GENERAL INFORMATION

This project won a "Technical Challenge" mention for the category "Outsde the framework" of the Trophées Bâtiments Circulaires 2022.

Re:Crete, designed and built by EPFL's Structural Xploration Lab (SXL), is a footbridge made of concrete blocks saw cut from the walls of a building under renovation and reassembled into a post-tensioned segmented arch. Created as a research prototype, this footbridge demonstrates for the first time the feasibility of reusing concrete elements extracted from a cast-in-place structure in a new load-bearing structure. Concrete is the most widely used building material in the world and is a major source of the construction industry's environmental impacts. Reusing saw cut elements extends the use life of obsolete concrete. It avoids its premature crushing, while reducing greenhouse gases, demolition waste and raw material extraction.

In collaboration with the State of Wallis, in Switzerland, the prototype could be installed over the Morge river for a period of 2 years, where it is accessible to the public. The structure was therefore equipped with handrails, also made of reused materials. It is used for pedestrian mobility during the construction works on the adjacent road bridge.

The concrete blocks are extracted from the walls of the source building using a circular diamond saw. The sides of the blocks are then drilled to allow the passage of the post-tensioning cables. For the assembly of the arch, the blocks are placed on a timber centering and the post-tensioning ducts and cables are threaded.
through the side holes. Before tensioning the cables and removing the centering, the joints are filled with mortar to ensure contact between each block. To make the footbridge permanent and suitable for outdoor use, the exposed cut rebars were covered with an anti-corrosion paint, a hydrophobic impregnation was applied on the concrete faces and the joints were covered with waterproofing strips. However, the characteristic texture of sawn concrete, showing aggregates and rebars, remains visible on the side faces of the arch. The materiality of the bridge expresses both the source of the material, with its own history preceding that of the bridge, and the technique used to implement it. Finally, the railing was made with metal tubes from obsolete festival tents and steel wire meshes from shop furniture.

Besides providing a new design material for architects and engineers, the reuse of concrete elements is an effective solution to reduce the demand for cement, CO2 emissions and concrete waste. A detailed life cycle analysis shows that the Re:Crete footbridge has a lower environmental impact than similar solutions in reinforced concrete (−63%) or steel (−75%) and approximately similar to that of a solution in new timber (+9%).

Progress Status
Delivered

Data Reliability
Self-declared

Funding Type
Private

Website Enterprise / Infrastructure

Sustainable Development

Preservation / Environmental Improvement :

Resilience
Hazards to which the infrastructure is exposed: frost

Resilience measures in place:
The concrete structure is exposed to rainwater and frost, which can accelerate its degradation.
The concrete elements, as well as the sensitive parts of the structure, have been protected from water by simple solutions common in the industry. These solutions ensure the durability of the structure for a longer period. The solutions implemented are as follows:

- the cut reinforcement bars, visible on the cut faces of the concrete blocks, were protected with anti-corrosion paint;
- the exposed concrete faces were covered with a hydrophobic impregnation;
- the post-tensioning cable ducts were injected with mortar;
- the joints were covered with waterproofing plastic strips.

Urban environment
This project was initially designed as a prototype to demonstrate the feasibility of reusing concrete blocks. The width of the Morge River at the road construction site corresponded to the span of the Re:Crete footbridge. It was therefore an opportunity to adapt the prototype to outdoor use. Its implementation in the Swiss Alps allows a dialogue between the minerality of the exposed cut concrete faces and the surrounding mountains.

Responsible use of resources :

Reuse (same use) / Reuse (change of use)

Work packages concerned by the reuse of materials:

- Structural work
- Metalwork

Material(s), equipment and product(s) reused or re-used:

Structural work:
- Concrete blocks: 2.43 m³
- Tie rod: 22 metres

Ironwork and metalwork:
- Steel posts and handrails: 40 linear metres
- Steel wire mesh: 44 m² (44 sq. ft.)

Origin, traceability of materials and field of use:

Structural work:
- Concrete blocks: sawn from the walls of a hotel basement under transformation in the canton of Vaud, reused as the structure of the arch. Supplied by the sawing company.
- Tie rod: recovered from a structural testing hall at the EPFL in Lausanne, reused as posts and handrail.

Metalwork:
Environmental performance

The re-use operation saved the equivalent of 22'788 kilometres travelled by a small car, or 26 trips from Paris to Nice, 117 rectangular bathtubs filled with water and 15 years of household waste for a French person.

