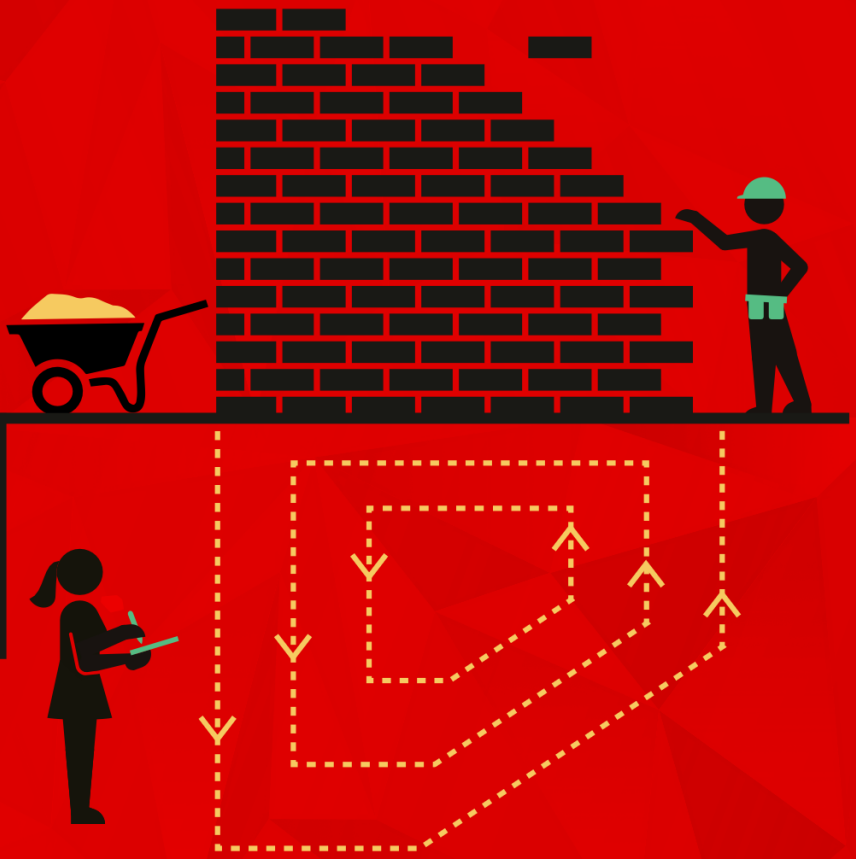
METABOLIC

City of Amsterdam

Copper8



The circular design of buildings

The circular tool box

Content

3 Summary

5 Recommendations

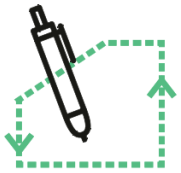
6 Substantive deepening

9 Example

After reading this article, you will:

- → Gain an understanding of circular design
- → Become familiar with various definitions of circular design
- → Understand the significance of circular design in construction

Summary



Circular design is gaining more momentum for creating both a sustainable built environment and public spaces. Circular design makes buildings more adaptable and facilitates the high-value reuse of a structure's products and materials once they have reached the end of their life. This article summarizes the circular design of buildings in eight core principles. These are based on two key elements: circular design and the circular use of materials. Figure 1 below offers a visual overview of the eight principles.

Circular construction requires a different design process than the traditional approach. It involves the expertise of external parties who specialize in circular design's methods of flexible, detachable, and waste-free construction. In terms of costs, a circularly-designed building or structure does not necessarily have to be more expensive. Consider the structure's entire life cycle. Over time, a circular approach results in less investment in maintenance and interim adjustments. The residual value of products and materials also remain higher. Some important decisions at the very beginning of the process help ensure a circular design's success, and these are outlined below.

