

Prestressed Masonry

Post-tensioned Shear Walls of Calcium Silicate Element Masonry



RESEARCH SCHOOL
INTEGRAL DESIGN OF STRUCTURES

Speerpunt
BOUW

Subject

Calcium silicate element (CASIEL) masonry with thin layer mortar is a popular construction method in Western Europe. It is used to build load-bearing walls, but also shear walls of single-family dwellings and medium-rise buildings. Units with compressive strength up to 44 MPa are available. However, the height of these shear walls is limited by the overturning moment. By post-tensioning CASIEL masonry, higher and more slender shear walls can be built. This research project aims to gain insight in the behaviour of post-tensioned shear walls of CASIEL masonry.

Goals

- Accurate assessment of prestress losses (creep, relaxation and shrinkage of high-strength CASIEL masonry);
- Insight in the structural behaviour of post-tensioned shear walls;
- Development of a simple and effective post-tensioning construction method;
- Development of design rules for post-tensioned masonry.

Expected Results

It is expected that insight in the structural behaviour of post-tensioned shear walls of CASIEL masonry will lead to design rules and ultimately to applications in building practice.



Semi-automated construction method using a small crane.



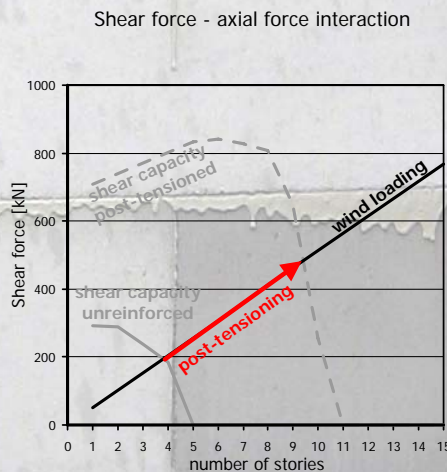
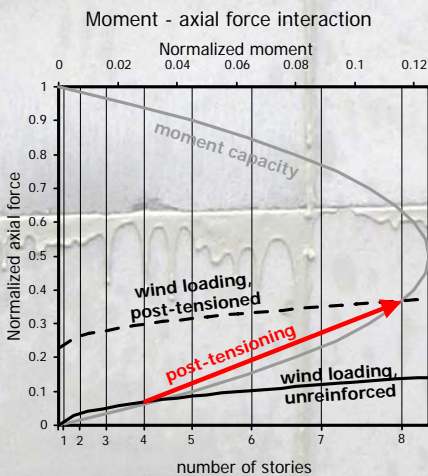
Small crane and CASIELs on 7th story of a building under construction.



Tool to apply thin layer mortar.



Kicker course for good dimensional set-out and smooth and plumb wall.



Diagrams for an example shear wall with the following properties:
length = 5.5 m, width = 214 mm, height = 3.2 m / story, axial force = 44 kN / m,
wind load = 16 kN / m, compressive strength $f_d = 10 \text{ N} / \text{mm}^2$,
initial shear strength $f_{vko} = 0.4 \text{ N} / \text{mm}^2$, buckling factor = 0.7

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Program Structural Design / Masonry Structures
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Subject

Calcium Silicate Element (CASIEL) masonry with thin layer mortar is used frequently in Western Europe for load-bearing structures. CASIEL masonry is also used to build shear walls of low- and medium-rise buildings. CASIELs can be processed on site by a semi-automated construction method using small cranes. Due to the use of thin layer mortar, setting times are relatively short. All in all, the construction method is time efficient, which explains its popularity. Unfortunately, the overturning moment is often normative for the maximum height of unreinforced masonry shear walls. Therefore, the compressive strength of the masonry cannot be used effectively. By vertically post-tensioning CASIEL masonry shear walls, additional axial load is added, which increases both the moment and shear capacity of the shear wall. By this method, higher and more slender masonry shear walls can be built.

Goals

- Accurate assessment of prestress losses due to shrinkage, creep and relaxation of high-strength CASIELs (experimental research).
- Insight in the structural behaviour of post-tensioned masonry shear walls (moment and shear capacity) at ultimate and serviceability limit states (experimental and numerical research).
- Development of criteria for a simple and effective post-tensioning system including anchorages and connectors, which also ensures overall stability during building construction.
- Development of design rules for post-tensioned masonry.

Research Question

How do vertically post-tensioned shear walls of element masonry respond to quasi-static loading?

Strategy

Experimental research will be performed to validate a numerical model, which will be used for a parameter study. Experimental and numerical results will form the basis for analytical design rules.

Expected Results

Insight in the structural behaviour of post-tensioned shear walls of element masonry will lead to design rules and eventually to applications in building practice.

Sponsors

Dutch Calcium Silicate Industry (VNK, main sponsor)

Dywidag Systems International

Prime Publication / Prototyping

Results will be published in international scientific journals and presented at international conferences. Proposals for design rules will be introduced to Dutch and European standardisation committees.

Research Period

September 2008 - 2012