CARBODIN
CAR BODY SHELL, DOORS AND INTERIORS

EAB meeting, January 17, 2022.

Conclusions and exploitation perspectives from an industrial point of view

Leader: ***MASATS*** (polis.karatzas@masats.es)
Partners: SMT, CGRAIL, and EUT.

Project coordinator: Fundació Eurecat
Project duration: from 01/12/2019 to 28/02/2022 (27 months)

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- **MASATS INTRODUCTION**
- WP5 – Modular tool design
- WP5 – Doorleaf FEM analysis
- WP6 – Door design solutions for improvement of thermal behaviour

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Why there is a need for composite doors in railway??

Weight: Aluminum alloys and other metallic structures have an isotropic "behavior" which prevents them from being completely optimized.

Thermal/Acoustic performance: The metallic structure serves a conductor through which heat is transfer from the exterior to the train interior and vice versa. Touching the door skins while inside the train one can feel this phenomenon. The use of foam reduces this effect but it does not eliminate it. The same applies for the acoustic performance and noise attenuation.

Manufacturing: The welding process used to manufacture the frames is tedious and often requires post-production operations that make the process less efficient

Corrosion: One of the most common problems in aluminum structures is corrosion. In many cases, water is trapped inside the doorframes, which in the long run causes corrosion.

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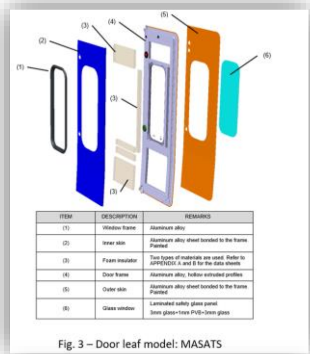
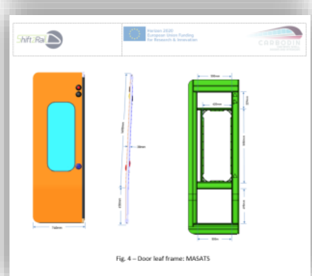
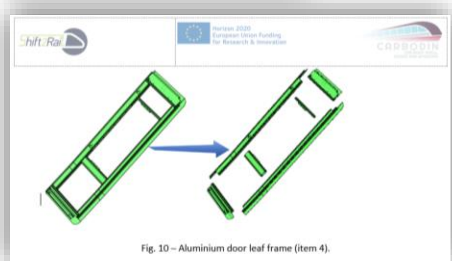
What we are looking for in the tooling design?







- develop a door leaf manufacturing process/technology accessible to the industry (composite materials).
- develop a tooling with high flexible for geometry changes adaptation to reduce the manufacturing cost. 3D technology will be used for inserts manufacturing (each train is different including repeat orders with the same train).
- reduce the NRC of the door leaf manufacturing process (making it versatile and flexible). The typical door quantity for a “big” project is around 400-600 doorleaves (in other words the quantity is quite low to justify a big expenditure in tooling)

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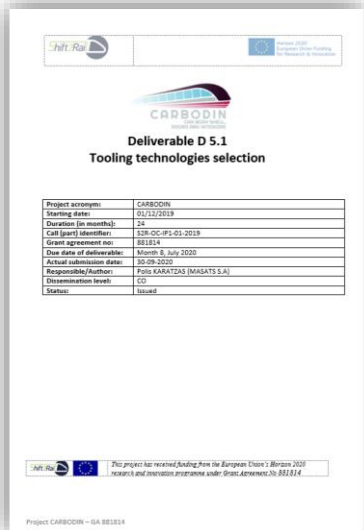

Deliverable D 5.1
Tooling technologies selection

Project acronym:	CARBODIN
Starting date:	01/12/2019
Duration (in months):	24
Call (part) identifier:	S2R-OC-IP1-01-2019
Grant agreement no:	881814
Due date of deliverable:	Month 8, July 2020
Actual submission date:	30-09-2020
Responsible/Author:	Polis KARATZAS (MASATS S.A)
Dissemination level:	CO
Status:	Issued

