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The Urban Lab of Europe !

Super Circular Estate project Journal N° 4

Project led by the Municipality of Kerkrade



**CIRCULAR
ECONOMY**



The Super Circular Estate project

The Super Circular Estate project will test new circular economy processes aimed at 100% reusing, repairing and recycling of the materials acquired from the demolition of an outdated social housing building. The project will experiment with and evaluate innovative reuse techniques for decomposing a high-rise tunnel formwork concrete building in Kerkrade. The demolition materials will be used to build 4 pilot housing units with 5 different reuse/recycle techniques to be compared in order to assess their viability and replicability. Besides the project will experiment with innovative techniques for water reuse in a social housing context by testing closed water cycle. Social tenants will be strongly involved in the co-design, operation and monitoring of new collaborative economy services/facilities (aiming at reducing the need for vehicles, tools, spaces etc.) to support the transition towards a sharing, reuse and repair community model.

Partnership

- Municipality of Kerkrade
- Brunssum municipality
- Landgraaf municipality
- Stadsregio Parkstad Limburg
- VolkerWessels Construction
- Real Estate Development South and Dusseldorp Infra
- Water Board Company Limburg
- Limburg Drinking Water Company
- IBA Parkstad B.V
- Zuyd University of Applied Sciences
- HeemWonen
- Association of Demolition Contractors (VERAS)

Table of Contents

- 1. EXECUTIVE SUMMARY 4**

- 2. ELABORATION OF DIFFERENT CIRCULAR BUILDING STRATEGIES WITHIN SCE PROJECT 6**
 - 2.1 Future reuse 10

- 3. STATE OF THE ART CONSTRUCTION OF THREE CIRCULAR HOUSES 12**
 - 3.1 House Type A and preliminary construction costs 12
 - 3.2 House Type B – and preliminary construction costs 13
 - 3.3 House Type C – and preliminary construction costs 15
 - 3.4 Construction cost – SCE house versus conventional house 16

- 4. LESSONS LEARNED 17**
 - 4.1 Lessons learned / feasibility of circular method of construction 17
 - 4.2 Lessons learned / Financial feasibility 17
 - 4.3 Main conclusions so far 18

- 5 GLIMPSE OF THE FUTURE 20**
 - 5.1 BRX reversible building block 20
 - 5.2 New reversible load bearing system in concrete 21
 - 5.3 Supply demand platform 21

- 6 CHALLENGES 23**

- 7. CONCLUSION AND NEXT STEPS 26**

- 8. REFERENCES 27**

1. EXECUTIVE SUMMARY

Construction and Demolition Waste (CDW) is the largest waste stream in the EU and has been identified as a priority waste stream by the European Union. The EU Waste Framework Directive aimed to have 70% of CDW recycled by 2020, however the current rate in most EU countries is only about 50%. In addition, the construction industry currently applies typically low value recovery processes: the majority of CDW is destined for backfilling and other low value applications (downcycling), while the amount of CDW subject to reuse and high-quality recycling (upcycling) remains below 3%. (EU CDW Protocol and Guidelines, 2018)

Furthermore, consumption of raw materials in construction has tripled in last few decades according to the UN report, while research in the Netherlands indicates that use of raw material in construction is responsible for 67% of CO₂ in comparison to 33% of CO₂ emissions related to construction site and transport.

A key factor in stopping further rise of Construction and Demolition Waste and raw material consumption is prevention by reuse and upcycling. EU Waste Management Protocol has adopted CDW management in line with the waste hierarchy (with a priority for prevention and reuse as higher-ranking options than recycling and recovery). (EU CDW Management Protocol 2018)

Deconstruction of buildings can effectively improve the overall performance of CDW and reverse “the end of life” of building materials to “restart of new life” of building materials, by enabling high value recovery. However numerous

challenges hinder the high value recovery of building materials. Deconstruction and reuse operations are relatively costly and require more time than usual demolition practices, partly caused by the lack of appropriate technical knowledge and information on the feasibility and actual implementation procedure of the deconstruction process.

There is also a lack of information about material composition of existing buildings, possible value of products in existing buildings and their actual reuse opportunities. Finally, there is a mismatch between supply and demand in terms of quantity and quality of recovered materials.

UIA Super Circular Estate (SCE) project in Kerkrade aims to decode the potential of circular economy in construction by tackling above challenges during one of the most frontrunning experiments on circular construction in the EU. SCE project has tested construction approach which relays on mining of materials from the existing building for new construction. During the last two years, SCE consortium was pushing the boundaries of what is feasibility in circular construction, while deconstructing existing 10-story flat building built in 1960's and developing and testing options for restart of new life of its products and materials.

As a result of the UIA SCE experiments, three new houses have been constructed by reusing more than 90% of materials from the existing building and 9 deconstruction and reuse strategies have been tested.

Many challenges with respect to the difference between circular and conventional building

process have been addressed by SCE consortium members and elaborate in Expert's zoom-in movie from January 2019 and Journal no.1, 2. (UIA Expert's Journal 2019) Lessons learned including results of experiments and testing indicated potential ways to close material streams in construction and boost transition towards circular construction. (UIA Expert's Journal 2 and 3) As such SCE results have already drawn attention of many Dutch and international research and industry groups dealing with circular economy in construction. Preliminary results and findings from UIA SCE project have been presented during (i) International Waste Build Expo and

conference organised in conjunction with the World Architecture Award in December 2019, (ii) International Dutch Design Week organised in October 2019, (iii) International Green Design Biennale for South East Europe, October 2019, (iv) National USA conference Build Reuse, November 2019. Above mentioned events form international platforms for knowledge transfer and collaboration. (Figure 1) USA national Build Reuse organisation expressed strong interest in establishing EU-USA collaboration platform around lessons learned within reuse and circular construction projects on both continents. This initiative will have its follow up during next year.



Figure 1: Presentation of lessons learned and preliminary results during international expos and conferences on circular construction and reuse.

Challenges faced by the SCE consortium members during the project were big, ranging from management of time and cost, change in deconstruction and construction culture and shifting of roles and responsibilities beyond the conventional path of design, engineer, construct, deconstruct. During the last six months of the project, the challenges were stretching further, considering feasibility of desired deconstruction and reuse techniques and understanding the key factors that play a role in measuring their environmental and economic impacts. Besides, SCE consortium extended its experiment beyond the project limits while envisioning and testing potential spinoff technologies and solutions such as BRX block developed with disassembly and future reuse in mind. (UIA Expert's Zoom in nr.2)

This forth Expert's Journal focusses on the preliminary results of construction of three SCE houses and new advancements of SCE project and elaborates:

- Different circular building strategies that have been tested during construction of three houses
- State of the art, construction phase of three Super Circular Estate houses
- Lessons learned
- Glimpses of the Future
- Challenges ahead

2. ELABORATION OF DIFFERENT CIRCULAR BUILDING STRATEGIES WITHIN SCE PROJECT

During the construction period of three SCE houses (Figure 2) noteworthy results have been achieved illustrating the potential of circular building construction grounded on the capacity of the existing building to be re-sourced for the new construction.

