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Monitoring the Working Performance of Soil Reinforced Mine Tip Walls in Africa: A series of Case Studies

Surveilles la performance des travaux du sol renforce' des murs de mine en Afrique: Etudes d'une
serie de cas

J.F. Meadows

Maccaferri Southern Africa, Johannesburg, South Africa

M. Pauselli

GAP Consulting, Johannesburg, South Africa

ABSTRACT

Clients, who have Mining Tip Walls constructed in Africa, have a direct and immediate commercial interest in their performance. The walls must perform under harsh conditions and as a maintenance free asset with low to zero risk. To provide such guarantees the design, selection of specific materials, integration of geotechnical parameters and local conditions, correct application of material combinations and construction according to design specification must be carefully considered. Mechanically Stabilized Earth walls use soil reinforcing principles that are both highly flexible and adequately durable to withstand the applied loading and working conditions for the design life span. Therefore an adequate system to monitor the walls working performance is required.

RÉSUMÉ

Les clients qui sont intéressés dans la construction des murs de mine en Afrique ont un intérêt commercial immédiat dans la performance. L'exécution des murs doit être faite sans aucun risque. Pour avoir de telles assurances, le dessin, la sélection des matériaux spécifiques, l'intégration des paramètres géotechniques et les conditions locales sont essentielles. Les murs qui sont mécaniquement stabilisés doivent se servir des principes flexibles et durables pour résister au poids et aux conditions des travaux et pour assurer la longévité et les performances du mur. Par conséquent un système adéquat de surveillance du mur est nécessaire.

Keywords : Monitoring, soil reinforced, tip walls, Africa, case studies

1 INTRODUCTION

Soil reinforced earth retaining structures have been built for over 120 years by numerous companies such as Maccaferri, Freyssinet, RECO and Hilfiker to name but a few. Some of these companies record and collate the working performance in a systematic manner.

Maccaferri SA has manufactured materials and designed structures for marine, civil, mining and wetland clients in a novel relationship by extending their interest with a custodianship monitoring program which is well appreciated by its clients in general.

Two long term projects that demonstrate this relationship well is the Marina at Thesen Island on the East Cape shore of South Africa and the tip wall at Marikana platinum mine North West of Johannesburg. These projects have monitoring programs in place since 2000 and 2002 respectively which is surveyed and reported on annually to the satisfaction of the owners of these fixed assets.

Thesen Island Marina is ideal in studying and monitoring the durability aspects of the double twist, galvanized, pvc, coated mesh, and polymeric materials, as they function in a tidal zone and is accordingly exposed to harsher conditions than usual.

2 MECHANICALLY STABILISED EARTH WALLS

The case histories in this paper all relate to MSEW technology. All the materials manufactured for these applications comply with international standards and specifications set by either B.S, SANS or ASTM and their design procedure and application is governed by the ISO9000 quality assurance system.

Despite the guidance and restrictions imposed by these august authorities, they define important sections of activity that

deal with the application to help enforce construction techniques, and ensure, the results are comparable when an effective performance evaluation cycle is installed. To the designer, the qualitative data received about the characteristics of the structural materials and the insitu foundation conditions, is crucial to enable a conservative and cost effective design. The construction activities and application of certain processes can be coarse and have a high incidence of error or poor installation. Experience with mining clients has shown that all aspects covering quality assurance and safe working practices augmented with controlled documentation is equal in value to the asset itself.

3 EXAMPLES OF SPECIFIC MSEW SOLUTIONS WITH DIFFERENT MATERIALS TECHNOLOGY FOR TIPWALLS

- i) Double twist galvanized gabions- mass gravity structures
- ii) Double twist galvanized PVC coated mesh – TerraMesh reinforced soil structures
- iii) Double twist galvanized PVC coated mesh – TerraMesh with geogrid soil reinforcement
- iv) MacForce – discrete concrete panels with synthetic soil reinforcement (ParaWeb).

The examples shown above are typical stand alone solutions but may be used in various combinations as the project requirements would dictate. The speed of construction, available rock and access to concrete manufacturing all contribute to the best fit application for the particular project. Each arrangement has its own performance requirements, quality assurance control and approval. The specific duration of performance will determine the appropriate monitoring system that will best suit the solution and client requirements.

4 CASE HISTORIES

4.1 Marikana Platinum Mine – South Africa

At Marikana Platinum mine, north west of Johannesburg, where the annual monitoring of the primary crusher tip wall settlement, is done on specific targets for the 22.5m high TerraMesh structure. See figure 1 below.

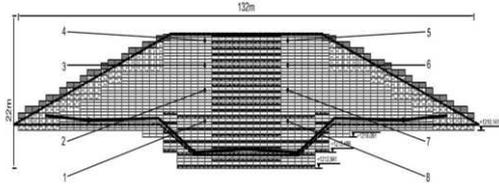


Figure 1: Marikana tip wall – targets to monitor settlement / movement

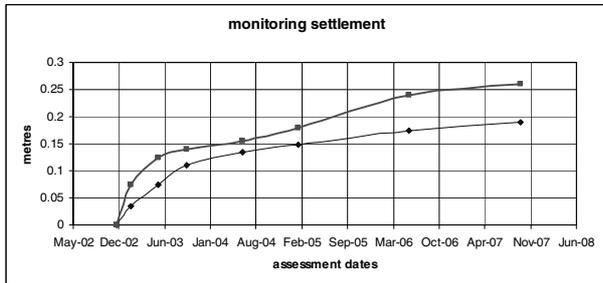


Figure 2: an envelope of the measurements over a period of 7 years

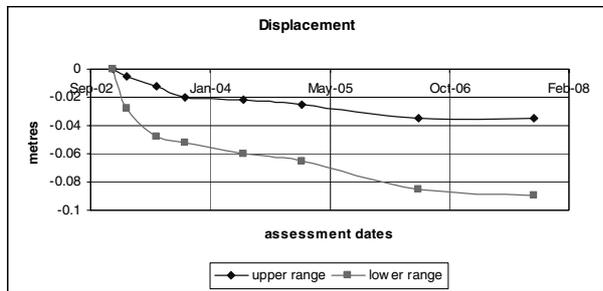


Figure 3: an envelope of the measurements over a period of 7 years

The graphs above demonstrate the range of values obtained over a period of 7 years to measure the settlement and movement away from the crusher. The measurements indicate a flattening off of change that will probably move towards zero in the next year or two.

