# NUMERICALLY BASED MODELS OF PRESSURE AND IMPULSE DENSITY INSIDE A TUNNEL WHEN EXPLOSION IN TUNNEL MOUTH

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The Swedish Fortifications Agency design rules for protective structures [1] is a collection of design rules and guidelines for the protection of buildings or other structures to resist weapon effects. A special interest lies in the area of blast mitigation in tunnel systems, since underground fortifications in most cases are connected to the outer world by a tunnel. The design rules are mostly based on old knowledge from tests and analyses done during the early era of the cold war, but also more recent work has been used to verify the calculation models [2], [3]. Unfortunately, some uncertainties have been found in the calculation model for the impulse density inside a tunnel for explosions outside the tunnel or in the tunnel mouth. Apollo Blastsimulator – a CFD (Computational Fluid Dynamics) code developed by Fraunhofer EMI for simulations of explosions and blast waves – has been used to clarify if the numerical simulations give the same results as the existing equations.

This paper will present numerically based models of how the pressure and impulse density in a straight tunnel is depending on the loading density (quantity of high explosive and tunnel geometry), for tunnels that are open in both ends as well as tunnels with one end closed.

[1] *Fortifikationsverkets konstruktionsregler FKR* (2011). Fortifikationsverket, Eskilstuna, Sweden

[2] Dalenius, R., Berglund, R., Carlberg, A., Forsén, R. (2012), *The Swedish Tunnel Trials – An Overview*. Proceedings of 22nd MABS, Bourges, France

[3] Forsén, R., Berglund, R., Carlberg, A., Dalenius, R., 2012, *The Swedish Tunnel Trials – A Comparison Between Tests And Calculations*. Proceedings of 22nd MABS, Bourges, France