SCE team has piloted deconstruction of the 10-story existing flat aiming to reuse at least 75 % of its materials during construction of three new houses.

Basic rule within conventional linear building model associated with linear (cradle to grave) material flow, is that end of building life means end of product and material life as well (Figure 3).

With such model in mind this would mean that 1.380.000 ton of building materials from 10-story flat building would end up in low level applications, backfilling and landfill. Furthermore 2.330.000 GJ embodied in existing materials would be lost together with CO2 emissions of 287.000 CO2/ton. (Ritzen 2019)



Three UIA SCE circular houses from left to right Type A, Type B and Type C

After nearly two years of development of UIA SCE project, SCE consortium has nearly finished construction of three new houses where major circular building strategies are being tested

challenging the linear building model in construction. (Figure 2)

SCE project managed to demonstrate implementation of three alternative circular material streams originating from the existing

10-story flat building. These alternative circular streams enabled restart of material life on different levels of building deconstruction: (i) material, (iii) product and (iii) building level (being in prospect as a spinoff project).

One can say that experiments within SCE project changed the conventional perception on the end of building life (Figure 3), illustrating that end of

life of a building does not necessarily mean end of product and material life. In contrary end of building life can be seen as a “restart” of new life and diversion of building products and materials from landfill and downcycling. Such philosophy is at the core of circular building and circular economy in construction. Its demonstration has been illustrated in figures 4 to 7.

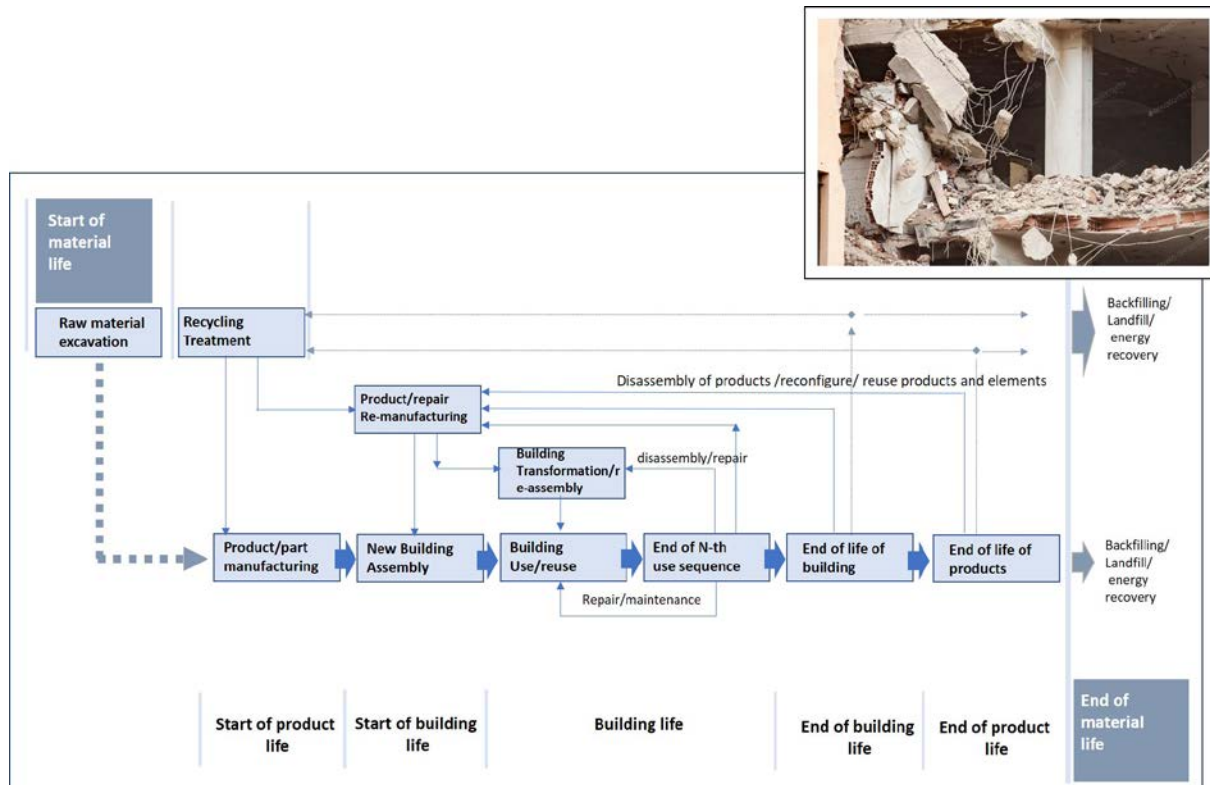


Figure 3: Conventional linear material stream in construction where end of building life equals end of product and material life

Depending on deconstruction and reuse strategy the end of use life of the building can trigger restart of material life on different levels of building composition and create shorter and longer material feedback loops along the material life phases. (Figures 4 to 7) In general shorter material feedback loop means that less effort (labour, machinery, technical intervention and time) is needed to put material back into equivalent function again. (Durmisevic 2006) For example, process of recycling of concrete forms a long feedback loop of material along all life

phases from the end of product life to the recycling and production of new product with recycled aggregate (Figure 4), while direct reuse of BRX block, creates a short feedback loop of material from the end of the first product life to disassembly and reuse as a product again (Figure 6). The higher the deconstruction and reuse level (from low to high: material, product, building level) the lower the number of reversed life phases, the shorter the material feedback loop and the lower environmental impact.

