

Integration of high content of good quality recycled aggregates and sand into prefabricated concrete elements.

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**Net-Zero
Future
2025**

Why this project ?

The problem

- We use too many natural resources
- We produce too much waste
- Concrete has a big carbon footprint

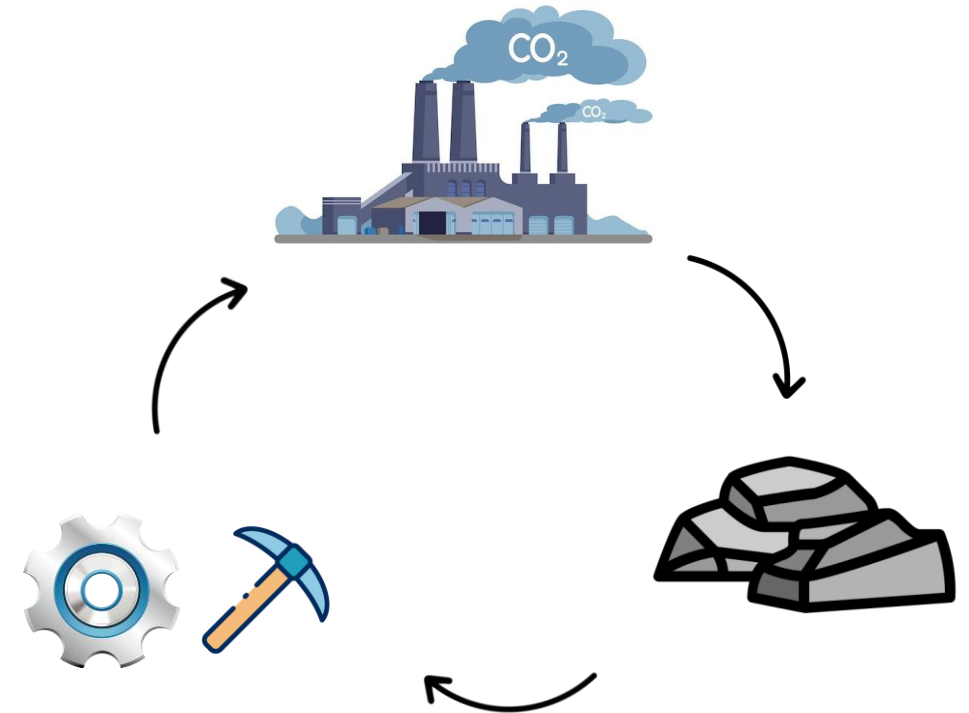
Our idea

- Reuse and recycle concrete
- Connect the mining and recycling industries
- Build a circular economy



Key question

Can we make concrete more sustainable?



Goal and challenge

The goal

- To create high quality precast concrete – blocks and walls – made with only recycled aggregates and sands
- The aim is to replace natural materials as much as possible and give a second life to mineral waste

The challenge

- Recycled aggregates often have :
 - High porosity
 - Variable quality
 - Require advanced processing to reach good standards

Our focus at ULiège

- Studying and characterizing recycled aggregates
- Manufacturing and evaluating the performance of precast concretes