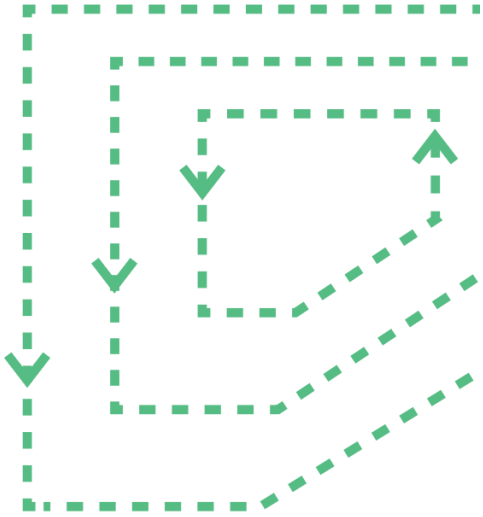
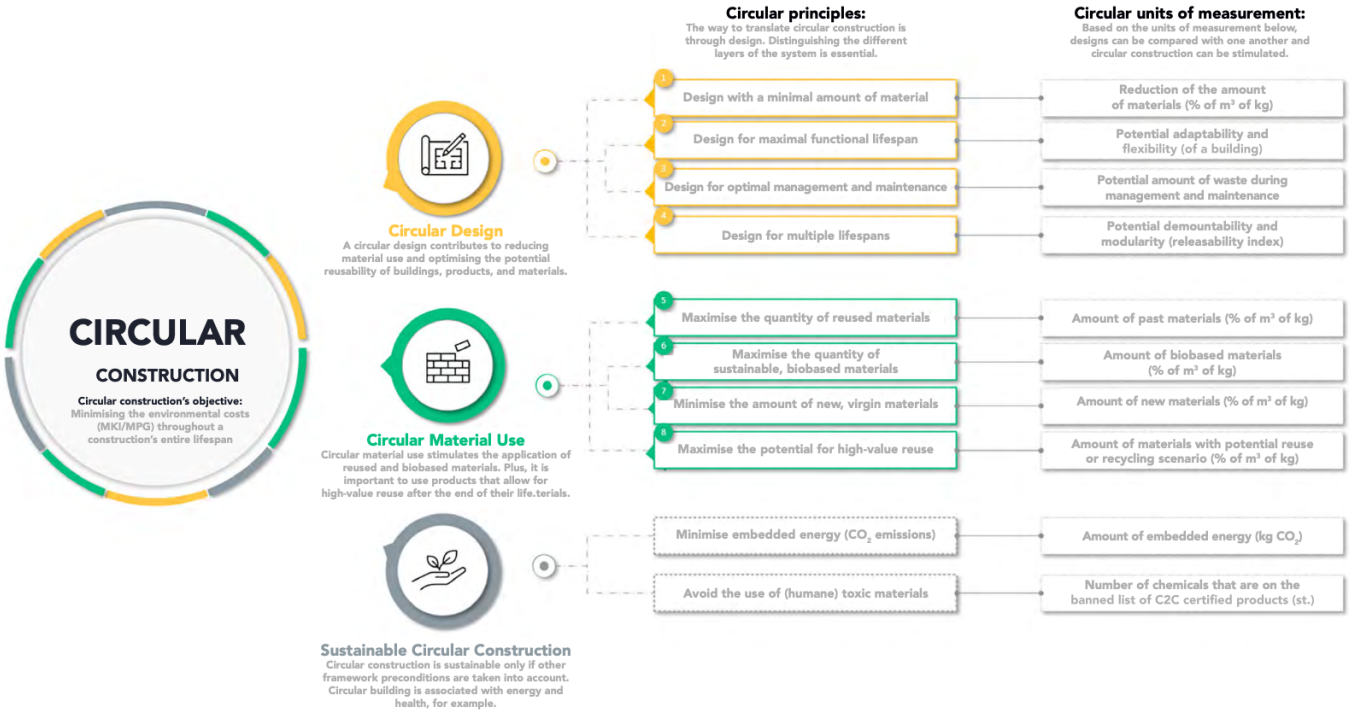


Figure 1: Circular Construction in 8 principles [1](Copper8, 2021)



Recommendations

- Determine which circular principles should be applied to the project at the beginning of the design process.These principles will determine the design process and technical design choices going forward.
- Make project-specific choices early in the design process to create clarity for all parties involved, such as establishing which circular building principles best suit the project.
- Include circular principles at the outset of the design process, as adding them later during construction will prove more difficult.
- While adaptable designs that allow for multiple life cycles are smart, stay realistic about any visions for plausible uses in the future. This prevents unnecessary material consumption, for example, as a result of oversizing.
- Involve parties with available materials early on, so they can contribute ideas about solutions and the compatibility of those materials to the design. Explore the implications of these materials on other aspects, such as legal issues (warranties and liability) and management (required maintenance).