The first deconstruction and reuse strategy (tested within SCE project) has been done on the lowest deconstruction level being material level. This level dealt with recovering of concrete and its recycling in order to produce aggregate for production of new concrete. A new recipe for production of recycled concrete has been developed by consortium member Dusseldorp implying application of 95-100% recycled aggregate re-sourced from the existing 10-story

flat building. Its successful application in production of foundation, floors slabs and load bearing walls illustrated that end of life of 10-story flat building, means restart of material life through high quality recycling treatment of old concrete structure. Deconstruction of building to recover material (low level deconstruction) creates long feedback loop for the recycled material before it becomes a functional part of the building again. (Figure 4)

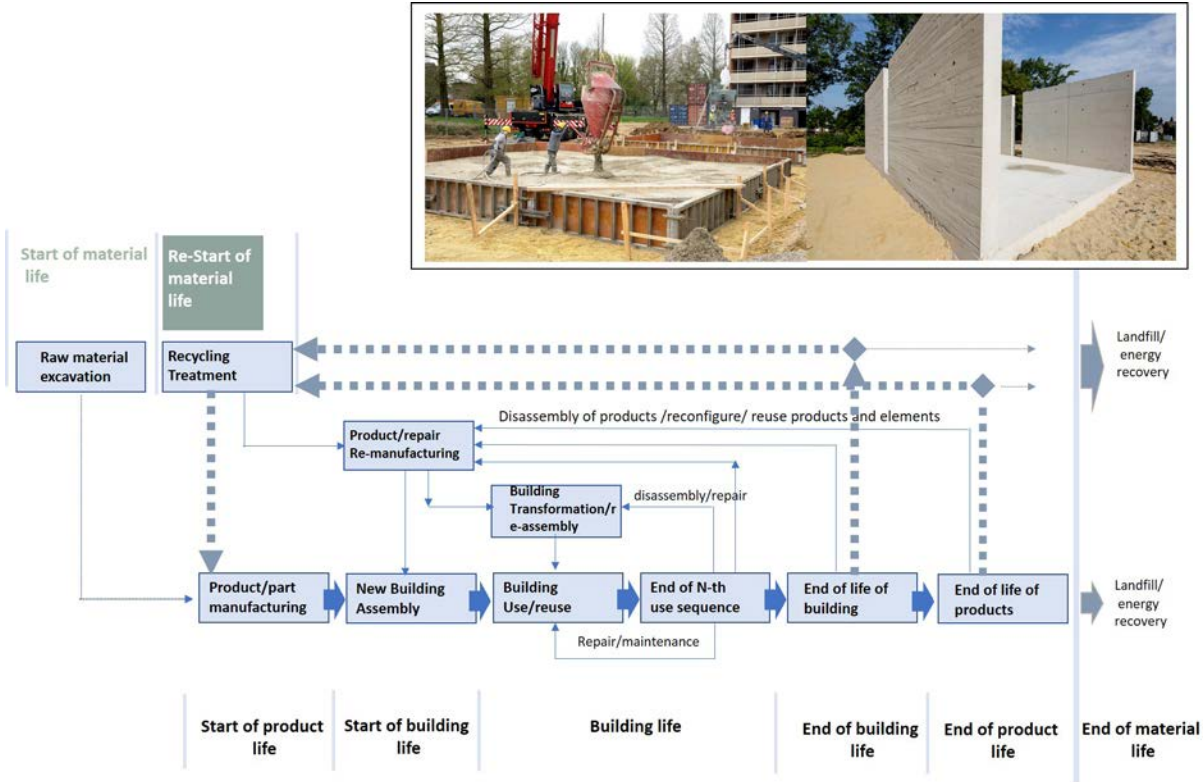


Figure 4: Restart of material life by resourcing aggregate for new concrete creates long feedback loop of the material by reactivating all phases of material life

Second deconstruction and reuse strategy has been tested on the product level by recovering part of the load bearing structure in a form of 3D tunnel shaped concrete unit to be reused as a load bearing structure of the two SCE houses. Besides this product, other product reuse strategies have been tested as well, such as reuse of facade and infill walls and doors. The brick facade wall has been cut into modules and used to configure new facade. Partitioning light-weight

concrete walls has been reused for infill as well as doors. These tests illustrated that material feedback loop can be shortened by direct reuse of part of the building and that end of building life does not necessarily mean end of product life. (Figure 5)

Nevertheless, besides the level of deconstruction and the length of the material feedback loop (both having direct impact on reduction of CO2, embodied energy and raw material consumption)

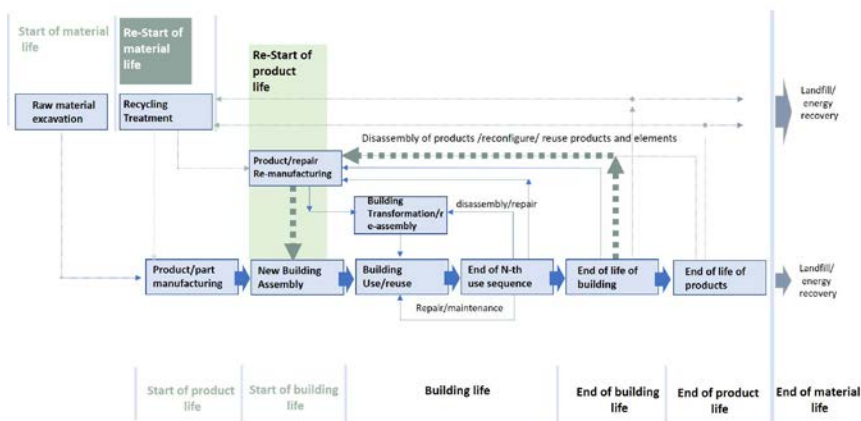


Figure 5: Restart of product life by resourcing 3D unit form the existing building otimised for one reuse

SCE experiment illustrated importance of additional factor in determining feasibility of reuse strategies. This additional factor, which is often put aside in “circular construction projects”, is method of construction and the way building parts are connected. Complex recovery operation around reuse of tunnel shaped 3D concrete unites illustrated that shorter material feedback loops are beneficial (from economic and environmental point of view), only if product is designed for high value reuse by disassembly. This means that product is designed for minimised effort and time needed to recover product from the building. Capacity of buildings to enable high

quality material reuse is not determined only by the quality of materials in the building but also by the way materials are put together. (Durmisevic 2006)

With this in mind SCE consortium partner Dusseldorf developed reversible BRX building block with future reuse in mind. (Figure 6) BRX illustrated that product designed for disassembly, not only enables high value reuse of product but enables transformation of the building, so that life cycle of the building itself can be extended, (creating ever smaller material feedback loop). (Figure 6)

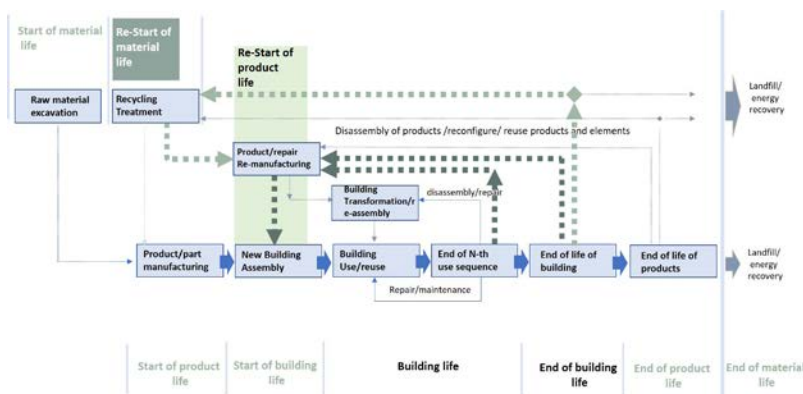


Figure 6: Restart of product life by design for future reuse, BRX product designed for future reuse and transformation of building without demolition actives

