Project No. 777595

Mat4Rail: Research on fire safe composite materials within the Shift2Rail programme

Fire protection of Rolling Stock 2018, Berlin 2018-03-01

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Content of presentation

- Shift2Rail: the research program
- Mat4Rail: the project
- Fire safety challenges of lightweight composites
  - Reaction-to-fire
  - Fire resistance
- Mechanical performance of composites
- Key facts and contact

Shift2Rail

A public-private partnership, a platform for the European rail sector as a whole to work together to drive innovation

- Manage all rail focused research and innovation actions co-funded by the Union
- S2R Undertaking created in 2014 and fully operational in 2016
- Long-term platform for research, until 2024

Shift2Rail

- **Members**: 8 founding members, 12 associated members, 7 associated members (consortia)
- **Budget**: 976M EURO (450M S2R-H2020 and 517M Railway sector)
- **Projects**: closed (members) and open (non-members)
- **Calls**: 2017 (112M; 93M+19M), 2018 (155M) – closing April 24

Mat4Rail in Shift2Rail

From the call for proposals in 2017:

- S2R-OC-IP1-01-2017: “Innovative materials & modular design for rolling stock applications”
  ➡ **Mat4Rail** (open call)
- S2R-CFM-IP1-01-2017: “Development of new technological concepts towards the next generation of rolling stock, applied to major subsystems such as Carbody, Running Gear, Brakes, Doors and Modular interiors”
  ➡ **PIVOT** (complementary project from closed call)

Mat4Rail

Designing the railway of the future:

Fire resistant composite materials and smart modular design

Background

- Europe’s railway industries require a step change in technologies and design for the next generation of rail vehicles to remain globally competitive.

- Available structural composites do not meet Fire, Smoke & Toxicity requirements of the railway sector.

- Innovative, energy- and cost efficient materials needed.

Project Objectives

- Reducing train weight by replacing metal parts with Fibre Reinfoced Polymers (FRPs)
  - Develop FRPs
  - Develop structural joints for FRPs
  - Innovate acces door system

Project Objectives

- Increasing capacity and passenger comfort via built-in modularity of train interior design
  -  Innovative plug & play system
  -  Innovative seats
  -  Innovative driver’s desk

