# Modifiable concrete walls

## A new structural design - more flexible, less $CO_2$

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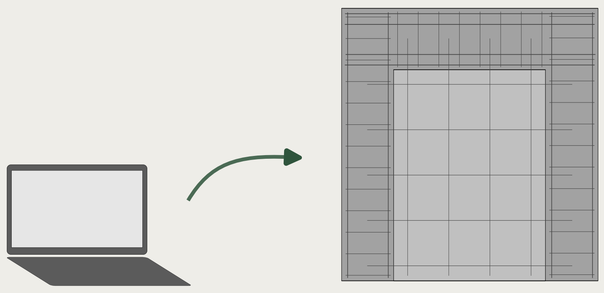
## Challenge

Concrete is a very durable material, and well-suited for building structures. However, a building consisting of concrete walls optimized for production purposes is not very flexible with respect to future building modifications such as merging apartments, transformation from housing to office spaces or other types of alterations, which requires new holes in existing concrete walls. Furthermore, the cement and concrete industry is responsible for around 8% of the global carbon emissions.

The aim is to find a new concept for the design of concrete structures, which offers more flexibility and reduces the carbon footprint.

## Research

1 **Optimization**
A material optimization algorithm is developed, which finds the combination of concrete strength and reinforcement design that minimizes the carbon footprint.

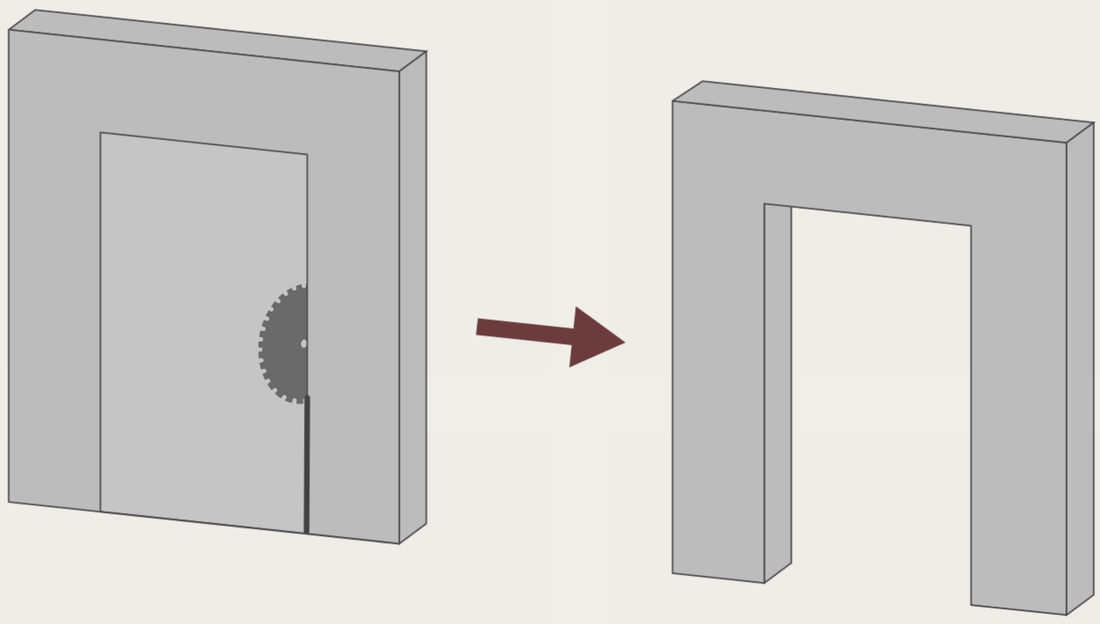


## Production

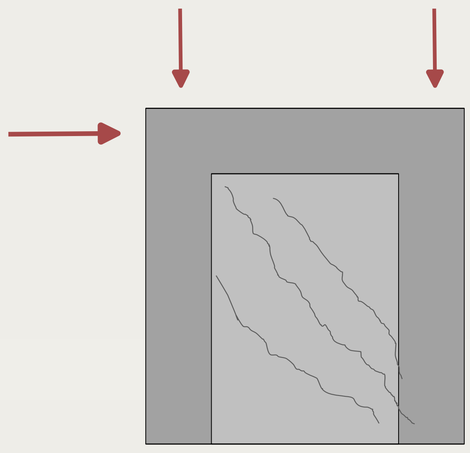
To ensure producability and scalability, the production of the modifiable concrete walls are tested at the concrete element factory Heidelberg Materials Precast Denmark.

## Solution: Modifiable concrete walls

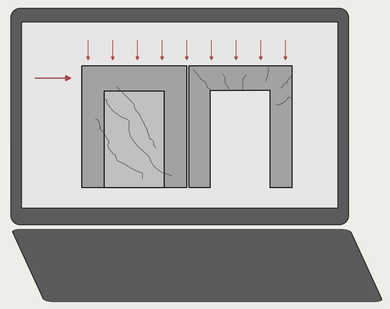
In this industrial PhD project a new structural design concept for prefabricated concrete walls is developed and analysed. The new prefabricated wall concept is called modifiable concrete walls. They consist of two zones: a frame zone and a flexible zone in the middle, which can be removed in the future if new openings in the walls are needed. To reduce the carbon footprint of the walls, the flexible zone is produced with very low strength concrete and with little amount of reinforcement. With this design a more flexible wall element is achieved with significant carbon reductions compared to a traditional concrete wall element.



2 **Experiments**
4 full-scale experiments of the modifiable concrete wall elements, to investigate the structural behavior when subjected to loads.



3 **Detailed analyses**
Nonlinear finite element analyses are conducted to investigate the structural behavior of different geometries and combinations of the modifiable wall elements.



## Conclusion

- 25-50% reduction in the carbon footprint of the modifiable concrete walls is found, when compared to traditional prefabricated concrete walls.
- A production technique suitable for current production facilities, which provides a good connection between the two conrete zones is found.
- The test elements, with a very low strength concrete in the flexible zone, has shown a satisfactory structural behavior during the full-scale experiments.
- Overall promising results have been found for the new structural design concept.

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