Development of an Innovative Insulation Fire Resistant Façade from the Construction and Demolition Waste

DEFEAT

INTEGRATED/0918/0052

DELIVERABLE D6.3

MATERIAL DATA SHEET WITH THE MOST CRUCIAL PROPERTIES

Acknowledgements

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PROJECT INFORMATION

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1	08 March 2023	Ioanna Giannopoulou (FRC)	Preparation of the template and data addition
2	06 April 2023	Marios Valanides (RECS) &	Addition of data and photos of prototypes
3	25 April 2023	Demetris Nicolaides (FRC) Pericles Savva (RECS)	Review of the document
4	26 April 2023	Ioanna Giannopoulou (FRC)	Final version with integration of the Reviewers' feedback

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EXECUTIVE SUMMARY

The Deliverable "***D6.3- Material Data-sheet with the most crucial properties***" deals with the Technical Data-Sheets (TDS) of the *Composite Materials* developed in the DEFEAT Project. These materials combine the optimized fire-resistant (compact) and the heat insulating (porous) geopolymers, which are based on Construction and Demolition Wastes (bricks and ceramic tiles). The optimization of these geopolymers resulted in two *Composite Materials*, which are the final products of DEFEAT project:

(i) the ***BFR-CTTI***, which consists of a waste brick-based fire-resistant and a waste ceramic tile-based heat insulating geopolymer and

(ii) the ***CTFR-CTTI***, for which waste ceramic tile-based geopolymers were used in both of its components, the fire-resistant and the heat-resistant.

The TDS prepared for the DEFEAT Composite Materials include all those properties that are considered mandatory for a corresponding commercial structural material. Each TDS contains a brief description of the corresponding product, its uses, main characteristics and advantages, while it also highlights the most important features contributing to the product's sustainability. Information on the product composition and storage conditions are also included in the relevant TDS. Moreover, each TDS provides with the technical properties of the corresponding Composite Material, which are mandatory for standard building materials that are commercially available today.

1. Introduction

The final product of the DEFEAT project is an innovative composite façade that can achieve both, the passive fire protection and thermal insulation of buildings. This innovative façade consists of two layered materials: a fire-resistant geopolymer, which is compact and placed on the outer side of the façade to protect the building in case of fire and a heat-resistant geopolymer, which is porous and placed on the inner side the facade, offering thermal insulation to the building. The above-mentioned geopolymers were designed, developed, and combined in a single item, the ***DEFEAT Composite Material***, in WP5 (Design and Development of the Composite Material) of the DEFEAT project. The prototype of the DEFEAT Composite Material was also produced and assessed in WP5.

Practically, the research work in WP5 resulted in two optimum Composite Materials:

(i) the ***BFR-CTTI***, which consists of a fire-resistant geopolymer based on waste bricks and a heat-resistant geopolymer based on waste ceramic tiles and

(ii) the ***CTFR-CTTI***, in which both of the layered geopolymers, the fire-resistant and a heat-resistant, are based on waste ceramic tiles

Details on the design, development and optimization of the fire- and heat-resistant geopolymers that are combined in the final DEFEAT Composite Materials are given in the deliverable "*D5.1- Report on the fire and insulation design*". Moreover, details on the prototypes of the DEFEAT Composite Materials are given in the deliverable "*D5.3- Material prototype with fire and insulation properties in sandwich type*".

In ***WP6-Material and Properties Engineering***, the production processing of the DEFEAT Composite Materials based on two different methods, casting and 3-D printing were investigated. More precisely, the basic properties required in each method followed for the production of the starting geopolymers have been tested and optimized in Task 6.1, while the most important properties of the DEFEAT Composite Material have been designed and assessed in Task 6.2. Details on the design and the production of the DEFEAT Composite Material for application on buildings, considering both of the production methods, are given in the deliverable "*D6.1-Report on the material engineering of the production method*". The production flowsheets of the DEFEAT Composite Materials, according to both the manufacturing processes, are fully presented in the deliverable "*D6.2-Flowsheet with the material production*".

The current deliverable "***D6.3-Material Data-sheet with the most crucial properties***" concerns the Technical Data-Sheets (TDS) of the *DEFEAT Composite Materials*. The TDS of each Composite Material summarizes the key feature of the relevant product in detail and is designed to be used for the technical and commercial communication of the product.

2. Technical Data-sheets of the DEFEAT Composite Materials

Below, the Technical Data-Sheets of the two optimum composite materials developed in the DEFEAT project, ***BRF-CTTI*** and ***CTFR-CTTI***, are presented.

TECHNICAL DATA SHEET

DEFEAT Composite BFR-CTTI

Fire-Resistant and Thermal Insulating Façade

Identification of material / Preparation & Company

Trade name:	**DEFEAT Composite BFR-CTTI**
Application:	Building façade for passive fire protection and heat insulation
Company:	DEFEAT INTEGRATED/0918/0052

Description

DEFEAT Composite BFR-CTTI is an innovative building material based on geopolymerization technology. For its production, construction and demolition wastes are utilized. It is used as facade on new or existing buildings, offering passive fire protection and thermal insulation. It is a two-layer composite material, consisting of a compact fire resistant layer based on brick waste and a porous thermal resistant layer based on ceramic tile waste.

Uses

DEFEAT Composite BFR-CTTI is fixed on building facades by fire resistant anchors and is placed with the fire resistant layer outside. It prevents the spreading of fire in the case of a fire event in the building, protecting thus the concrete frame and the masonry of the building from collapse. At the same time, its porous layer acts as a heat insulating material, significantly reducing heat losses in the building and therefore, the consumption of energy.