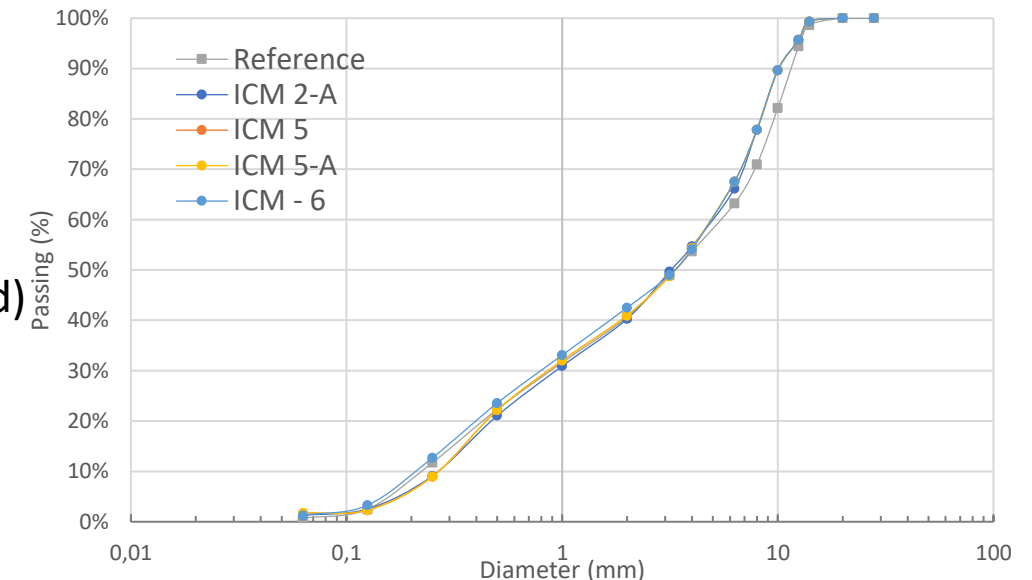
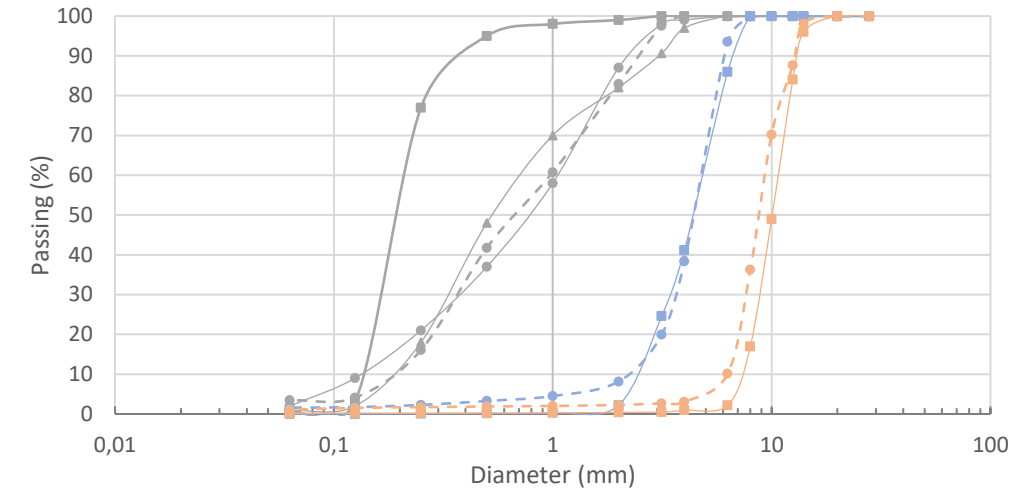
Mix design and materials

Aggregates

- Goal : match the granulometric distribution of recycled concrete aggregates (RCA) with natural aggregates (NA)
- Result : Very similar curves

Concrete mixes

- Reference mix -> 100% NA
- ICM 2-A -> 50% replacement (coarse + sand)
- ICM 5 / ICM 5-A -> 75% replacement (50% coarse + 25% sand)
- ICM 6 -> 50% replacement of coarse aggregates only



All mixes show very similar grading curves, meaning that the recycled materials can reproduce the same particle size distribution as the reference mix.

Fresh behaviour

Production requirements

Parameter	Reference	ICM 2-A	ICM 5	ICM 5-A	ICM 6
Recycled content (%)	0%	49%	78%	78%	53%
Target strength class	C30/37				
Environment class	EE3				
Durability requirement	T (0,50)				
Minimum cement (kg/m ³)	320				

Fresh concrete results

Parameter	Reference	ICM 2-A	ICM 5	ICM 5-A	ICM 6
Slump (mm)	230	245	220	210	230
Air content (%)	2,2	2,8	3,6	3,1	1,6
Volumic mass (kg/m ³)	2360	2270	2190	2200	2310
Reel W/C (-)	-	0,52	0,48	0,53	0,51

