

Prestressed Masonry

Post-tensioned Shear Walls of Calcium Silicate Element Masonry



RESEARCH SCHOOL
INTEGRAL DESIGN OF STRUCTURES

Subject

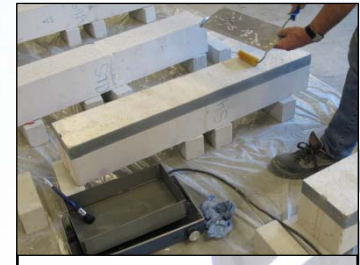
Calcium silicate element (CASIEL) masonry with thin layer mortar (TLM) is a popular construction method in Western Europe. It is used to build load-bearing walls, but also shear walls of single-family dwellings and medium-rise buildings. Units with compressive strength up to 44 MPa are available. However,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

Goals

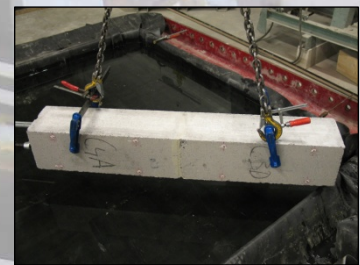
- Accurate assessment of prestress losses (creep, relaxation and shrinkage of high-strength CASIEL masonry);
- Insight in the structural behaviour of post-tensioned shear walls;
- Development of a simple and effective post-tensioning construction method;
- Development of design rules for post-tensioned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

Expected Results

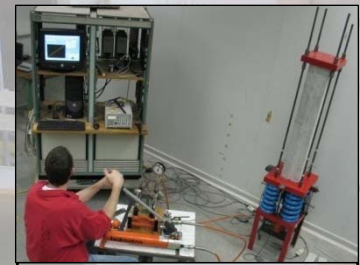
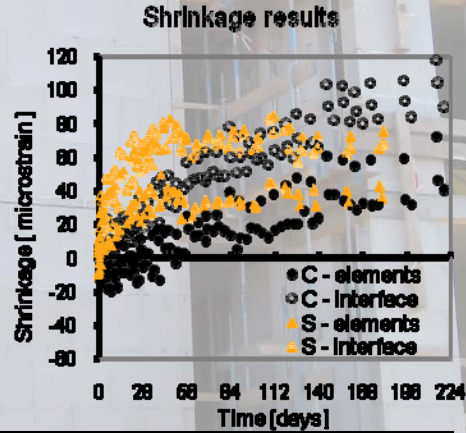
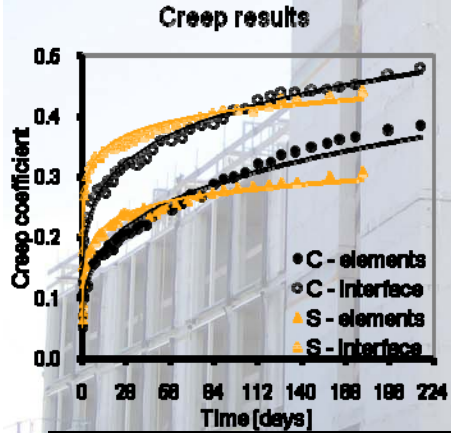
It is expected that insight in the structural behaviour of post-tensioned shear walls of CASIEL masonry will lead to design rules and ultimately to applications in building practice.



Preparation of specimens for long-term experiments:
(1) Applying TLM;
(2) Sealing (photo);



(3) Immersing in water (photo);
(4) Storage in plastic to allow moisture distribution;



(5) Applying prestress (photo);

Graphical results of long-term experiments on CASIEL-TLM specimens:

- Normalized compressive strength = 49 MPa (C- and S-series)
- Young's modulus = 18,200 MPa (C-series, average moisture content = 3.5 % m/m)
- Dry density = 1960 kg/m³ (S-series) and 2140 kg/m³ (C-series)
- Moisture content = 6.5 ± 0.5 % m/m
- Prestress (creep test) = 8.3 MPa
- Environment: climate room, T = 21.0 ± 0.5° C and RH = 60 ± 5 %



Measurements:
(6) Specimen by DeMec (photo)
(7) Bars by strain gauges.

Acknowledgements

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Dywidag Systems International



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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 capacity and the stiffness of the shear wall.

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 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 analytical models and 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 numerical modelling, 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

Van der Meer L. J., Martens D. R. W. and Vermeltoort A. T. : *Introduction to post-tensioned shear walls of calcium silicate element masonry*. Proceedings of the 11th Canadian Masonry Symposium, Toronto, Canada, 2009.

Research Period

September 2008 - 2012