Soothill Structures
Timber|Heritage|SmallWorks

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Dear Inge

St Catherine's College – Garden Walls – Structural Issues and Strategy for Repair

Following my visit to the college on 21st October I confirm my opinion on the cause of the damage to the garden walls and suggest a strategy for repair. This proposal will emphasise the structural issues within my discipline and reference should be made the report by Pendery Architecture and Heritage regarding architectural and conservation issues. Please refer to photographs appended when reviewing these proposals.

The Walls Effected:

- Cracking and disruption of brickwork, along with localised leaning, had been noted on three low garden walls that run roughly north to south through the college.
- The inspection and these observations are limited to these three walls.
- The walls are referred to as: east, central and west.
- Two trial pits have been excavated at the worst effected east wall to confirm the depth and nature of the foundation.

Form of Construction:

- The walls, 275 thick, are constructed from two leaves of calcium silicate bricks with a stretcher bond with only a limited overlap. This type of brick and bond is common to the whole college.
- The walls form a barrier to the edge of the terraces at changes in level and in the case of the central wall is also adjacent to the long pond by the Master's Residence. The retained height is up to c750mm generally, with the extra height adjacent to the pond achieved in concrete from about 150 above water level, the pond depth being about 600mm.
- Damp proof courses are present at different levels on each leaf of the wall. This suggests that there is an unfilled cavity, including below the upper ground level. If this is the case, then retaining action is achieved by two independent 100mm thick walls. (This will be confirmed by opening-up during the first stage of the repair process.)
- The walls are of varied length, the longest being 60m and 80m. The shortest being c9m. Generally, there are no movement joints. The only one found splits the 80m wall into two lengths of c 40m. This movement joint steps with the purpends of the small overlap stretcher bond, the original flexible sealant is still present.
- The mass concrete footings to the wall are founded c1.15 below the lower ground level on clay. Above this level disturbed old fill material was encountered including glass bottles. The site is known to have been an old rubbish dump.
- The lack of movement joints and the apparently insubstantial retaining wall may both be considered as original design defects.

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General Condition:

- All of the walls exhibit roughly vertical cracking at regular centres from dpc level up to coping level. The frequency of these cracks is c6-8m. Even the shortest c9m walls often have cracks at about the centre point.
- A lean towards the lower side of the retaining walls is noted in several locations and is evidenced by the 'waviness' of the coping stone (Photo 1.2). Some lengths of wall lean more evenly by small amounts over their whole length (Photo 2.6).
- There are localised areas of disrupted brickwork, each different in nature. In places the 'low side' wall leaf above the dpc bows outward away from the 'high side' forming an overhang at the dpc (Photos 1.4). If the movement is in the 'high side' leaf, movement toward the 'low side' is evidenced by a ledge forming at the dpc (Photo 3.3). Elsewhere the top of the wall has rotated outward by over 50mm (Photo 1.6). Movement in one leaf of the cavity wall is often not mirrored by movement in the other leaf. In some locations there is similar differential movement below dpc (Photo 2.3).
- Previous patches of repaired brickwork can be observed (Photo 2.7).
- There is no indication of foundation movement at the trial pit locations and vertical settlement cannot be observed.

Likely Cause of Movement:

- The movement observed is due to two mechanism: cyclic moisture movement and lateral pressure from retained soil behind the wall.
- Calcium silicate bricks (unlike fired clay bricks) are formed in a wet cementing process (like concrete) such that they are often installed in a semi-dry state. Early drying out leads to shrinkage and this is the cause of the regular near vertical cracks. These will have been there since the first dry period after construction. Design standards recommend that movement joints are installed at <6m intervals in calcium silicate brick walls.
- Subsequent wetting and drying of a calcium silicate wall results in cyclic expansion and contraction. Without movement joints, on an expansion cycle, compression stresses can build up which may or may not be relieved by longitudinal movement of the wall. An exceptionally long wall resulting in greater stresses.
- Lateral pressure from the soil behind the insubstantial retaining wall will result in movement towards the 'low side' by sliding or rotation.
- A combination of built up longitudinal stresses and lateral movement is likely to have caused the variety of disruption to the brickwork observed.

Strategy for Repair:

- There will have to be a balance struck between preserving the existing structure, minimising future damage, and ensuring safety.
- The most heavily leaning section of the east wall should be rebuilt to ensure safety. The c40m length between the movement joint and the free end could be re-constructed using re-used bricks. It is likely that not all bricks will be recoverable and new matching bricks could used below dpc. On the high side the retaining leaf below paving level should be 215 thick, either dense blocks laid flat or fully bonded brick. A land drain and sealing of the back of the wall below ground will ensure long term performance (2 coats RIW LAC).
- At present the other leaning walls are not currently at risk of collapse. These may be locally patch repaired or short c6m sections could be rebuilt where they are particularly disrupted (Photos 2.3 and 3.2).
- Removal of the cyclic longitudinal stresses and consequent movement, by installation of new movement joints, is recommended. 8mm saw cut movement joints through both leaves of wall down to top of foundation, should be formed at 6m centres. Walls less than say 9m long could be left as they are, as further disruptive movement is unlikely.

- It must be acknowledged that, even with the new movement joints, the inadequate retaining wall may lead to further lateral movement and the need for future localised replacement. However, in the spirit of good conservation, wholesale replacement is not proposed at this time.

I suggest that this letter should be forwarded to the conservation officer for approval of the strategy ahead of development of a full specification.

Yours sincerely

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Director
For and on behalf of Soothill Structures

Enc. Drawings 01-, 02-, 03- Photographs

c.c. David Pendery - Pendery Architecture and Heritage