Third reuse strategy is the most beneficial from environmental point of view. This strategy focuses on reuse of building by transformation. Building level reuse project has been planned as a follow up of SCE project aiming to reuse and upgrade the structure of the flat building in Kerkrade according to the new use requirements. By doing so ca 60% of construction and consumption of

new raw materials will be avoided from the beginning. The highest prevention of CO2 emissions and material consumption can be achieved by reusing building structure through its transformation and modification to new user needs. This results into shortest material feedback loop and highest benefits. (Figure 7)

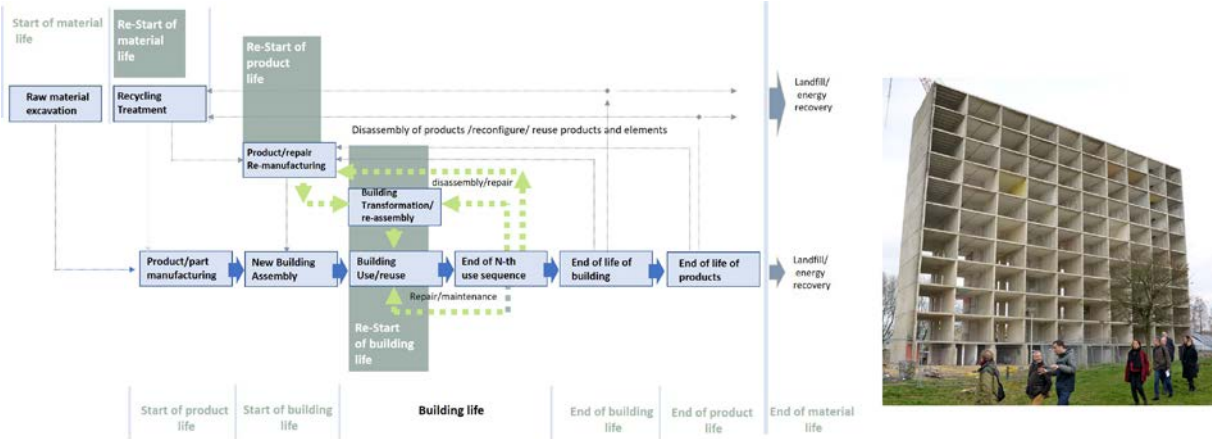


Figure 7: Restart of building life by reuse of the main core of the building and its modification to meet new requirements.

2.1 Future reuse

Initial objective of SCE project was to illustrate that materials from existing building can be reused to build new building while focusing on one reuse cycle of materials. After tasting environmental and economic effects of major deconstruction and reuse strategies (see Journal 3), SCE consortium concluded that focus on one reuse cycle of materials from 10-story flat building, will not solve challenges that circular building and circular economy is facing. Such effort relaying on design for the first reuse cycle and not on design for the future reuse cycles will only delay downcycling of materials and negative effects associated with it.

of CO2, 34% of embodied energy and 100% of raw materials, compared to conventional construction with concrete which consumes 100% of raw materials. In contrast to that construction of load-bearing structure with recovered tunnel shaped concrete 3D module cost 75% more than construction of new load-bearing structure. This is due to the heavy machinery and complex operations around cutting, hoisting and placing of 3D concrete units, which were not designed for disassembly and reuse. Yet this structure has been integrated into a new house without considering its future disassembly potential. The likelihood that this deconstruction technique will be applied in again is very low.

According to the report J.J.M Zaad 2019, recovery of tunnel shaped concrete 3D module saved 34%

These findings have inspired some members of the consortium to test product design solutions with future reuse in mind. (Figure 5) Such solutions tend to enable short feedback loops of material towards new application, eliminating major negative environmental effects by triggering multiple product lives in the future. This approach will be discussed further in chapters 4 and 5.

3. STATE OF THE ART CONSTRUCTION OF THREE CIRCULAR HOUSES

Construction of three UIA SCE houses started in the first half of 2019 after very challenging deconstruction process of the 10-story apartment building. This pre-construction phase required advanced testing of existing materials as well as cutting and hoist technology.

Although the initial aim of construction of three new houses was to construct houses using at least 75% of reused materials re-sourced from the donor building, thanks to the advancements during the project and testing of nine deconstruction techniques, 90% of material used during construction of three houses has been harvested from the existing flat building.

3.1 House Type A and preliminary construction costs

House Type A has 74m² and is a two-bedroom house. (Figure 8) Construction cost of this house amounts € 212.049,- excluding recovery of materials from the existing building. Recovery of materials and their applications have been

organised by the deconstruction company (one of the SCE consortium partners). Preliminary costs of these operations will be elaborated in further text.

