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# EFFECTS OF VOID RATIO AND RATE OF MASS REMOVAL IN DEM MODELLING OF TUNNELLING-INDUCED SETTLEMENTS

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When tunnel excavations are carried out, the stress relief in the surrounding soil can cause ground settlements that may affect existing structures. As demonstrated by Bym et al [1], the discrete element method (DEM) has been shown to be suitable for the analysis of tunnelling induced settlements. It has been demonstrated that 2D DEM analyses are in reasonable agreement with the results of empirical and analytical methods, as well as centrifuge models. In the study by Bym et al [1], the tunnelling process is simulated by gradually removing a limited number of particles close to the centre of the longitudinal axis of the tunnel (out of plane direction in 2D simulations). They discussed choosing a rate of removal of 10 particles at a time. This was based on preliminary studies for which there is no published data. Similarly, the work of Marshall et al [2] presented results comparable to centrifuge model experiments in which tunnel construction was simulated using 2D DEM by removing an area equivalent to the tunnel diameter in a single time-step. This is an approach followed by other researchers. Although the work in [2] considered some of the effects of initial density on ground movements, the work in [1] was limited to a single initial density. This work therefore attempts to fill the gap left by these two studies by considering both different initial densities as well as different rates of particle removal.

A set of DEM simulations to study the tunnelling-induced displacements were performed. Multiple rates of soil removal were used to assess their effects at different initial void ratios in terms of ground deformation magnitude and mechanisms relate to the line-sink. Removal rates were modified by systematically varying the amount of particles removed at a single time step, from less than tens of particles (as in [1]) to hundreds (equivalent to the approach in [2]). Similarly, a range of initial void ratios was considered to assess its influence on tunnel-induced ground movements. Some of the results show that a modified Gaussian distribution of ground surface movements is more accurate than other existing empirical and numerical solutions currently used by geotechnical engineers and designers.

## REFERENCES

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