Consortium

Mat4Rail
a Project of the S2R JU

cidetec
IK4 Research Alliance

Universität Bremen

ITAINNOVA

CENTEXBEL

RISE

AIMPLAS
INSTITUTO TECNOLÓGICO DEL PLÁSTICO

IMA DRESDEN

HUNTSMAN

coexpair

ASAŞ

NVGTR

spirit design
thinking the future

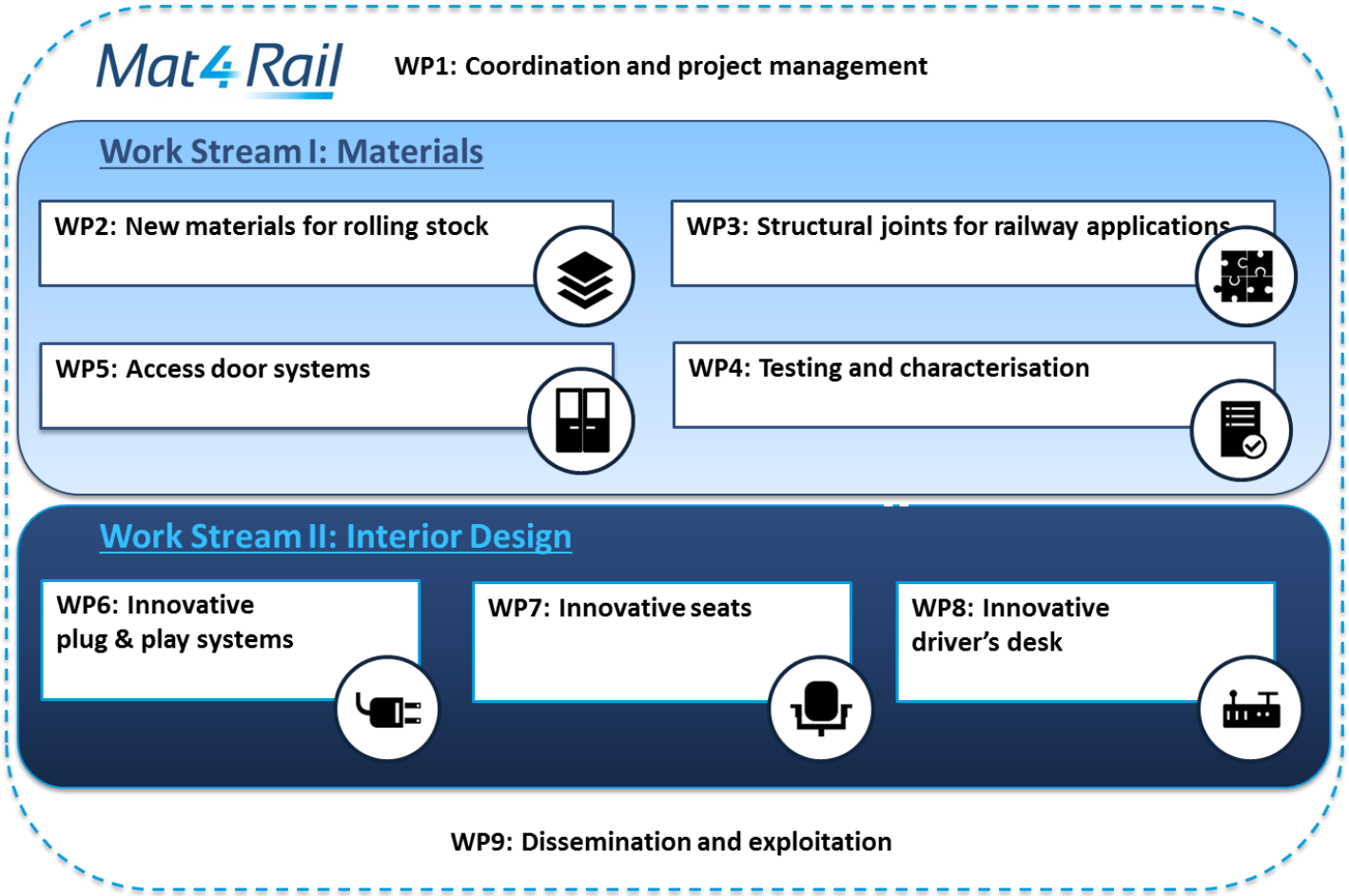
ESCATEC

GRAMMER

INDAT
INNOVATION

accelopment
takes you further

Work Streams



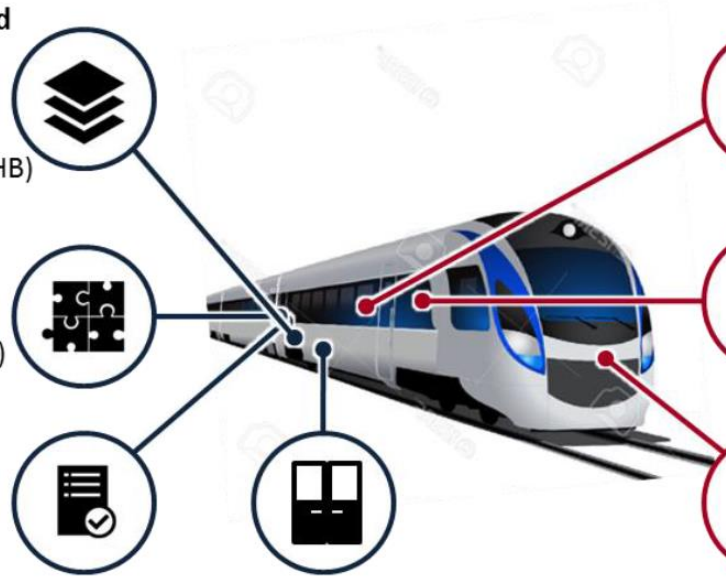
Research areas

Materials

Resin development, fibre selection and composite manufacturing
Benzoxazine resins (UNI-HB)
Epoxy resins (CIDETEC, AIMPLAS)
Fibres (CENTEXBEL)
Manufacturing (COEXPAIR, CIDETEC, UNI-HB)
Resin manufacturing (HUNTSMAN)

