Zukunft Bau [Future of Construction], final report, online: www.bbsr.bund.de/BBSR/DE/FP/ZB/Auftragsforschung/2NachhaltigesBauenBauqualitaet/2013/Kreislaufwirtschaftspotenzial/Endbericht.pdf?__blob=publicationFile&v=2

Urban Mining – Ressourcenschonung im Anthropozän (2017) [Urban Mining – Protecting Resources in the Anthropocene], Federal Environment Agency, Berlin, online: www.umweltbundesamt.de/sites/default/files/medien/1968/publikationen/uba_broschuere_urbanmining_rz_screen_0.pdf

Kartierung des anthropogenen Lagers in Deutschland zur Optimierung der Sekundärrohstoffwirtschaft (2015) [Charting the anthropogenic storage in Germany to optimise the secondary raw material economy], Federal Environment Agency, Berlin, online: www.umweltbundesamt.de/sites/default/files/medien/378/publikationen/texte_83_2015_kartierung_des_anthropogenen_lagers.pdf



▸ **Our brochures to download**
Short link: bit.ly/2dowYYI