Agenda

Time	Activity
11:00 – 11:10	End of life wind blade components: A demonstration plant to bring it back to life (Ana Teresa Lima)
11:10 – 11:20	Recycling routes and characterization of wind turbine blade waste (NTUA-Dionysis Semitekolos/Maria Modestou)
11:20 – 11:40	Circular Valorization of Wind Turbine Blade Waste into Reinforced Polypropylene Composites (TUE, Shashank Tumkur Karnick)
11:40 – 12:00	Cold-bonded lightweight aggregates rich in wind turbine blade waste for sustainable concrete (TUE, Ceren Duyal Kulak)
12:00 – 12:10	*Coffee Break*
12:10 – 12:30	From Waste to Resource: Circular Innovation in Construction Transformation (HOLCIM, Duc Tung DAO)
12:30 – 12:50	Wind turbine blade waste as fibre reinforcement for cementitious composites (DTU/IBAC, Tao Liu/Cynthia Morales)
12:50 – 13:20	Circular construction with wind turbine blade waste: Industrial Trials & LCA (Holcim/RWTH, Victor Pacheco/Duc Tung DAO | David Hysi/ Rose Mankaa)
13:20 – 13:30	Closing and wrap up

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BLADES2BUILD

Recycle, repurpose and reuse end-of-life wind blade composites – a coupled pre- and co-processing demonstration plant

Ana Teresa Lima
Senior Researcher
Technical University of Denmark

On behalf of the Blades2Build consortium

B2B Webinar | 06 July, 2026

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The consortium

Universities

DTU

ΕΘΝ. ΜΕΤΣΟΒ. ΠΟΛΥΤΕΧΝΕΙΟΝ

RWTH AACHEN UNIVERSITY

TU/e EINDHOVEN UNIVERSITY OF TECHNOLOGY

Industry

acciona Construcción

HOLCIM

ELDAN RECYCLING

GLOBAL CONSULTING —SUSTAINABILITY— THINK GREEN, RESPONSIBLE AND FUTURE

prezero

RENAD GLOBAL CONSULTING

endesa

GE VERNOVA

LM WIND POWER a GE Renewable Energy business

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Blades2Build Annual meetings

Jan 2026, Tudela del Duero, Prezero plant

Jan 2025, Madrid, Acciona

Ambition of the project

Implement a demonstration plant for circular use of end-of-life wind turbine blades (WTB) based on three options of circularity

Repair (R4) EOL wind blades with minimal refurbishment or processing for re-use

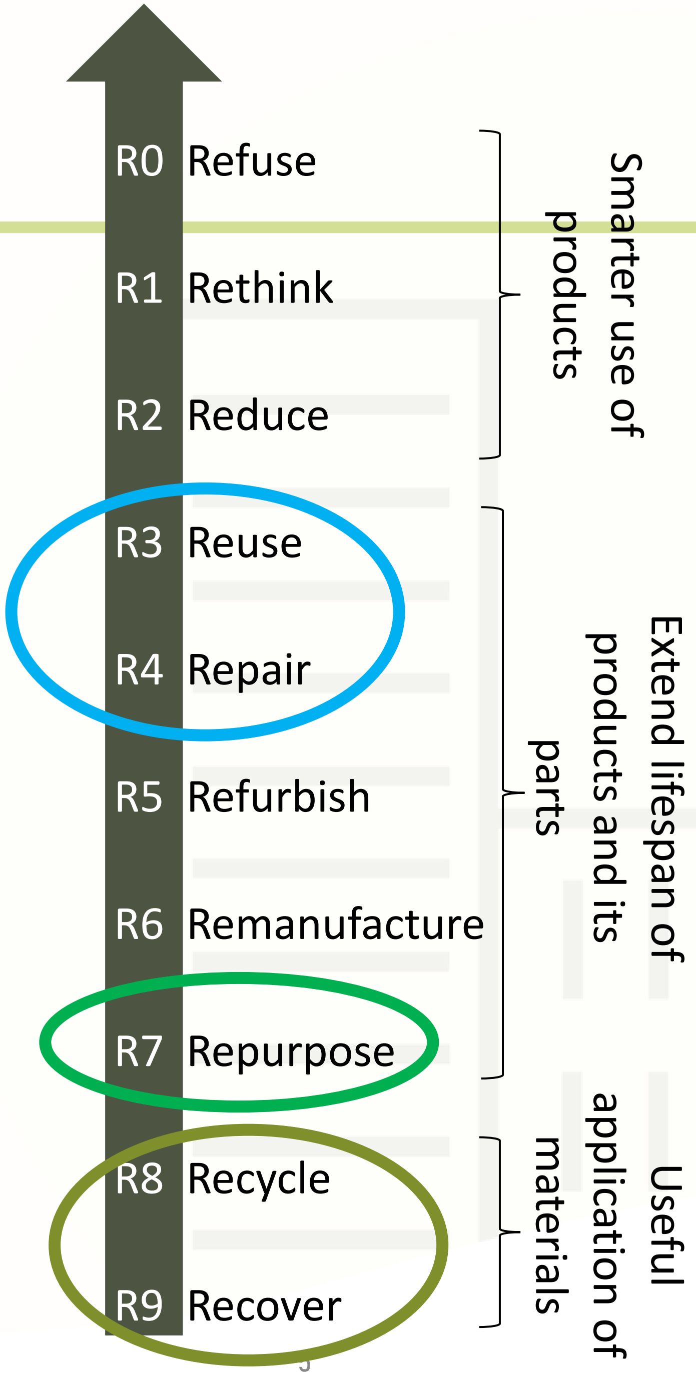
- R3

Re-purpose of individual materials constituents of the blades in construction products, like concrete and asphalt mixtures

- R7

Recycling the blade and glass fibre textiles scraps from the wind blade manufacturing in cement/clinker co-processing as an

R8/R9



What are we working with?

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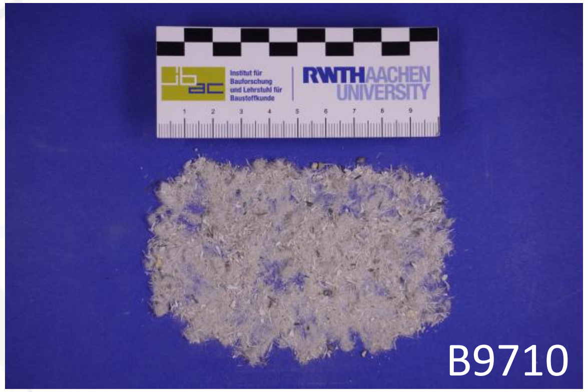
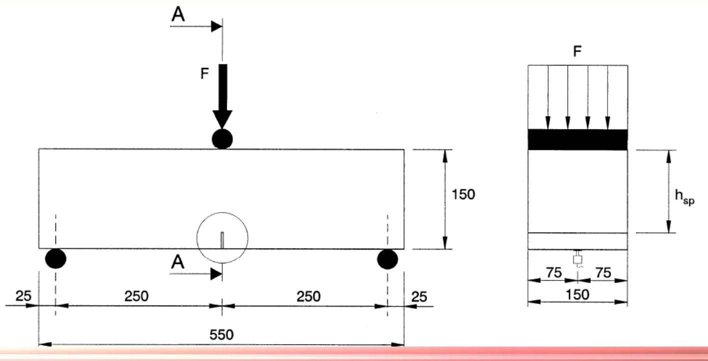
Updates from ibac / RWTH

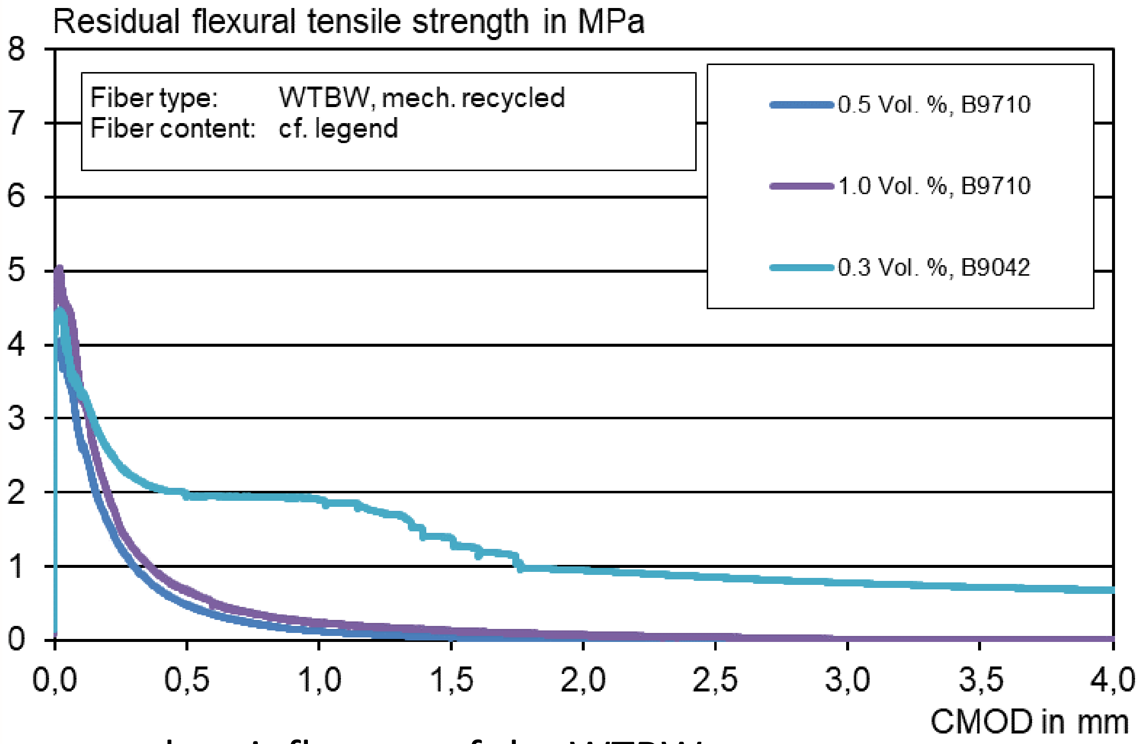
3-Point Bending test
(EN 14651:2007)



B9710

B9042





- clear influence of the WTBW geometry.
- significant residual flexural strength was already achieved at 0.3 Vol. % when using coarser recycled WTBW.

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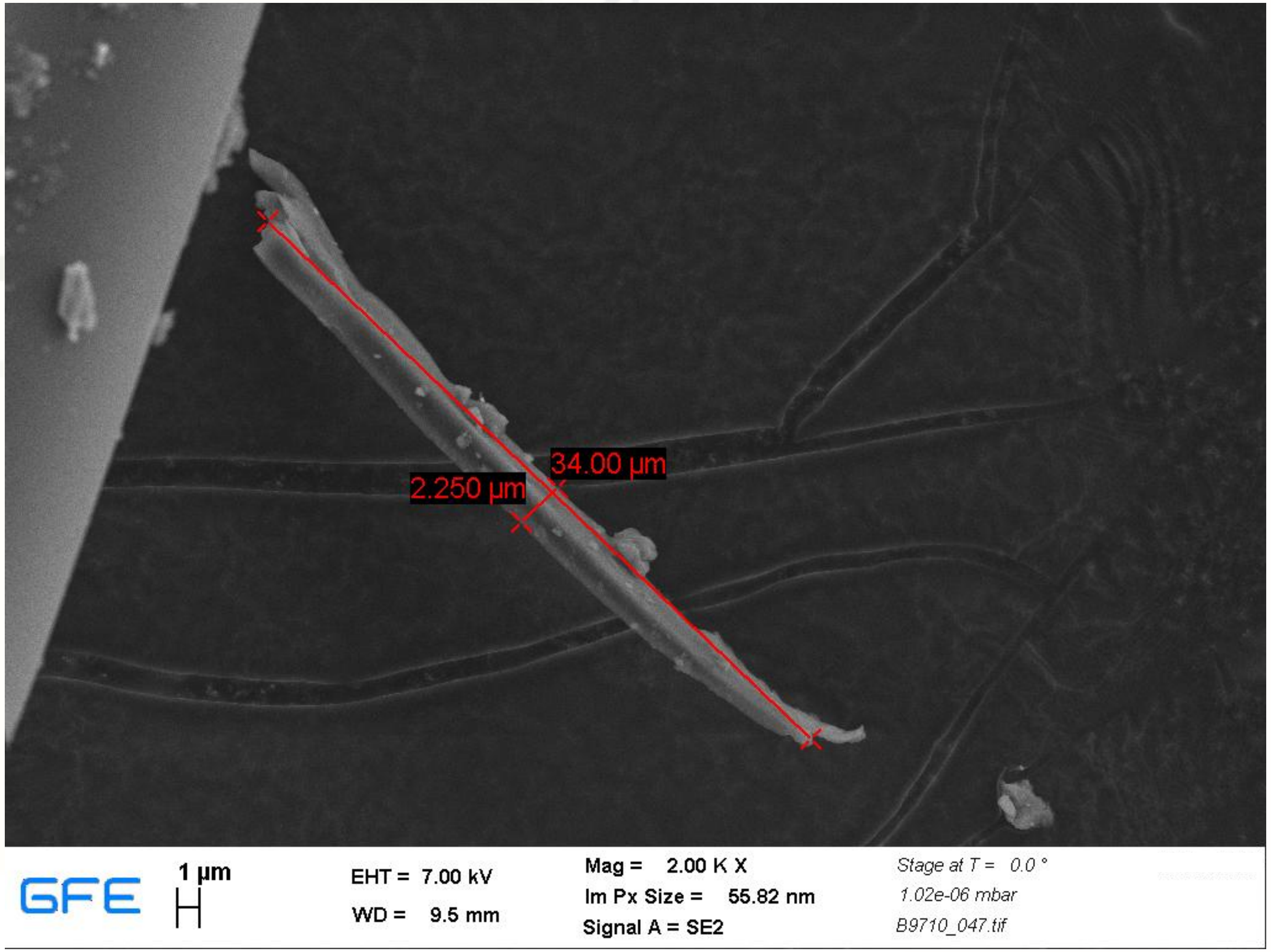
WHO fibre in rotor blade fragment (SEM–EDS)



- **Origin:** mechanical recycling
- **WHO fibre criteria:** length > 5 µm, diameter < 3 µm, aspect ratio > 3:1
- **Measured geometry (SEM):** length ≈ 34 µm, diameter ≈ 2.25 µm, aspect ratio ≈ 15, therefore consistent with a WHO fibre
- **Material indication (EDS):** spectrum dominated by C and O, consistent with an organic resin-rich fragment or resin-coated fibre surface

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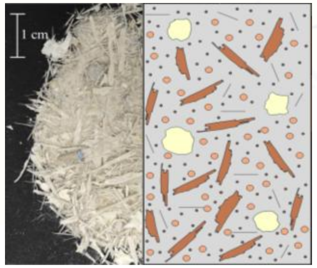
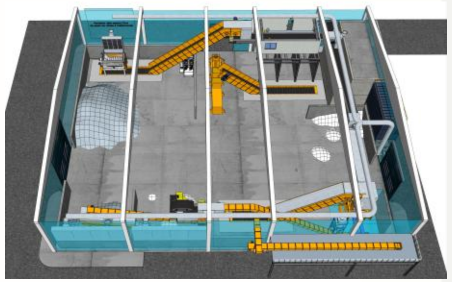
Our results

Characterisation of the WTB wastes and developed methods on solvosisys and pyrolysis of WTBW