In order to calculate the avoided impacts, the material "breeze block - with concrete filling" was used as an equivalent to concrete blocks. To compensate for the different densities and assumptions about the future of the materials, the amount of concrete was increased proportionally. It is therefore assumed here that the entire quantity of concrete blocks would have been eliminated if they had not been re-used.

Replicability and Innovation

Reuse has been integrated into the genesis of the Re:Crete footbridge project, which serves as a demonstrator of the possibilities of reuse for structures and in particular the reuse of concrete. The project took advantage of technologies well known to the construction industry, such as sawing, drilling of concrete and post-tensioning. Such a bridge could therefore easily be replicated for another site. The innovation comes from the idea of reusing sawn concrete blocks reclaimed from a cast-in-place structure and from the design methods that incorporate reuse. Designing structures with reused materials presents several constraints that modify the project phases compared to a conventional project. For a reuse project, the design must be resilient to the unknowns of the material stock (availability, quantity, mechanical performance, geometric and textural variability), as was the case for the footbridge project.

The contribution of companies is also a key to the success of this project. The search for reused concrete blocks was done in a non-systematic way by contacting several concrete demolition and sawing companies. The blocks were finally supplied by the company Diamcoupe, which understood the needs of the project and was able to identify a renovation site that could serve as a source for the footbridge project. The reuse of concrete creates a new value chain where the concrete sawing companies are no longer at the end of the material's life, but become suppliers.

The Re:Crete footbridge has attracted considerable media attention in Switzerland and abroad since the inauguration of the prototype in October 2021. Here is a summary (as of 17 May 2022 and available at https://actu.epfl.ch/news/the-recrete-footbridge-in-the-news/):

On LinkedIn

Our post of 23 October 2021 on the construction of the prototype received over 1460 likes and was shared 164 times. The video has been viewed over 50,000 times.

Our May 5, 2022 post on the installation of the Re:Crete footbridge in the Swiss Alps received over 370 likes and was shared 12 times.

Media Switzerland

In Switzerland, in addition to the main EPFL media, the Re:Crete footbridge was published in the general local newspapers: La liberté, Heidi News, La Gruyère, le Nouvelliste and La Côte. As well as in specialised media: Espazium/Tracés, Baublatt, Batimag. The members of the Structural Engineering Laboratory (SXL) were invited on two occasions to the Swiss National Radio: RTS CQFD, RTS Forum. Videos for television channels were also produced for RTS nouvo on RTS 2 and TVS monde, and for Canal 9.

Foreign media

Abroad, the Re:Crete arch has been published in the USA for Popular Science and SlashGear, in England for RIBA journal, in France for Le Moniteur and Usine Nouvelle, in Germany and Austria for PresseText, in India for TimesNowNews, and in China.

GHG emissions

Methodology:

The calculation is done according to the LCA method and the Swiss KBOB database. The system considers all procedures related to deconstruction, preparation of elements, production of new materials, transport and construction works.

GHG emissions before use: 25 KgCO2 /m2
Lifetime of the building: 15 years
Total GHG emissions from cradle to grave: 25 KgCO2 /m2

Only the footbridge structure was assessed. The CO2 emissions related to the construction of the railings are not included in this figure.

Testimony / Feedback

What if I could do it again?

This pioneering experience of reusing concrete elements extracted from a cast-in-place structure confirmed a new way of designing structures. The technologies used (e.g. concrete sawing and post-tensioning) proved to be appropriate for the reuse of concrete blocks to design a new structure. Nevertheless, we have identified ways to further increase the environmental benefits of the approach:

- Minimization of transport distances for reused materials
- Verification of the properties of reused materials before their deconstruction or acquisition
- Minimization preparation work required on the reclaimed concrete elements
- Consideration of the durability of reused concrete through adequate construction details

Governance

Etat du Valais

Holder Type: Regional Authority
**Builder Type:** Other

**Project owner**
State of Valais  
Contact: Jean-Baptiste Luyet (engineer for engineering structures and exceptional transport)

**Project manager**
École Polytechnique Fédérale de Lausanne (EPFL), Structural Exploration Laboratory (SXL)  
Contact: Corentin Fivet (professor and head of the Structural Exploration Laboratory (SXL))

**Company**
Diamcoupe SA  
Guillaume Mittnacht (Regional Manager, French-speaking Switzerland)  
Diamcoupe supplied and prepared the concrete blocks. It sawed the blocks in the walls of the source building and drilled the cores for the post-tensioning cables.

