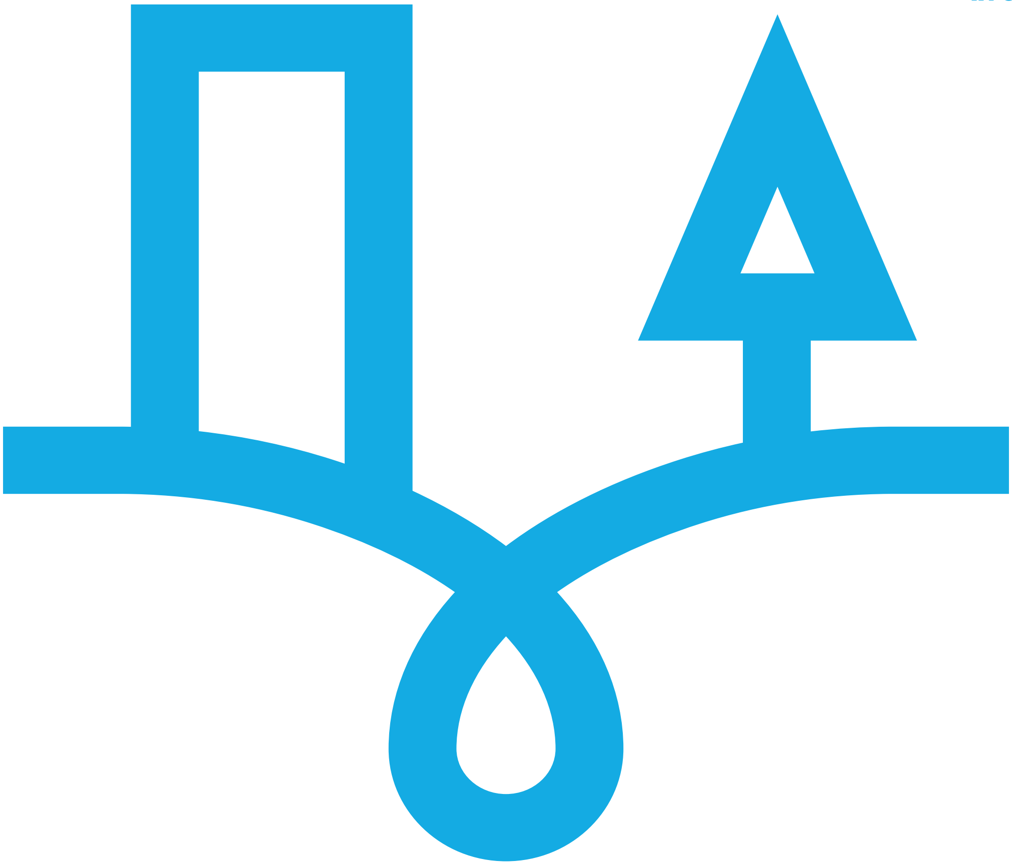
CIRCULAR
ECONOMY
IN CITIES



MAKING BUILDINGS WITH NEW TECHNIQUES THAT ELIMINATE WASTE AND SUPPORT MATERIAL CYCLES

ELLEN
MACARTHUR
FOUNDATION

ARUP

The construction and demolition of buildings accounts for around one-third of global material consumption and waste generation. This can be countered by implementing new construction and manufacturing techniques that are in line with circular economy principles.

CASE FOR CHANGE

Construction materials and the building sector are responsible for more than **one-third** of global resource consumption[1]

11% of global energy related CO_2 emissions can be attributed to the construction industry[2]

Up to 40% of urban solid waste is construction and demolition waste (CDW)[3]

54%

54% of construction and demolition waste in Europe is landfilled[4]

EXAMPLES OF CIRCULAR ECONOMY OPPORTUNITIES

Sourcing materials strategically

Selecting construction materials that can be sourced locally (including by-products), and kept in use continuously, can reduce virgin material demand. Materials made available during deconstruction could then be reused. Selecting renewable materials where appropriate, can furthermore reduce dependence on finite resources.

Building with resource-efficient construction techniques

New industrial construction techniques are gaining traction due to their many benefits, including cost-efficiency and reduced waste generation. Prefabricated building elements (such as a wall or sections of a wall) can easily be assembled on-site, significantly reducing construction time.
3D printing (also known as additive manufacturing) of building units on- or off-site, from components to entire buildings, can minimise waste generation and resource consumption.[5] This is because 3D printing eliminates off-cuts and can create shapes that use less material and that cannot be made using conventional techniques. For example, in China industrial construction techniques are being mainstreamed in accordance with a governmental target for 30% of new buildings in China to be prefabricated by 2026.[6]

Developing 'buildings as material banks' (BAMB)

Technology such as building information modelling (BIM) and similar digital building mapping technology can help turn buildings into 'banks of material'. With such building material maps, owners will have information on what materials and components are in the building, where they are sourced from, and guidance on their potential future use. This makes reusing building components and recycling materials significantly easier.[7]

RELEVANT CASE EXAMPLES

Industrial construction without waste

The Broad Group, a Chinese contractor specialising in industrial construction, has increased efficiency in production, installation, and logistics 6–10 times, with almost zero material waste and 40% lower total cost of construction. The Broad Group has demonstrated impressive time savings by constructing a 57-storey building in just 19 days.[8]