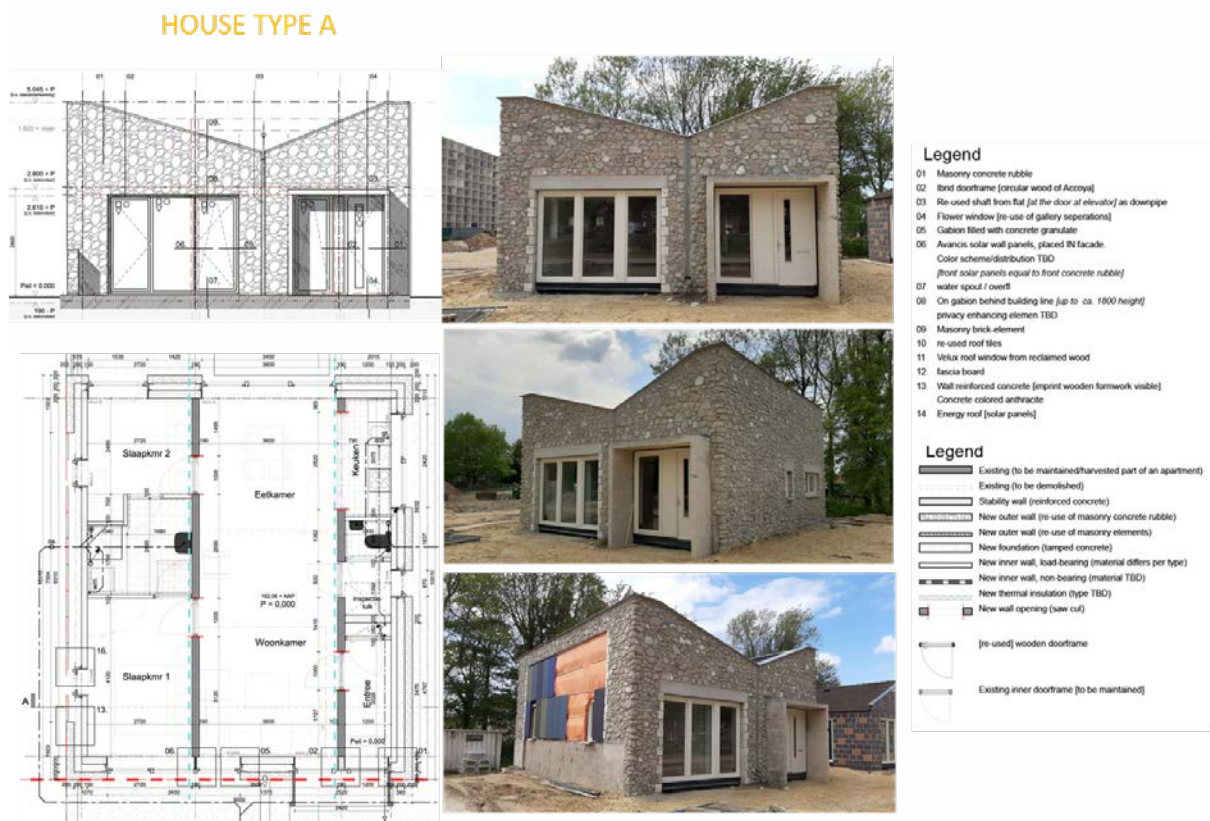


Figure 8: Construction of UIA SCE house Type A

During construction, circular techniques listed below have been tested:

1. Recycling of concrete. Only 7% of new cement has been added during production of concrete for the foundation, while 93% is activated cement from the existing structure.
2. cutting off the tunnel shaped concrete elements in a form of 3D modules has created main loadbearing structure for house Type A
3. partitioning light weight concrete walls have been reused from the exiting building
4. bigger crashed concrete pieces from the existing building have been reused to construct the façade of the house
5. stability walls have been produced using 90% recycled aggregate
6. doors have been reused

Preliminary costs of construction of house type A excluding VAT and recovery of 3D tunnel shaped concrete unit is € 212.049,-.

M2 prise of house type A is +/- €2.897,-/m² excluding VAT and recovery tunnel shaped concrete unit

Additional costs related to the deconstruction and reuse of tunnel shaped 3D concrete unit are listed below.

Labour cost for deconstruction	€ 14.791,38
material	€ 16.671,15
equipment	€ 70.170,38
Total deconstruction 3D unit	€ 101.632,91
M2 prise deconstruction 3D unit	€ 1.376,- /m²

Construction costs including deconstruction and reuse of load-bearing structure (tunnel shaped 3D concrete unit) for Type A house costs +/- €4.273,-/m² excluding VAT. This is preliminary cost calculations and costs of some deconstruction and reuse components still needs to be verified.

3.2 House Type B – and preliminary construction costs

House Type B has 74m² and is also a two-bedroom house. (Figure 9) Construction cost of this house amounts € 193.396, - excluding recovery of 3D tunnel shaped concrete unit from the exiting

building. Recovery of materials and their applications are also organised by the deconstruction company Dusseldorp.

HOUSE TYPE B

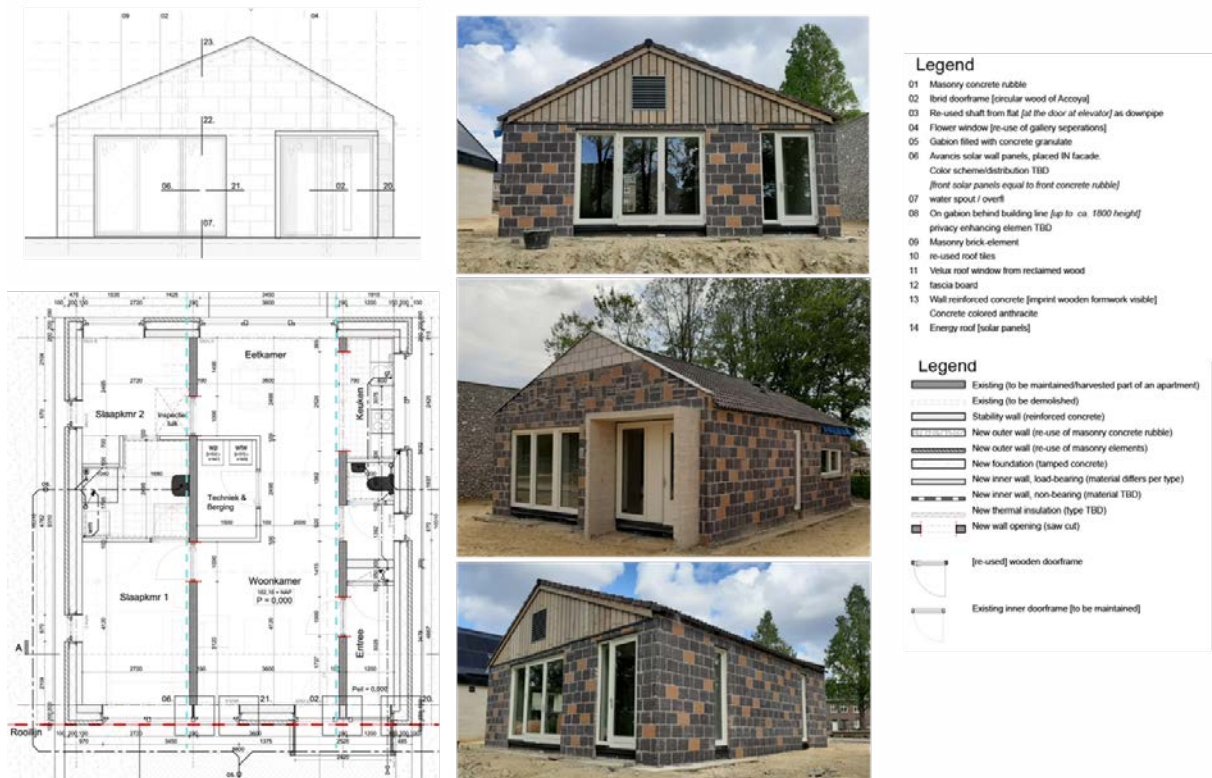


Figure 9: Construction of three UIA SCE Type B

During construction of house Type B, the following circular techniques have been tested:

1. Foundation has been made out of circular concrete. Aggregate and cement for the concrete have been acquired by crashing the existing concrete structure. Only 7% of new cement has been added during production of concrete for the foundation
2. cutting off the tunnel shaped concrete elements in a form of 3D modules has created main loadbearing structure also for house Type B
3. partitioning walls have been directly reused from the existing building
4. Insulation has been reused from the existing building

5. Facade has been made of reused brick modules, which have been cut out from the existing brick façade building

Preliminary construction costs of house type B excluding VAT and recovery of 3D concrete unit is €193.396,-.