Characteristics / Advantages

DEFEAT Composite BFR-CTTI offers:

- Up to 60 min resistance to fire, according to the standard ISO834 time-temperature curve
- Very good compressive strength after exposure to high temperature, up to 1050 °C
- Good thermal insulation
- Low shrinkage and mass loss
- Non-combustible
- Unaffected by humidity
- Retain shape stability and load capacity in humid conditions

DEFEAT Composite BFR-CTTI does not contain any toxic or harmful substances / Asbestos free material.

Sustainability

- Utilization of large quantities of secondary resources / waste materials
- Low energy consumption (in production)
- Reduced GHG emissions
- Low emitting material

Product Information

Composition:	Construction and Demolition Waste materials and alkaline / silicate solutions
Storage conditions:	Store properly in dry conditions. Protect from direct sunlight and frost.
Alkalinity:	Approx. 12 (pH value)

Technical Information

a. Fire resistant BFR

Technical Characteristic	Units	Value	
Color		Reddish Brown	
Behavior against fire	class	non-combustible (A1)	
Density	kg/m^3	1526 (28 days)	
Cold compressive strength			
50 °C	MPa	19.25 (7 days)	33.45 (28 days)
600 °C		15.44	18.76
800 °C		19.42	23.68
1050 °C		21.06	25.65
Mass loss			
600 °C	% wt.	6.21 (7 days)	7.81 (28 days)
800 °C		7.53	9.46
1050 °C		7.97	10.02

b. Heat insulating CTTI

Technical Characteristic	Units	Value
Color		Grey
Behavior against fire	class	non-combustible (A1)
Density	kg/m^3	574
Thermal conductivity (25 °C)	$Wm^{-1}K^{-1}$	0.16
Compressive strength	MPa	1.1

Basis of product data

All technical data stated in this data-sheet are based on laboratory tests performed by the DEFEAT project Partners. Actual measured data may vary due to circumstances beyond our control.

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TECHNICAL DATA SHEET

DEFEAT Composite CTFR-CTTI

Fire-Resistant and Thermal Insulating Façade

Identification of material / Preparation & Company

Trade name:	**DEFEAT Composite CTFR-CTTI**
Application:	Building façade for passive fire protection and heat insulation
Company:	DEFEAT INTEGRATED/0918/0052

Description

DEFEAT Composite CTFR-CTTI is a novel building material based on geopolymerization technology. For its production, construction and demolition wastes are utilized. It is a two-layer composite material, consisting of a compact fire resistant layer and a porous thermal resistant layer, both of them based on ceramic tile waste. It is used as facade on new or existing buildings, offering passive fire protection and thermal insulation.

Uses

DEFEAT Composite CTFR-CTTI is fixed on building facades by fire resistant anchors and is placed with the fire resistant layer outside. It prevents the spreading of fire in the case of a fire event in the building, protecting thus the concrete frame and the masonry of the building from collapse. At the same time, its porous layer acts as a heat insulating material, significantly reducing heat losses in the building and therefore, the consumption of energy.

Characteristics / Advantages

DEFEAT Composite CTFR-CTTI offers:

- Up to 60 min resistance to fire, according to the standard ISO834 time-temperature curve
- Very good compressive strength after exposure to high temperature, up to 1050 °C
- Good thermal insulation
- Low shrinkage and mass loss
- Non-combustible
- Unaffected by humidity
- Retain shape stability and load capacity in humid conditions

DEFEAT Composite CTFR-CTTI does not contain any toxic or harmful substances / Asbestos free material.

Sustainability

* Utilization of large quantities of secondary resources / waste materials
* Low energy consumption (in production)
* Reduced GHG emissions
* Low emitting material

Product Information

Composition:	Construction and Demolition Waste materials and alkaline / silicate solutions
Storage conditions:	Store properly in dry conditions. Protect from direct sunlight and frost.
Alkalinity:	Approx. 12 (pH value)

Technical Information

a. Fire resistant CTTI

Technical Characteristic	Units	Value	
Color		Grey	
Behavior against fire	class	non-combustible (A1)	
Density	kg/m^3	1621 (28 days)	
Cold compressive strength			
50 °C	MPa	33.10 (7 days)	37.99 (28 days)
600 °C		16.83	27.69
800 °C		13.17	23.62
1050 °C		36.61	38.19
Mass loss			
600 °C	% wt.	9.55 (7 days)	13.02 (28 days)
800 °C		9.60	13.19
1050 °C		9.91	13.35

b. Heat insulating CTTI

Technical Characteristic	Units	Value
Color		Grey
Behavior against fire	class	non-combustible (A1)
Density	kg/m^3	574
Thermal conductivity (25 °C)	$Wm^{-1}K^{-1}$	0.16
Compressive strength	MPa	1.1

Basis of product data

All technical data stated in this data-sheet are based on laboratory tests performed by the DEFEAT project Partners. Actual measured data may vary due to circumstances beyond our control.

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3. Conclusions

Deliverable D6.3 contains the technical data-sheets of the DEFEAT Composite Materials, namely BRF-CTTI and CTRF-CTTI, which are the final products of the project.

The two Composite Materials have been designed to be used as building facades, offering to the buildings passive fire protection and thermal insulation. They are based on the geopolymerization technology and the recycling of CDW materials; therefore, they contribute to the saving of primary resources and energy and the reduction of the GHG emissions, which highlight their sustainability.

The technical properties of the Composite Materials are comparable or even better to those of commercial building materials currently used for the same purposes. The TDS given in this deliverable can be used for the technical and commercial communication of the two Composite Materials, BRF-CTTI and CTRF-CTTI, which are developed and up-scaled in the DEFEAT project.

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