**Company**
Freyssinet SA  
Adrian Motte (branch manager, Switzerland)  
Freyssinet supplied the ducts and the post-tensioning cables. It carried out the tensioning of the cables and the injection of the ducts.

**Other**
Bridgology SA  
Alexis Kalogeropoulos (founder and director)  
Bridgology carried out non-destructive measurements on the structure to determine the cover of the pre-existing reinforcing bars and to check the condition of the concrete.

**Company**
Sika Switzerland Ltd  
Cédric Chetelat (consulting engineer, French-speaking Switzerland)  
Sika supplied the products applied on the footbridge to protect it from water (anti-corrosion paint, hydrophobic impregnation, waterproofing strips).

**Company**
Emil Egger Romandie SA  
Frédéric Marilley (project manager)  
The company Emil Egger transported the footbridge from its manufacturing site in Fribourg (Switzerland) to its installation site in Conthey (Switzerland). It also carried out the lifting for the installation of the bridge over the river.

**Business Model:**
Total cost: 67,000 €  
Financial aid: 25,900 €  
Total amount of work dedicated to reuse (excluding study costs: AMO, MOE, CT, etc.): 19,200 €.  
% reuse on total cost of the operation: 29%

As the project was carried out within the framework of academic research activities, the design costs have not been quantified. Financial aid comes from internal funding at EPFL as well as corporate sponsorship. The reuse was estimated to result in an approximately 30% increase of cost compared to a conventional alternative. However, we believe that this additional cost is mainly due to the novelty of the method. Optimization of the sourcing, assembly and rehabilitation processes should provide a reduction in costs. Moreover, these costs are compared to a conventional alternatives whose aesthetics are not the same. Replicating an aesthetic similar to the Re:Crete footbridge with conventional materials would likely increase costs.

**Sustainable Solutions**

**Sawing**

**Description:**
- Diamcoupe SA  
- Guillaume Mittnacht

Diamcoupe supplied and prepared the concrete blocks. They carefully saw cut the blocks in the walls of the source building directly to the desired size. The small size of the blocks allowed them to be easily removed from the deconstruction site. Diamcoupe then drilled the side of the blocks to allow the passage of the post-tensioning cables for the new structure. The re-use of these blocks on a new project allowed the company to save on landfill costs.

The approximate cost of sawing, preparing and transporting the 25 concrete blocks was around 15,000 euros.

For the sawing company Diamcoupe, this is a revaluation of their work. They become a supplier of materials, at the beginning of the value chain. The solution was therefore well received by the workers, especially as it did not fundamentally change their methods.
Freyssinet supplied the ducts and prestressing cables that run through all the concrete blocks. These were inserted into the holes directly when the concrete blocks were placed on the centering. Freyssinet then proceeded to tension the cables and inject the ducts.

The post-tensioning ensures the structural safety of the structure under all live load configurations.

The approximate cost for the supply of the ducts and cables as well as the post-tensioning is approximately 5,000 euros.

Post-tensioning is a very well known and widespread method. Its use in this case makes it possible to recycle materials that were originally destined for landfill. The solution was therefore well received by the workers, especially as it did not fundamentally change their methods.

Photo credit

École Polytechnique Fédérale de Lausanne (EPFL), Structural Xploration Lab (SXL)

Contest

Reasons for participating in the competition(s)

The Re:Crete footbridge is a groundbreaking project that incorporates for the first time the structural re-use of concrete elements from an existing cast-in-place building. It demonstrates technical feasibility while using technologies known to the construction industry such as concrete sawing and prestressing. To ensure the long-term durability of the reused concrete elements, the structure has been adapted, by simple methods, for outdoor use. The railings are also designed with reused materials.

Confirming that sawn concrete elements are a new structural material for re-use, this project extends the application of circular economy principles in the construction industry. A new field of activity is created, with the reuse of sawn concrete elements for the construction of traditional buildings. Furthermore, this first prototype convincingly demonstrates that the approach allows for a drastic reduction in greenhouse gas emissions, construction site waste and raw material extraction. Its generalisation offers new perspectives to rapidly contribute to the mitigation of global warming and increase the sustainability of the construction industry.