ES4.1

Assessment of Stability of Recent Earthworks

Jesmond Dene Stadium Tredegar

1. Introduction

Capita Symonds (CS) were commissioned by Blaenau Gwent County Borough Council (BGCBC), to undertake the following work in regard to the stability of the recent earthworks undertaken on land belonging to the Jesmond Dene Stadium, Tredegar, which is situated to the rear of the properties of Marian Close.

- Review existing reports.
- Carry out site inspection.
- Provide an Assessment Letter outlining CS's opinions and recommendations for additional work to undertake detailed assessment.

2. Site Inspection

The site was inspected by CS geotechnical engineers on 4 November 2011 and met on site by Mr Carl Powell of BGCBC. The site lies on steeply sloping ground, below the Jesmond Dene Stadium, at the rear of the recent Marian Close development, Tredegar. The steep slopes were originally grassed, but have recently been reprofiled to form a bench of up to 10m width, about midway downslope. The new slopes are largely bare.

Why was I not invited

Examination of the materials exposed in the newly cut and filled slopes, indicate that they are mainly the products of past mining for coal and ironstone. However, a zone of the slopes immediately behind the rear boundaries of the Marian Close properties is covered by building waste. The upper slopes above the bench have been cut in a fairly consistent manner, to an angle of 30 to 34° without signs of significant failure.

The lower slopes are less steep (25 to 30°) and irregular in profile, indicating that they may have been loosely placed and not been subject to systematic compaction. Inspection of the materials exposed in the lower slopes indicates that although they are mainly composed of mining spoil, building waste is also present.

In terms of stability, the lower slopes appeared to be in a relatively stable condition despite their irregular profile. However, some localised erosion is evident.

In the northern section of the site, behind Plot 11 where reprofiling had not been undertaken, a small backscar was noticeable in the steep grassed slopes, suggesting that some localised shallow slipping had occurred in the past. A row of steel rails had been driven into the slope below this backscar, possibly in an attempt to stabilise this localised slipping.

Block walls were evident at the rear of the gardens of the recently constructed Marian Close properties. In some cases (Plots 3, 4 and 5), these walls support cuttings made at the rear of the properties to provide a level garden space. In other cases, the walls support fill placed on the Jesmond Dene Stadium land.

3. Stability Assessment

Dr Noake's Report

Stability calculations carried out by Dr Noake and presented in his November 2010 report (Ref. 1) suggest that the lower slopes below the mid slope bench have factors of safety ranging from 1.26 to 1.63 for a shallow translational type of slip and slopes ranging from 25 to 30°. To obtain these figures, an angle of internal friction of 36° and a dry slope condition has been assumed. Based on our visual inspection of the site, these assumed ground conditions and derived factors of safety are not unreasonable, but in the absence of site investigation and groundwater data cannot be verified. The angle of internal friction assumed may also be slightly on the high side.

Similar calculations have also been undertaken by Dr Noake for the upper slopes, for slopes ranging between 28 to 32°. However, if it is assumed that an angle of internal friction of 36° has been used by Dr Noake in his stability computations as stated in his report, then the factors of safety should range from 1.16 to 1.37 and not from 1.37 to 1.63 as quoted, for dry slope conditions. The result of this computational error means that the factors of safety for the steeper slopes do not comply with the factor of safety of 1.3, stated as being required in Dr Noake's report.

It is also possible that the factors of safety computed above, may slightly over-estimate the true stability of the slope, because the cross sections on which they are based appear to have been undertaken 'skew' to the slope and therefore underestimate the maximum slope angle.

4. Mining

In his report, Dr Noake draws attention to the past mining activities which have occurred in the area for both coal and ironstone and the possibility that shallow mine workings and untreated mine entries underlie the Marian Close development.

In view of this it may be necessary to undertake further research and risk assessment of the mining situation, dependent on whether a detailed assessment has already been carried out.

However, given the long history of mining in the area and the likelihood that unrecorded mine workings may be present it will be difficult to make a wholesale and comprehensive assessment of the mining position and to evaluate whether it has any relevance to the stability of the new earthworks within the Jesmond Dene Stadium land.

5. G.A. Spacey & Associates Report

G.A. Spacey and Associates state in the conclusions to the report (Ref. 2) that the earthworks carried out on site appear to be in an unstable condition, particularly the lower slope area. They also recommended that appropriate remedial works should be carried out which include:

- Considerable regrading and recompaction of the lower slopes and provision of herringbone land drains and geotextile slope protection measures.
- Only land drainage and geotextile erosion protection to be provided for upper slopes. No regrading of upper slopes deemed necessary.

However, this report does not include any details of analysis they may have carried out to verify these conclusions or to prove that the remedial measures they recommend will result in increased stability.

6. **Undercutting at the rear of Marion Close Development**

It is stated in Dr Noake's report that due to excavation on the Marian Close side of the boundary, during the construction of this development, that a 2m high unsupported face was left which undercut the Jesmond Dene Stadium land.

At the time of the CS site visit, there was no evidence of such unsupported excavation, as a block work wall had been constructed at the rear of the properties, presumably in the position of the original excavation. The height of the boundary wall was generally up to about 1.5m from ground level. It is not known whether these walls have been designed in terms of global stability and include the land upslope within the Jesmond Dene Stadium.