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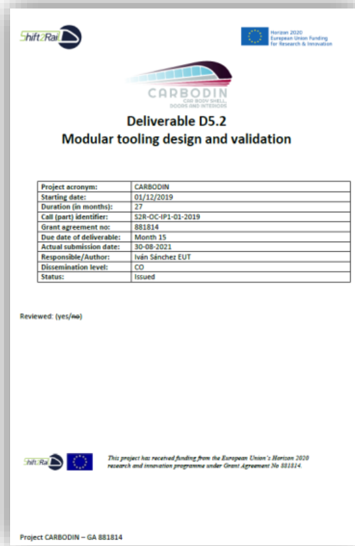
Project CARBODIN – GA 881814



Horizon 2020 European Union Funding for Research & Innovation

Deliverable D5.2
Modular tooling design and validation

Project acronym:	CARBODIN
Starting date:	01/12/2019
Duration (in months):	27
Call (part) identifier:	S2R-OC-IP1-01-2019
Grant agreement no:	881814
Due date of deliverable:	Month 15
Actual submission date:	30-08-2021
Responsible/Author:	Iván Sánchez EUT
Dissemination level:	CO
Status:	Issued

Reviewed: (yes/~~no~~)

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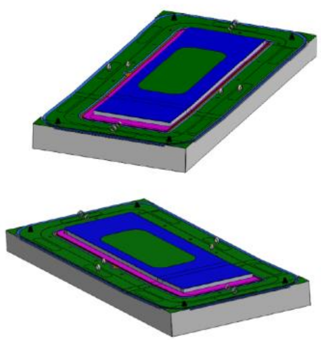

1. The final door design lead to the conclusion that a **"single step" process** can be employed in conjunction with an RTM method to produce a "realistic" door structure

2. The **modularity concept is achievable** through the combined use of 3D printed parts and specific mould design techniques. However, as already identified in D5.1, the **curvature of the doorleaf** seems to be a limiting factor in using "modular" manufacturing tools.

3. It is possible to achieve a significant cost reduction in the tool manufacturing thanks to the use of **mould holders** + **interchangeable headblocks** in the tool design (up to **29%** when compared to the manufacturing of 2 separate moulds)