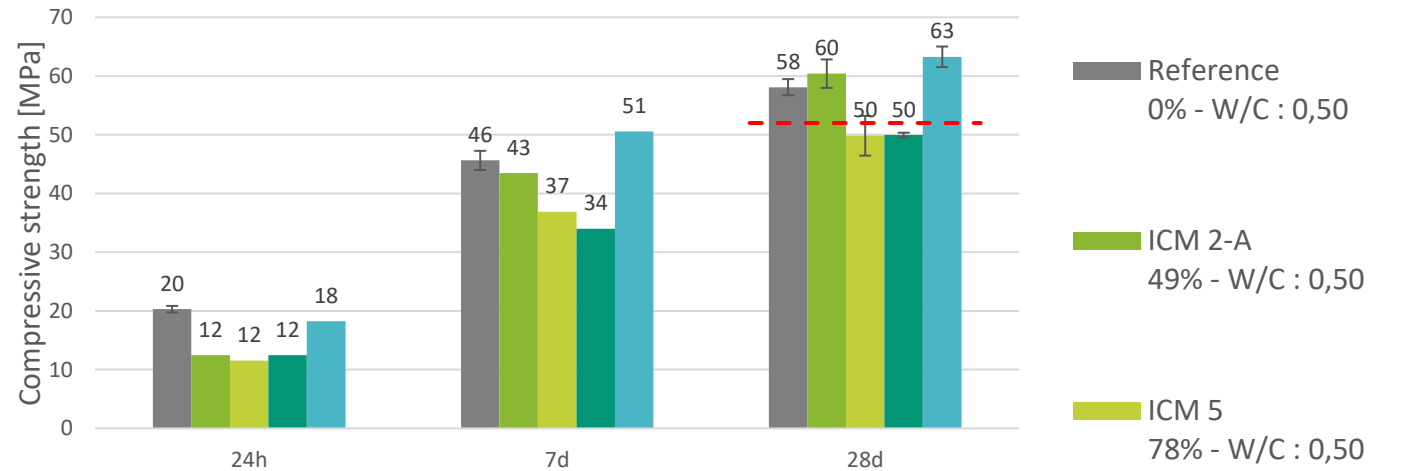


All mixes comply with Eurocode 2 and BENOR standards for fresh concrete.

Mechanical performance

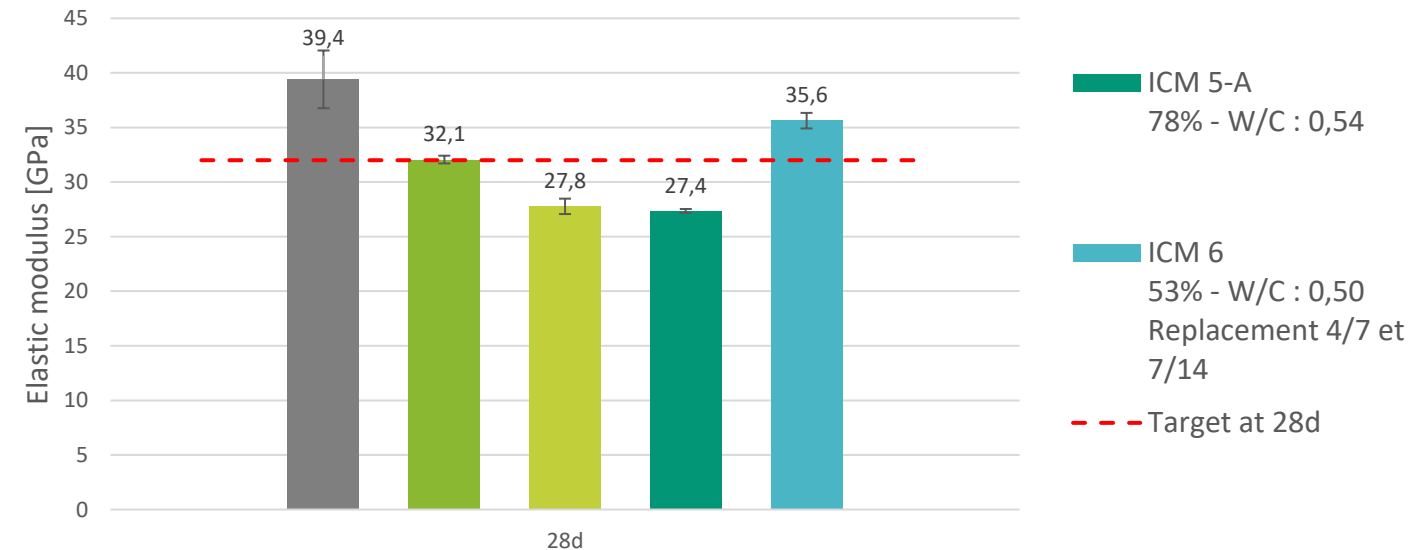
Compressive strength

- All mixes reach or exceed target strength (C30/37)