Developed circular building materials with WTB waste



Construction of demonstration plant for **to recycle end-of-life wind turbine blades**

Industrial Scale Concrete Pavements Demonstrators

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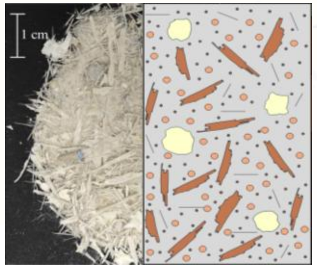
Characterisation of the WTB wastes and developed methods on solvosisys and pyrolysis of WTBW



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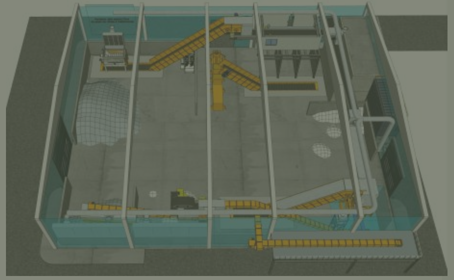

Industrial Scale Concrete Pavements Demonstrators

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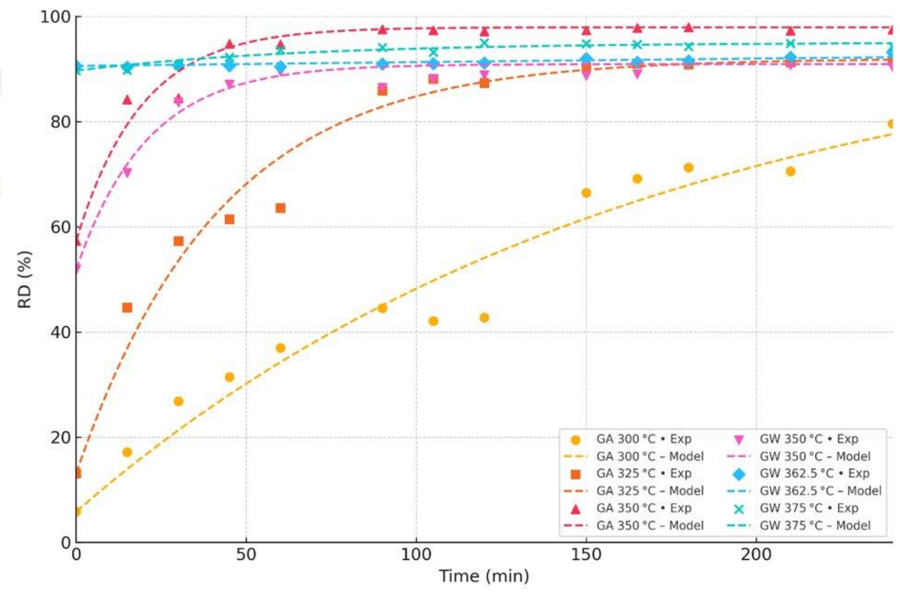
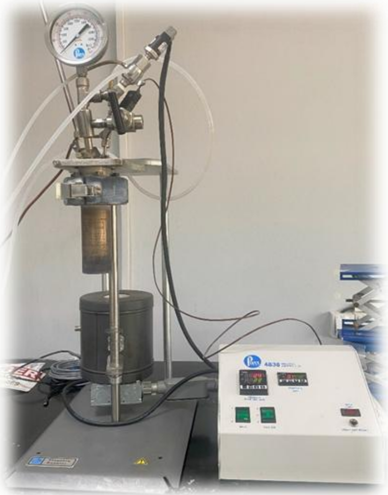
Updates from NTUA

Supercritical Solvolysis of WTBW with Acetone & Water

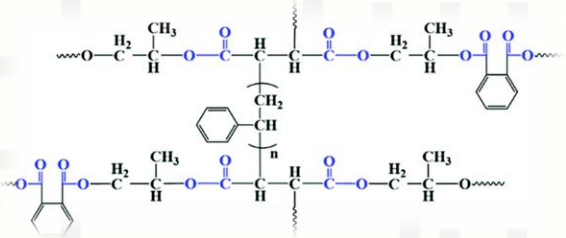


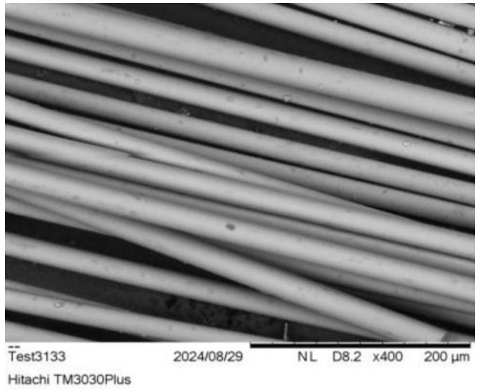
Kinetics Analysis



Lab-scale setup (100ml)

Pilot-scale setup (4L)





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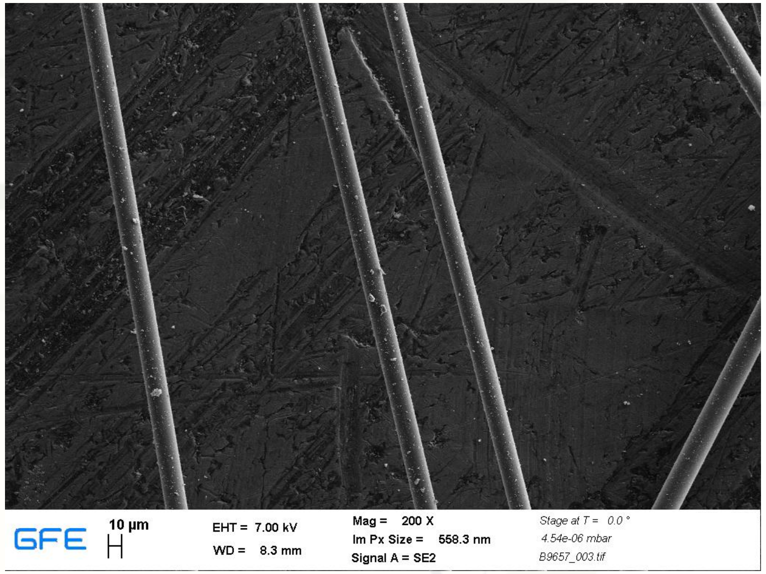
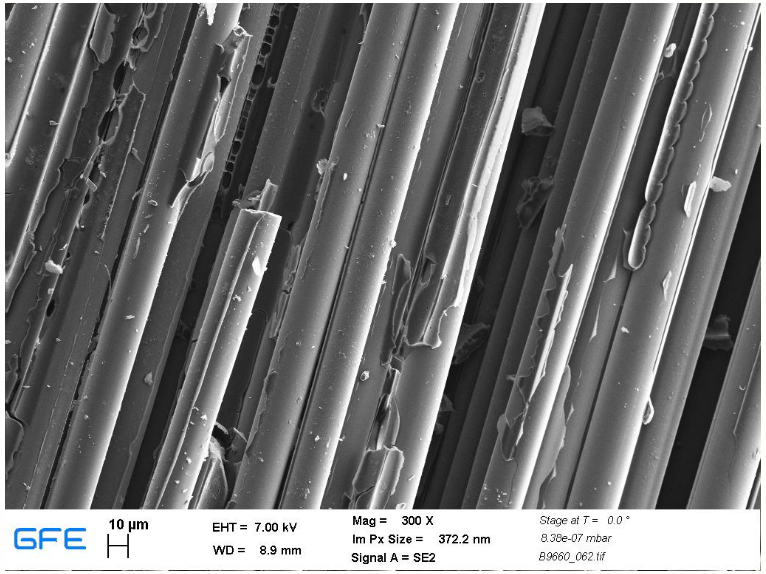
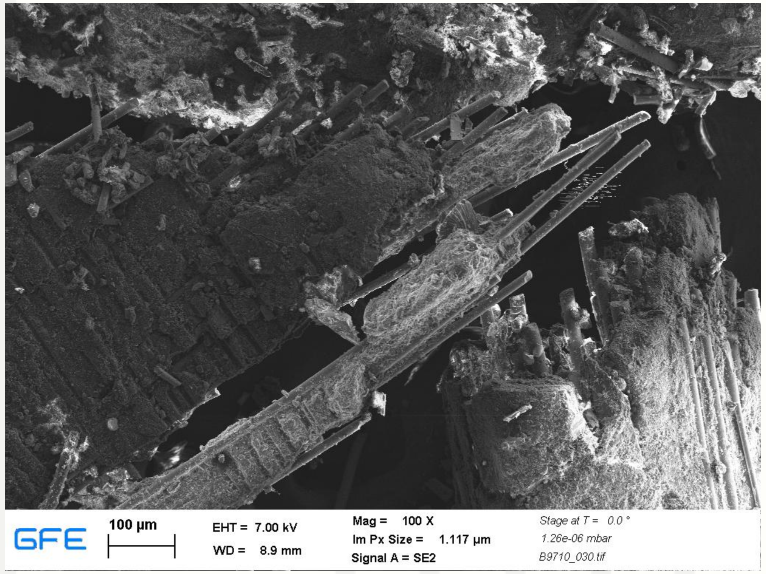
Recovered rotor blade fibres: chemical, thermal, mechanical







Chemical
- Clean fibre surface, low matrix residues
- Sharper edges, less attached debris
- More uniform diameter appearance

Thermal
- Charred polymer residues attached to the fibre surface
- Porous surface deposits and local defects visible
- Brittle fragments and broken ends

Mechanical
- Matrix-rich fragments attached
- Fibre bundles and broken ends
- Strong heterogeneity, debris on surface

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RWTH AACHEN UNIVERSITY

Our results

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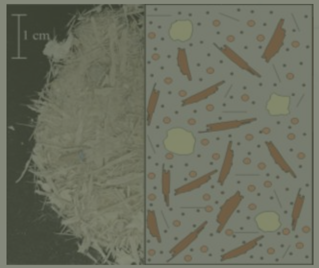
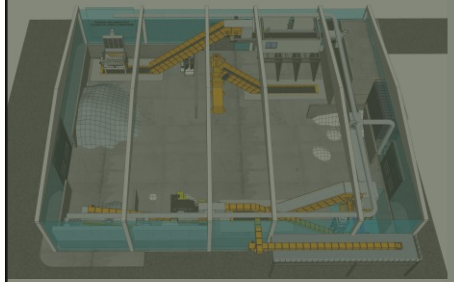


Developed circular building materials with WTB waste

Construction of demonstration plant for **to recycle end-of-life wind turbine blades**



Industrial Scale Concrete Pavements Demonstrators

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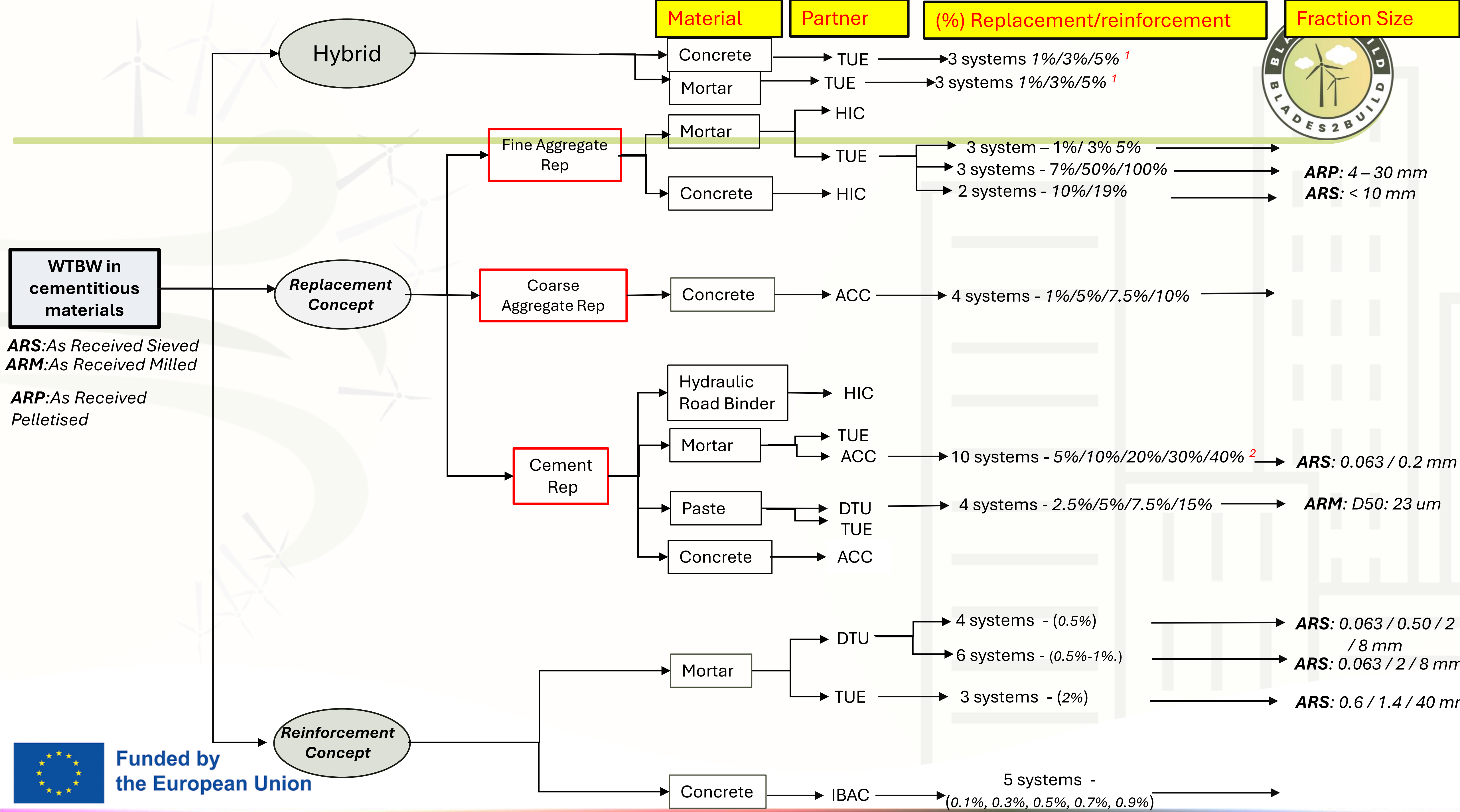

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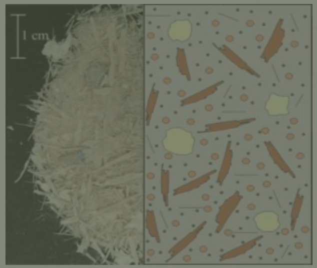

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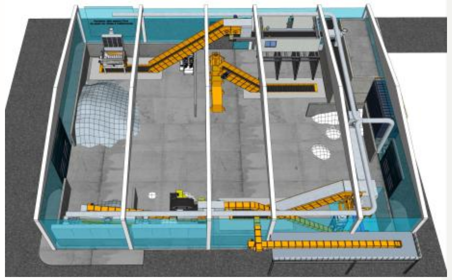

Industrial Scale Concrete Pavements Demonstrators

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Blade processing solution

Demonstration plant – Tudela de Duero

- **Demonstration plant located in Tudela del Duero, Spain**
  - **Led by Prezero**

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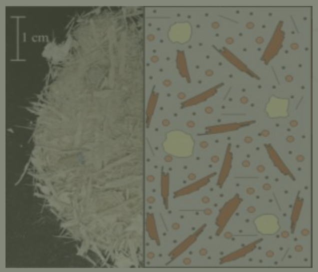
Technical University of Denmark

Our results

Characterisation of the WTB wastes and developed methods on solvosisys and pyrolysis of WTBW



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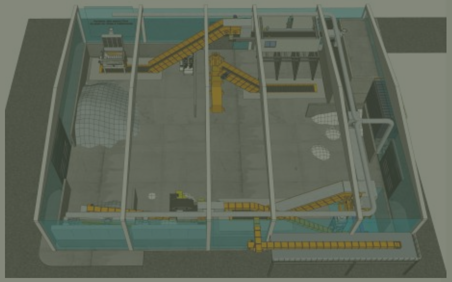

Industrial Scale
Concrete Pavements Demonstrators

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INDUSTRIAL TRIALS

Funded by
the European Union

HOLCIM

Environmental and Economic performance?