Substantive deepening

The importance of circular design

Circular design is a vital component to both circular construction and the circular economy. To enable the high-value reuse of building elements, parts, and materials, it is important that they can be easily detached from each other. This prevents buildings from being dismissed prematurely or even demolished, without consideration for alternative uses after its original use. As most buildings and structures today are immovable and not yet consisting of separate elements, we can only reuse a select few products, with redeployment and recycling of materials often being the only option.

Departure point: thinking in layers and purposes

An important perspective in circular design is to view a building as having different layers. Stewart Brand identified a useful framework for the different functions of a building, known as the Six S's: site, structure, skin, services, space plan, and stuff. A different circular design can be prioritized per layer to promote circularity within that part. The six layers must be divided between functionality and functional lifespan in order to develop each separately.

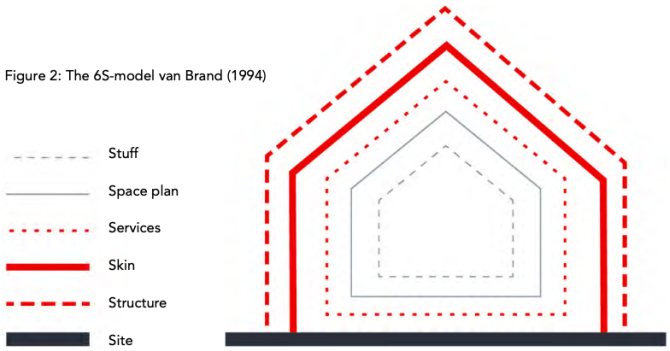
The eight principles of circular construction

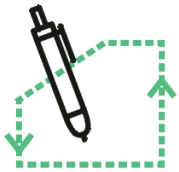
Circular construction can be summarized in eight principles (see Figure 1):

1 Design using a minimum amount of materials
2 Design to maximize the functional lifespan
3 Design for optimal management and maintenance
4 Design for multiple life cycles
5 Minimize the use of new or virgin materials
6 Maximize the amount of recycled materials used
7 Maximize the use of sustainable, bio-based materials
8 Maximize the potential for high-value reuse

These eight principles mainly focus on design choices and materials, but other circular topics are also important, such as optimizing a building's energy efficiency and avoiding toxic materials. Each project is unique and requires a project-specific set of design principles. This can depend on a building's purpose, its expected life span, and the availability of materials being released back into the market. For example, a building with an expected long lifespan calls for a robust design with a main bearing structure that can last more than 100 years and a flexible layout to suit a variety of purposes. If a building is intended for a shorter lifespan, perhaps 30 years, opt for a design that includes multiple life cycles and detachable parts for future disassembly.

Figure 2: The 6S-model van Brand (1994)





Approaching a project with the six-layers-perspective helps determine the circular principles most appropriate for the project, layer by layer. For example, planners can design for a maximum functional lifespan (structure), optimal management and maintenance (skin and services), or multiple life cycles (space plan). And when choosing materials, one could opt for maximizing the amount of sustainable, bio-based materials (structure and skin) and recycled materials (space plan).