Joining technologies
Adhesive bonding (ITAINNOVA, UNI-HB)
Mechanical fasteners/connectors (UNI-HB)

Characterisation and testing
Load cases development (IMA)
Accredited FST testing (SP/RISE)
Mechanical Testing (IMA, SP/RISE, CIDETEC, UNI-HB, ITAINNOVA, AIMPLAS)



Access doors
Aeronautic doors (COEXPAIR)
Railway doors aluminium (ASAS)
Door leaves engineering (ITAINNOVA)

Interior design

Plug & play systems
Inductive charging (ESCATEC)
Design (NVGTR, SPIRIT)

Innovative seats
Design (NVGTR)
Textiles (CENTEXBEL)
Railway seat manufacturer (GRAMMER)

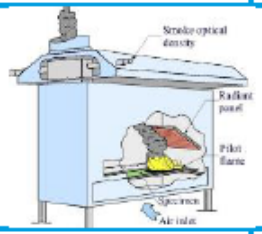
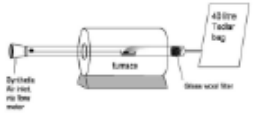
Innovative driver's desk
Design & Concept (SPIRIT)
Engineering (INDAT)

Reaction-to fire

Reaction-to-fire = the production of heat, smoke and toxic gases of a material/product

EN 45545-2, “Railway applications – Fire protection on railway vehicles – Part 2: Requirements for fire behaviour of materials and components”

Reaction-to fire testing in M4R

R-sets	ISO 5660-1 "Cone calorim-eter"	EN ISO 5659-2 "Smoke/Tox"	ISO 5658-2 "Flame spread vertical speci-men"	EN ISO 9239-1 "Flame spread horizontal spec-imen"	EN ISO 4589-2 "Oxygen index"	NF X 70-100-1,-2 "French tube furnace, tox"
R1, R7, R17	X (50 kW/m^2)	X (50 kW/ m^2)	X	-	-	-
R8	X (25 kW/ m^2)	X (25 kW/ m^2, with pilot flame)	-	X	-	-
R22, R23	-	X (25 kW/ m^2, with pilot flame) only smoke	-	-	X	X (600 °C)
R24	-	-	-	-	X	-
						
Sample size	100 x 100 mm	75 x 75 mm	800 x 155 mm	230 x 1050 mm	80-150 mm x 10 mm x 4-10 mm	1g

Fire resistance

Fire resistance = fire insulation, smoke and flame tightness and structural integrity of a construction

EN 45545-3, “Railway applications – Fire protection on railway vehicles – Part 3: Fire resistance requirements for fire barriers”