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Updates from INaB / RWTH

- ONGOING – First results are shown today! Stay tuned :)

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Summary

- Mechanical recycling of EoL wind turbine blades shows promising results in producing construction materials
  - Demonstration plant is soon to be operational (again)
- Cementitious construction materials showed the highest technical performance
  - Several industrial scale tests have been carried out and are planned
- Project approaching the end in December 2026 – contact us for more information!

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Webinar Structure

- WTBW Treatment Methods
- Products
  - Lab Scale
    - **Polymer Based Composites**

      

      1. Primary Applications
      2. Synthesis Process
      3. Performance vs Virgin Case
    - **Lightweight aggregates**

      

      1. Primary Applications
      2. Synthesis Process
      3. Performance vs Virgin Case
    - **Asphalt**

      

      1. Primary Applications
      2. Synthesis Process
      3. Performance vs Virgin Case
    - **Fibre-reinforced cement-based composites**

      

      1. Primary Applications
      2. Synthesis Process
      3. Performance vs Virgin Case
  - Industrial Scale
    - **Cement-based Industrial Trials/Projects**
      1. Primary Applications
      2. Use Cases
      3. Performance vs Virgin Case
      4. LCA

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Thank you!

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www.sustain.dtu.dk
https://www.holcim.com/innovation
www. tue.nl

DTU – Technical University of Denmark
HIC – Holcim Innovation Center
TUE – Technical University of Eindhoven

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BLADES2BUILD

Recycle, repurpose and reuse end-of-life wind blade composites – a coupled pre- and co-processing demonstration plant

Recycling routes and Characterization of Wind Turbine Blade waste

Dionisis Semitekolos
Maria Modestou

06.07.2026 | Teams

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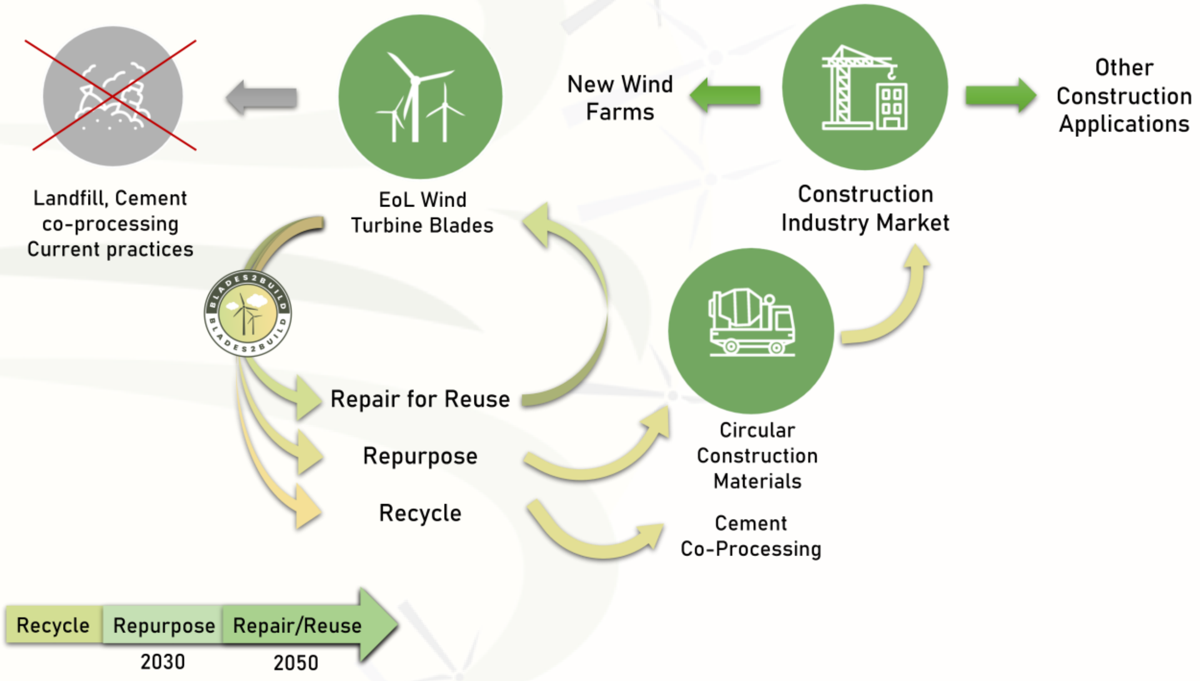
DTU Technical University of Denmark

Introduction



→ 90% decrease of landfill disposal by 2030

The aim of BLADES2BUILD is to improve and support **circularity options of end-of-life wind blades** by exploring three different circular stages:

- Direct **re-use of the EOL wind blades** with minimal refurbishment or processing.
- **Re-purpose** of individual materials constituents of the blades (and manufacturing waste).
- **Recycling** the blade and glass fibre textiles scraps from the wind blade manufacturing in cement/clinker co-processing as an alternative fuel.

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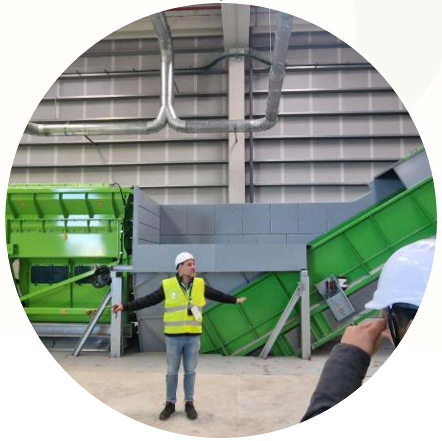
Recycling Routes in Blades2Build

Mechanical Recycling

Thermal Recycling

Chemical Recycling



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Mechanical Recycling

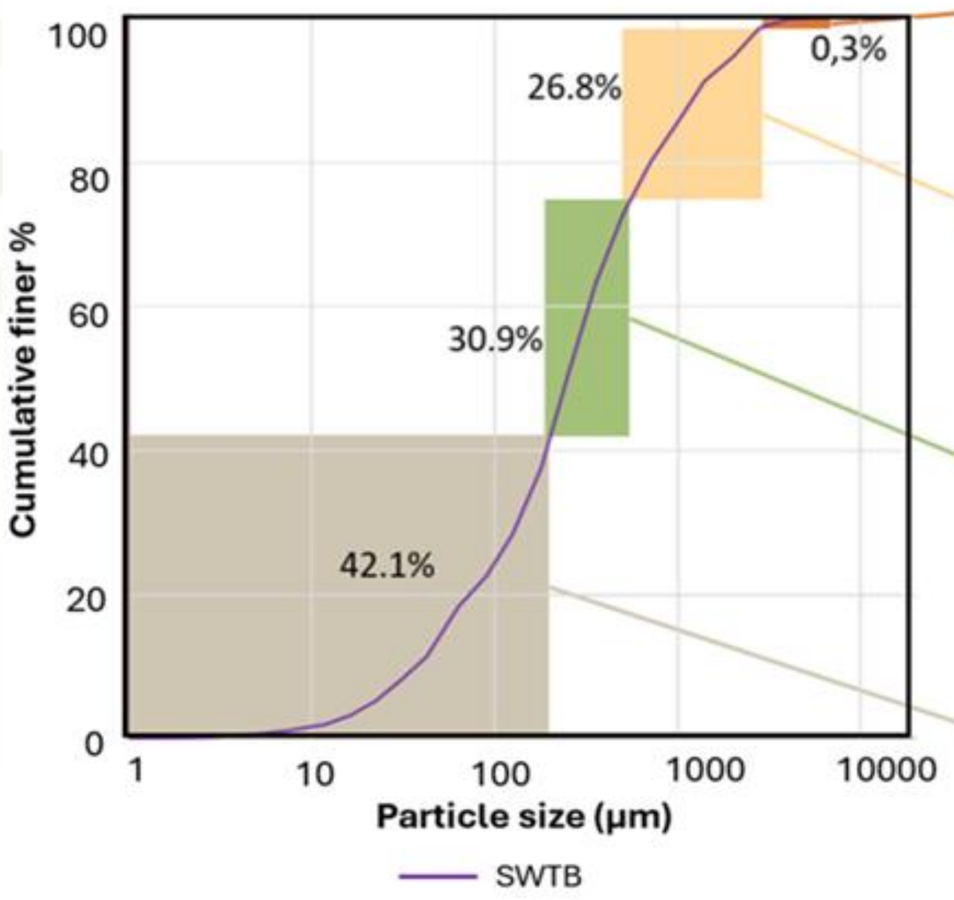

*Image on courtesy of TU/e

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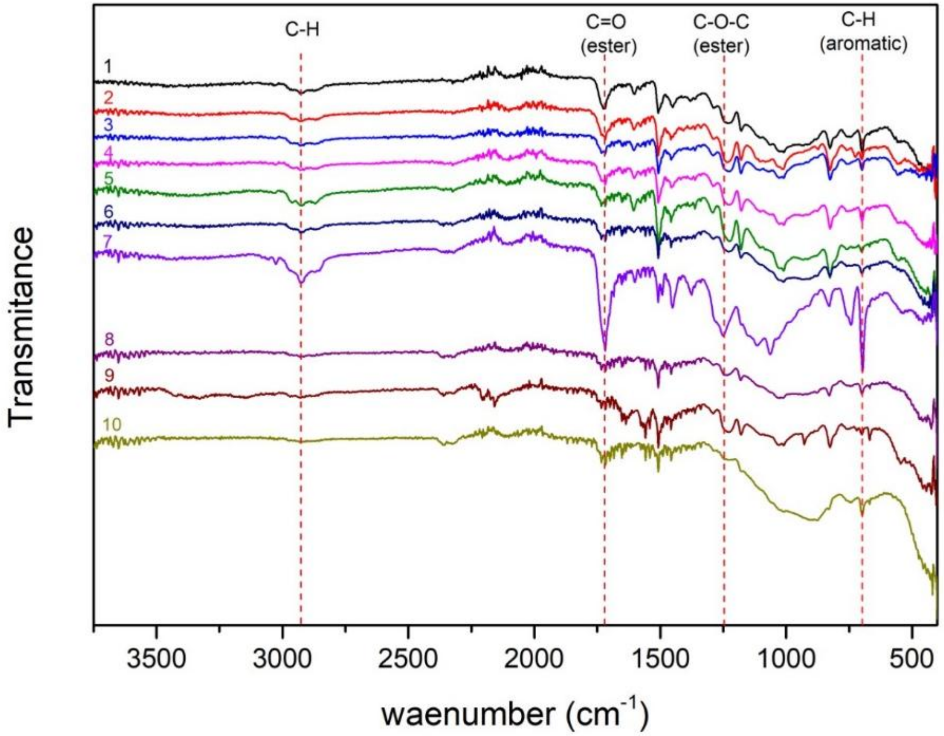
WTB Waste Characterisations

FT-IR

Characteristic peaks associated with Unsaturated Polyester Resin



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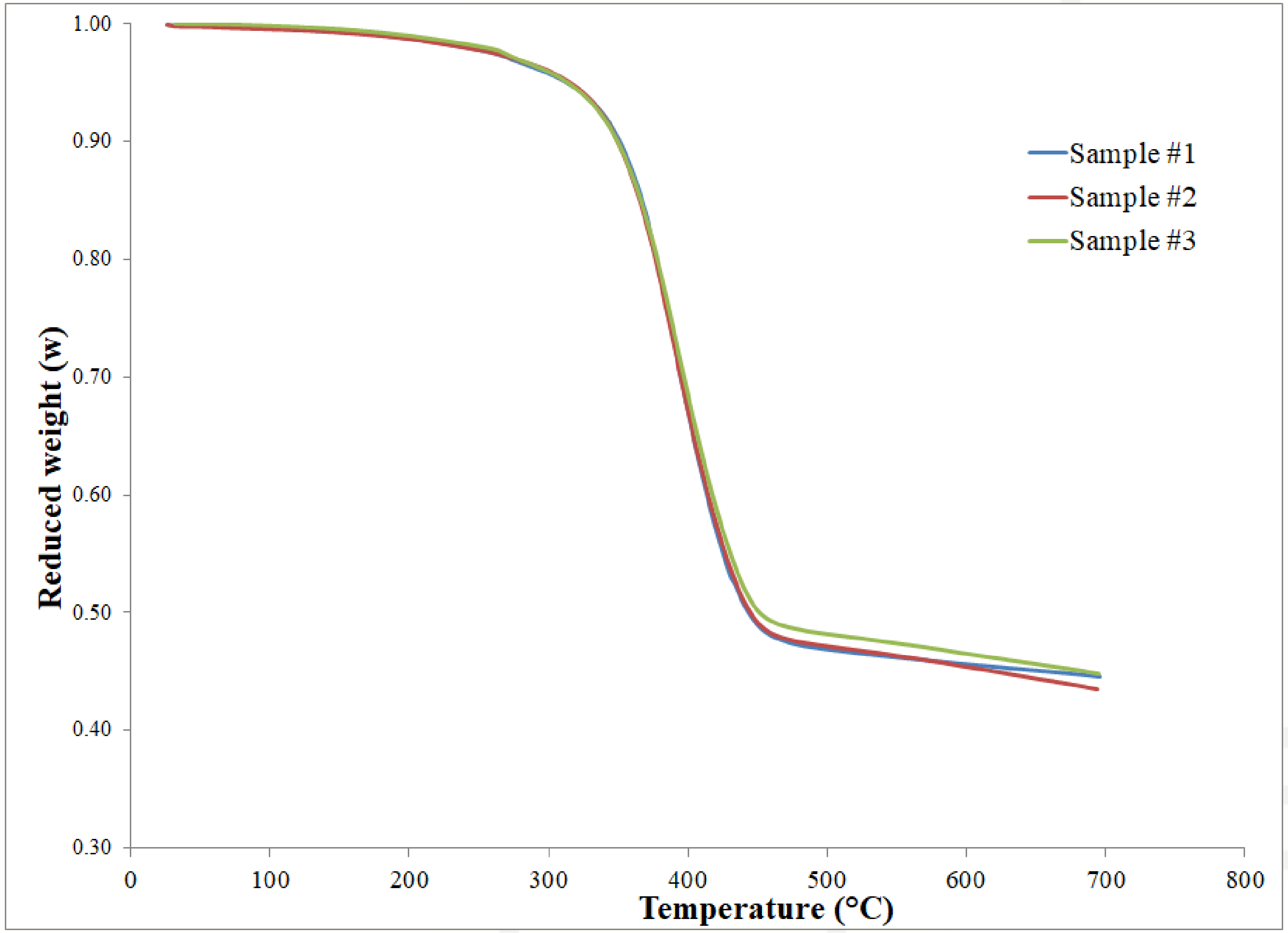
WTB Waste Characterisations

Thermogravimetric Analysis

- Under inert atmosphere (N2, scan rate 20 K/min)