Definitions

- **Building flexibility:** the ability of a building during its lifespan to undergo spatial change, in terms of its ability to be rearranged, scaled up, or scaled down
- **Adaptivity:** the ability of a building to undergo functional changes during its lifespan
- **Detachability:** detailing the building in such a way that its products and materials can be reused in subsequent life cycles, for example, the dismantling of fasteners
- **Modularity:** the extent to which products and materials of a building or structure can be separated and combined

Considerations for the design process

Circular design not only results in a different technical design; it also requires a different approach to the entire design process. When designing for a building's maximum functional lifespan, for optimal management and maintenance, or for multiple lifecycles, designers will have to think differently about the value of elements and products and the various fasteners that connect them. It is important to contact suppliers to explore how to incorporate elements and products that are detachable. While this might sound straightforward, this is not standard practice; most building components are attached with "wet" adhesives (like a glue or sealant), so they are not detachable and therefore only suitable for a single purpose or layout. However more options present themselves when factored into the process early enough, as first demonstrated by the first sample projects.

If parties involved begin with a design that uses available materials, they must meet during the early stages with parties that supply residual material streams to determine what kind of products are available. This allows for tailoring the design to the specifications of the materials that are available. When included early on in the process, this can be done relatively efficiently and as such, makes for a circular design that is not necessarily more expensive. It is also important to assess the implications of using recycled materials in terms of guarantees, liability, required maintenance, and other issues. This requires solid agreements between the client, owner, and suppliers.

The impact of circular design

A circularly-designed building offers various benefits. For example, using recycled materials decreases environmental impact, because fewer new materials need to be produced. Residual value comes into play as well, thus preventing a building's total depreciation.

In addition, a circularly-designed building continues to generate value during its maintenance and replacement phase, because products can be replaced in parts (modular), interior walls can be moved (flexible and adaptable), and demolition costs can be avoided (detachability). Calculating the total costs over its entire lifespan, a circular building should therefore cost less than a "traditional" building.

Case study 1

A Temporary District Court in Amsterdam

Construct a building that will be dismantled after five years?The DPCP consortium was asked to do just that. The temporary building (section G) recently opened on the site of the Parnas complex of the District Court in Amsterdam. The client, the Central Government Real Estate Agency, strongly emphasized preventing waste and maximising residual value during its construction. Attention was paid to the reduction, reuse, and recycling of materials on every level. Temporarily housing the court, the entire building can be dismantled once the construction of the permanent building is complete. The parties have developed new mounting systems that make it easy to attach and reuse products. Financial agreements were made about the period after the building's functional lifespan. All parts can be reused and enter a new life cycle. Not only are the parts reusable, the building as a whole can be reused. After the first period of use, it can be completely reassembled at a different location, and in a different configuration, if so desired.

With an ingenious demountable steel structure, the temporary District Court fulfilled the Central Government Real Estate Agency's request for an interim courthouse that still meets the highest standards for comfort and safety.

Case study 2

A modular student complex

Vestide commissioned the firm Jan Snel to construct 300 studios for students in June 2021, spread over four blocks on a vacant site in Eindhoven. Based on a modular construction system, the studios will be located at Berenkuil for the first fifteen years, after which the modules will be destined for another location.

The student complex is within cycling distance of many Eindhoven college and university buildings. Since the studios are made up of units, the buildings are easily adaptable and movable. The use of steel walls and concrete floors makes the units suitable for permanent use as well.

The use of electric heating and water supply lends even more flexibility to the modular units. Solar panels was a sustainable choice that keeps costs for residents within limits. The design of the complex even considered its impact on the environment; swales were installed to properly process rainwater. In consultation with Groendomein Wasven, various grass species and plants were used to stimulate biodiversity.

More Information

The following publications offer additional background on circular design:

- **Greenpaper Circulair Ontwerpen (Cirkelstad): a paper describing the main principles for the circular design process and the collaboration it requires**
- **Inspiratieboek Circulair Ontwerpen (IPV Delft): an "inspiration book", providing many examples from civil and hydraulic engineering that include circular design principles**
- **Witboek circulair ontwerpen (BNA): an overview of circular designs of various buildings in the Netherlands**
- **Gebouwflexibiliteit MAT8 (BREEAM): a method for measuring "building flexibility" in non-residential construction**

Footnotes

1 **Copper8** (2021) Circulaire businesscase: rekenen aan vastgoed in een circulaire bouweconomie.

2 **Steward Brand** (1994) How Buildings Learn.