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Earthquake, Masonry and Concrete Engineering Specialists

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To Whom it May Concern

I confirm that I have provided peer review for the Wienerberger POROTHERM Clay Construction System used for the Hibberd New Dwelling project at Weld Street Martinborough.

Confined masonry is a building system that is not widely used in New Zealand and for which we have no national design guidance. However, confined masonry is promoted in many other parts of the world in recognition of its proven satisfactory earthquake performance when designed appropriately. Most importantly, confined masonry is a codified construction technique in Europe, where its use is incorporated into Eurocode 8 "Design of structures for earthquake resistance" and Eurocode 6 "Design of masonry structures". In these Eurocodes there are no limitations placed on the level of seismicity that the confined masonry system can be designed to sustain.

I am a member of the standards committee for both NZS 1170.5 "Earthquake actions" and NZS 4230 "Design of reinforced concrete masonry structures". I am also a corresponding member for the masonry chapter of ASCE 41. I confirm that the loading applied in the design procedure for POROTHERM is consistent with the limit state loading criteria specified in NZS 1170.5. I also confirm that the design philosophy adopted for the design of POROTHERM is consistent with the philosophy of NZS 4230 in that the European approach to partial safety factors using a ratio of (1/1.5) is directly analogous to and mathematically consistent with the New Zealand approach of using a strength reduction factor of $\Phi = 0.75$.

The design of POROTHERM Clay Construction Blocks has been undertaken using two approaches. In the first approach an equivalent static design has been developed using the European factor q=2 which effectively corresponds within NZS 1170.5 to the ratio k_{μ}/S_p . The factor of q=2 recognises that confined masonry in effect has limited ductility, rather than being brittle. This value is codified into the Eurocodes and is well supported by technical literature and physical testing evidence. This methodology and the design shear strength for confined masonry have been used to establish that the in-plane response of the walls, appropriately accounting for torsion effects, exceed the design base shear demands.

The equivalent static analysis has been supplemented with a nonlinear pushover analysis using custom-written software developed in Europe specifically for the confined masonry system being used in this project. Within that software I confirm that all country-specific variables have been matched to the corresponding New Zealand-specific spectra. The design calculations provide further documentation to show that when subjected to design level earthquake loading the building loads and deformations are well below those corresponding to ultimate limit state strength and drift levels.

The out-of-plane analysis of the gable ended wall has been undertaken accounting for parts loading, consistent with the standard procedure adopted in New Zealand when assessing unreinforced masonry walls responding out-of-plane. The capacity of face loaded walls has been determined using the codified EN 1996-1-1:2005 + A1: 2012 Annex A procedure, and explanatory text has been provided to explain this procedure.

The detailing associated with the reinforced concrete boundary elements is consistent with Eurocode requirements for spacing of confining elements and the detailing of reinforcement within these confining elements, with supplementary strength checks for elements such as lintels having been undertaken using design software provided by the Structural Engineering Society of New Zealand.

The design of the floor and roof diaphragms are consistent with current New Zealand practice and are outside the scope of my peer review.

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