- Approximately 53-48% fibres within the composite



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Thermal Recycling

Pyrolysis chamber

Shredded epoxy GRFPs (Glass Fibre Reinforced Composites)

GFRPs pyrolysis

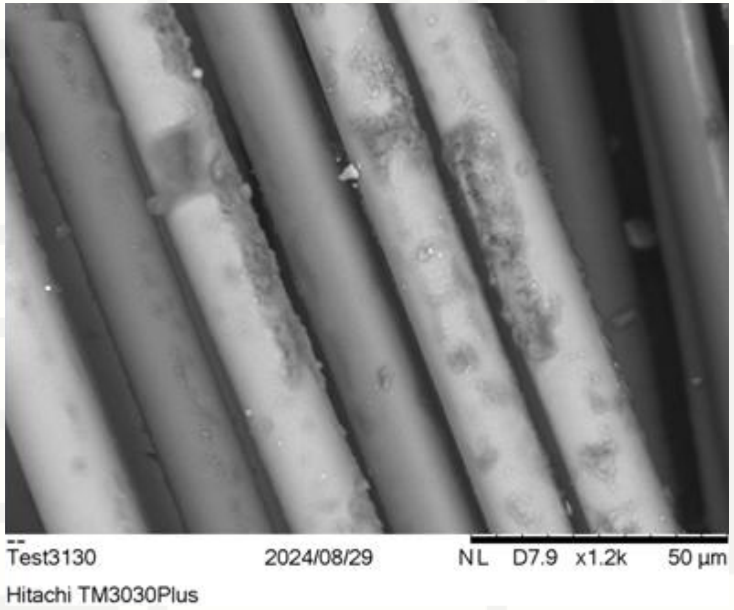
550 °C, 5h (N_2)

Pyrolyzed GFRPs

Post pyrolysis GFRPs

500 °C, 1h (Air)

Reclaimed GFs



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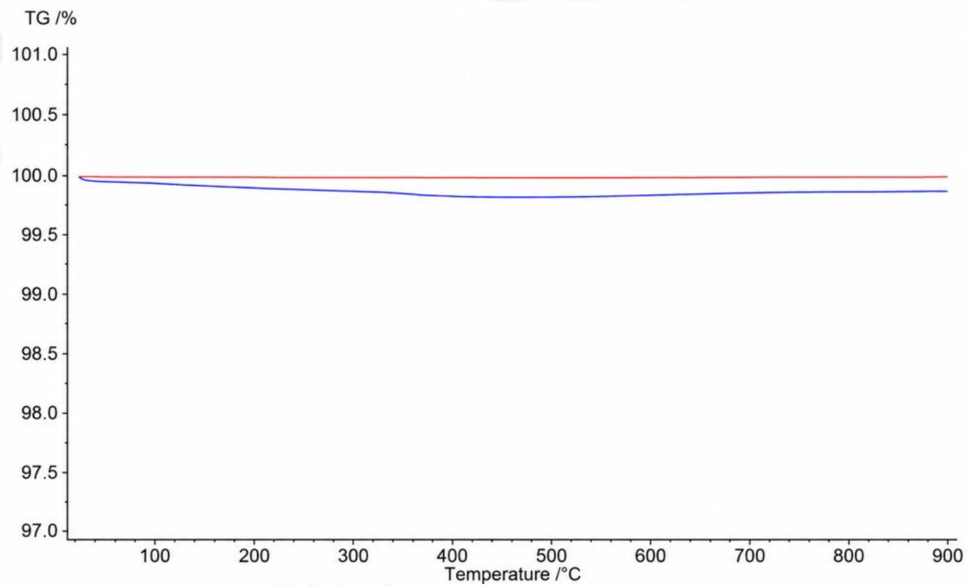
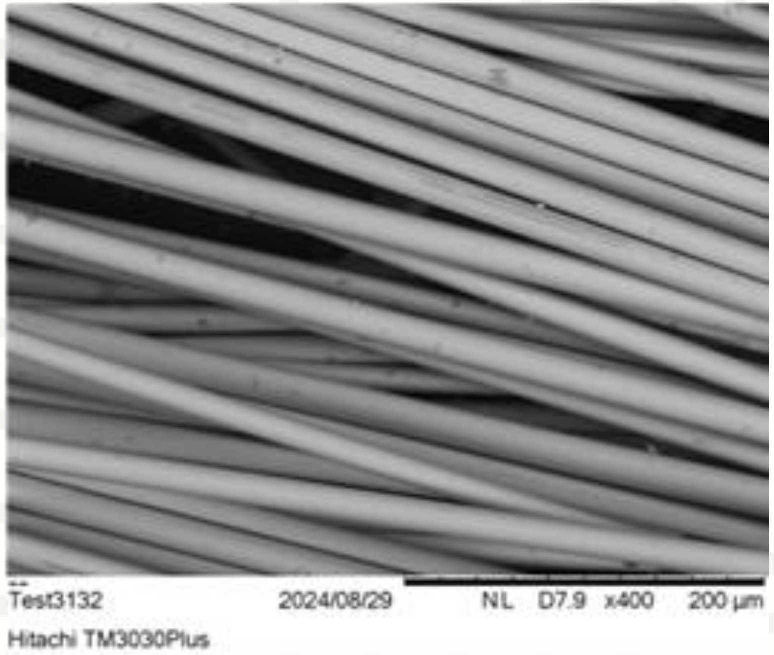
Chemical Recycling

Solvolysis

TGA



SEM



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Use Case per Recycling Method

Waste Processing

Wind turbine blade section

Factory shredding

Shredded WTBW

Mechanical

Cement-Based

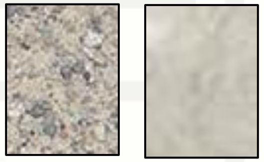
Polymer-Based

Asphalt

1. Fibre Reinforcement

2. SCM

3. Fine Aggregates



4. Coarse Aggregates

Chemical

Cement-Based

Polymer-Based

Asphalt

1. Fibre Reinforcement

Thermal

Cement-Based

Polymer-Based

Asphalt

1. Fibre Reinforcement

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Thank you!

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modestou@chemeng.ntua.gr

r-nano.gr

R Nano NTUA

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R-NANO

BLADES2BUILD

Recycle, repurpose and reuse end-of-life wind blade composites – a coupled pre- and co-processing demonstration plant

Circular Valorization of Wind Turbine Blade Waste into Reinforced Polypropylene Composites

Shashank Tumkur Karnick

06.07.2026 | Teams

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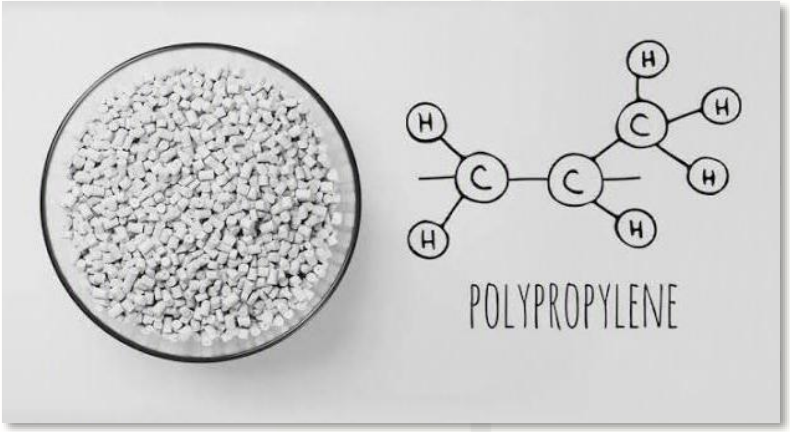
Recycling of WTB

Can we recycle WTB waste into a new polymer composite?

Shredded WTB

+



Polypropylene (thermoplastic matrix)

→

SWTB/PP composite specimen

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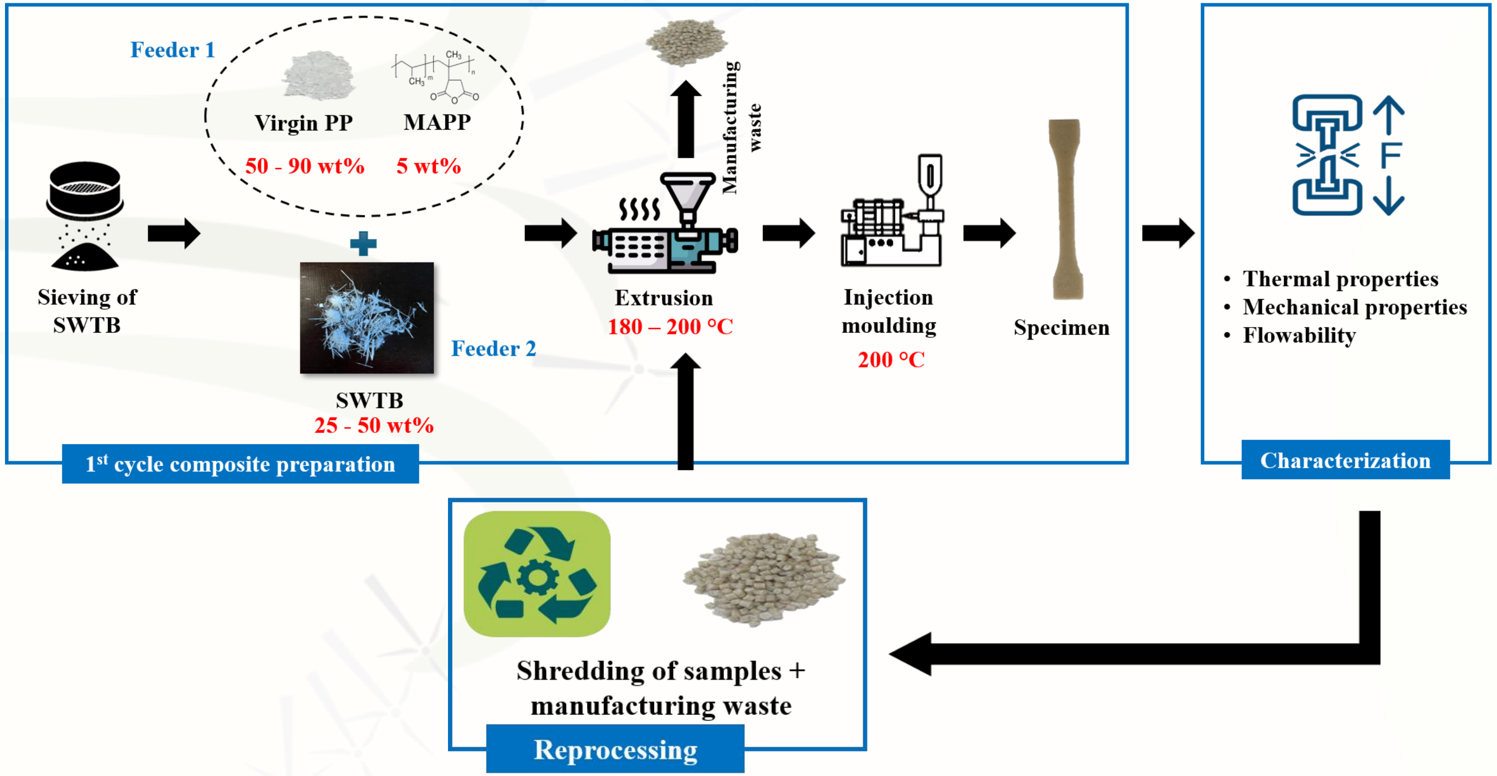
Experimental procedure



How to make it circular?

Answer: Reprocessing of secondary composites

Why reprocessing?

- Polymer composite production requires 111 MJ/kg
- Embodied energy of manufacturing for virgin glass fiber (13–32 MJ/kg)
- The energy consumption of mechanical recycling is 0.1–4.8 MJ/kg

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Potential applications

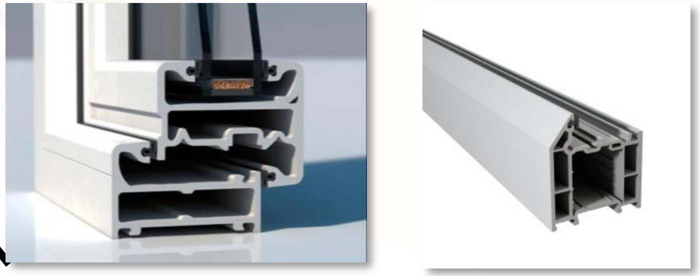
Specimens to products

Exterior cladding panels

Ceiling panels

Interior wall panels and partition systems

Decking boards



Window and door profiles

Street and outdoor furniture

Advantages

- Lightweight
- Recyclable thermoplastic composite
- Corrosion free
- Easier fabrication & installation
- Moisture resistance
- Easy cleaning

Additional tests

- Fire performance
- UV weathering
- Building code compliance

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Do they perform like virgin composites?

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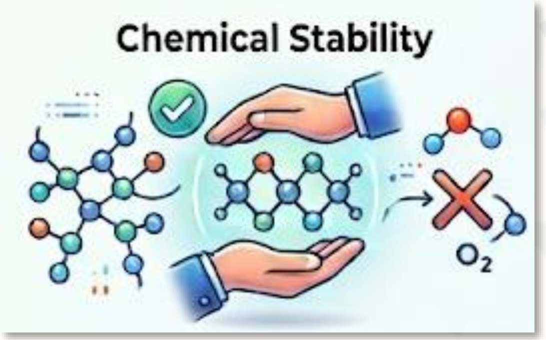
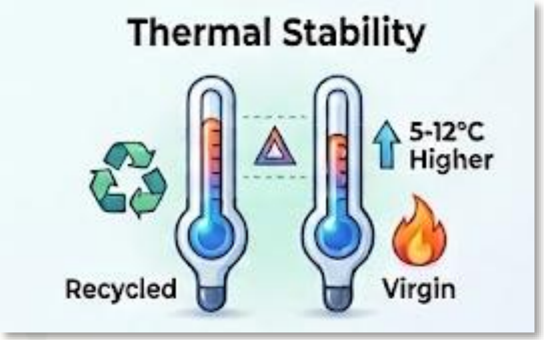
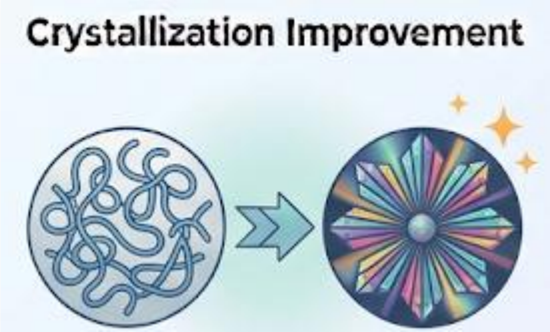
Performance of SWTB/PP composites



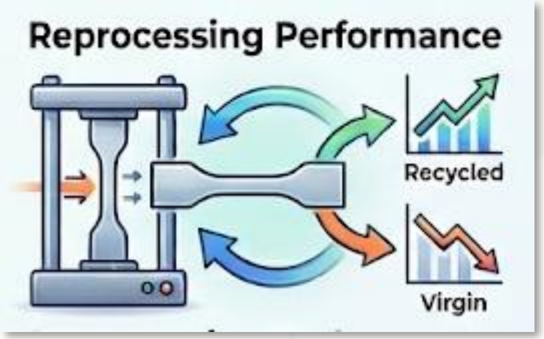
No substantial chemical structural change



The increase in degradation temperature of recycled composites

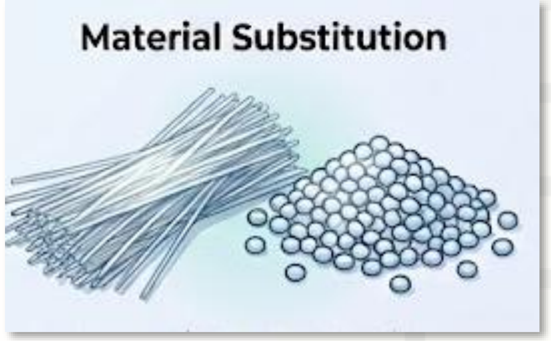


The improvement in crystallinity and crystallization temperature



Increase in tensile and flexural strength upon reprocessing

Material fluidity that helps injection molding



Potential for substituting the virgin materials

Key results

- 50 wt% SWTB composites achieved 86% tensile strength (T_s) after the 1st cycle
- T_s increased to 98% at the end of the 3rd cycle
- Improved flexural performance
- Thermal stability increased by 5-12°C
- Crystallinity increased up to 80%
- Potential to substitute 10 to 15wt% of virgin glass fibers

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What are the benefits of such recycled polymer composites?