4.2 Optimum Coal Mine – South Africa

This project demonstrates a TerraMesh combined with a MacForce solution that uses ParaWeb soil reinforcement for the retaining tip wall at Optimum Coal mine South Africa.

The speed of construction for this 1673m² tip wall on a coal mine was 11 weeks, which although it met the mines speedy construction program, has prompted an immediate need to monitor the geotechnical aspects of, settlement and consolidation of backfill, with attention to possible displacement of cladding. Some baskets were placed out of true alignment during the construction phase and these needed to be identified as such, rather than be regarded as a result of subsequent changes in the backfill or facing. Monitoring this

structure is important to the client as an asset and also to the reassurance of safety for work staff on site. Targets at specific points and checked off control stations help assess the situation and maintain records for future management. So far the results indicate no significant movement or significant changes. Monitoring continues every 6 months until the end of 2009, thereafter annually.



Figure 4: A combination structure of Terramesh™ and Macforce

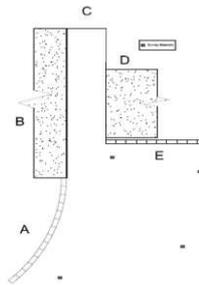


Figure 5: A plan view of walls A and E =Terramesh™ and walls B,C,D = Macforce

4.3 Klipspruit Coal Mine – South Africa



Figure 6: 4000m² Macforce walls at Klipspruit coal mine west of Johannesburg

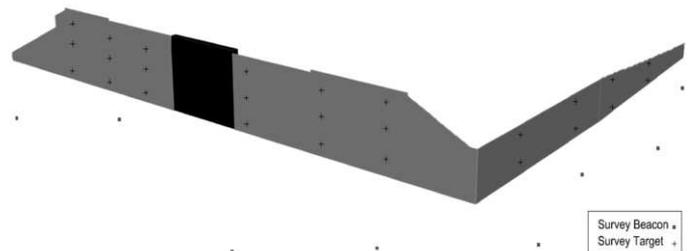


Figure 7: an isometric view indicating the monitoring points on the walls

This structure is 21m in height with retaining walls covering 4000m². The backfill was of good quality and the entire wall has a drainage layer behind the panels to prevent pore water

build up. External beacons assist to measure the targets on the front and side walls must to show results of behavioural changes. Two positions, have post construction, shown panels that are displaced and will need to be monitored.

Targets and measuring stations are in place and the survey system is similar to that which is used at the other tip wall sites. So far the measurements indicate minor movement with some localised changes. The first six months post construction and prior to the operation of the tip wall is considered a base date status from which subsequent changes are compared.

4.4 Iduapriem Gold Mine – Ghana



Figure 8: A Terramesh™ retaining wing walls for a tip wall on a Gold mine

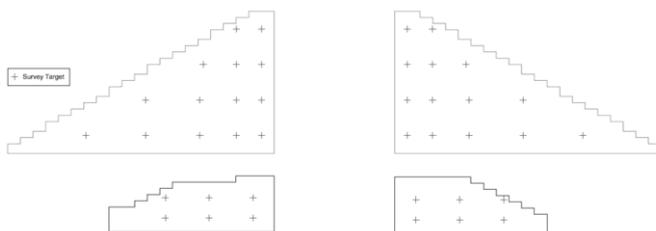


Figure 9: Monitoring targets to maintain records of performance

The TerraMesh™ retaining walls (17m high) adjacent to the concrete structure have been placed well and the installation procedure followed was strictly according to the installation manual. Regular measurements by the surveyor have indicated the settlement and/or consolidation has been small and not enough to affect the aesthetics of the walls at this stage. The structure is now into the second six month phase, post construction but has as yet not become operational. So far no significant movement or change has taken place. The lower walls adjacent to the main wing walls have shown displacement

during construction which needed to be reconciled before new readings could be monitored for subsequent change. It is estimated that a slow and small amount of consolidation of the fill and insitu material should take place as the materials insitu and backfill used where of good quality. Compaction density test results are all above the designed minimum of 95% mod Aashto

5 CONCLUSION

Mining clients have expressed their appreciation for the added value of a custodian relationship in the projects described. Custodianship-“is defined as a person who takes responsibility or looks after...” Because Maccaferri has diversified internationally it was considered necessary to offer a service that satisfies the client’s need of ongoing reassurance, thereby providing confidence that the asset is monitored by the same systems that supplied the materials and performed the engineering design of the structure. Because the assets performance is evaluated and maintained as recommended by the designer, it demonstrates good governance by the incumbent mine management which has formulated a common mining industry motto.

Assistance to the consultants during the design process and construction supervision creates a strong relationship of shared interest in the well being of the project. The technical training and site staff from labourer – foreman – site agent and site engineer, also creates and develops a skilled team that work towards a common goal.

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