INTEGRITY/ RELIABILITY/FAILURE

IN AUTOMOTIVE, LOCOMOTIVE, AEROSPACE, CIVIL ENGINEERING AND BIOMECHANICS

J.F. Silva Gomes
Shaker A. Meguid
Editors

Proceedings of the 6th International Conference on Integrity, Reliability and Failure, Lisbon/Portugal, 22-26 July 2018

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(2018)

IRF2018

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PREFACE

IRF2018 is the sixth international gathering of a prestigious series of Integrity-Reliability-Failure conferences coordinated by the International Scientific Committee of Mechanics and Materials in Design. This series of conferences are wholy devoted to advances in mechanics, materials, structural integrity and design. IRF2018 is jointly sponsored by the University of Porto, the University of Toronto and the Portuguese Society for Experimental Mechanics. The conference attracted over 200 participants with 258 accepted submissions involving 702 authors from 42 different countries around the world. The conference themes which address novel and advanced topics on Integrity, Reliability and Failure focused on Automotive, Locomotive, Aerospace, Civil Engineering and Biomechanics, including Computational Mechanics, Experimental Mechanics, Fracture and Fatigue, Composite and Advanced Materials, Tribology and Surface Engineering, Mechanical Design and Prototyping, Biomechanical Applications, Civil Engineering Applications, Energy and Thermo-Fluid Systems, and Industrial Engineering and Management, among other topics.

The conference also included an Open Forum on "*Can Professors Balance Scholarly Work, Teaching and Administration? The Challenges Going Forward*", where an expert panel with many years of collective and active researchers and educators addressed the issue of balancing the activities of teaching, research and services within the universities.

We believe that the meeting offered our delegates a forum for the discussion and dissemination of their recent work in assessing the integrity, reliability and failure of engineering structures, components and systems, fostered research that integrates mechanics and materials in the design process, and promoted exchange of ideas and international co-operation among scientists and engineers in this important field of engineering.

We are particularly indebted to the authors and special guests for their presentations. Each of the 258 contributions offered opportunities for thorough discussions with the authors. Particularly, we acknowledge the excellent contributions of the participants, their innovative ideas and research directions, the novel modeling and simulation techniques, and the invaluable critical comments. We are also indebted to the outstanding keynote speakers who highlighted the conference themes with their contributions and covered the main topics of the conference. We also take this opportunity to thank the members of the International Scientific Committee and the reviewers for their time and helpful suggestions, the symposia organisers for their efforts and valuable contributions to the success of the event, and the local organising committee for an absolutely superb organization of the meeting in this magnificent city. To all of you, we offer our gratitude.

Given the rapidity with which science is advancing in all areas related to the topics discussed in the present meeting, the next conference in this series (Integrity-Reliability-Failure / IRF2020) will take place in the beautiful city of Funchal/Madeira, in July 2020. Undoubtedly, we expect IRF2020 to be as stimulating and interesting as IRF2018, as evidenced by the excellent contributions offered in this current event. We look forward to seeing all of you in Madeira in July 2020.

Shaker A. Meguid and J.F. Silva Gomes
Lisbon / Portugal, July 2018

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FIRE DYNAMICS IN OPEN COMPARTMENTS

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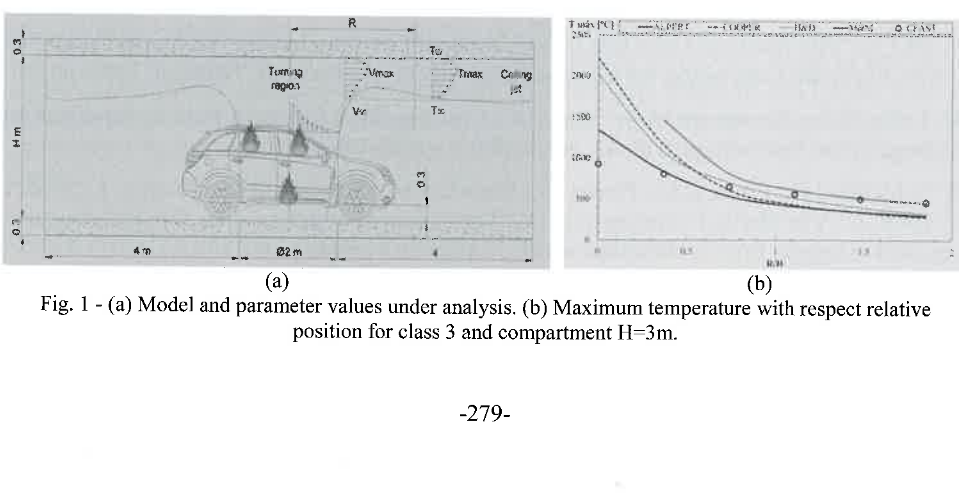
ABSTRACT