Contamination

The issue of potential contamination has been raised on Dr Noakes's report in relation to the Marian Close development and it is assumed that this issue has been previously investigated as part of the development.

Cross Sectional Data

The cross sections presented with the G.A. Spacey and Associates report appears to have been taken slightly 'skew' to the slope and therefore may not represent the maximum slope gradient needed to be used in slope stability analysis. If further slope stability analysis is carried out, the accuracy of the cross sections and whether they portray the maximum slope angle will need to be verified.

Conclusions and Recommendations

1. Appraisal of the available information and inspection of the site to the rear of the recent Marian Close development within land belonging to the Jesmond Dene Stadium has shown that the site is mainly covered by tip materials associated with the disposal of waste from coal and ironstone mining.

2. The steep slopes of the existing tips were originally grassed but have been recently re-profiled using cut and fill techniques to form a bench, approximately midway downslope. The re-profiled upper slopes are largely un-vegetated and currently stand at a fairly consistent angle ranging between 28 and 34°. The lower slopes below the berm have a flatter irregular profile, of between 25 to 30°, and shows sporadic sign of re-vegetation. The hummocky nature of the lower slopes suggest that they may not have been formed by benching and compaction to formal engineering requirements.

3. Stability analysis undertaken by Dr Noake and presented in his report (Ref. 1), suggest that the new earthworks profile are stable and have a more than adequate factor of safety (exceeding 1.3 for the upper slope and 1.26 for the lower slope). However, there is an error in the factors of safety quoted for the upper slopes, which should range from 1.16 to 1.37, for an angle of internal friction of 36° and slope angles of between 28° to 32° (not 1.37 to 1.62 quoted in the report). This means that the upper slopes do not comply with the long term factor of safety of 1.3, stated to be the minimum required for the upper slopes by Dr Noake. Additionally, the factors of safety given in Dr Noake's report assume dry slope conditions apply and would be less than the stated figures if groundwater was present.

4. G.A. Spacey and Associates state in the conclusions to their report (Ref. 2), that the earthworks carried out on the site appear to be in an unstable condition, particularly the lower slope area. They also recommend that appropriate works are undertaken to remediate the slope, involving regrading, recompaction and drainage measures. However, they do not include any details of analysis they may have carried out to verify these conclusions or to prove that the remedial measures that they recommend will result in an increase in stability.

5. Block walls have been erected at the rear boundary of the Marian Close development, at the foot of the reprofiled slopes. The walls have a dual purpose, firstly to provide local support to any excavation or fill and secondly to be adequate in terms of the overall stability of the re-profiled slopes above them. It will be necessary to determine the size and structure of the walls to undertake any global stability assessment.

6. A small backscar was evident in the steep original grassed slopes of the tip behind Plot 11, indicating that a shallow translational slip had occurred in this vicinity. A row of steel rails had been driven into the slope below the small backscar, possibly in an attempt to stabilise this localised slipping. The slip is located to the north of the zone of recent earthworks re-profiling and outside the area included in the original brief.

7. In his report Dr Noake raised other issues relating to mining and contamination particularly in respect to the Marian Close development. It is unlikely that these factors will have a major impact in terms of slope stability of the Jesmond Dene Stadium land, but in the event that these matters have not been subject to previous research, further investigation may be necessary.

8. Based on examination of the re-profiled slopes and material exposed on site, our preliminary view is that the newly formed earthwork slopes are currently stable with a factor of safety exceeding unity. However, how far the factor of safety exceeds 1.0 is uncertain and cannot be determined with any confidence without good quality information of the ground conditions at the site. In particular it is essential to confirm whether groundwater is present and will have an impact on stability.

9. In order to provide a definitive opinion on the stability of the new earthworks profiles and on the previous stability assessment undertaken by Dr Noake and Spacey and Associates it will be necessary to carry out a ground investigation to determine the ground and groundwater conditions which prevail at the site.

10. The scale of the ground investigation required is estimated to be as follows:

- 4 cable percussive boreholes in the vicinity of the recent earthworks, including in situ testing.
- 2 further boreholes if the small translational slip behind Plot 11 is to be evaluated.
- 6 hand dug trial pits adjacent to the boundary walls at the rear of Marian Close to assess the size of the walls and foundation levels.
- Piezometers to be installed in all boreholes and monitored over at least one winter period.
- Associated laboratory tests.

The cost of the ground investigation is estimated to be of the order of £12,000. Additionally, further allowance should be made to undertake stability analysis and reporting following receipt of the ground investigation factual information.

11. In addition to the ground investigation detailed above, it is recommended that further topographical survey work is carried out to provide accurate slope profiles at additional locations and in the area of the small translational slope identified in the non-landscaped grass section of the tip behind Plot 11.

The cost of additional topographical survey work is estimated to be £1200.

12. The issues raised by Dr Noake's regarding contamination and mining risk relate mainly to the Marian Close development and are of less concern in evaluating the slope stability of the earthworks under construction. It is understood that these matters have already been assessed as part of the Marian Close development and accordingly we have not costed for any further research / desk study work to look into these issues.

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(1) Geotechnical Assessment of Land Adjacent to Jesmond Deane Stadium, Tredegar – Dr J Stewart Noake, 7th November 2010
(2) Land at Rear of Marian Close, Site Stability Report – G.A. Spacey & Associates, July 2009.