M2 prise of house type B is +/- €2.613,-/m² VAT excluding recovery of tunnel shaped 3D concrete unit.

Additional costs related to the deconstruction and reuse of tunnel shaped concrete are listed below.

Labour cost for deconstruction	€ 14.791,38
material	€ 16.671,15
equipment	€ 70.170,38
Total deconstruction 3D unit	€ 101.632,91
M2 prise deconstruction 3D unit	€ 1.376,- /m²

Construction costs including deconstruction and reuse of load-bearing structure (tunnel shaped 3D concrete) for Type B house is +/- €3.989,-/m²

excluding VAT. This is preliminary cost calculation as the costs of some deconstruction and reuse components still needs to be verified.

3.3 House Type C – and preliminary construction costs

House Type (C) is a one-bedroom house and has 54 m². (Figure 10) Construction cost of house amounts € 163.415,-. This is preliminary cost calculations as the costs of some deconstruction and reuse components still needs to be verified. During construction, circular techniques listed below have been tested:

concrete have been acquired by crashing the existing concrete structure. Only 7% of new cement has been added during production of concrete for the foundation.

1. Foundation has been made out of circular concrete. Aggregate and cement for the

2. Main loadbearing structure has been made of circular concrete as foundation
3. Facade has been made of circular concrete as foundation

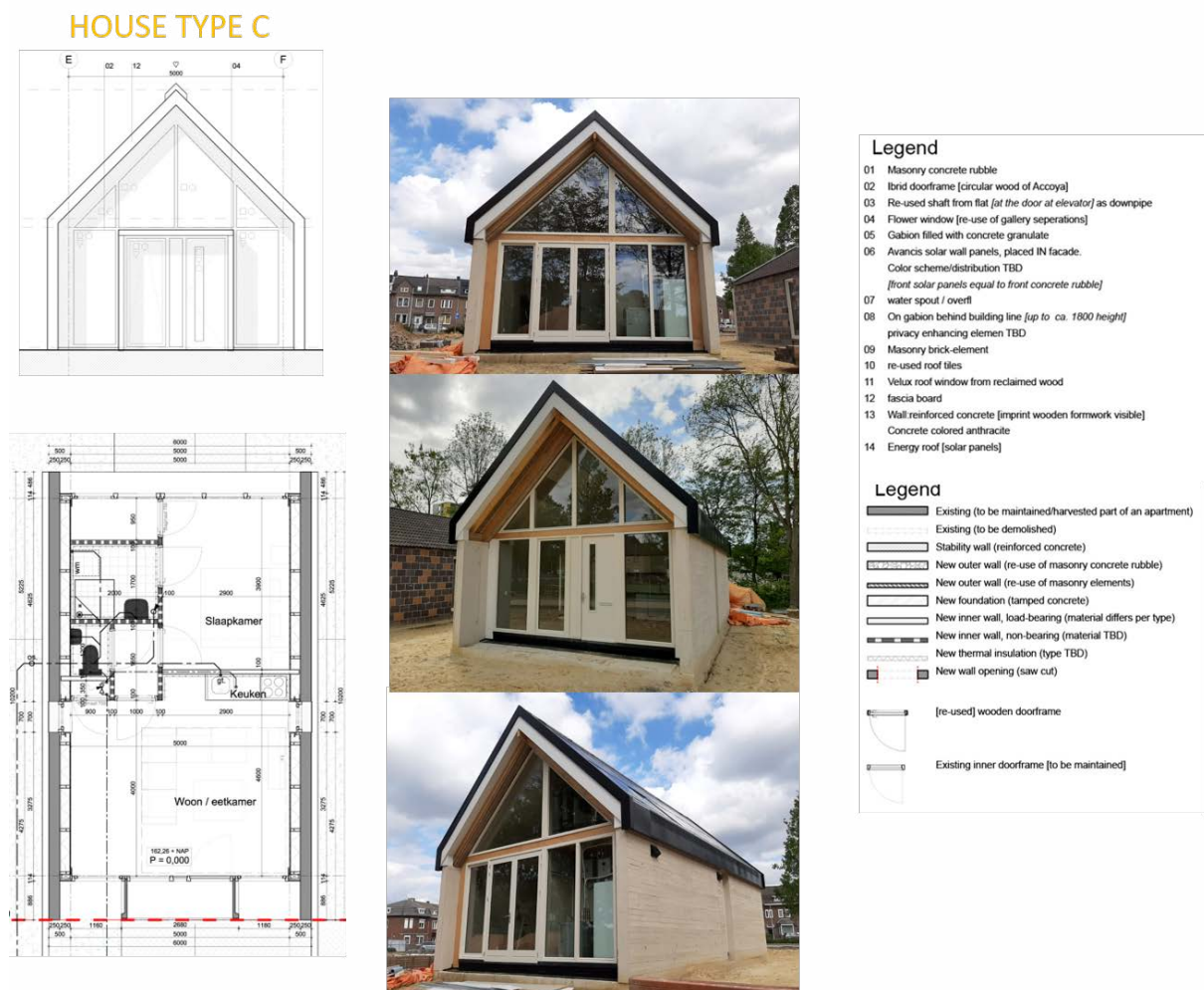


Figure 10: Construction of three UIA SCE Type C

Type C: Total +/- 54m²

Preliminary construction costs of house type C excluding VAT is € 163.415,-. M2 prise of house type C is +/- €3.026,-/m² excluding VAT.

3.4 Construction cost – SCE house versus conventional house

In order to have better understanding of financial impact of the SCE experiments, construction costs (m2 prise) of reference linear housing project developed in 2018 (by the same housing cooperation for the similar typology) has been compared with construction costs of circular SCE houses. Reference linear building project has been developed by the same housing corporation HeemWonen and has similar typology.

Construction costs of conventional linear reference house is Euro 1.294,-/m². (Figure 11)

This project applied 0% of reused materials and had no environmental savings. The project created additional environmental costs in terms of CO₂ emissions, energy use and raw material applications.

Although during construction of SCE House Type A, (i) 90% of raw material has been saved (18,5-ton material were directly reused from neighboring donor building), and (ii) savings of CO₂ emissions and Energy are significant:

- 18,45 ton raw material saved
- 46,21 ton CO₂ saved
- 33,5 GJ,energy saved

this is not reflected in construction cost of circular SCE house Type A. Construction cost of circular Type A house is 3,5 times higher than construction cost of linear housing project.



Figure 11: Reference project / Conventional Linear Building project

4. LESSONS LEARNED

4.1 Lessons learned / feasibility of circular method of construction

Significant lesson learned by the consortium is that circular building is not about design for one reuse cycle of the product but design for multiple reuse options and future cycles of the product.

