

Preface

Fires in buildings, industrial plants, as well as in road, railway and underground tunnels are considerable threats for human safety. The importance of safety in road and railway tunnels and, more specifically, the concern for the risks associated with fires has grown after some recent tunnel disasters.

In this book the authors present the experience and discuss the results obtained during the experimental and modeling activities carried out within the research project “IMPROVED CFD MODELS FOR TUNNEL FIRE RISK ANALYSIS” promoted and funded by the Politecnico di Milano.

The project is the result of initiatives carried out in the field of enclosed fire dynamics and tunnel fire safety, tackling the problem from both a transportation engineering and combustion point of view. For these reasons, the activities saw the synergic cooperation of researchers of the transportation and chemical engineering departments of the Politecnico di Milano. Moreover, the project saw the active participation of public and private entities, such as *Corpo Valdostano Vigili del Fuoco* (fire fighters of Valle d’Aosta region) and the RAV company (Raccordo Autostradale Valle d’Aosta S.p.A.), which owns and operates the tunnel where the real scale tunnel fire experiments were performed.

In this book, the authors describe in detail how they planned, designed, organized and performed the experimental activity related to full-scale fire tests inside the Morgex North tunnel, a road tunnel actually in use on the A5 Aosta—Mont Blanc highway (Italy). The entire organization of the experimental activity, from preliminary evaluations to the solutions found for managing operational difficulties and taking into account potential safety issues are described in this book. Pictures, figures and tables containing the technical details are used to illustrate the activity and allow the reader to find advice on several technical and safety issues for both the infrastructure and workers involved, on how to manage them effectively and to develop appropriate policies and procedures.

This text is targeted at researchers and engineers involved in the field of safety engineering, in particular the modeling of tunnel fires dynamics and fire safety in tunnels, but also the design of safety management systems for both normal operation and emergency conditions resulting from a relevant fire event. These include,

for example, tunnel managers, emergency services, risk analysts, designers of plants and equipment, as well as students in the field of risk management and prevention and safety engineering.

The book has two main purposes. The first is to provide a detailed technical guidance on the organization of a controlled real scale tunnel fire test, specifically in the case of a tunnel which is normally open to traffic, highlighting the solutions adopted to effectively protect the tunnel infrastructure during the test while ensuring minimal traffic disruption.

The second is to collect all the experimental results related to the Morgex North fire tests in a single document with the complete details of the measured quantities and corresponding theoretical and modeling predictions. Hence, the complete fire test results are also discussed with particular attention to the evaluation of the fire heat release rate and the comparison of the values of temperature and pollutants composition, measured in several sections of the tunnel, with predictions made using semi-empirical models and CFD (Computational Fluid Dynamics) simulations. Gas concentrations and temperatures were measured both upstream and downstream of the fire, with the aim of investigating the effect of different emergency ventilation strategies on smoke backlayering and in general on the fire dynamics.

A peculiar aspect of the Morgex fire tests refers to the geometry of the tunnel and the characteristic of the accidental scenario: the presence of a bypass zone ahead of the fire region and an obstacle representing a semi-trailer located immediately downstream of the fire zone make this experiment a challenging test-case for CFD modeling of tunnel fires with longitudinal ventilation. Moreover, the Particulate Matter (PM) concentration and size distribution were measured and can be used to validate the combustion model of CFD codes with particular attention to PM formation and thermal effects.

In essence this book provides guidance to the reader on the following aspects:

- How to design a real scale fire test in a tunnel.
- Which kind of instruments can be used.
- Where to place the instruments and devices.
- How to protect these instruments from fire, thermal effects, smoke deposition, etc.
- How to protect the tunnel and its infrastructures and selection criteria for materials to be used.
- How to organize a rapid preparation and disassembling of the experimental setup.
- How to manage the safety issues and the presence of technical personnel and external observers.
- The impact of active ventilation strategies on fire dynamics with temperature and smoke composition analyses.
- Which is the accuracy of semi-empirical models and CFD simulations.

The book is organized into chapters and annexes as follows:

- Chapter 1 contains a general brief overview about safety in road tunnels.
- Chapter 2 illustrates the aim of this research project and the partners involved.
- Chapter 3 describes the tunnel geometry and the accidental scenario, and gives details on the preparation of the fire tests.
- Chapter 4 describes the results of the fire tests and the comparison with the predictions of semi-empirical correlations for tunnel fires and CFD simulations.
- Chapter 5 describes a methodology for the quantitative assessment of the severity of the fire consequences on the users safety.
- Annex A—Sections of encoded measuring instruments.
- Annex B—Selected experimental results of the Morgex fire tests.

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Tunnel Fire Testing and Modeling

The Morgex North Tunnel Experiment

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