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Benefits of SWTB/PP composites

Environmental

- Reduces landfilling and incinerating of WTBs
- Reduces non-biodegradable waste
- Reduces virgin material extraction

Economical

- Growing market for polymer composites
- Job creation in the recycling sector
- Reduced production costs

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QR Survey

POLYMER-BASED COMPOSITES

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Thank you!

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BLADES2BUILD

Recycle, repurpose and reuse end-of-life wind blade composites – a coupled pre- and co-processing demonstration plant

Cold-bonded lightweight aggregates rich in wind turbine blade waste for sustainable concrete

Ceren Duyal-Kulak, PhD Candidate

06.07.2026 | Teams

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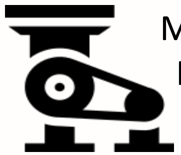
Properties of shredded wind turbine blades

EoL Wind Turbine Blades (WTB)

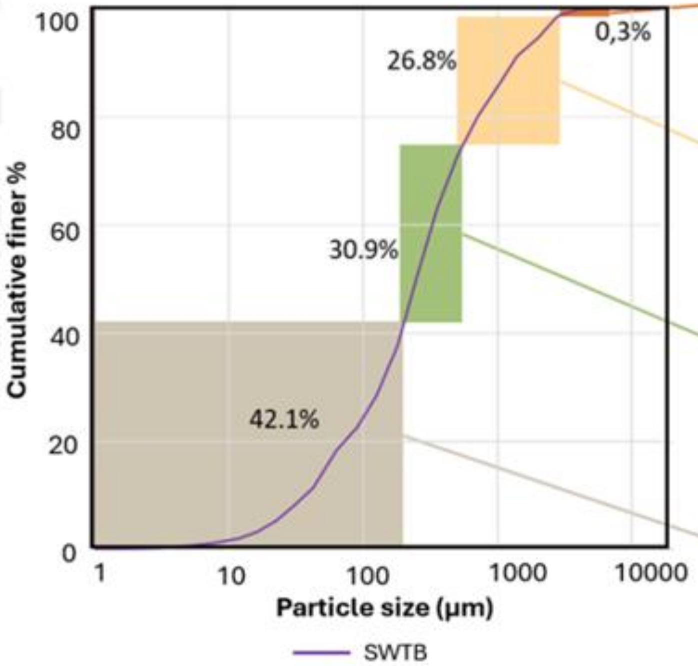
LANDFILLING ✗

RECYCLING AND REPURPOSING ✓

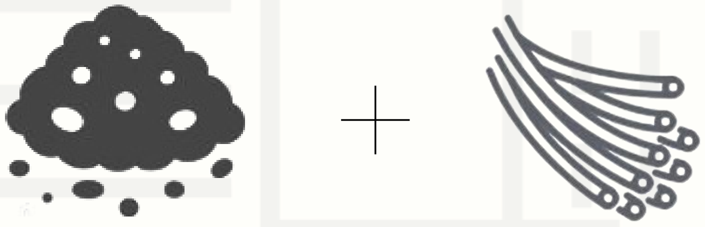


Mechanical Recycling

Shredded Wind Turbine Blade (SWTB)



- Consists of GFRP
  Glass fiber reinforced polymer
- Heterogeneous in size and shape



The concrete industry has the capacity to consume large quantities of SWTB, but high incorporation levels remain challenging

Density: 1,79g/cm^3 **Water Absorption:** 22,97%
Composition: Epoxy (32%), Inorganic (68%),
Low surface energy

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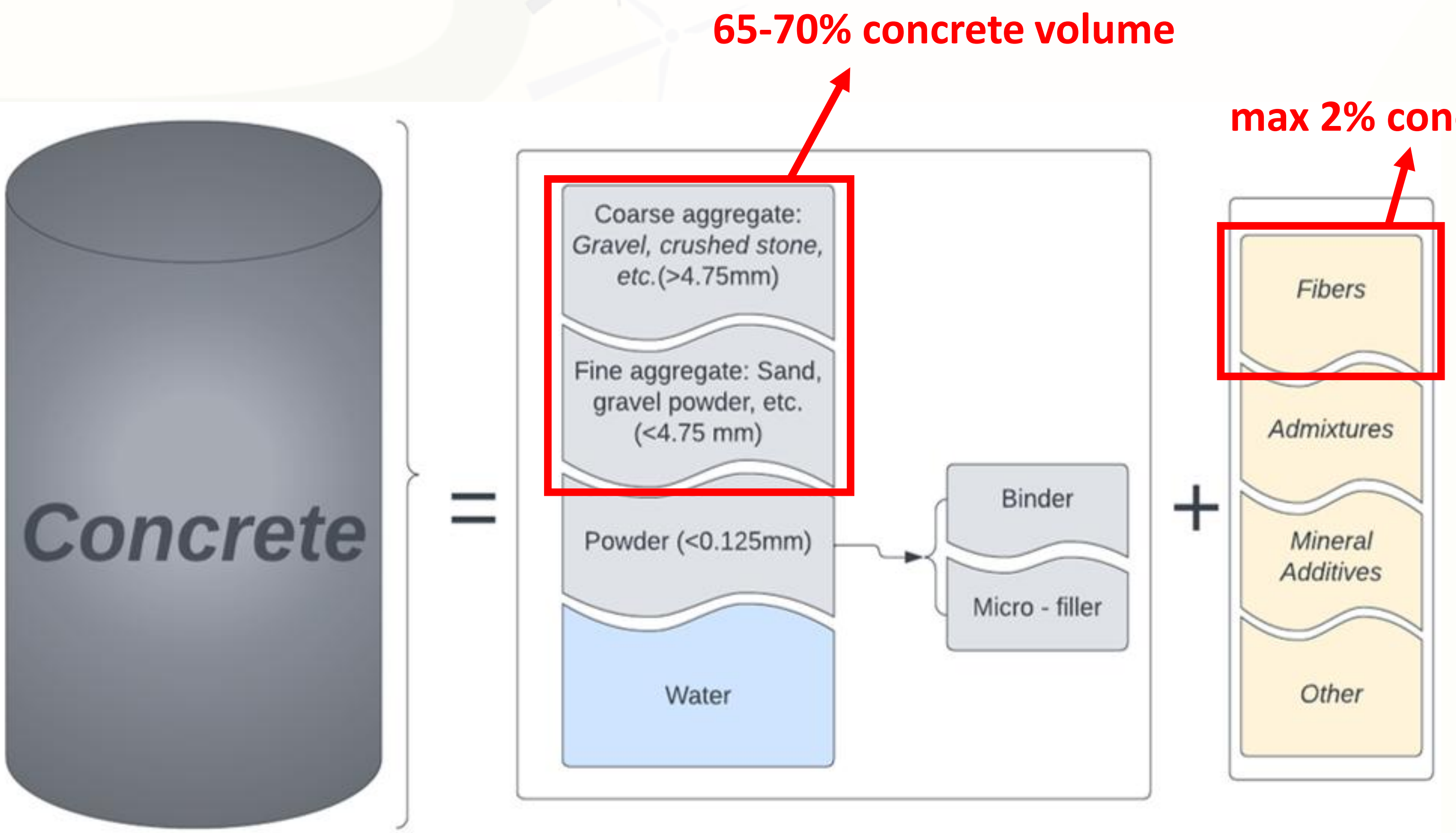
Incorporation of SWTB in cement-based composites



Replacement	Reinforcement
- Difficulty in separating granular fractions - Heterogeneous mix and poor dispersion - High water demand - Workability loss - Reduced stiffness and strength - Weak ITZ	- Improvement in bending - Irregular fiber shape - Challenge in repeatability and predictability - Interlocking of fibers - Workability loss - Difficulty in separating fibrous fractions

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Artificial aggregate production using SWTB

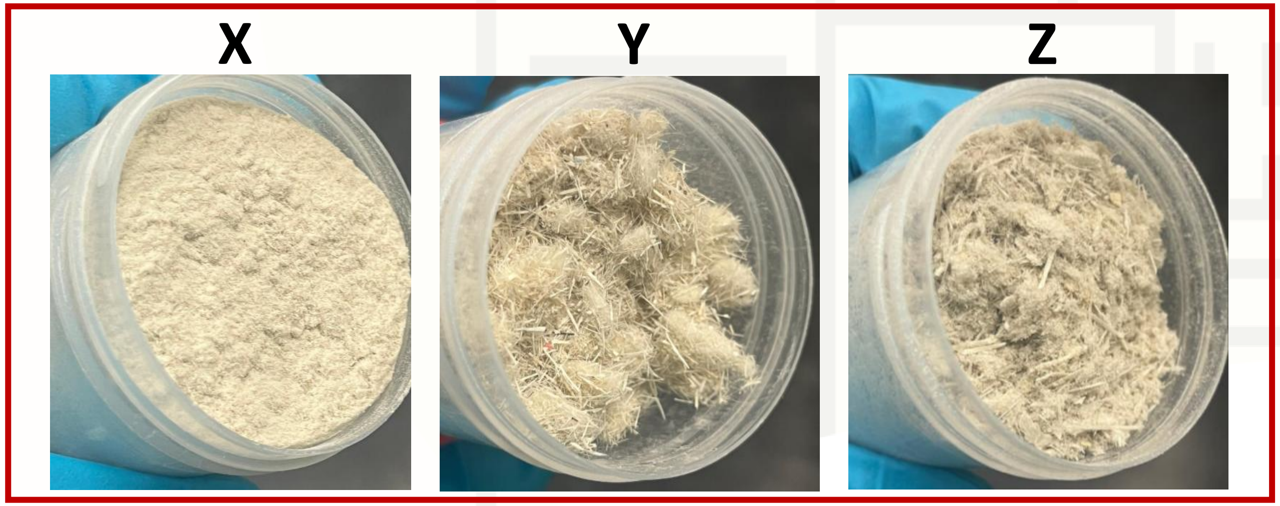
- Pelletizer
- SWTB
- Cem I 52,5R
- Water
- Moist curing

3 size fractions

3 cement dosages

10%, 20%, 30%

Engineered pelletization process



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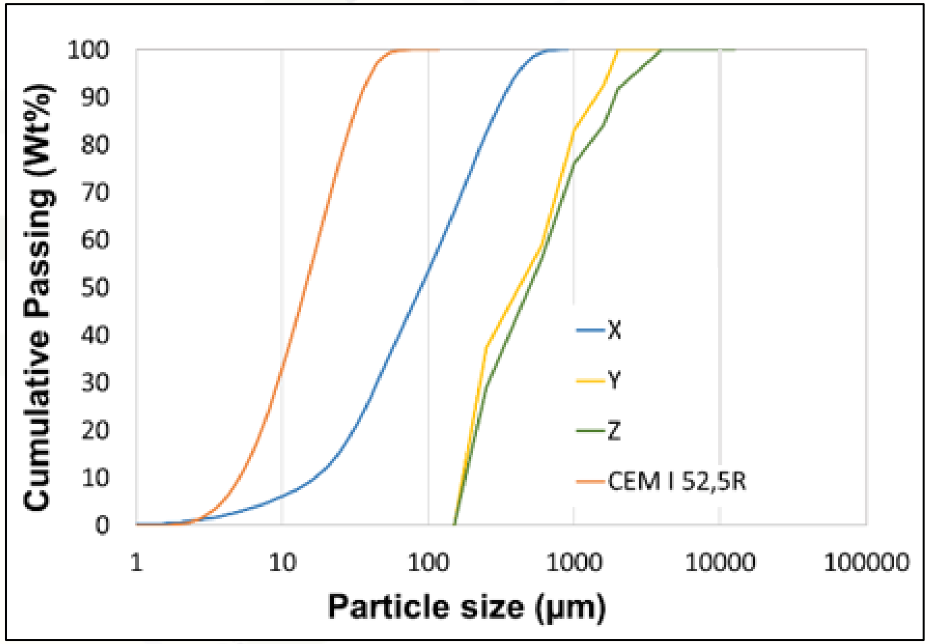
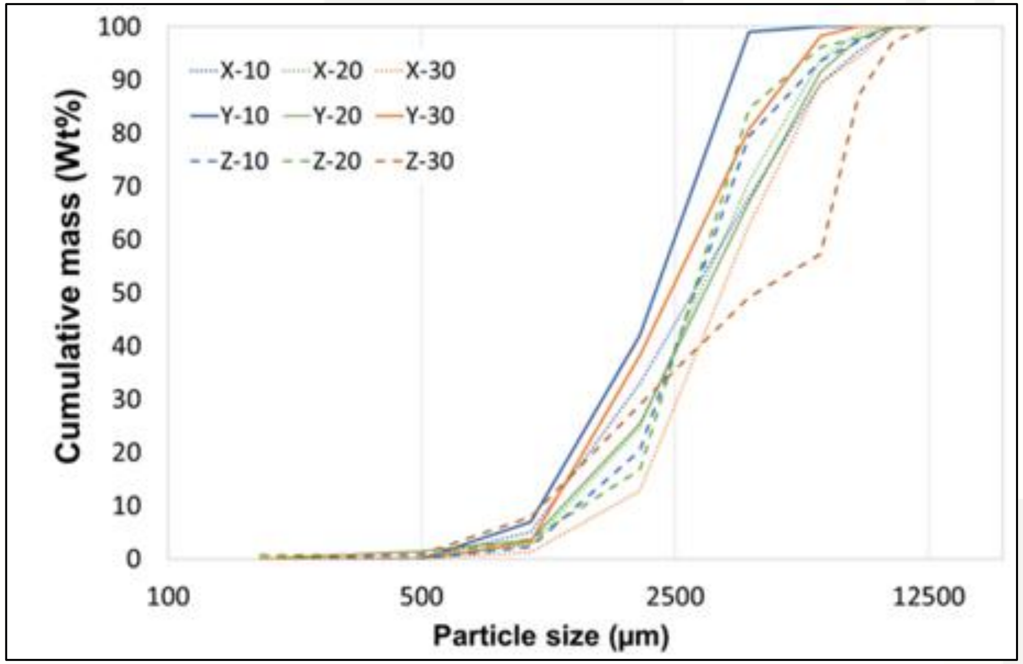
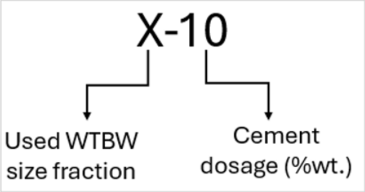
Artificial aggregate production using SWTB



