

# ICRAMCS 2026

THE EIGHTH EDITION OF THE INTERNATIONAL CONFERENCE ON  
RESEARCH IN APPLIED MATHEMATICS AND COMPUTER SCIENCE  
April 23-24-25, 2026 | Marrakech, Morocco



## Density–Stress Coupled Modeling of Pedestrian Evacuation Dynamics

### Communication Info

#### Authors:

Abdelkarim LAMGHARI<sup>1</sup>  
Aissam JEBRANE<sup>2</sup>

<sup>1</sup> LAMAI, Faculty of Sciences  
and Technics, Department of  
Mathematics, Cadi Ayyad  
University, Marrakech,  
Morocco

<sup>2</sup> Ecole Centrale Casablanca,  
Complex Systems and  
Interactions Research Center,  
Ville Verte, Bouskoura,  
Morocco

#### Keywords:

- (1) Pedestrian dynamics
- (2) Evacuation modeling
- (3) Crowd stress

### Abstract

Pedestrian evacuations in confined spaces exhibit nonlinear collective behaviors, including clogging, arch formation, and extreme pressure near exits [1,3]. These effects are amplified by stress, which alters walking speed and local interactions, impacting overall crowd dynamics [1]. Understanding the coupled influence of density and stress is essential for safety in high-occupancy infrastructures.

We propose a continuum framework where crowd motion is governed by a congestion-aware navigation field coupled with a density conservation law. Walking speed depends on both density and an evolving stress field transported by the flow and reinforced in bottlenecks. This formulation extends classical microscopic and continuum models [3,4] and recent multi-scale approaches incorporating emotional and collective effects [1].

Simulations reveal critical density–stress thresholds that trigger rapid congestion and pressure amplification, consistent with microscopic and macroscopic crowd force estimations [2]. The model provides a unified, mathematically consistent framework for analyzing stress-induced evacuation dynamics.

© ICRAMCS 2026 Proceedings ISSN: 2605-7700

### References

- [1] Lamrhary, Y., Jebrane, A., Argoul, P., Boukamel, A., & Hamdaoui, A., *A Coupled SFM-ASCRIBE Model to Investigate the Influence of Emotions and Collective Behavior in Homogeneous and Heterogeneous Crowds*, Collective Dynamics, 9, 2024, 1–29.
- [2] Jebrane, A., Argoul, P., Hakim, A., Rhabi, M.E., *Estimating contact forces and pressure in a dense crowd: Microscopic and macroscopic models*, Applied Mathematical Modelling, 74, 2019, 409–421.
- [3] Helbing, D., Molnár, P., *Social force model for pedestrian dynamics*, Physical Review E, 51, 1995, 4282–4286.
- [4] Hughes, R.L., *A continuum theory for the flow of pedestrians*, Transportation Research Part B, 36, 2002, 507–535.