



ATS11-03522

Concepts for handling changing muck properties caused by TBM excavation

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1. INTRODUCTION

It is a well known practice – most of the claims on tunnelling are due to unexpected geological conditions whereas in many cases where TBM have been used it should be clear that ground properties as described in the Geotechnical Baseline Report (GBR) are very likely to be changed during the excavation by the TBM. So a contractual line has to be drawn between the term unexpected ground conditions and expected permanent changes of muck properties caused by the TBM.

From a contractual point of view it is very important for both sides – owner and contractor – to have the best assessment on the ground properties in the GBR which have been gained from traditionally quasi-static exploration tests in the laboratory. However, the excavation and mixing of the ground in the working chamber of a TBM is far away from being quasi-static but are highly dynamic to chaotic why traditional soil mechanics have to be judged critical in this case. Quasi-static ground properties change under dynamic conditions due to the complex 3-phases system of the ground (solids, water, air). The economic prediction of the TBM performance and efficiency of a tunnel project is mainly depending on these ground properties changes because they determine geotechnical phenomena like clogging, abrasion and face stability which are most important for the contractor's assessment. Furthermore he has to predict the penetration of the cutting tools into the face which again is a highly dynamic process.

Since every TBM is unique and furthermore the human factor during operation of the TBM comes into

play a generalization on how it will react on geotechnical phenomena can not be made. But the client has to expect from the contractors who are bidding on his project that they are aware of the ground property changes during excavation of the TBM and the associated phenomena. Therefore fundamental practical experiences of the contractor on how the ground will behave under dynamic conditions are the most important base for a realistic prediction of TBM performance and efficient TBM application.

2. GEOTECHNICAL PHENOMENA IMPACTING TBM TUNNELLING

Both systems ground and TBM are at the same time two fascinating and very complex systems that have to be understood each separately by practical experiences as a base for assessing, planning, designing and consulting on TBM tunnelling. Traditional soil mechanics are pretty well understood within quasi-static ground conditions. In contrast to that TBM tunnelling happens under highly dynamic to chaotic conditions at the tunnel face and in the working chamber. Therefore approaches of assessing the dynamic interface reactions between ground and TBM on the base of traditional quasi-static soil mechanics should be questioned. The geotechnical phenomena which have important impact on the performance of a TBM are:

- clogging
- face/ground-stability
- wear and tear
- ground-water flow
- electro-chemical loadings in the ground
- convergence

These geotechnical phenomena have to be predicted on the base of the GBR by the contractor who has to give his best price estimation on how to handle them