Elastic modulus

- Elastic modulus also in the expected range

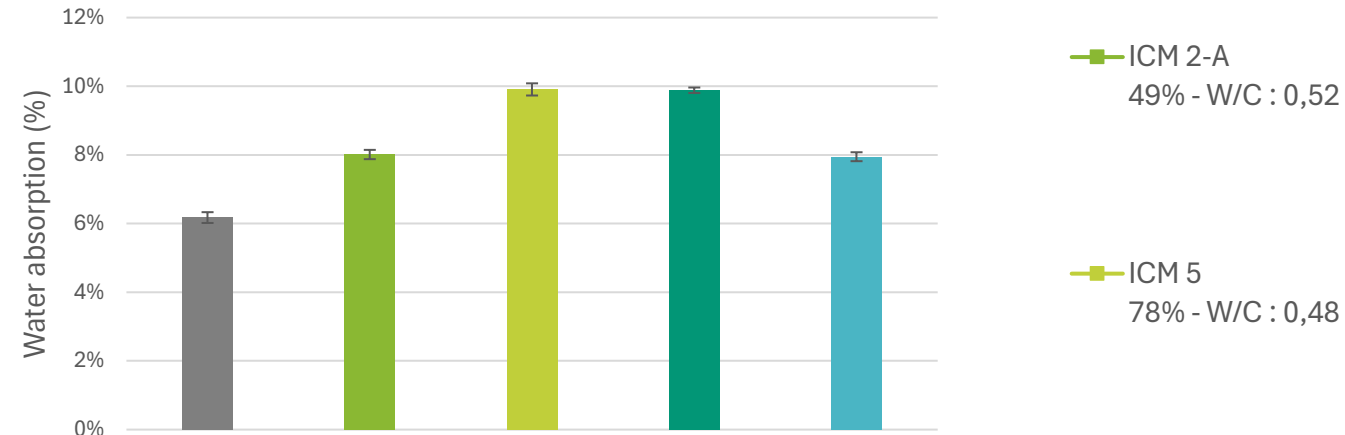


ICM 2-A and ICM 6 exceed the 28-day strength

Durability

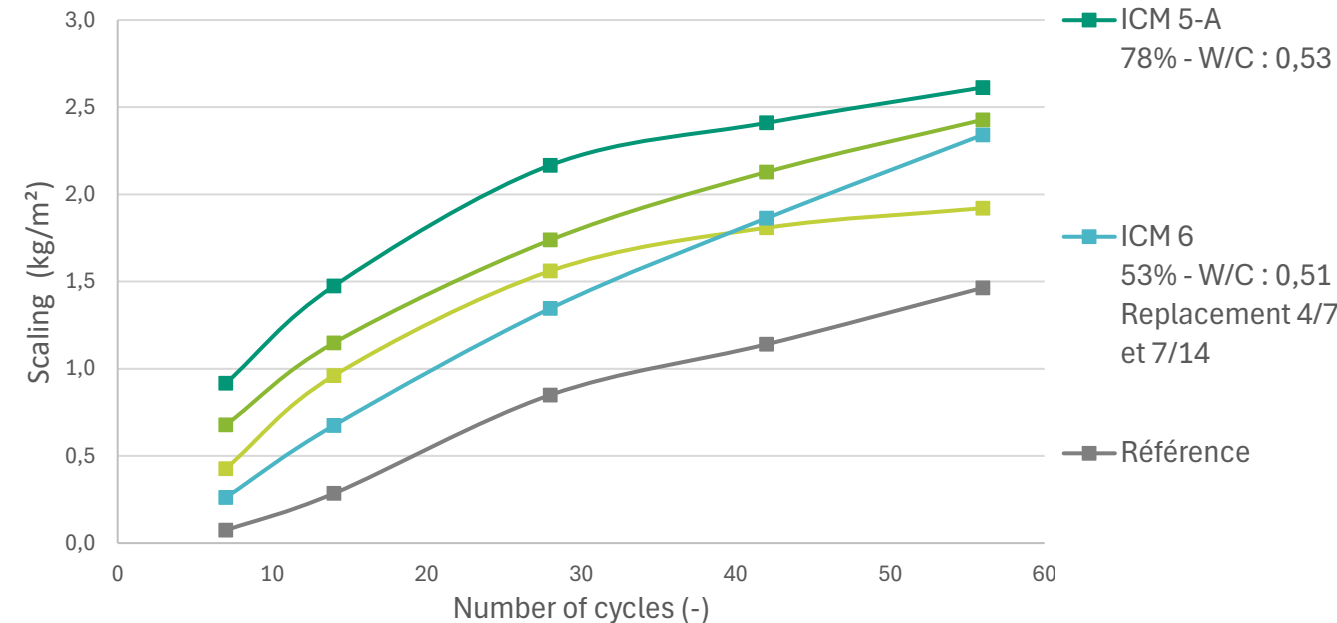
Water Absorption by immersion

- Water absorption **increases with recycled content**
- This is linked to **higher porosity** of recycled aggregates