Building with locally salvaged materials

Villa Welpeloo is a Dutch house designed by Superuse that highlights the massive potential of unused or 'misplaced' resources. Aided by Google Earth, Superuse selected a construction area for a new building based on the area's proximity to industrial salvaged materials. This meant that they were able to construct the final building with 60% locally recovered material. The agency now uses this strategy on 90% of its projects and has created an online marketplace, Harvest.org, for upcyclers.[9]

Buildings as material banks

Arup's circular building pilot project harnessed technology to maximise the utilisation of components and materials. Arup designed the building for disassembly, using non-harmful and prefabricated components that could easily be taken apart. Arup applied BIM to enable the building to function as a material bank. The 3D BIM model for the building ensured transparency about the building's material composition. Using digital technology, all parts of the building, from window frames to individual fittings, were tagged with a unique QR code containing the information needed for reuse. This improved access to information that helped multiple stakeholders collaborate more efficiently on building design, construction, and operation. This information also enabled Arup to contract with suppliers to take back materials after their use.[10]

EXAMPLES OF WHAT URBAN POLICYMAKERS CAN DO

City governments can incentivise the use of new construction techniques and smarter material choices by specifying these in **public procurement** tenders for construction projects. Through **fiscal measures**, such as landfill taxes, and **regulation** on material management, city governments can encourage resource-efficient construction and de-construction practices. While industrial construction is less labour intensive than traditional construction practices, deconstruction (including reuse and recycling) is more labour intensive and entails higher skill-level requirements than demolition and landfilling. To support this, developing **capacity-building** programmes for construction workers can be an important way of ensuring the demand for expertise and skills can be met and new job opportunities can be opened up. The creation of material passports for public buildings will better support the **asset management** of these buildings, as cities will have much clearer information about the building materials they own and their potential for reuse.

To explore further see **Policy Levers**

EXAMPLES OF LINKS TO OTHER SYSTEMS AND PHASES

Buildings: Designing The way new buildings are constructed, and later disassembled, is highly dependent on building design. For example, whether the design supports industrial construction techniques and appropriate material sourcing.

Mobility: Planning Industrial construction techniques can reduce the amount of heavy freight needed in and out of the city. This will have positive impact on urban mobility, especially in fast-expanding cities.

EXAMPLES OF BENEFITS

ECONOMIC PRODUCTIVITY

Decreasing construction time and increasing resource-efficiency

Industrial construction techniques, such as 3D printing and off-site prefabrication, can reduce construction time by 50–70%.[11]

Increasing economic productivity

By integrating circular economy principles in the building construction chain in Amsterdam for 70,000 new homes by 2040, the city can achieve a 3% productivity increase worth EUR 85 million per year.[12]

JOBS, SKILLS, AND INNOVATION

Creating jobs and skills opportunities

Studies in the US and UK have found that deconstruction requires significantly more labour than demolition – one 'landfill job' can be replaced by 10 'resource recovery' jobs. Deconstruction also paves the way for employment and training opportunities for relatively unskilled and low-skilled workers. These workers can receive on-the-job training and the basic skills needed for deconstruction can be easily learned and transferred to the construction trades.[13]

Lowering unemployment

Integration of circular economy principles in the construction supply chain of 70,000 new homes in Amsterdam before 2040 can generate 700 additional jobs. The approximately 1% gain would be a significant contribution, resulting in a 10% drop in unemployment in the construction sector.[14]

RESOURCE USE

Reducing material consumption

Adopting advanced construction technologies as well as reusing and recycling construction and demolition waste could reduce virgin material consumption in China's urban built environment by 18% in 2030 and by 71% in 2040.[15]

Saving materials and increasing self-sufficiency

Improving the reuse of materials in the construction of 70,000 new apartments in Amsterdam before 2040 can lead to a saving of 500,000 tonnes of materials required. Set against the current annual import of 1.5 million tonnes of biomass for the entire metropolitan region, this is significant.[16]

Increasing resource-efficiency

A circular economy development path for India could, by 2050, reduce resource use in the construction of new buildings, with 37% less virgin, non-renewable materials needed, 24% less water consumed, and 18% less inner-city land used compared with the current development scenario.[17]

Reducing material costs

Industrial construction uses less material and can generate 50% in material cost savings.[18]

Reducing waste with industrial construction techniques

Off-site industrial construction greatly reduces waste generation and all off-cuts can be fully recycled in the factory.[19]

Reducing waste to landfill

Scaling up reuse and recycling in Chinese cities would see 32 billion tonnes of urban construction and demolition waste recycled by 2040. Due to waste reduction, the landfill volume could be cut by 81% in 2040 when compared with the current development path.[20]

HEALTH AND ENVIRONMENT

Reducing air pollution

Use of industrial construction techniques could decrease dust pollution (PM2.5 and PM10 particulate emissions) from construction in Chinese cities by 11% in 2030 and by 61% in 2040.[21]

Reducing CO^2 emissions from processing

Processing of recycled aggregates can generate 40–70% less CO^2 emissions than the processing of virgin aggregates.[22]

Reducing CO^2 emissions from construction

Integration of circular economy principles in the construction of 70,000 new homes in Amsterdam before 2040 can reduce CO^2 emissions by 500,000 tonnes per year, equivalent to 2.5% of the city's annual CO^2 emissions.[23]

COMMUNITY AND SOCIAL PROSPERITY

Reducing disruption and noise

Industrial construction entails fewer site deliveries and reduces site traffic by up to 70%, compared to more traditional ways of building – minimising noise, dust, and overall disruptions in urban areas.[24]

ENDNOTES

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