

STUDY ON MULTI-GALVANIC SOURCE TRANSIENT ELECTROMAGNETIC RESPONSE FOR AHEAD GEOLOGICAL PROSPECTING IN TBM-EXCAVATED SUBWAY TUNNELS

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To prevent water inrush and the resulting sinking or collapsing of urban surface during excavation of subway tunnels, there is an increasing need for an effective geological forward-prospecting method that can locate the water bearing body ahead of tunnel face. For subway tunnels excavated utilizing Tunnel boring machine (TBM), transient electromagnetic method (TEM) suffers limitations including: a) narrow and limited space for configuring the measuring system of TEM; b) strong electromagnetic interference of the eddy current from metal components of TBM. To overcome these limitations, we present a solution called Multi-galvanic source TEM for TBM tunneling, which including: a) replacing the transmitting loop with transmitting electrodes installed on the cutter head to realize galvanic excitation of transient electromagnetic field; b) using measuring electrodes installed on the cutter head to measure secondary electric components instead of measuring magnetic components utilizing receiving loop; c) applying multi-galvanic source excitation to enhance radiation energy and the signal to noise ratio (SNR). We present this study as a primary research to indicate the multi-galvanic source transient electromagnetic response, and for the further research on TEM forward-prospecting in TBM tunnels. Numerical simulations achieved by a 3D finite difference time domain method (FDTD) indicate that a) the secondary electric components suffer less TBM interference than the time derivative of secondary magnetic induction; b) the special distribution of electric field receives tiny influence from the variation of distance between tunnel face and TBM cutter head, c) the application of multi-galvanic source can effectively improve the amplitude of secondary electric field.