Lot of effort has been done in order to recover 90% of material needed for the construction of three houses from the existing 10-story flat building. However, design of new SCE houses did not take into account next life of building products and materials. This means that reused materials in SCE houses are assembled in such a way that their recovery, at the end of their first reuse life, will result in significant effort and time. For that reason, some of SCE materials will most probably end up in low quality applications and backfilling at the end of SCE houses use life. SCE consortium

learned that in order to open a wide path towards circular building not only deconstruction strategies need to be developed but also new circular methods of construction are needed with a view on future reuse cycles.

Circular building is not about recycling of volume, but about continue reusing of value and should not be seen as one stop to delayed execution of downcycling. If such long-term view is not applied in new building projects than the reduced negative impacts achieved by complex recovery and deconstruction operations would be erased and diminishing of resources and degradation of environment will only be prolonged on a short run.

4.2 Lessons learned / Financial feasibility

Environmental and economic impact of reusing recovered 3D concrete unit from the 10th floor building turned out to be 4 times more expensive than construction of a new wall. When analysing the environmental impact of this operation it turned out that this operation saves (i) 33,94% of CO₂ emissions in comparison with construction of conventional concrete unit, (ii) it saves 34% of energy in comparison with conventional construction and (iii) ca 75% of material value (residual value) has been saved. Considering relatively low CO₂ price at the moment these

environmental savings do not compensate the construction costs which are 4 times higher than conventional construction. This is primarily related to the effort needed to recover and reuse 3D unit, 60-man hours compared to 34-man hours needed for conventional construction of a concrete structure. The effort is also reflected in the machinery needed to recover 3D units. Three mobile cranes of 750 ton, 500 ton and 100 tone where used compared to one mobile crane of 50 tone for conventional construction concrete structure. (Figure 12)

Prices per component	Reused unit from the flat	Prefabricated Concrete reference building
Manhours	€ 14,791.38	€ 1.440,00
Material	€ 19,999.99	€ 8.039,20
Materiel	€ 99,000.00	€1.355.00
Subtotal cost	€101,632.91	€ 10,834,20
Total price per m³	€ 2540	€ 637,29

Figure 12: Construction costs with recovered 3D concrete unit compared with costs of construction of conventional concrete structure

Financial feasibility of reuse of tunnel form 3D concrete units will be a big challenge because of intensive labour and sophisticated machinery/equipment needed for this operation. Contrary to that, BRX block designed for reuse by disassembly has indicated short material

feedback loop with beneficial environmental impact and potential positive economic impact. Economic impact of second use of BRX has not been calculated yet and will be done in the next phase.

4.3 Main conclusions so far

Key conclusions and challenges with respect to upscaling are listed below:

- SCE savings in row material, CO2 emissions and energy are high but this is not reflected in the construction costs and market prices at the moment
- Existing building stock was not designed to be deconstructed, the reason why recovery of materials is labour intensive and financial feasibility very challenging
- There is disbalance between labour cost and material costs

Reason:

- Emitting CO2 is free of charge, energy and material saved by reuse is not encouraged by legislation
- Labour price cannot compete with low price of new materials

Solutions proposed in the project:

- Integrating external costs as part of total investment cost
- If today's CO2 tax, energy price, residual value of materials would be integral part of investment costs today, then four techniques tested during SCE would be more affordable than conventional techniques. Those are *recycled concrete, reuse of insulation, façade modules, "BRX" wall block*
- Standardisation of circular building quality is needed
- Industrialisation of circular deconstruction and construction processes and techniques
 - Biggest impact can be reached with construction methods optimised for reuse
 - Such as BRX product developed during SCE project with future reuse in mined

- Field factory concept has been developed to enable direct reprocessing of existing concrete into a recycled concrete. This has positive environmental impacts and can be upscaled quickly. This method will be applied in new construction projects next year.

Barriers:

- Business case for circular building projects, is not there yet, there are no economic incentives in place
- Mind-set of people and their value perception needs to change
- Legislation for circular economy is missing. This is reflected in challenges with respect to certification, quality and warranty
- There are no standards for circular buildings, procurement

Opportunities:

Circular economy opens a door for new skills and job opportunities related to:

- Reversed-logistics
- Refurbishment, remanufacturing
- Reversible design
- ICT sectors and
- Research (models, protocols and tools for measuring circularity indicators and supporting circular procurement)

Success factors of innovative UIA projects:

- High level of resilience within project team, in order to be able to handle challenges
- Identifying key human resources to deliver the project on time covering legal, procurement and financial expertise
- Identifying partnership and key stakeholders prior to writing application
- Be realistic when defining ambition specially in the context of time frame
- Innovation addresses unknown solutions. Management of expectations and communication of potential benefits of innovation need continuous attention.

Circular economy is a springboard for long-term extension of products life cycles through multiple reuse cycles and not one stop to delayed execution of downcycling.

5 GLIMPSE OF THE FUTURE

5.1 BRX reversible building block

After experiments and testing of 9 deconstruction and reuse technologies, it can be concluded that materials released during the demolition of 10-story flat buildings cannot be reused straightaway. Brick façade, concrete load-bearing structure, wooden windows etc. cannot be reused without additional processing. Adjustments are always necessary.

In general, one can conclude that due to traditional construction methods, existing buildings are less suitable for disassembly and high value recovery. This finding indicates that if we are to develop circular buildings for the future circular economy, all future buildings should adopt fundamentally different approach to the methods of construction. This calls for a different

and innovative approach to building/product design and development with focus on modularity, standardisation and reversible connections. (Durmisevic 2006)

This inspired one of the SCE consortium partners Dusseldorp, (deconstruction company responsible for recovery of material from the existing 10-story flat building) to develop a new building block with new standard for connections. The aim was to enable assembly and disassembly of building/part of a building in fast and easy fashion. While developing demountable building block BRX, Dusseldorp considered uniformity in construction works in terms of dimensions and connections, just as standards for roof tiles and installation components exist.



Figure 13: BRX design of connections left and one assembly option of BRX block right (developed by Pieter Sheer, Dusseldorp 2020)

The concave and convex notches of BRX allow for a wall to be stacked without any cracks and without adhesion. (Figure 13) This saves mortar and allows for future disassembly. BRX makes high-quality reuse possible at product level. Besides, initial material of BRX is made of recycled aggregate from the 10-story building. This makes

BRX true example of how existing buildings can become material bank for new buildings, by applying innovative building design and technology. Design which has a view on future reuse potential of building products can re-start material and product life enabling X reuse loops

in the future. (Durmisevic, Strategies for Reversible Building Design 2019)

This reversible BRX block will be tested during construction of storages for 3 UIA houses in Kerkrade. If the application of the universal BRX

connection principle succeeds, assembly and disassembly of some parts of the building will be easier in the future. As a result, labour costs of dismantling would decrease, and reuse could become more attractive from a financial point of view.