Fire resistance, design and tests

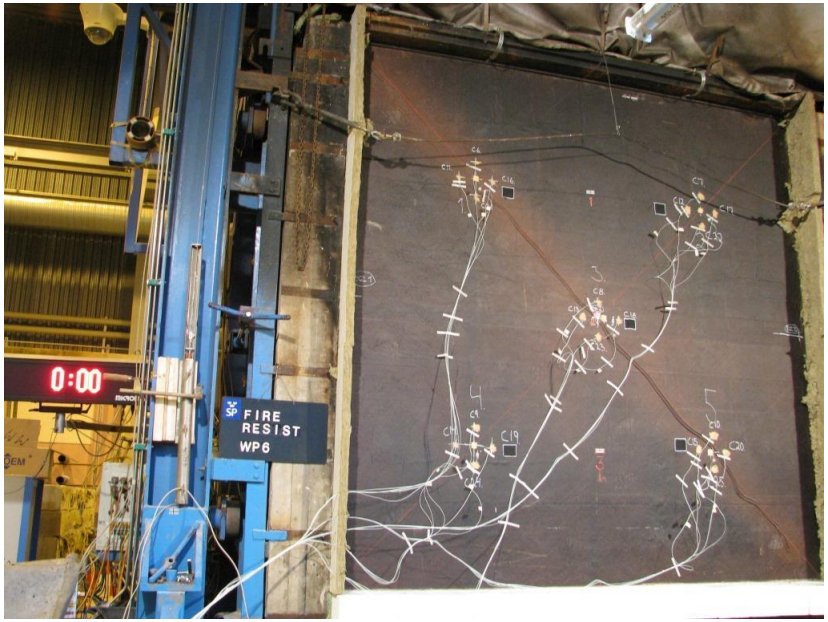
- ***Design** aspects with respect to fire resistance*

  Design concepts with respect to insulation and fire protection on the level of components for FRP materials and joints (mineral wool insulation, protective coating)

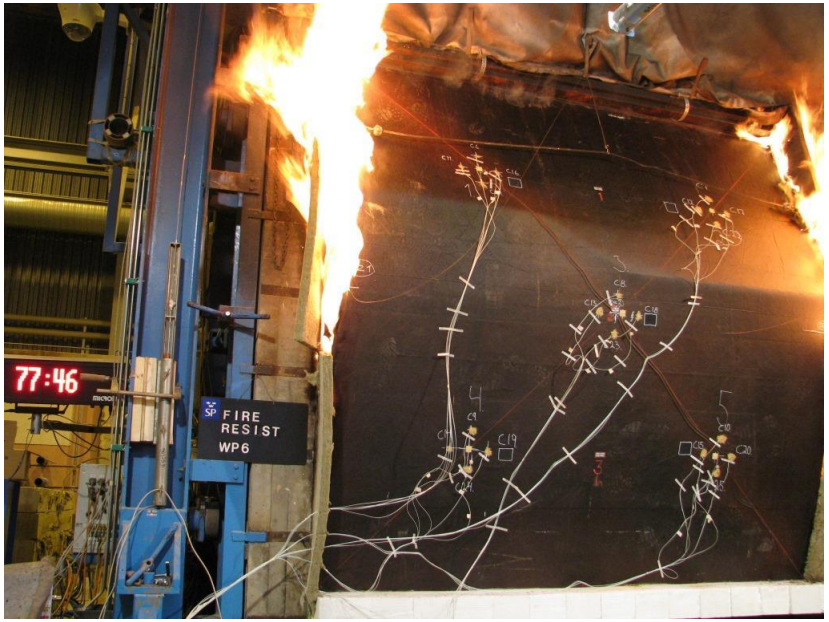
- ***Testing and demonstration** of fire resistance*

  Implementation of design solutions and tests to evaluate the fire resistance of FRP materials and joints applications

Furnace test (example)



