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An application of A Multi-layer Zone Model to A Tunnel fire

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ABSTRACT

In this study, a new zone modeling approach, which we call a MLZ model, is addressed to predict vertical distributions of temperature and chemical species concentrations in a tunnel fire. In this model the space volume in a tunnel is divided into an arbitrary number of areas and layers as the control volumes, and the physical properties, such as temperature and species concentrations, in each layer of each area are assumed to be uniform. The boundary walls are also divided into segments in accordance with the layer division and the radiation heat transfer between the layers and between the layers and the wall segments are calculated, as well as the convective heat transfer between the layers and the wall segments. This model still retains the advantage of zone models in terms of computational loaded so is expected to be useful for practical applications associated with fire safety design of tunnels. The calibration and verification of the model against an experiment with small tunnel facility are presented, then predicted temperatures generally show satisfactory agreement with the experiments.

1. INTRODUCTION

Recently, computational fluid dynamics (CFD) models are applied to some major tunnels for designing fire protection and smoke control system [1]. They can calculate the temperature and velocity field and predict the smoke movement in the fire, throughout the domain of interest. Three-dimensional time-dependent equations describing the laws of fluid dynamics are solved numerically with the surface conditions specific to the problem. An advantage of the models is that they can predict detailed distributions of temperatures and velocities in the domain of interest. On the other hand, CFD models need tremendous CPU time. In a complicated case, it can be more than a couple of days for only 1 minute of simulation time.

The other methods available for predicting the smoke movement are zone models, which are used