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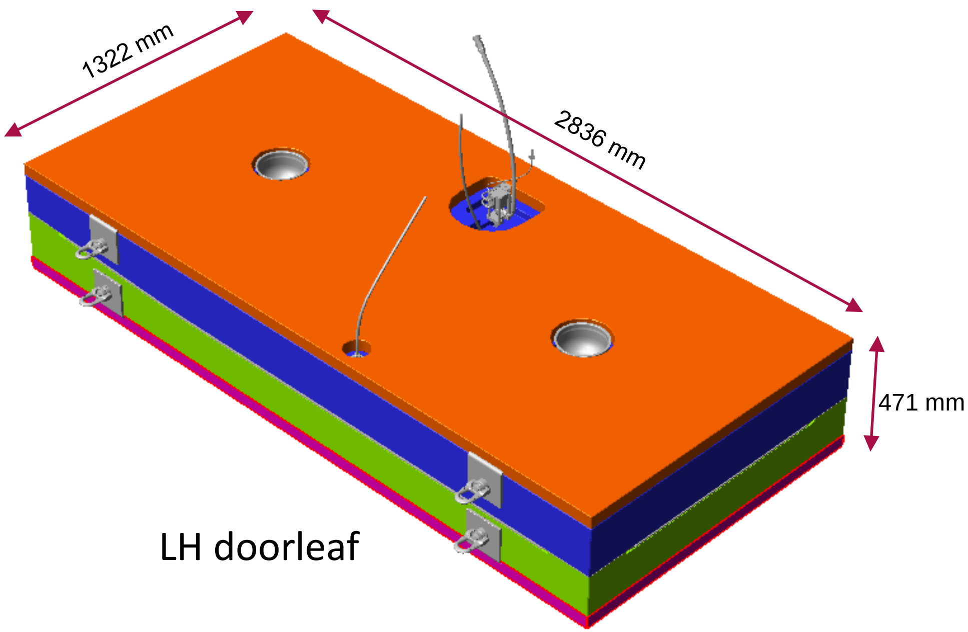
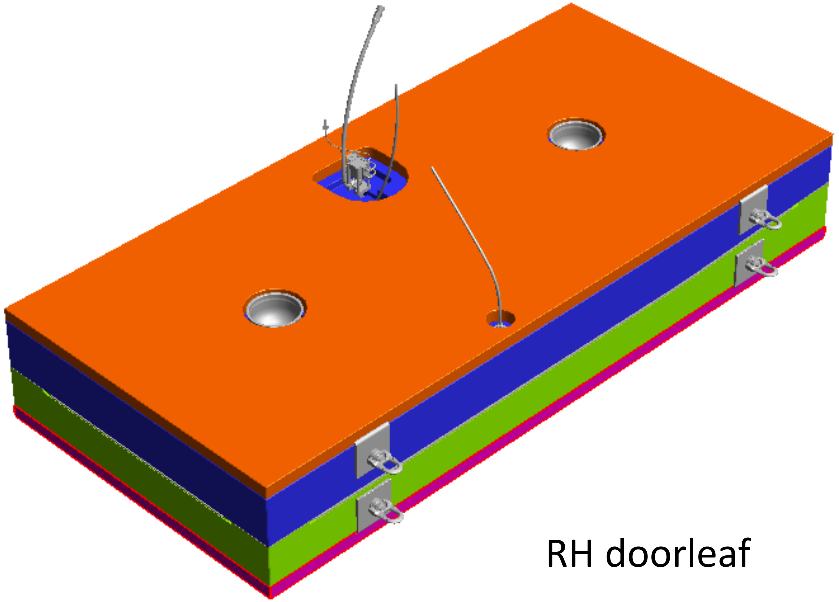
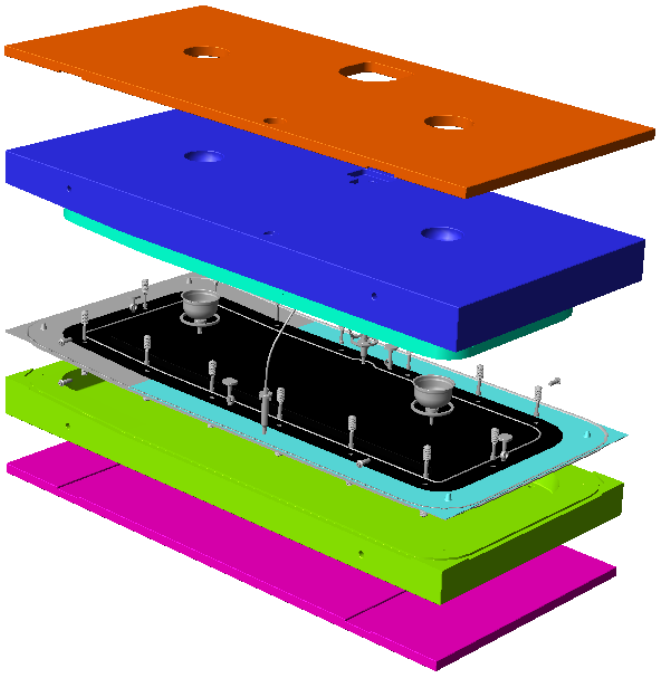
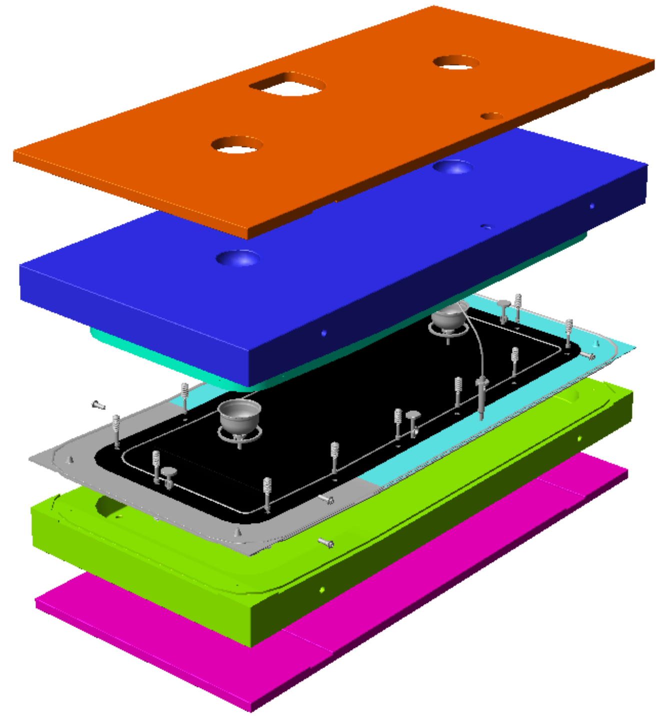