5.2 New reversible load bearing system in concrete

After first testing of BRX blocs done by Dusseldorp, other SCE Consortium member JongenBouw (contractor responsible for the construction of three SCE buildings) joined forces with producer of prefabricated concrete elements to develop prefabricated concrete system for foundation, walls and floors with demountable connections.

Just as BRX, these elements are produced reusing the recipe developed by Dusseldorp during SCE project and use 90 to 100% of recycled aggregate. (Figure 14) This reversible concrete system will be used for the construction of additional 15 new circular homes as a spinoff from three SCE houses in Kerkrade.



Figure 14: Reversible circular concrete system

5.3 Supply demand platform

One of the key obstacles that SCE consortium partners are facing, when analysing potential scaling up of developed technologies, is the fact that the market for circular building materials and platforms, which can help match supply and demand, does not exist. SCE consortia is aware of the fact, that on the demand side industries are developing and testing circular building products and services but the offset market for these

innovative products is not there yet. That is why the housing corporation HeemWonen (SCE consortium partner) took an initiative to propose development of “Commissioning Platform for Circular Building (CPCB)” in collaboration with Municipality of Kerkrade (SCE managing partner). The aim of this platform will be to bridge the gap between already developed circular building products with potential circular building

developers, investors and public authorities. Bringing supply and demand side together can accelerate implementation of circular building strategies in new building projects and help boost Dutch national initiative and objective to reach carbon neutral construction before 2050.

6 CHALLENGES

CHALLENGES	LEVEL	OBSERVATIONS
1. Leadership for implementation	Low	<p>Leadership of SCE project continued facing challenges with respect to delays of some activities within the project. Risks associated with the delays have been identified timely together with the consortium members. MUA asked active participation of each consortium member in proposing measures as how to mitigate the risks. Based on these joint efforts and initial findings, MUA formed smaller working groups per risk to identify more concrete measures for risk mitigation.</p> <p>Such approach enabled systematic analysis of impacts that delays have on deliverables. This enabled structured approach towards finding the balanced solutions, which will enable the consortium to meet the objectives of the project without causing major financial challenges to consortium members and UIA.</p> <p>Major approach to mitigate risks was found through reorganisation and redefinition of some activities in order to deliver project objectives timely and with minor budget deviations.</p>
2. Public procurement	Low	Not relevant for this phase. Important procurement issues have been addressed in earlier project phases.
3. Integrated cross-departmental working	Low	<p>All permits for the construction of the three SCE houses have been organised in previous phases. As a part of analyses of delay plans, cross- departmental collaboration took place within MUA.</p> <p>The SCE project is involved with instalment and testing of recycling water system. Testing has been jeopardised due to the delays in construction. Planning department of MUA involved water management department in search for alternative solution to testing of water recycling. In order to enable testing and provide results to UIA, SCE consortium reached to EU LIFE program, which is financing part of the water recycling activities within the SCE project. Joint proposals for solutions have been sought in order to find a feasible solution for testing of water recycling technology within the three SCE houses with help of ongoing EU LIFE project. It has been agreed to fund testing of the system by EU LIFE program after the completion of SCE houses. Testing results will be communicate with UIA.</p>

CHALLENGES	LEVEL	OBSERVATIONS
<p>4. Adopting a participative approach</p>	<p>Low</p>	<p>Strong participation and engagement of local stakeholders is evident, thanks to very active promotion activities of SCE public and private partners through international events, informing national government about the projects achievements and organisation of stakeholder events. This has also been a part of ongoing efforts to keep key local stakeholders informed about the results, important lessons learned and importance of the project for the region.</p> <p>SCE public and private partners managed to draw attention of provincial and national government but also of local companies. This resulted into an initiative for development of regional platform and strategy for circular building. First kick-off has been organised by Region of Parkstad in collaboration with IBA 2020 and Province of Limburg. The aim of the initiative is to create broad stakeholder's platform that will be involved in forming of new strategy for construction, based on circular building. Lessons learned during UIA SCE project will form important input for the stakeholder's platform and definition of future strategy.</p>
<p>5. Monitoring and evaluation</p>	<p>Low</p>	<p>Monitoring of key project indicators has been intensified, as the construction of houses progressed in the last six months. This enabled ZUYD University of Applied Science to apply real time monitoring and testing of different reuse and construction strategies and collect actual data about construction process, construction time, and equipment used on the construction site. This has been elaborated in chapter 2 as follow-up on extensive report about monitoring results of 9 deconstruction techniques published in the previous Journal nr. 3.</p>

CHALLENGES	LEVEL	OBSERVATIONS
6. Communicating with target beneficiaries	Low	<p>Besides already well establish channels of communication about the progress of the SCE project (newspapers and website), the SCE consortium was invited to present first results and lessons learned during national and international expos, conferences, and events. This drew attention of industry and public authorities and has triggered establishment of multi-stakeholders' platform for circular building (mentioned above under point 4 "Adopting a participative approach"). The aim of the platform will be to share knowledge and experience from circular building projects in the region and support acceleration of the circular building agenda in the Region of Parkstad. Thanks to well-organized promotion and image of the project, lessons learned from the SCE project have already found application in new local initiatives.</p>
7. Upscaling	Medium	<p>Based on initial monitoring results, the SCE consortium members started developing strategies for scaling up and development of spinoff initiatives and progress.</p> <p>This has resulted in the first development of BRX block wall and plans for its implementation during construction of three storages of SCE houses.</p> <p>Recipe for production of recycling concrete, developed by SCE consortium member Dusseldorp, has been used by external concrete industry for production of reversible prefabricated concrete elements. This system will be used for construction of 15 houses (direct scaling up of the three SCE houses).</p> <p>Housing Corporation HeemWonen joined forces with MUA Kerkrade in proposing development of Commissioning Platform for Circular Building (CPCB) that will help bridge the gap between supply and demand.</p>

7. CONCLUSION AND NEXT STEPS

During the construction of three SCE houses and testing of reuse techniques during last 6 months, SCE consortia has gained many new views on feasibility of new circular building techniques and strategies. More importantly, consortium was able to identify some key barriers for the successful scaling up of circular economy in construction, which has been presented in chapter 5. Besides construction of tree houses, SCE consortium partners took an opportunity to look further beyond the SCE project and initiate a few new experiments and applications of new reversible approach towards circular construction with view not on the first reuse but on future reuse cycles.

Next journal will focus on final environmental and economic impact elaboration after construction of SCE has been completed and will elaborate on further scaling up strategies and recommendations based on lessons learned.

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