A Decision Support Tool for Fire Safety Designers and Rescue Services

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Introduction

The multidisciplinary research project *Tactics and methodology to facilitate rescue operations during underground fires* (translated from Swedish) was initiated in 2012. Within the project, work is carried out by Lund University to develop a simple computer model; a decision support tool, which in its final version can be used by both fire safety designers in the design of underground systems, and by fire rescue services in the planning of rescue operations in underground environments.

BACKGROUND

For reasons related to environmental concerns, urbanization and optimization of driving distances and travel times, the number of road and rail tunnels has continuously increased during the last decades. In addition, the length of these transportations systems have increased, with the 24.5 km long Lærdal tunnel in Norway being one example, and the 50.5 km long Channel tunnel between France and the UK being another.

Nothing indicates that the development of these types of facilities will decrease in the future, which implies two things:

1. Fire safety designers will to a greater extent be required to verify different design solutions as a apart of the performance-based design of underground transportation systems, and
2. Fire rescue services will be required to plan and train for future rescue operations in underground transportation systems.

Approach

In order to meet with the topics addressed above, a computer model – a decision support tool – is currently being developed. The tool, which is developed in object-oriented Java, will in essence include four basic sub models:

1. A tunnel model
2. A fire model
3. An evacuation model
4. A rescue operations model

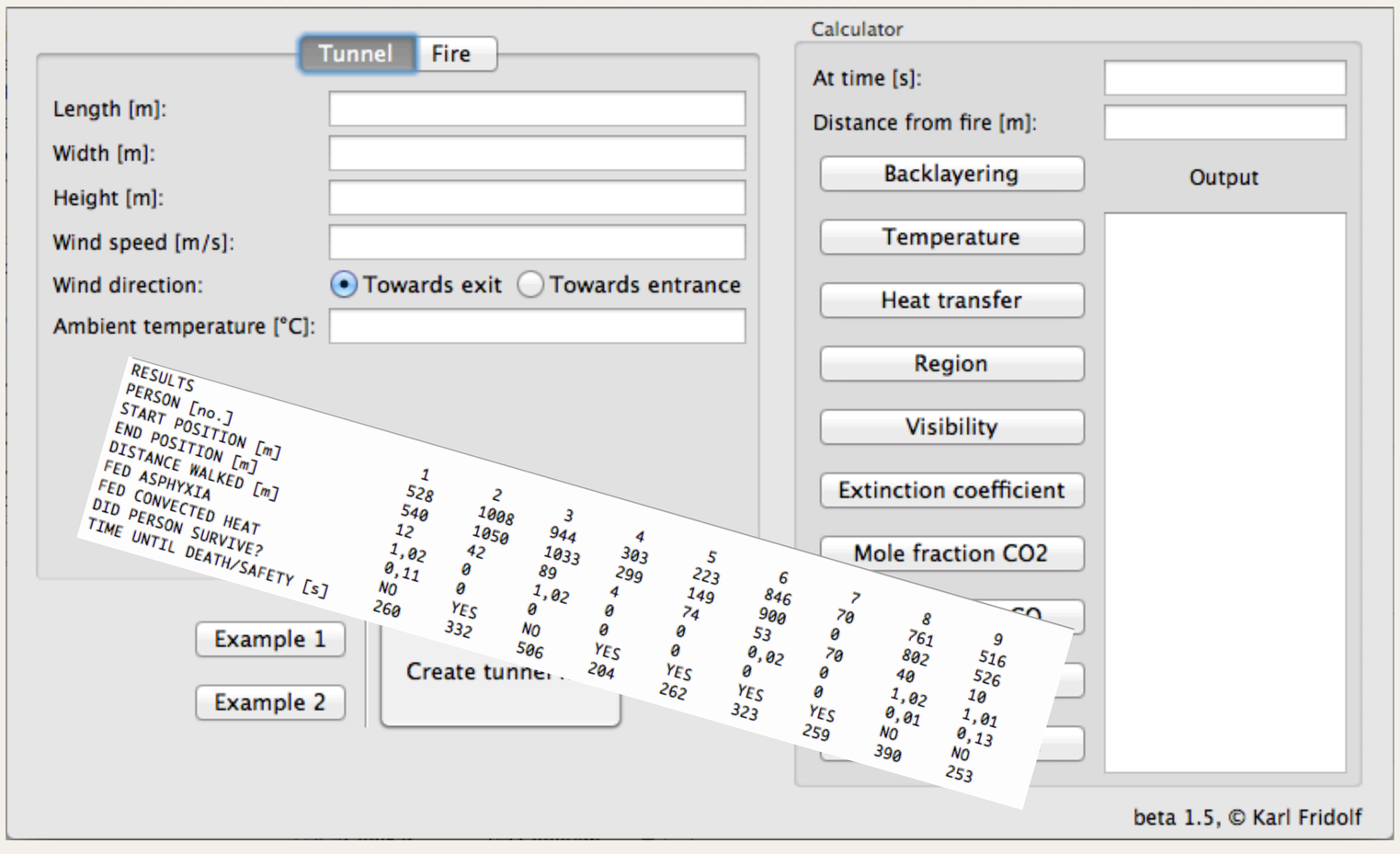
By defining a tunnel and fire, the user will be able to calculate various parameters related to fire dynamics in tunnels, such as backlayering distances, fire and gas temperatures, heat fluxes, visibility and mole fractions of different species, at any time and position in the tunnel both upstream and downstream the fire. The underlying equations used in the model are in essence based on the research performed by Dr. Ingason, summarized in Ingason (2012).

The equations are also used in the evacuation and rescue operations sub models, in which the user may choose to study either or both of the evacuation and the fire rescue intervention possibilities by defining, e.g., the number of evacuees and their positions in the tunnel, or the available fire rescue resources and knowledge about tactics. The tool then performs a simulation in which the evacuation and the fire rescue operations sub models in each time step calls for the necessary fire dynamic parameters.

Example and Output

In each time step (1 second), the visibility of all evacuees is evaluated in order to account for the eventual reduction of movement speed, which in turn affects the travelled distance in that time step. FED calculations, based on the equations by Purser (2008), are conducted at the position of each evacuee in the tunnel, and also estimated and evaluated in each time step and summarized over time. In terms of evacuation, and/or rescue intervention possibilities, output will be summarized in spread sheets and graphs as a support to the decision that is to be taken.

In summary, the tool will offer a relatively quick prediction of a defined fire scenario in an underground transportation system to be used as an alternative to more expensive and time consuming CFD and evacuation simulations.



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