1322 mm
2836 mm
471 mm
LH doorleaf


RH doorleaf





- MASATS INTRODUCTION
- WP5 – Modular tool design
- **WP5 – Doorleaf FEM analysis**
- WP6 – Door design solutions for improvement of thermal behaviour

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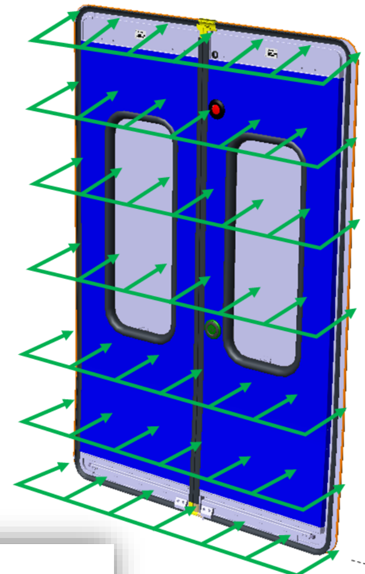
DESIGN CRITERIA		
ITEM	**VALUE**	**REMARKS**
OVERALL THICKNESS	40mm (max.)	
DOORLEAF WEIGHT	23-25 Kg	Without the window and door accessories.
LOADING CONDITIONS		Refer to the figures below
DISPLACEMENT	10-20mm	



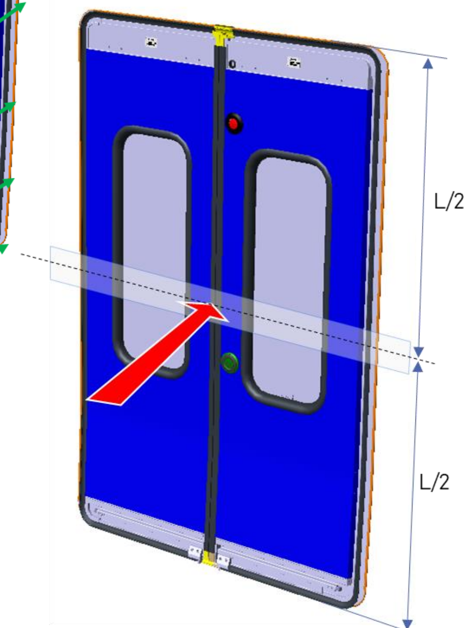
10.1 LOAD CASE

Pressure load was applied in the whole door area. Pressure value has been obtained taking into account REF. [1] . In this reference, the external static proof pressure load at 160 Km/h is 1900 Pa. This pressure load considers two effects:

- External wind pressure: 700 Pa
- Train velocity pressure: 1200 Pa

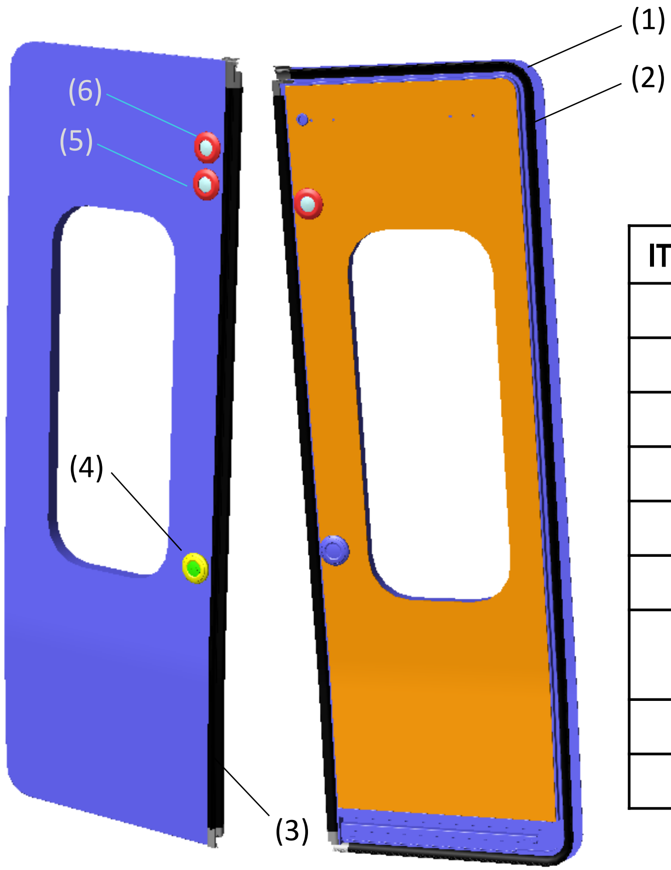
This external door is assembled in a train with a maximum velocity of 120 Km/h. The train velocity pressure is quadratically proportional to the velocity, so the external static proof pressure load at 120 Km/h is 1375 Pa as detailed below:

- Train velocity pressure: 675 Pa
- External wind pressure: 700 Pa

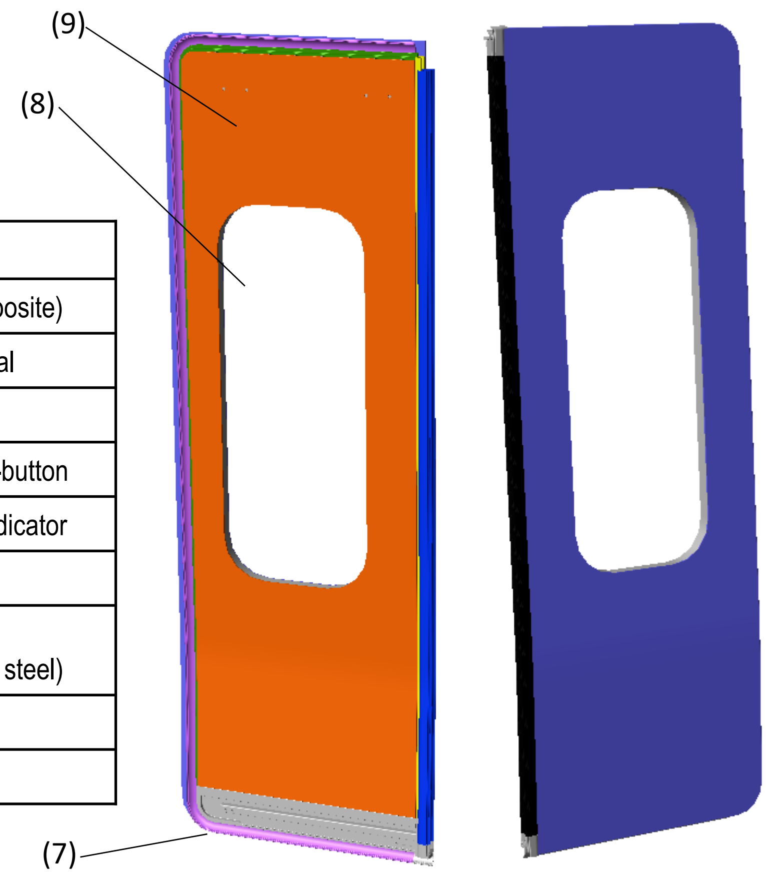


1. To be able to design the tool it was necessary to have at least a "realistic" door design as reference for the tool development. Due to lack of this information from PIVOT 2, the team developed internally a "quick" doorleaf model based on realistic design criteria of a doorleaf given by MASATS and an "estimation" FEM carried out by EURECAT.(refer to deliverable D5.2). SMT finalized this design.

Doorleaf design proposal



ITEM	DESCRIPTION
(1)	Door structure (composite)
(2)	Perimetral rubber seal
(3)	Central rubber seal
(4)	OPEN/CLOSE push-button
(5)	Door status visual indicator
(6)	Buzzer
(7)	Lower guide (aluminum+stainless steel)
(8)	Glass window
(9)	Fixing points



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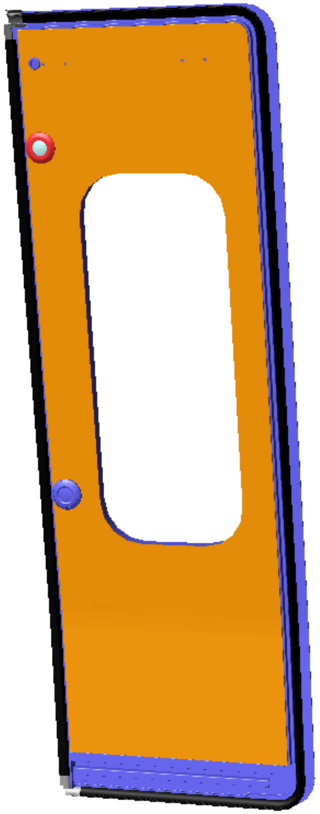

1. The use of composite materials in the door manufacturing can contribute to its weight reduction.

2. The use of carbon fabrics **significantly improves** the solution in terms of light weighting and stiffness.

3. The use of carbon fabrics enables the fulfilment of all the criteria.

4. The analysis indicated that an **internal reinforcing structure** is necessary in order to achieve an acceptable stiffness (i.e. maximum allowable displacement).

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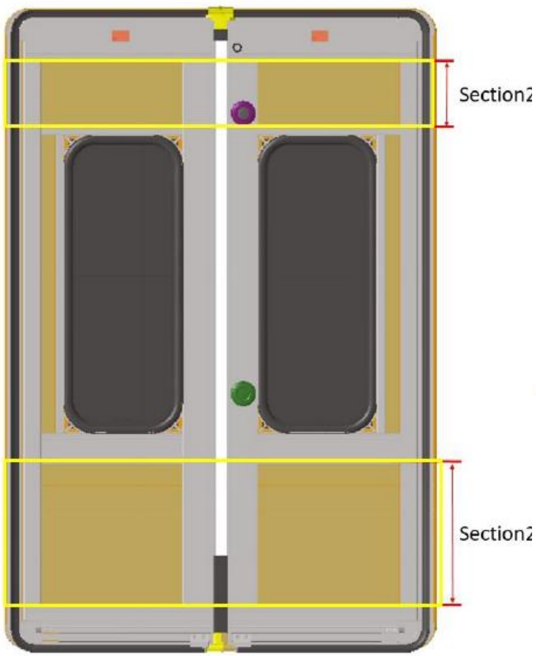
Comparison analysis: Material proposal



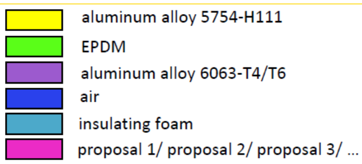


Fig. 12: Original materials in section 2; view 1

Fig. 13: Proposal materials in section 2; view 1

1. The thermal analysis comparison and material proposal was carried out by DESART within the scope of WP6

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Thank you for your attention!

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