BLAST EFFECT ANALYSIS OF EARTH COVER BUILDING STRUCTURE CONSIDERING STRUCTURE – SOIL INTERACTION

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Abstract: Earth Covered Buildings (ECB) are Protective Structures utilised for storage of Explosive Ordnance (EO) pallets and containers, with an external earth covering, and a hardstand to assist with receipt and dispatch activities. The design of the ECB is typically to prevent the occurrence of a Maximum Credible Event (MCE) at a Potential Explosive Site (PES) transferring to an adjacent ECB at an Exposed Site (ES). To achieve this, the ECB design prevents subsequent sympathetic detonations from occurring in neighbouring ECBs (the 'receptor' ECBs). For the ECB design, Explosive Safety publications such as eDEOP101, AASTP-1 typically nominate prescriptive blast load parameters for the design of the ECB structure (ES), i.e., headwall, sidewall, rear wall, and roof structure to be representative of the blast hazard at the ES from the explosion at an adjacent ECB (PES).

In this study, Computational Fluid Dynamics (CFD) analysis will be utilised to capture the blast load parameters on the surface of a generic template reinforced concrete box ECB structure and surrounding soil layers from the explosion of the adjacent ECB to compare with the prescriptive blast load parameters nominated within the Explosive Safety publications. The equivalent blast pressure and impulse predicted by the CFD simulation are then used in the blast effect analysis of the ECB structure by using Single Degree of Freedom (SDOF) Analysis or Finite Element Analysis (FEA). Typically, the mass of the soil layer above the roof structure is considered in the SDOF or FEA analysis to account for its inertia resistance; however, it is typically not taken into consideration in the analysis of the sidewall and rear wall. Additionally, the effect of the soil stiffness and the soil–structure interaction during the blast event is normally not considered in those analyses. Although those analysis assumptions would provide conservative design outputs, the actual blast performance of the ECB structure is not accurately represented from the analysis results. Furthermore, the EO Safety publications do not have a clear and consistent set of requirements for what load parameters to apply to the rear wall when it is covered by the soil barrier. Therefore, in this study, the blast performance of the ECB structure with, and without the surrounding soil layer will be investigated by using High-Fidelity Physics-Based (HFPB) Finite Element (FE) analysis. The influence of the equivalent prescriptive load distribution applied to the soil surface with the soil response will characterise the actual load applied to the ECB structure. The contribution and effectiveness of the soil layer in resisting the blast pressure will also be extensively examined in this study by undertaking numerous parametric studies on its stiffness and thickness.