CERIS Civil Engineering Research and Innovation for Sustainability

Behaviour of external wall and roof cladding systems for industrial buildings in case of fire

PhD student
Deives Junior de Paula

PhD program
Fire Safety Engineering (FCT, University of Coimbra)

Supervisor
João Paulo Rodrigues (FCT, University of Coimbra; CERIS, IST, University of Lisbbon)

Co-supervisor
Aline Camargo (FCT, University of Coimbra)

Period
2020-2024

Funding
PCIF/MOS/0129/2018 – InduForestFire - Interdisciplinary Methodologies for the Protection of Industrial Sites from Forest Fires

PCIF/AGT/0109/2018 – House-Refuge - Development of best practices and standards for buildings and their surroundings in forest fire risk areas

DSAIPA/DS/0088/2019 - AI-4-MUFF - Artificial Intelligence for the Management of the Degree of Readiness in Fighting Urban Fires

Summary

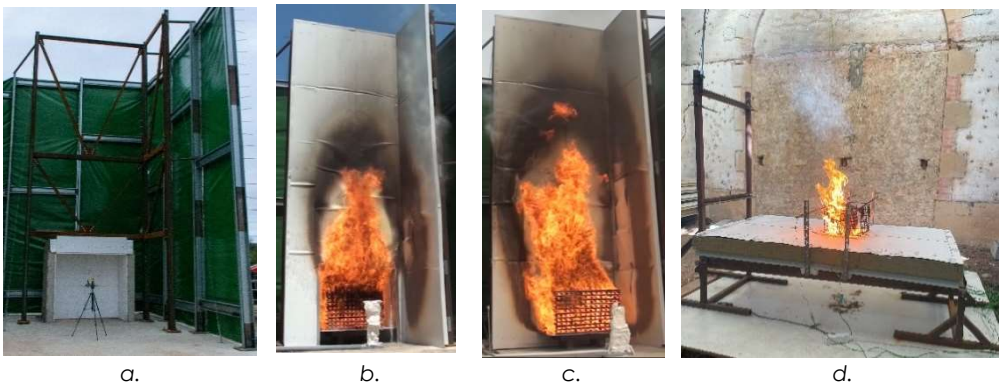
The catastrophic forest fires recorded in recent years in Portugal have highlighted the vulnerability of urban agglomerations and industrial zones located in forest areas. The 2017 fires significantly impacted the loss of human lives and infrastructures, particularly in industrial sites. Concerning the latter, there is an urgent need to understand what can be done to avoid the damage caused by large fires through scientific studies that allow us to know the phenomena associated with these damages. The main objectives of this research were to study the fire behaviour of external wall cladding and roof covering systems for industrial buildings, focusing on the systems and materials used in the construction or rehabilitation of these buildings, regarding of which solutions in terms of construction that hinder or prevent the start and spread of fire.

Concerning the external wall cladding systems, after a comprehensive review of mainly test methods for evaluating the fire behaviour of facades, the experimental setup was based on the BS-8414-2:2020 test setup (Fig. a). The experimental setup is designed to measure temperatures at two levels (4.5 m and 7.0 m height) during the test period and continuous observation of the specimen. The fire source is a wood crib with 250 sticks and 450 ± 25 kg of mass. The test program includes four different insulation core materials (mineral wool, polyisocyanurate, organic polymer and polyurethane), typically used in industrial buildings. These tests were carried out by modifying the fire source position from the facade wall, to compare its performance, including two typical fire exposure scenarios: Scenario A - fire load inside a building compartment (Fig. b) and, Scenario B - fire load outside the building stored close to an external wall (Fig. c). The walls' performance was checked according to BRE 135 Annex B criteria. The test results included the temperature profiles, temperatures in the exposed and unexposed side of the specimen, and incident radiant heat flux when the heat source was in the front of the specimen. Eleven real-scale tests were carried out in Vila Nova de Poiares Fire Brigade site, in Portugal. The action of an external fire source against the façade wall showed to be more penalizing for the tested walls than the action of the internal fire, which is an interesting result because this scenario is not yet considered in the standards.

For roof covering systems, were conducted bench scale experimental tests to evaluate the fire behaviour in these systems, in four different roof decking assemblies, each one composed of three layers: weatherproof, insulation board and trapezoidal steel profile sheet deck. The test method used to carry out the tests was Test 1 of the CEN TS 1187 standard, a burning brand test applied on the surface of the specimen, as presented in Fig. d. The extension of fire spread in external surface were measured and temperature profiles were recorded during tests at 10 mm near and surrounding the fire source and under the specimen. Fourty-six experimental tests were conducted, varying some parameters: position of joints in the specimen in weatherproof/insulation layers, installation slope and a supplementary wind on the specimen surface.

Keywords

Fire spread, faced wall, industrial building, cladding system, roofing system.



a. *b.* *c.* *d.*

Experimental Tests: Facade Tests (a, b and c); Roof Covering Tests (d).