Abstract— The damage of human body inside a tunnel is estimated in this study. By using finite element analysis, a peak pressure is estimated inside the tunnel. By using Probit regression model, the damage of human body inside the tunnel is estimated.

Keywords— Damage, Tunnel, Probit regression

I. INTRODUCTION

Predicting the peak pressure is important in designing protective structures. In case of free field burst, several researchers have suggested an equation for predicting the peak pressure based on a scaling law. However, these prediction is underestimated and used in specific cases (i.e. free air blast with small scale).

In case of the detonation outside a tunnel, estimating the peak pressure inside the tunnel after the breach of blast proof door is important to understand the blast propagation phenomena inside of the tunnel. The peak pressure and blast propagation phenomena can be used in estimating the damage of human body inside the tunnel.

In this paper, the damage of human body inside the tunnel is estimated by using finite element analysis.

II. SIMULATION

70 kg TNT detonation with 20 mm thick blast proof door is simulated with LS-DYNA [1]. Figure 1 shows the simulation model. The measured peak pressure is used in estimating the weight of the effective TNT mass after the blast proof door absorbs the blast energy. Combining the measured model and two pressure propagation model (spherical and plane), the peak pressure inside the tunnel is estimated [2,3].

Fig. 1 Simulation model.

A. Probit Estimation

Probit regression model is used to estimate the damage inside the tunnel. Two Probit numbers (injury and death) are converted to the damage
percentage. The numbers are estimated with peak overpressure ($P_o$) shown at below [4]. Figure 2 shows the damage estimation of 70 kg TNT detonation.

\[
\text{Probit}_{\text{death}} = -77.1 + 6.91\ln(P_o) \quad (1)
\]

\[
\text{Probit}_{\text{injury}} = -15.6 + 1.93\ln(P_o) \quad (2)
\]

Fig. 2 Damage estimation of 70 kg TNT detonation

\section*{III. CONCLUSION}

The damage of human body inside a tunnel was estimated. By using finite element analysis, a peak pressure was estimated inside the tunnel. By using Probit regression model and the predicted peak pressure, the damage of human body inside the tunnel was estimated.

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\section*{REFERENCES}