Particle size distributions of the raw materials used for aggregate production



Particle size distributions of the produced aggregates



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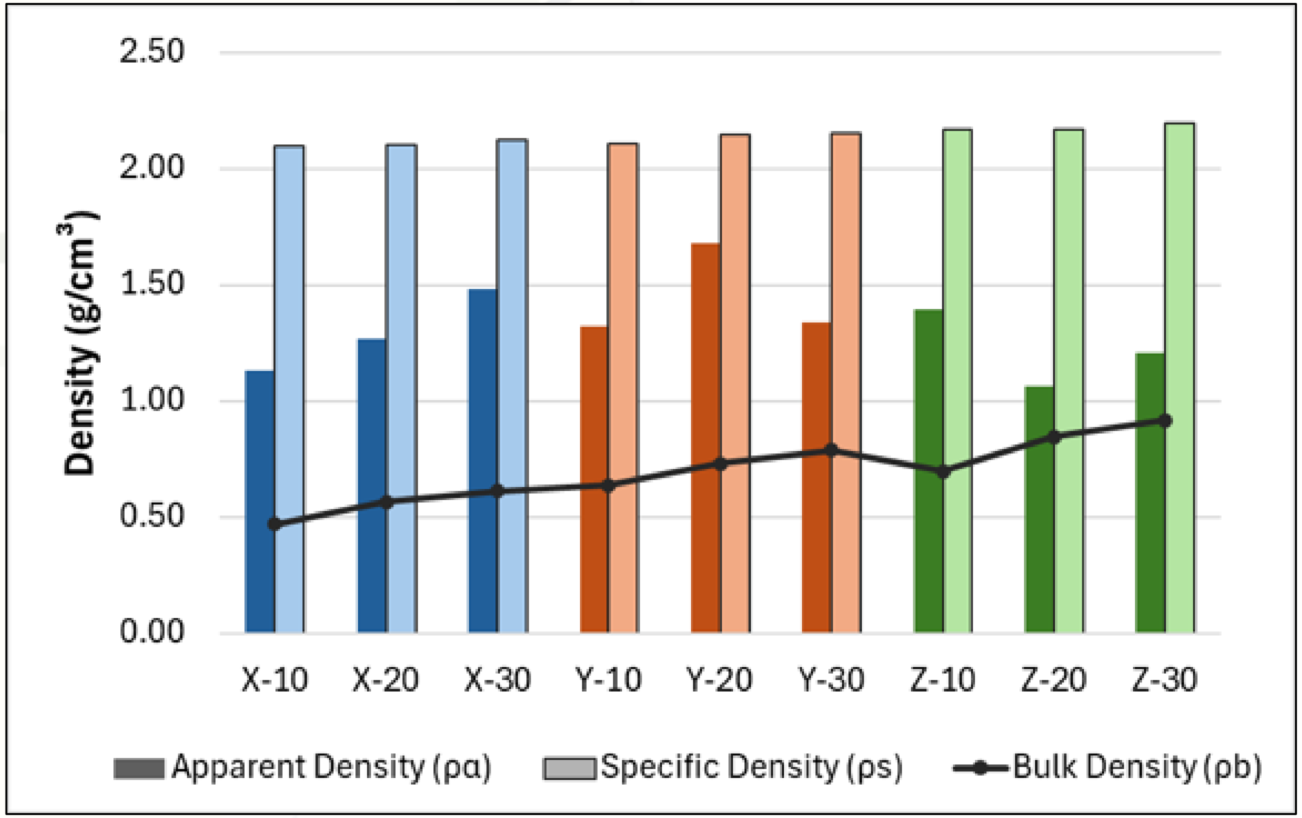
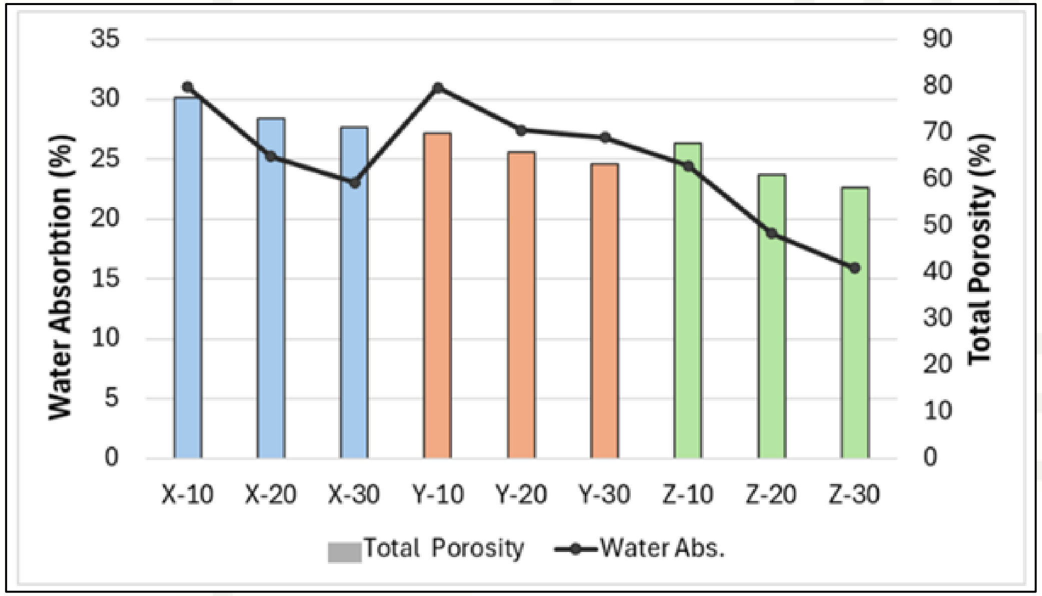
Properties of SWTB aggregates



- Upper limit of bulk density for lightweight aggregates is 1.2 g/cm³ according to EN 13055-1.
- The loose bulk density of all produced aggregates were below 1 g/cm³.

Lightweight aggregate



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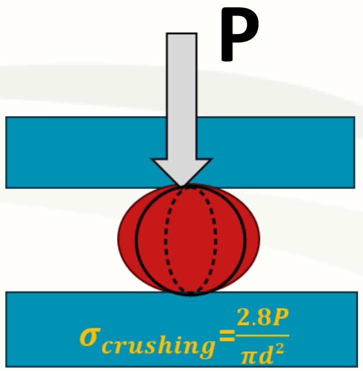
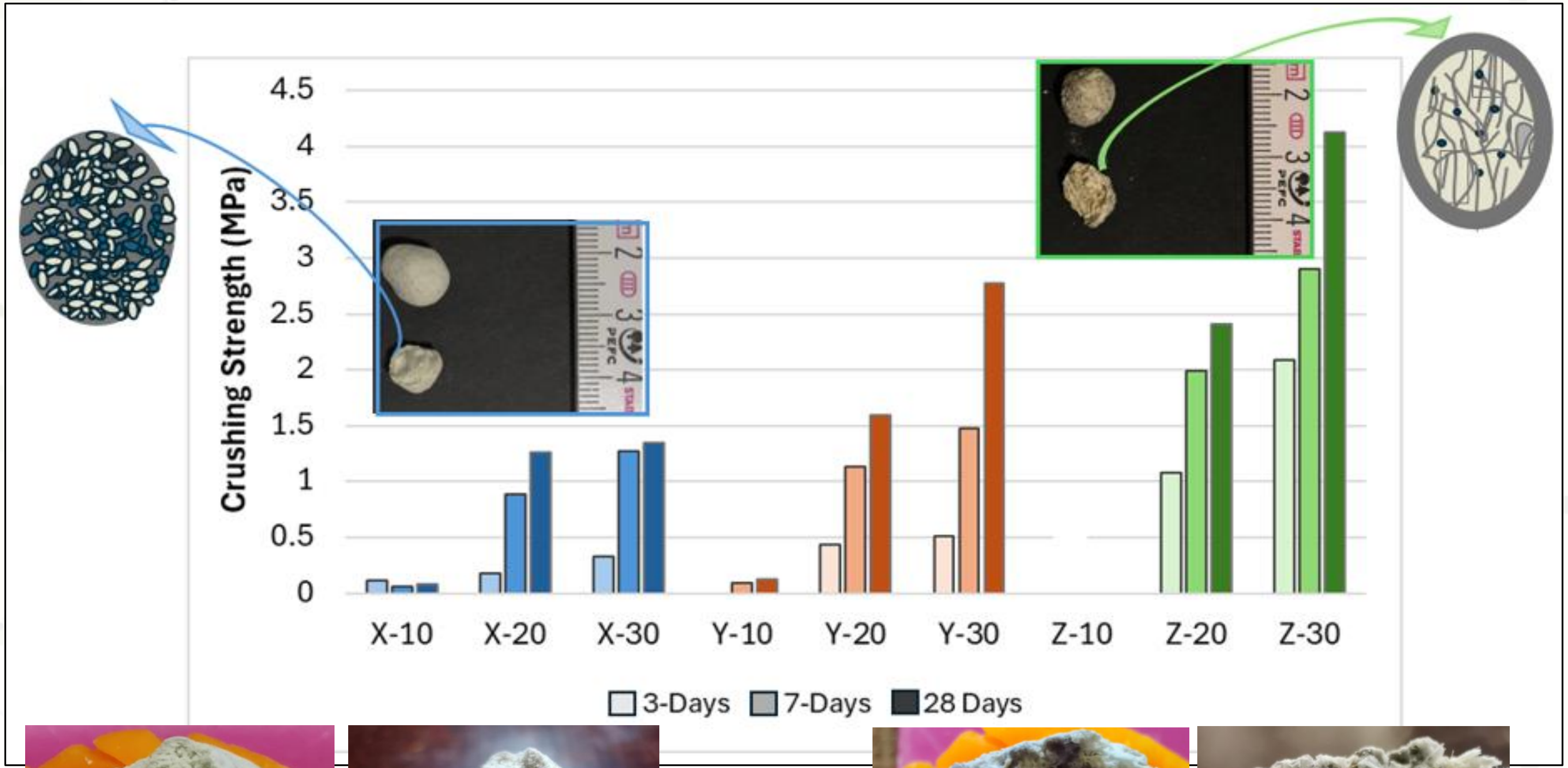
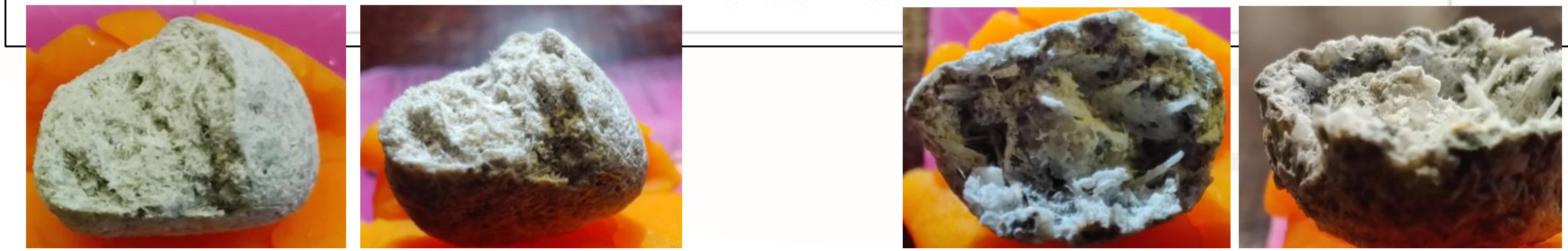
Properties of SWTB aggregates







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Performance of SWTB aggregates in mortars

Mortars are prepared with Z-30 aggregates with 50% and 100% sand replacement

Materials (kg)	Density (g/cm^3)	REF	Z30 - 50%	Z30 - 100%
Cem I 42.5 N	3.15	1.017	1.017	1.017
Sand	2.65	2.288	0.887	0.000
Z-30 Aggregate	1.6	0.000	0.887	1.381
Water	1	0.478	0.478	0.478