Slab test

- All mixes show **higher scaling** than the reference
- Results are **below standard limits**
- The influence comes from both the **amount of recycled aggregates** and **W/C**



Conclusion

Industrial application

- In the next steps, the company plans to use the ICM 6 mix
- This mix contains 50% recycled coarse aggregates (fractions 4/7 and 7/14)
- The plant produces 10.000 to 12.000 m³ of precast concrete every year
- Each cubic meter contains about 950 kg of recycled aggregates

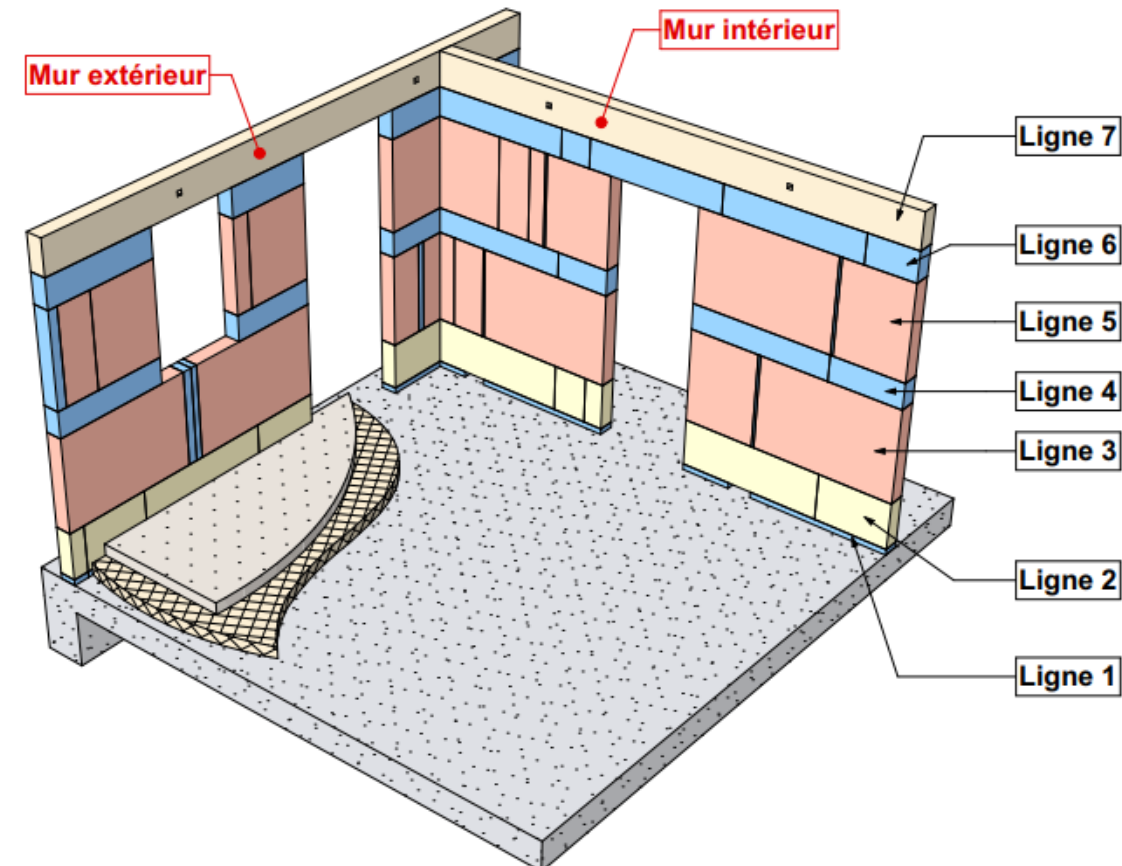
Impact

- This represents 9.500 to 11.400 tonnes of recycled aggregates used each year instead of natural ones



