THE ENGINEERING COUNCIL OF SOUTH AFRICA

PRACTICE NOTES ARISING FROM CONTRAVENTION OF ECSA's RULES OF CONDUCT FOR REGISTERED PERSONS.

PUBLISHED BY ECSA TO MINIMISE THE RISK OF RECURRENCE

Practice Note No. 2015/3:

Inadequate attention to foundation design and construction of a house

THE PROJECT

A single storey dwelling house, founded in clayey subsurface materials

BACKGROUND

A building contractor had a contract with a client to build a "shell" for a dwelling house, comprising concrete work, brickwork, plaster work and roof. The structural engineer for the project was a Consulting Engineer, appointed by the client. The site was extensively underlain by clayey materials. When the Builder queried at a meeting why the Engineer did not specify removal of clayey materials and replacement with compacted backfill of G5 or G7 quality the Engineer replied this was too costly and a raft type foundation would be used instead. After construction had been completed significant cracking occurred in the super structure, particularly horizontal cracks in masonry below the surface bed. Following an investigation commissioned by ECSA, deficiencies were found to have taken place in regard to the foundation design and construction monitoring by the Engineer.

Arising from the above it was considered by an expert commissioned by ECSA that the Engineer had been guilty of professional negligence and had contravened ECSA's Rules of Conduct, particularly under clause 3 (Competence).

DETAILS OF THE PROBLEMS ENCOUNTERED

For the house foundations, to be placed in a clay stratum which the Engineer suspected would heave, the Engineer elected to use a "stiffened raft" which in cross section comprised a sunken reinforced concrete beam 300mm wide x 600mm deep with 2 x Y12 bars top and bottom and Y10 stirrups at 350mm centres, topped by a variable depth of 300mm wide brickwork up to the underside of the 85mm thick surface

bed (to be recessed approximately 150mm into the brickwork) with the brickwork continuing upwards above surface bed level. The surface bed slab was reinforced with Ref. 193 mesh.

Roof wire ties, cast into the RC beam at 600mm centres, were to project upwards in the brickwork, to be cast into the surface bed. Brickforce was specified to be placed in the first and last brickwork courses and at every fifth course in between. A 10mm wide expansion joint with polysulphide sealer was called for at 6m intervals along brick walls and at interfaces between new and existing brickwork.

The Engineer signed a Completion Certificate confirming the excavation sizing and rebar fixing had been inspected and approved. It was further stated that if the concrete, of required strength, was placed within the stipulated dimensions, the foundations would carry the SABS specified loads safely.

After the meeting between Builder and Engineer referred to above, the Engineer reduced the beam spacing from 3m to 2m. In addition the Engineer confirmed his completion certificate dealt only with the excavations and beam reinforcement and not the floor slab, which he had not been called to inspect. The Engineer also confirmed he was satisfied for the 193 mesh reinforcement to be placed in the bottom of the slab.

The foundation structure did not function as a stiffened raft because the concrete beams and slab did not form a monolithic unit. As a result, its strength in both bending and shear and its flexural stiffness were compromised. In addition a number of other factors contributed to the problem:

Firstly, no geotechnical investigation was done and hence no sampling and laboratory testing results were available for the prediction of heave movements. The prediction of heave is an essential design input.

Secondly no design calculations were prepared. An empirical approach was used which proved inadequate.

Thirdly, the construction did not follow all the prescribed details, which rendered the design as constructed to be even further inadequate.

It was found the Engineer had acted negligently and incompetently in all three phases of his assignment - Investigation, Design, and Construction Monitoring.

As a result several of the rules in Clause 3 of ECSA's Rules of Conduct can be considered to have been transgressed:

Registered Persons:

3(1)(a) - must discharge their duties to their employers, clients, associates and the public with due skill, care and diligence,

3(1)(b) – may only undertake work which their education, training and experience have rendered them competent to perform and is within the category of their registration,

3(2)(b) – must not undertake work under conditions or terms that would compromise their ability to carry out their responsibilities in accordance with the norms of the profession,

Transgression of any of the above Rules could also constitute contravention of Rule 3(5)(a) – must order their conduct so as to uphold the dignity, standing and reputation of the profession.

WHAT LESSONS CAN BE LEARNED?

Lessons are to be learned from transgression of Rules of Conduct in the above project and are summed up as follows:

1. Competence – Ensure you do not undertake work for which you have insufficient competence to perform. This risks dangerous outcomes and prevents carrying out the work with the due skill, care and diligence which it demands.

2. Always ensure a geotechnical investigation, including sampling and laboratory testing to an extent commensurate with the nature and complexity of the project, is carried out, and that it yields sufficient information to design the foundations

3. A stiffened raft foundation structure usually comprises a grid of reinforced concrete beams integrally cast with a concrete slab at top or underside of the beams. In heave conditions the slab reinforcement is best placed near the top of the slab to resist negative bending moments. A slab connected to the beams with roof ties, especially if the slab is on brickwork above the beams, will be ineffective as a stiffened raft as the slab and beams will act independently rather than monolithically, due to an absence of an adequate shear connection between them.

4. Do not certify a structure or portion thereof as complete if work still outstanding on it, such as concreting, is not also inspected and approved – certification of such a stage cannot rely on test results yet to be available or standards of workmanship it is assumed will be satisfactory.

5. The Engineer should not wait to be “called“ to inspect. He must decide in advance which critical construction operations require construction monitoring or inspection and must ensure he is kept informed of progress in order for monitoring or inspection by him to take place timeously.

6. It is not an excuse for the Engineer to state he can be held responsible for only those items checked or approved by him, when he neglects to check or approve other critical items which need his verification.

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