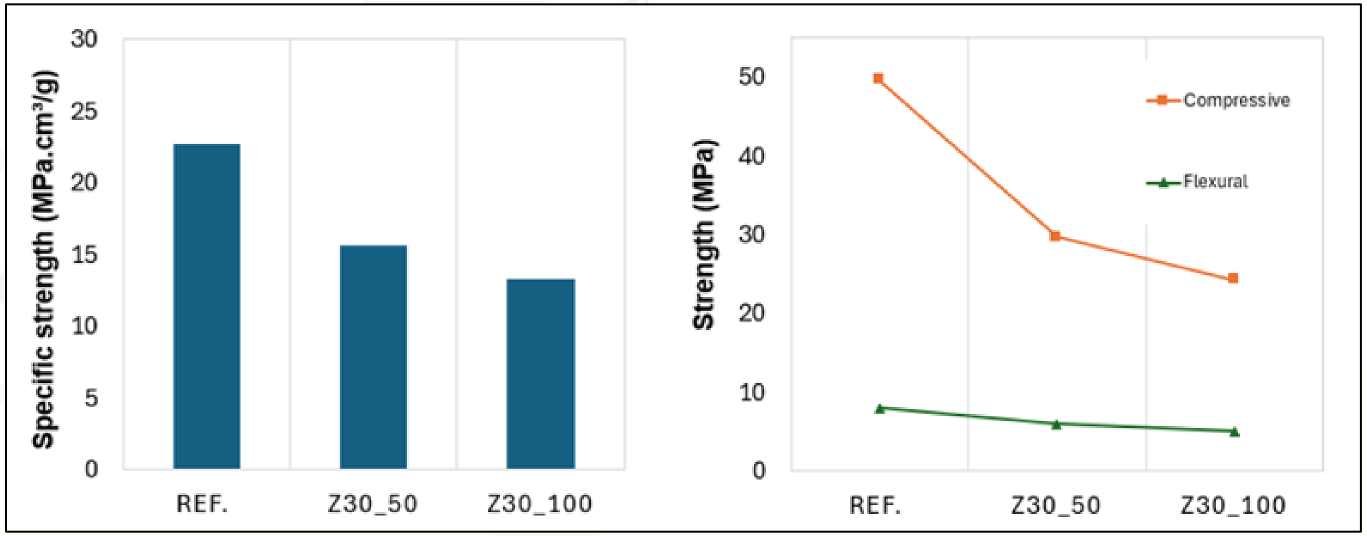

Ref mortar

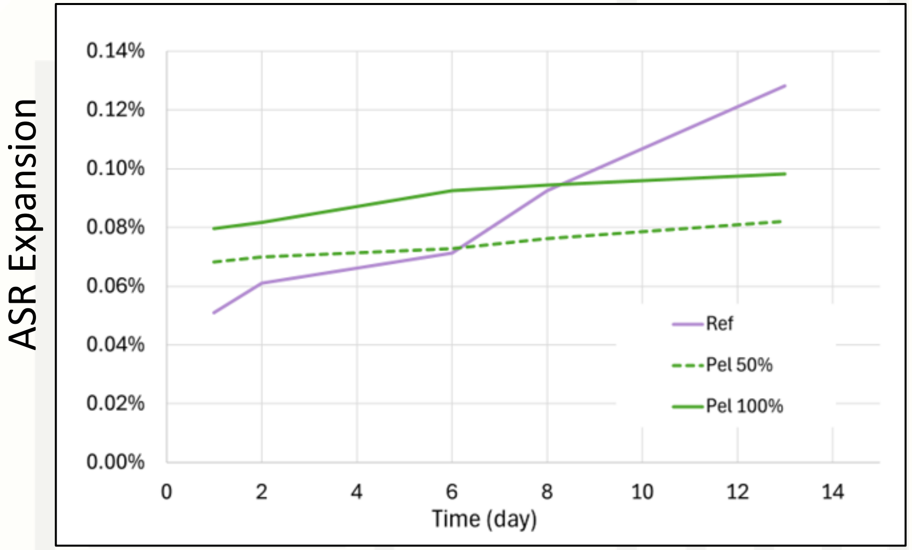

Z30-100 Mortar

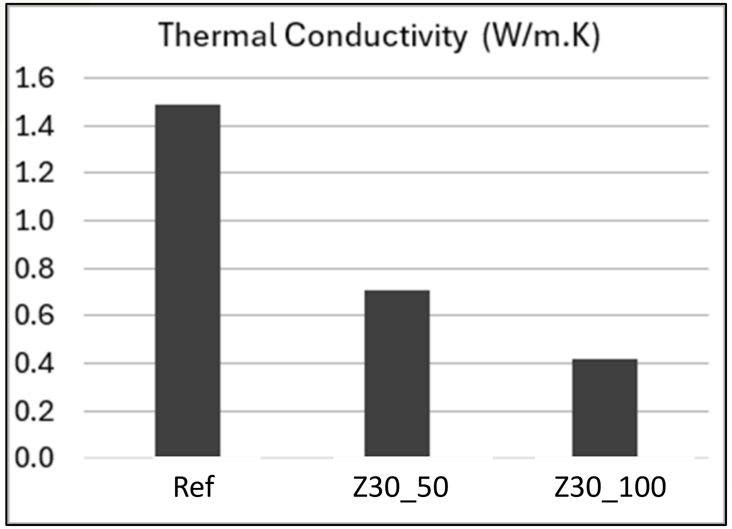
33.6 % WTB in total mortar mass

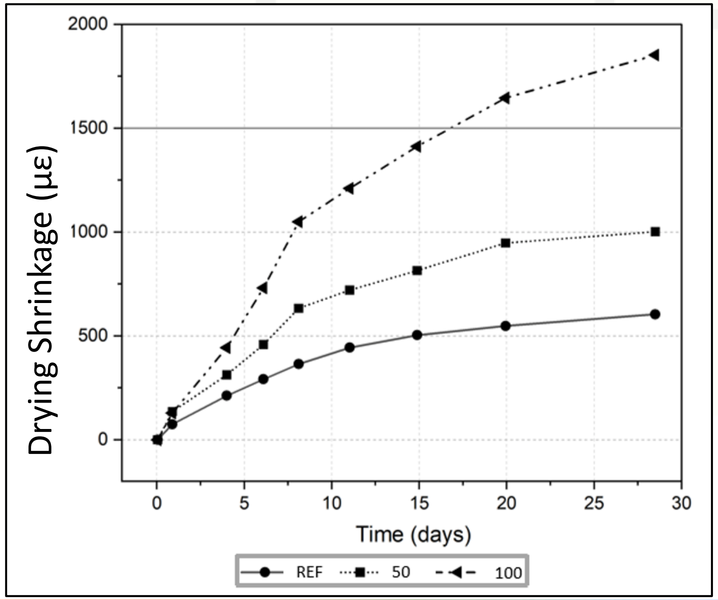

5% SWTB replaced mortar

Performance of SWTB aggregates in mortars









- ✓ Leaching test preformed and no heavy metal leaching risk found according to Dutch Soil Quality Regulation (SQR)

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Cold-bonded lightweight aggregates rich in wind turbine blade waste for sustainable concrete

Patented method& product:
“Method for producing artificial lightweight aggregates from shredded wind turbine blade waste and a binder as well as artificial lightweight aggregates.”

Conclusions

A high-value end-of-life solution for retired wind turbine blades.

Converting difficult composite waste into usable lightweight aggregate.

Easy and scalable production using only a pelletizer and humid curing.

Effective utilization of high amounts of wind turbine blade waste

- Structural lightweight concrete
- Non-structural concrete applications
- Thermal insulation applications
- Green infrastructure
- Prefabricated products

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LWA PELLET

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Thank you

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BLADES2BUILD

Recycle, repurpose and reuse end-of-life wind blade composites – a coupled pre- and co-processing demonstration plant

From Waste to Resource: Circular Innovation in Construction Transformation and Findings in Asphalt

Duc-Tung DAO
R&D Research Scientist
Holcim Innovation Center

06.07.2026 | Teams

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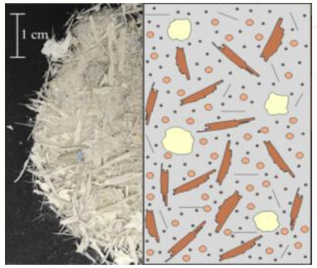
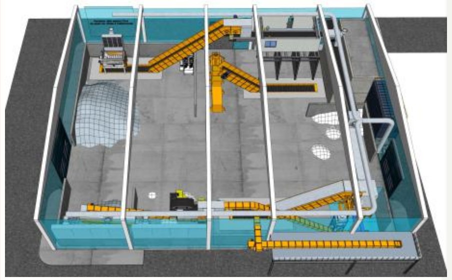
R&D road map

Characterisation of the WTB wastes and developed methods on treatment of WTBW



Developed circular building materials with WTB waste

Construction of demonstration plant for **to recycle end-of-life wind turbine blades**



Industrial Scale Concrete Pavements Demonstrators

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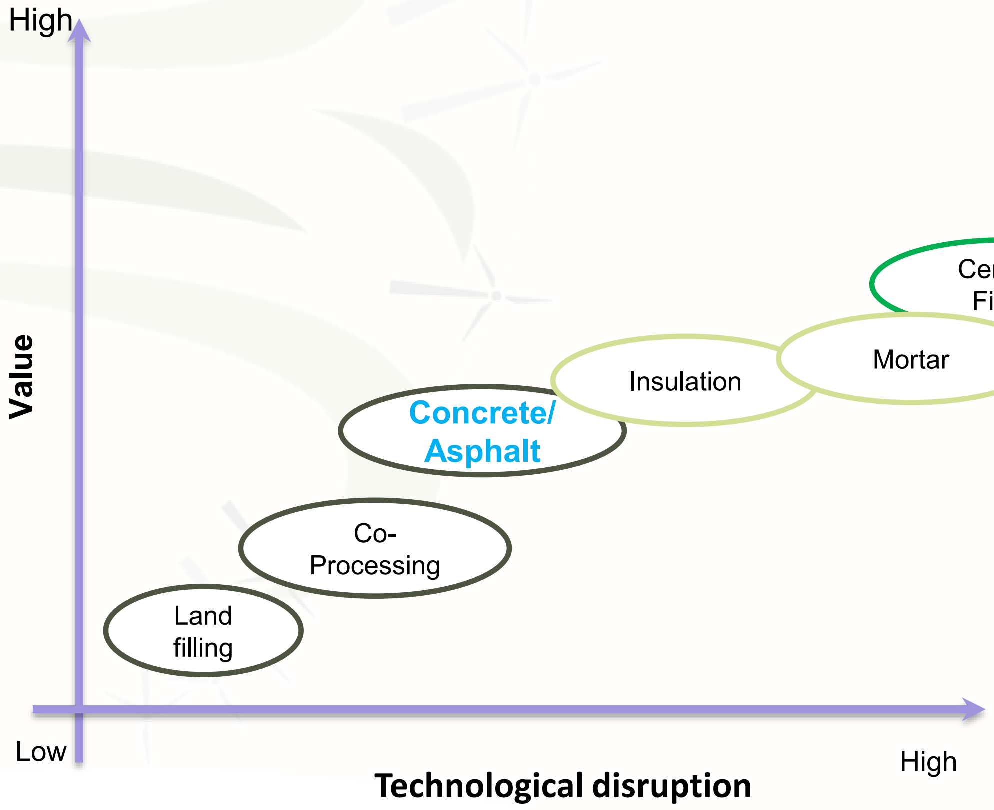
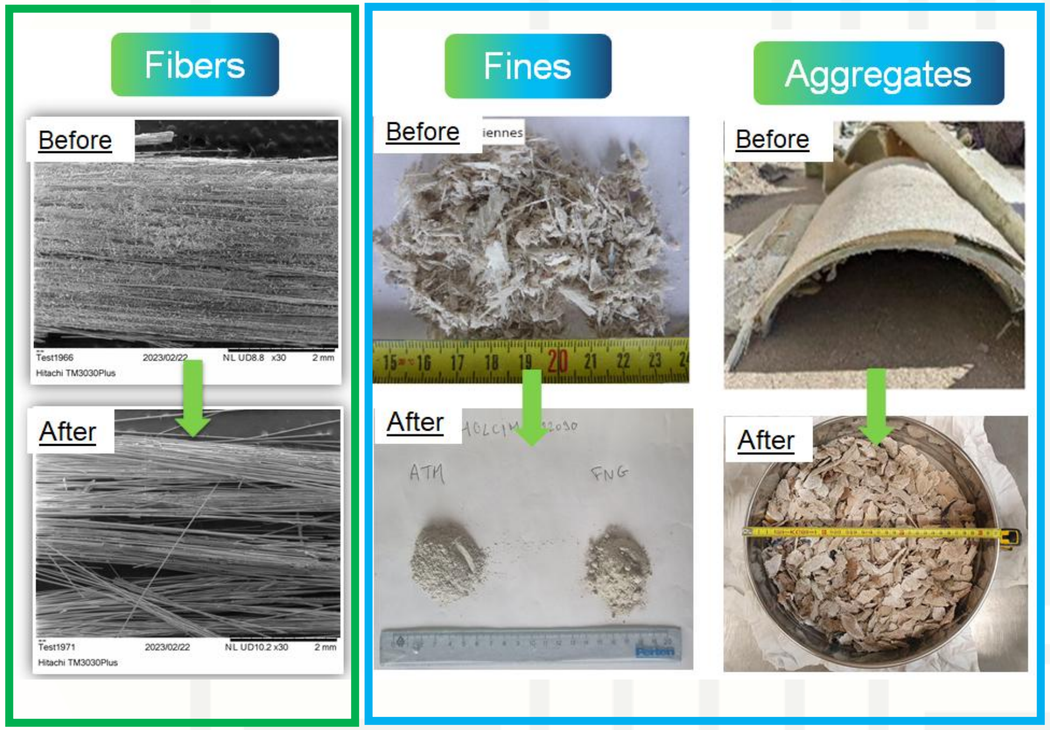
From Waste to Resource: Circular Innovation in Construction Transformation





Thermal and chemical transformation

Mechanical transformation

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Use of recycled fibres in asphalt (ACCIONA)

Objectives and methodologies

Evaluate the feasibility and performance of recycled glass fibres (rGFs) obtained through different recycling technologies in asphalt concrete mixtures, compared with conventional asphalt mixtures and compliance with Spanish road construction specifications, assessing their effect on:

- Asphalt mixture workability and production
- Density - UNE-EN 12697-6
- Internal structure (air void content) - UNE-EN 12697-8
- Durability against water damage (water sensitivity) - UNE-EN 12697-12
- Mechanical behaviour and structural performance (stiffness) - UNE-EN 12697-26, Annex C.

Tests results with recycled fibres (solvolysis and pyrolysis) with residual content of resin at 1%

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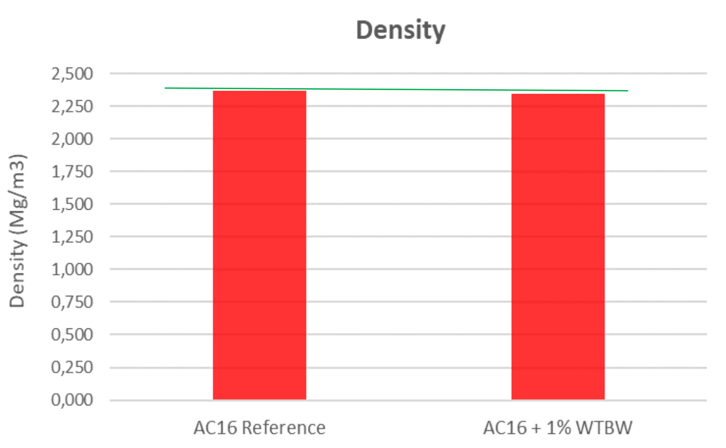
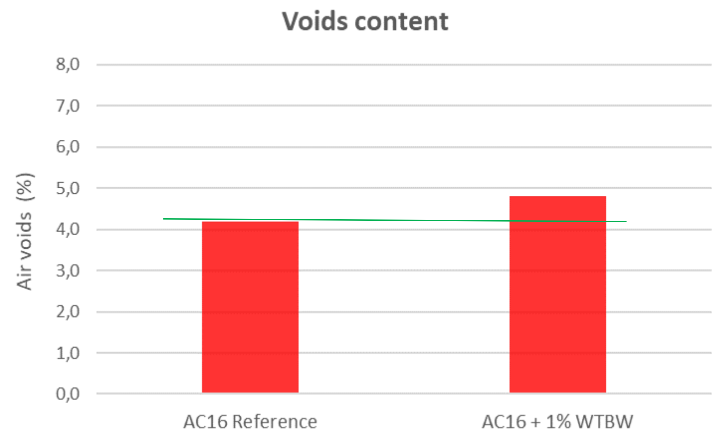
Use of recycled fibres in asphalt (ACCIONA)

Asphalt design and results





Asphalt mixture selected for the study:

- AC16S - siliceous & limestone aggregates + B 50/70
- Production temperature= 165 °C

- Recycled fibres well integrated into the bituminous matrix & well coated by the binder
- No significant impact has been observed in mixing and density/voids content for the asphalt mixtures modified with fibres compared to the reference mixture

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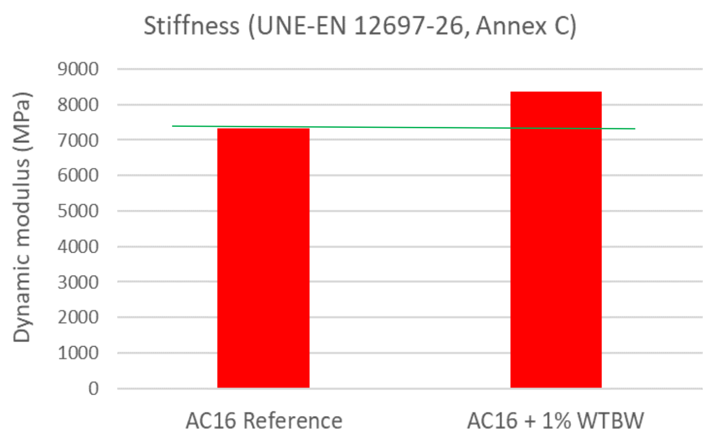
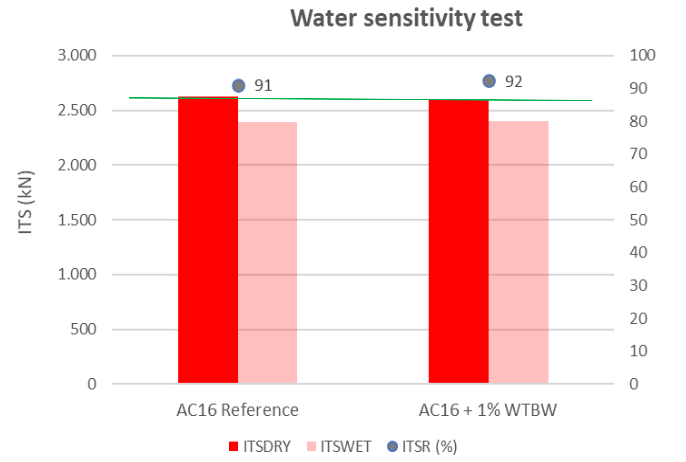
Use of recycled fibres in asphalt (ACCIONA)

Asphalt design and results





- **Stiffness:**
  - Recycled fibres obtained by **solvolysis** showed the best overall performance, with **1% fibre content** giving the most favorable results. A reinforcement is likely seen with the addition of fibres
  - The addition of recycled fibres increased **stiffness by 14–45%**, depending on fibre type
- Mixtures with recycled fibres exhibited **higher moisture damage resistance** than the reference mixture

=> All designed mixtures **meet the strictest Spanish road specifications**, allowing their use on any Spanish roadway

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QR Survey

ASPHALT

Thank you!

