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Corrosion Attack Mechanisms of Acid Mine Drainage on Concrete

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Acid Mine drainage (AMD) is currently one of the biggest socio-economical threats to environment, infrastructure and health in the Gauteng and Mpumalanga provinces. AMD forms because of contact between groundwater (oxygenated water) and mineral pyrite (FeS_2), found in the both coal and metal mine shafts and tunnels. Resulting from the uncontrolled groundwater flowing through abandoned mines, formation of AMD has been accelerated and now poses a serious problem as it overflows to the surface through the openings.

The purpose of the study is to determine and understand the mechanisms of AMD attack on concrete. Field conditions are recreated in the laboratory to determine the mechanisms of the attack. AMD from coalmine (TDB with pH=3.5) and gold mine (WZ with pH=3) are used in the experiment to assess their different characteristics and deteriorating effects on concrete. During the experiment different concrete mixtures; namely; Ordinary Portland Cement (OPC), Fly Ash and Ground Granulated Blast-Furnace Slag (GGBS) are used.

Two full types of experiments were conducted; immersion test in the laboratory and partial immersion test in the field. In full immersion test concrete core and prism are immersed in AMD, Sulphuric acids, sodium sulphide, iron sulphide (3000mg/l at pH=2.5) and water. During the experiment, change in length and weight is monitored to determine expansion.

Figure 1: AMD overflow into a wetland and stream in Witbank coal fields.

X-Ray Diffraction (XRD), Scanning Electron Microscope (SEM) and Petrography were later performed to determine the mineral composition of the deteriorated concrete tests.

Early results show that the pH increases faster with AMD from TDB than AMD from WZ, although the latter has more deteriorating effects on concrete. In the initial stages of the experiment, cracking of concrete was visible, indicating acid attack. Further increase in pH resulted in sulphate attack indicated

by either white or orange precipitants, depending on concrete mixture. Cracking and precipitation contributes to expansion of concrete. Sulphate attack can be visually seen by a white substance on concrete, as seen in Fig 1 along the AMD track. Further work is on-going to improve and optimise the system prior to field demonstration studies.