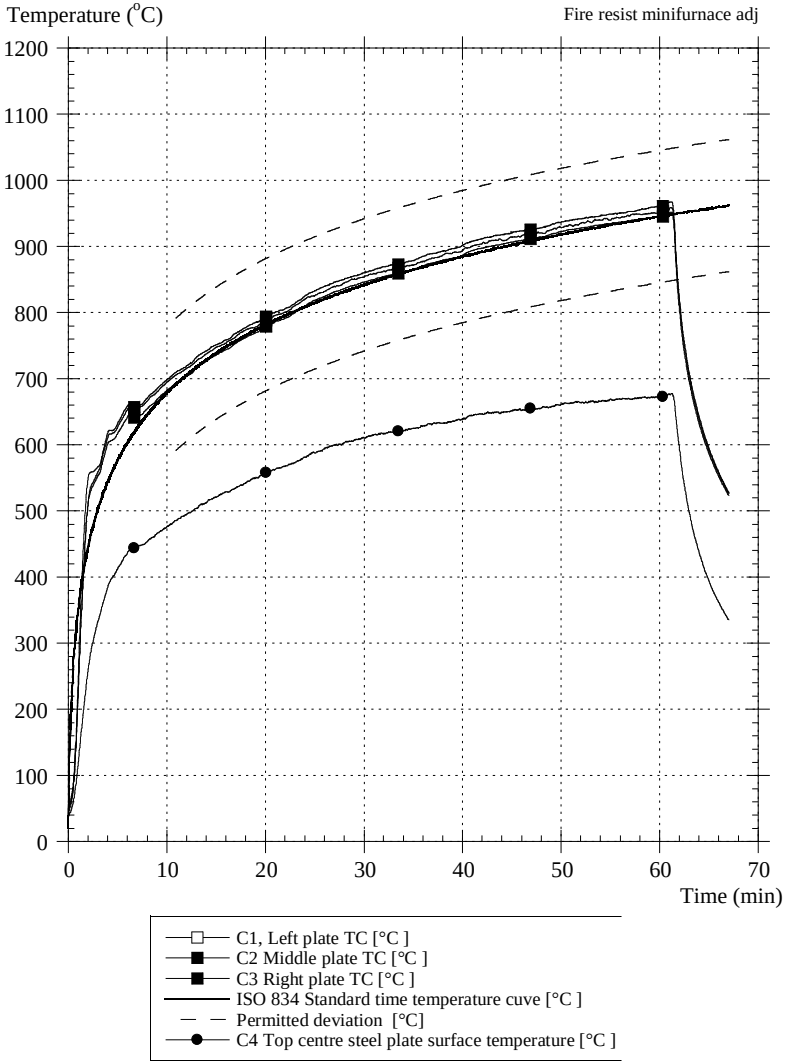
Example of full-scale fire resistance test with FRP sandwich wall construction



Integrity (E), insulation (I), and load bearing capacity (R) were all maintained for more than 60 minutes

M. Rahm and P. Blomqvist, "Fire testing on cork - furan/glass fibre sandwich panel for marine application", SP Report 2015:15

Reduced scale furnace in M4R



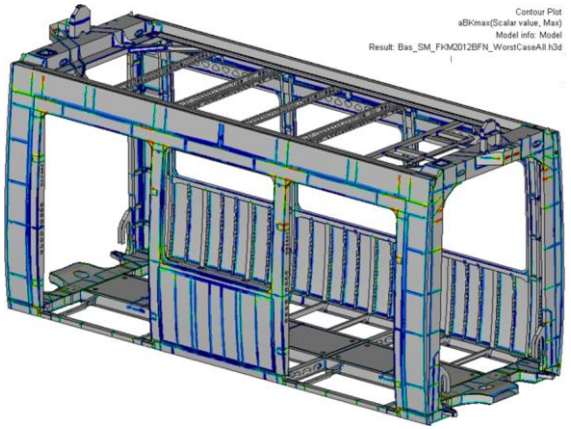
Mechanical properties

Development of design load assumptions for fatigue strength assessments from measurements

- Design loads are given in e.g. EN 12663 but are valid for metallic structures
- For new materials, e.g. composites, the knowledge of real load spectra is necessary
- Measurements, statistical analysis and finite element analyses are tools for acquiring local test loads

Contour plot of calculated forces on a car-body of a tram.

Rennert, R., Mieth, S.: A method for generation of synthetic service loads. In: 14. International Conference for Railway Vehicles, Dresden, 2015



Testing of mechanical properties

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Testing of mechanical **static** (tensile strength, shear strength, etc.) and **fatigue** properties

- FRP composites
- Joints
- Repairs

Test apparatus for mechanical properties.

Mat4Rail Key Facts

Funding Programme

Horizon 2020 / Shift2Rail Joint Undertaking

Duration

01.10.2017 – 30.09.2019 (2 years)

Budget

3.5 million euro

Project Website

www.mat4rail.eu

Contact

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Testing and characterisation (WP4)
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