Concept and innovation

- Development of a new modular concrete block system
- Each standard block : 1,2 m²
- Handled by a robot, can be moved with one finger
→ No more heavy lifting for masons
- Blocks are modular and adjustable
 - Height adjustable to within 1 cm
 - Openings of any size and position
 - Built-in holes for sockets, cables and conduits



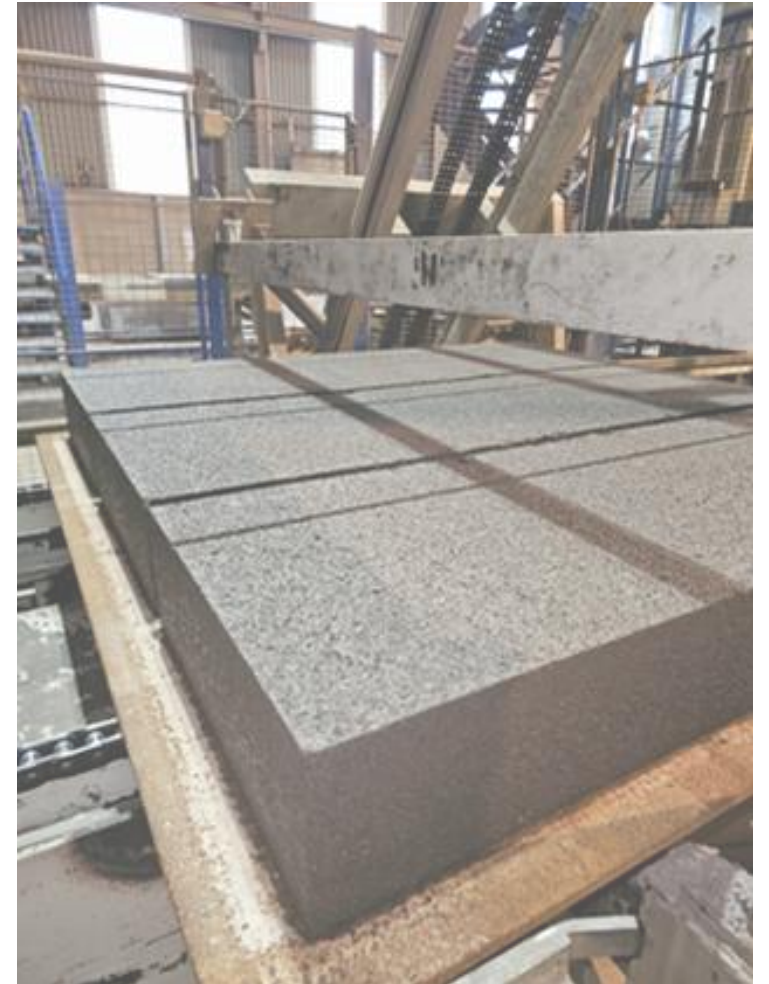
Materials and composition

Concrete blocks

- 140 kg of CEM III/C 32,5 N
- Addition of a set accelerator
- Aggregates (unwashed, mixed):
 - 0/4, 4/7 and 7/14
 - All aggregates are non-washed mixed recycled materials

Mortar composition

- 150 kg of CEM III/C 32,5 N
- Addition of a set accelerator
- 75% of 0/2 washed concrete sand
- 25% of fine soil particles ($< 63\mu\text{m}$) from mixed earth and gravel materials



Results

Block and wall performance

- Blocks : ≈ 12 Mpa compressive strength at 28 days
- Walls (with mortars) : > 9 MPa
 - The testing machine was not strong enough to reach failure
 - Walls behave like precast concrete panels, stronger than traditional masonry walls
 - Fire resistance : 2 hours (RF 2h)

Mortar performance

- Low adhesion recycled mortar
- ≈ 3.5 MPa at 90 days
- Designed for easy dismantling and reuse of blocks
 - Supports circular construction and waste reduction



Results

Precast concrete walls (ICM 6)

- Up to **50% recycled aggregates** (4/7 and 7/14)
- Around **9.500 to 11.400 tons** of recycled materials used each year
- A proven **industrial application** with real **CO₂ reduction**



Modular concrete blocks

- Already **6 houses sold** and **4 under construction**
- **2026 goal** : 100-2500 buildings
- **2027 vision** : around 1.400 buildings
- Made with **100% recycled aggregates** and **low-cement formulations**





Thank you!
Questions?

