Applications of digital ground models to support the maintenance and upgrading of rail infrastructure

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The development of digital conceptual and observational ground models has become more widespread over the last few years. This paper describes the construction and use of a 3D geological model for the Leeds-York North Trans Pennine Electrification project (TPE), which was created by the British Geological Survey (BGS) and commission by TSP (Technical Solutions in Partnership). The model covers 28 km of railway line and represents the bedrock and superficial geological units to a depth of 30 m below track level. It was created using BGS's cross-section based methodology (GSI3D) utilising high resolution LiDAR data and 1:10,000 scale digital geological map data. Of the 804 borehole and pits available in the area, 102 borehole logs were used in the model, however, they were generally clustered, of variable quality and, in some areas, sparse, which provided a particular challenge for the modelling process.

The bedrock geology along the route includes the Carboniferous Pennine Coal Measures Group, Permian Zechstein Group and Triassic Sherwood Sandstone Group. In the east of the area, the bedrock is concealed beneath thick superficial deposits associated with the Devensian glaciation. The final conceptual ground model (CGM) shows the top and bases of the bedrock formations, namely the Pennine Coal Measures Group coal seams and sandstone units, the superficial units including the likely upper and lower depths of weathered bedrock and artificial ground such as railway embankments. Geological faults were defined as separate surfaces, with the modelled bedrock units displaced across them. Two major hazards associated with the geology were identified: dissolution of gypsum within the Permian mudstone of the Edlington and Roxby formations and mine workings r were not modelled but were included in the associated report.

The model was delivered in CAD format and 3D pdf, as required by the client, with an accompanying report including the limitations of the model and its recommended uses. Major challenges with projection systems and delivery in CAD compatible format were overcome so the model complements the client's work streams. The main purpose of the work was to assist in the selection for electrification mast foundation (deep or shallow) types for the route. The model was also used to identify areas where intrusive ground investigation was needed.

The model and associated assurance document have been used to inform geotechnical decisions during the option selection stage of the Trans-Pennine Route Upgrade (TRU) line speed increase scheme. This raised the issue of how could the existing model be developed for use in understanding the new geotechnical design requirements? This development will be described in this paper and how a model produced by separate organisations can be assured.

This paper describes future ambitions of both organisations regarding ground modelling, data integration and assurance. An important aspect of the assurance process is to communicate how the model can be used by different parties (client, contractor and designer). When these developments are communicated clearly, they can be used to reduce programme risks and project duration by increasing productivity in construction. It also forms a part of the sub-surface BIM requirement.