

THE ENGINEERING COUNCIL OF SOUTH AFRICA

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

PUBLISHED BY ECOSA TO MINIMISE THE RISK OF RECURRENCE

Practice Note No. 2016/2

Consequences of a failed retaining wall next to a stream

THE PROJECT

A retaining wall on a residential property in a suburban area, constructed along the property boundary situated on the banks of a stream ("spruit")

BACKGROUND

The wall was designed by a registered person, to be constructed alongside the bank of a stream flowing past the property. The construction resulted in a raised terrace being formed above the natural slope of the ground surface at the stream bank. Part of the wall collapsed before construction was complete, caused by a rise in the water level of the stream and inundation of portion of the wall. Following a complaint to ECOSA in an affidavit by the property owner, the registered person was charged with contravention of ECOSA's Rule of Conduct relating to faulty design and called to face a disciplinary hearing. In keeping with ECOSA's policy for Practice Notes to reduce the risk of recurrence of mishaps and contravention of its Rules of Conduct, this note examines the design to identify its deficiencies and demonstrate what would be a correct course of action through the section below on Lessons to be learned.

DETAILS OF THE PROBLEM

The owner of the property arranged for the registered person to design and monitor the construction of a wall to retain earth fill placed on the ground surface behind it, to create a terraced surface with a 2% slope towards the property boundary. The existing ground surface sloped towards a stream flowing alongside the boundary. In cross section, the wall was sited at a point where the existing ground surface sloped more steeply towards the stream. Details of the wall construction could be deduced from a cross sectional construction drawing prepared by the registered person.

The structure of the retaining wall consisted of proprietary precast concrete blocks laid one row above the other to a height of 1.8m with the outer face being 15 degrees off the vertical. The bottom row of blocks was filled with 20 MPa concrete and also the top two rows, in which a palisade security fence was embedded. The wall was founded on a mass concrete footing approximately 300mm wide x 100-200mm thick, cast integrally with a 200mm thick wire mesh "mattress" filled with crushed rock. The mattress was laid on a geofabric on the ground surface for 2m in front of the wall, along part of its length. Over the remainder of the wall length the wall was founded on a 20 MPa concrete footing 600mm wide x 150mm thick. The earth backfill behind the wall was specified to be compacted to 90% Mod AASHTO density. Two layers of geosynthetic reinforcement were provided over the upper half of the wall extending 1,7m into the fill. These layers were spaced 400mm apart and sandwiched between the blocks to anchor them to the wall. The terrace was covered with precast concrete "grass blocks".

The stream flows all year round and drains an extensive catchment, covered almost entirely by developed suburban housing and infrastructure. This resulted in a high percentage of rainfall precipitation being translated directly into runoff to the stream, which after a thunderstorm, became a torrential river. The retaining wall and terrace encroached beyond the flood line of the river and constituted a restriction to the river flow.

During a heavy storm, part of the wall collapsed. This led to the property owner addressing a complaint to ECSA. The investigation by ECSA's Investigation Committee was followed by a meeting with the registered person and referral of the design to an expert. The expert found that the design did not consider certain critical failure modes and requested further calculations to verify the stability of the wall under such conditions. The original and subsequent calculations contained fundamental errors, indicating a lack of understanding of soil mechanics by the registered person.

At the interview and with reference to communications with the property owner and the local authority, the registered person averred the wall had been constructed in accordance with his design – although construction was still incomplete. Written assurance had been given to the property owner by the registered person that he was familiar with the requirements for river/stream management, before designing the wall. He averred the stream flow would be unaffected by the positioning of the wall – although the wall encroached beyond the flood line of the stream and created a constriction.

The Investigating Committee concluded the design of the wall was deficient and its construction inadequate, arising from a lack of understanding of the basic principles of soil mechanics on the part of the registered person. The committee considered sufficient grounds existed for charges to be preferred against the registered person for contravening ECSA Rules of Conduct 3(1)(a), 3(1)(b), 3(1)(c), 3(2)(g), 3(2)(a), and 3(4)(a) (described below). The registered person was formally charged and pleaded guilty to contravening ECSA Rule of Conduct 3(1)(c) – Registered Persons must, when carrying out work, adhere to acceptable practices. As a sequel a fine of R5000 was imposed by ECSA.

WHAT LESSONS CAN BE LEARNED?

There are fundamental lessons to be learned, in two areas:

In design of precast block retaining walls:

1. This is a specialised area of structural design. Although an apparently simple wall to construct, the design needs to be done with extreme care. The precast blocks form an outer facing to the retained material; they must be effectively interlocked and connected to any tie back into the retained material so that the facing skin and retained material to act monolithically.
2. Cognisance must be taken of the variation in earth pressure behind the wall arising from changes in the moisture content of the retained material, particularly if the wall becomes inundated giving rise to a temporary water table behind the wall.
3. Similarly it is essential that the nature of the founding material beneath the wall be considered and the structure as a whole must be designed to withstand settlement, bearing failure, overturning or sliding. The wall must be connected to its foundation, which must be designed to withstand these forces.
4. Proximity to a river will require particular attention to be given to the design to cater for the conditions above. If the wall is within the flood line of the river, it will create a constriction which will accelerate the flow of water past the wall and raise the risk of scour to the founding material below the wall. The hydrology of the catchment area and hydraulic behaviour of the river flow past the wall must be considered.

In risking charges of contravening ECSA's Rules of Conduct:

The complaint and its outcome showed a clear contravention of the Rule of Conduct under which the registered person was charged, namely 3(1)(c). Considering the undertaking given by the registered person to the property owner and the circumstances surrounding the carrying out of the undertaking, the registered person could well have faced further charges for contravening the following Rules of Conduct in addition to Rule3(1)(c):

5. 3(1)(c): Registered Persons must, when carrying out work, engage in and adhere to accepted practices; (*did not possess basic knowledge of soil mechanics principles required for competent execution of his chosen line of work*)
6. 3(1)(b): Registered Persons must only undertake work of a nature which their education, training and experience have rendered them competent to perform; (*ditto*)
7. 3(1)(a): Registered Persons must discharge their duties to their employers, clients, associates and the public with professionalism, knowledge, competence, due care and diligence; (*ditto*)
8. 3(2)(a): Registered Persons must discharge their duties to their employers, clients, associates and the public with integrity fidelity and honesty; (*indicating the wall had been constructed to his design when the wall had not yet been completed and subsequent events proved otherwise*)

9. 3(2)(g): Registered Persons may not knowingly misrepresent or permit misrepresentation of their own or any other person's academic or professional qualifications or competency, or knowingly exaggerate their degree of responsibility for any work or that of any other person; *(misrepresenting his competence with regard to river/stream flow management)*
10. Registered Persons must at all times have due regard and give priority to the health, safety and interest of the public and in their work avoid adverse impact on the environment. *(Failing to consider the possible adverse effects on the environment of restricting the stream flow)*

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