With the aim to increase fire safety in open compartments, such as open car parks, some correlative models were used to test the ability to recover both dynamics and thermal characteristics of a ceiling-jet flow. The flow occurs when the fire plume impinges the ceiling and develops in the radial direction of the fire axis. Both temperature and velocity predictions are decisive for sprinklers positioning, fire alarms positions, detectors (heat, smoke) position and activation times and back-layering predictions. This investigation deals with a parametric analysis using different fire events, fire scenarios and correlative formulations (Alpert, Cooper, Heskestad and Delichatsios, Motevalli and Marks). An advance calculation method (CFAST) based on a two zone model formulation was used to compare the results.

Keywords: open car parks, ceiling jet; correlative models, two zone models (CFAST).

INTRODUCTION

Fire events in car parks have been a major problem for buildings, vehicles and humans. The main causes for fire propagation are the combustible materials of the vehicles. The estimate time for fire propagation has been experimentally determined to be 12 minutes (D. Joyeux *et al.*, 2002) or 15 minutes between vehicles, according to the recommendation of European Convention for Constructional Steelwork (ECCS, 1993). A study revealed that approximately in 97% of the fires only 1 burning car was involved (Li Yuguang *et al.*, 2007). A statistical analysis showed that the car class is also important and 90% of the vehicles involved in fires are classified as class 1, 2 or 3 (Schleich *et al.*, 1999). The Building Research Establishment (BRE, 2010) developed a study of 3096 fire events for 12 years, where 51% started with the ignition of a car, but in most cases, no fire spread to other cars was identified. According to car fire experiments, most of the flames extend from the wind screens of the vehicles, describing a cylindrical plume zone with 2m on diameter, see Figure 1.



(a) (b)

Fig. 1 - (a) Model and parameter values under analysis. (b) Maximum temperature with respect relative position for class 3 and compartment H=3m.

Using 4 correlative models (Alpert, Cooper, Heskestad and Delichatsios, and Motevalli and Marks) and the software CFAST, a total of 48 simulation results were obtained taking into consideration 2 different heights for the compartment (H=3m and H=5m), 4 different car classes (fire events) and 6 radial positions (R).

RESULTS AND CONCLUSIONS

The results of the maximum speed and maximum temperature near the ceiling depend on the classes of the cars. From the results of velocity and temperature calculated by the correlative models, the maximum speed and the maximum temperature are obtained for the time equal to 25 minutes. The maximum speed and temperature values increase with the class of cars. In all cases, the maximum temperature and velocity decrease with the R/H ratio, as expected.

The model proposed by Motevalli and Marks presents higher maximum temperatures for all calculated R/H scenarios. When the R/H ratio increases, the results for the maximum temperatures of the other correlative models(Heskestad and Delichatsios, Cooper and Alpert) get closer.

Cooper's results for the velocity are usually in between the results of Alpert and Heskestad & Delichatsios. As R/H increases, the results of Cooper and Heskestad and Delichatsios approach to the Alpert's results. The model proposed by Motevalli and Marks has higher maximum velocity for all calculated R/H.

The velocity values obtained by the software CFAST are consistent with the results of the correlative models. For a compartment of H=3m, the results of CFAST for temperatures are also close to the results of the correlative models. With the increase of the classes of the cars, the results of the correlative models become higher in comparison with the values obtained by CFAST. For a compartment of H=5m, the results of the CFAST are generally higher than the results of the correlative models. The maximum temperature decreases for R=1, due to the transition position from fire plume to well established ceiling jet.

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About the Book:

This volume contains the extended Abstracts of papers accepted for presentation in the *IRF2018 - 6th International Conference on Integrity-Reliability-Failure* held in Lisbon/Portugal, 22-26 July 2018. The book is complemented by an accompanying USB-card containing the full length papers.

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