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ACC - Acciona
HIC – Holcim Innovation Center

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BLADES2BUILD

Wind turbine blade waste as fibre reinforcement for cementitious composites

Presenter: Dr. Tao Liu, Dr. Cynthia Moralez Cruz

From DTU/RWTH

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DTU

Content

1. Project background
2. Wind turbine blade waste materials
3. Strategy and pathway
4. Reinforcement pathway
5. Final remarks

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3. Strategy and pathway – Can we use WTBW in cement – based composites

Repurposing WTBW in cement – based composites

Reinforcement + Replacement

Fiber reinforcement in cementitious matrix

Replace cement powder or aggregates

Potential impacts:

1. Advancing new material design theories based on cement chemistry.
2. Enabling customized performance and new design of green binders.
3. Enabling efficient and integrative use of complex solid wastes.

The research bridges material science theory with engineering application. It unlocks new possibilities for customizing binder performance while promoting efficient, eco-friendly solid waste utilization.

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3. Strategy and pathway

Reinforcement + Replacement

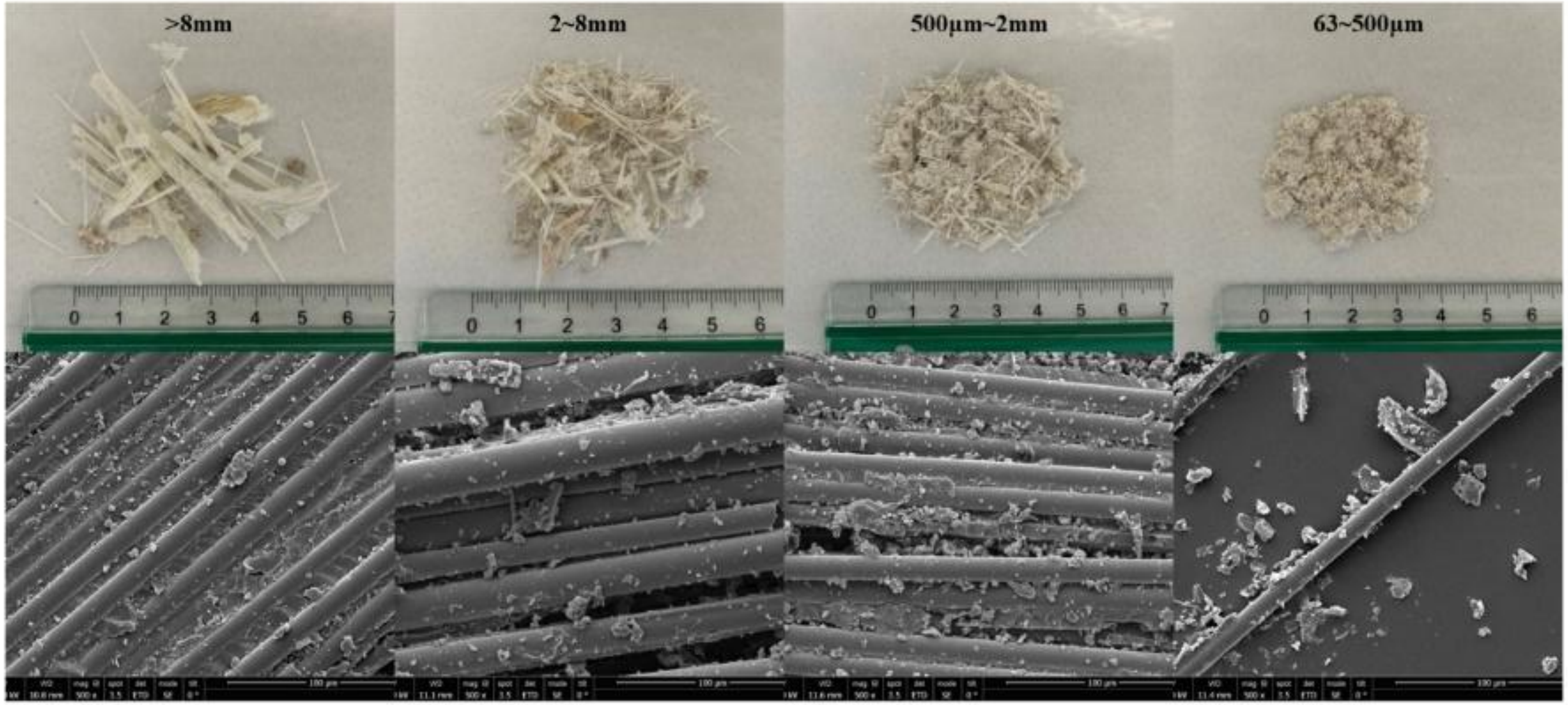
Fiber reinforcement in cementitious matrix

Replace cement powder or aggregates

Funded by the European Union

- Published paper: Mechanisms and applications of wind turbine blade waste in cementitious composites: A review 10.1016/j.matdes.2025.113732

4. Reinforcement pathway



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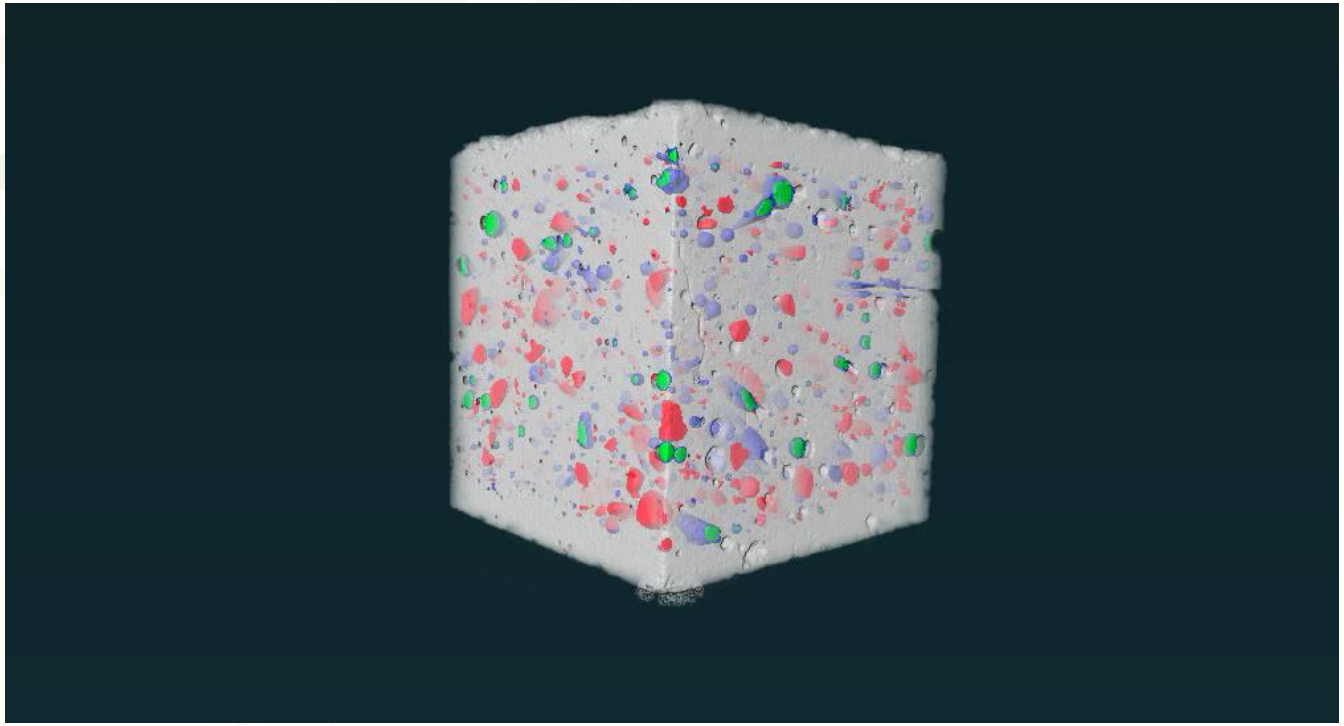
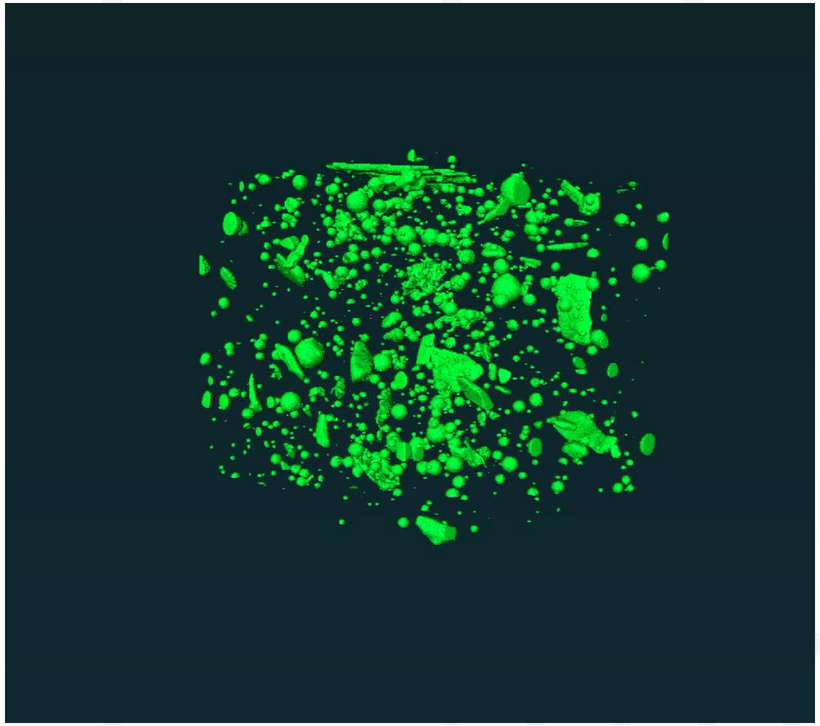
- Published paper: Impact of wind turbine blade waste fiber size on the properties of mortar: From material characteristics to performance. DOI: 10.1016/j.conbuildmat.2026.146416

DTU

4. Reinforcement pathway



WTB waste containing mortar

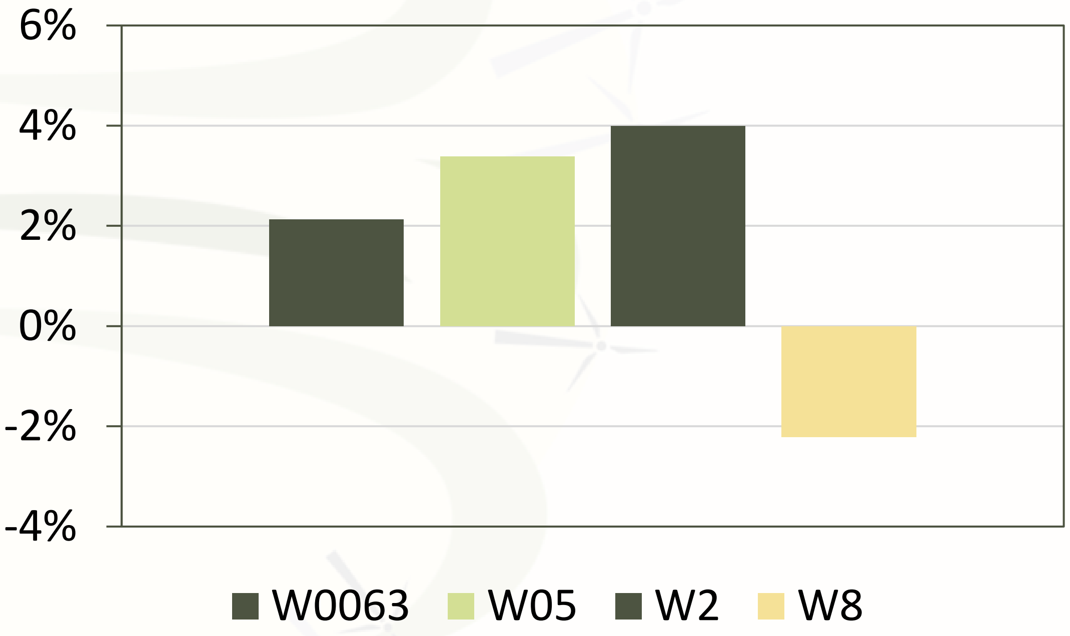


Pores and fibers

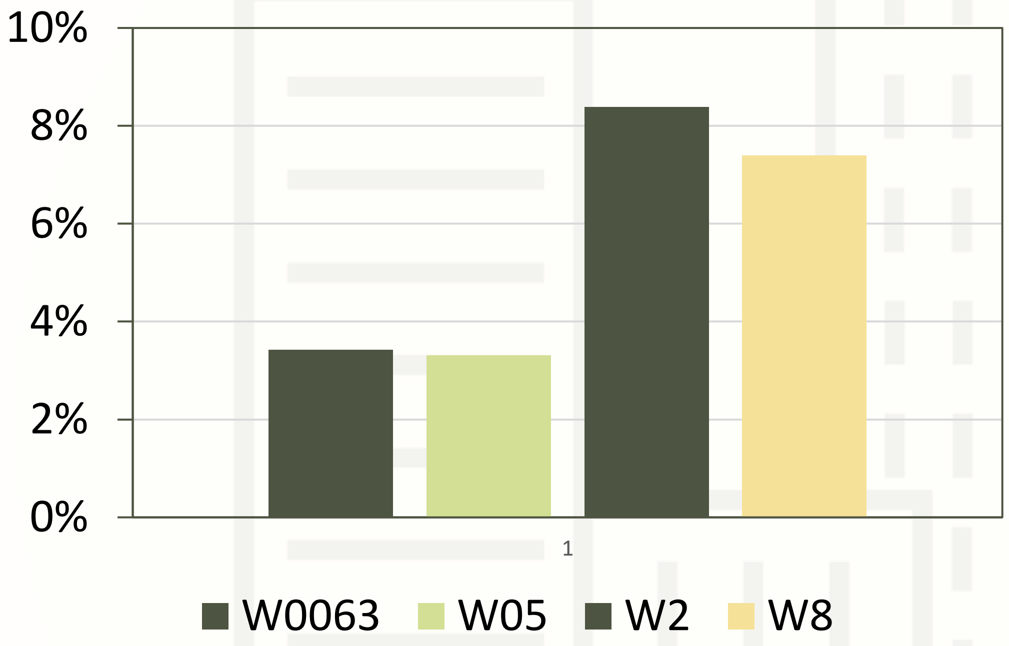
Funded by the European Union

- Published paper: Impact of wind turbine blade waste fiber size on the properties of mortar: From material characteristics to performance. DOI: 10.1016/j.conbuildmat.2026.146416

4. Results



Compressive strength changes by different sizes of WTBW

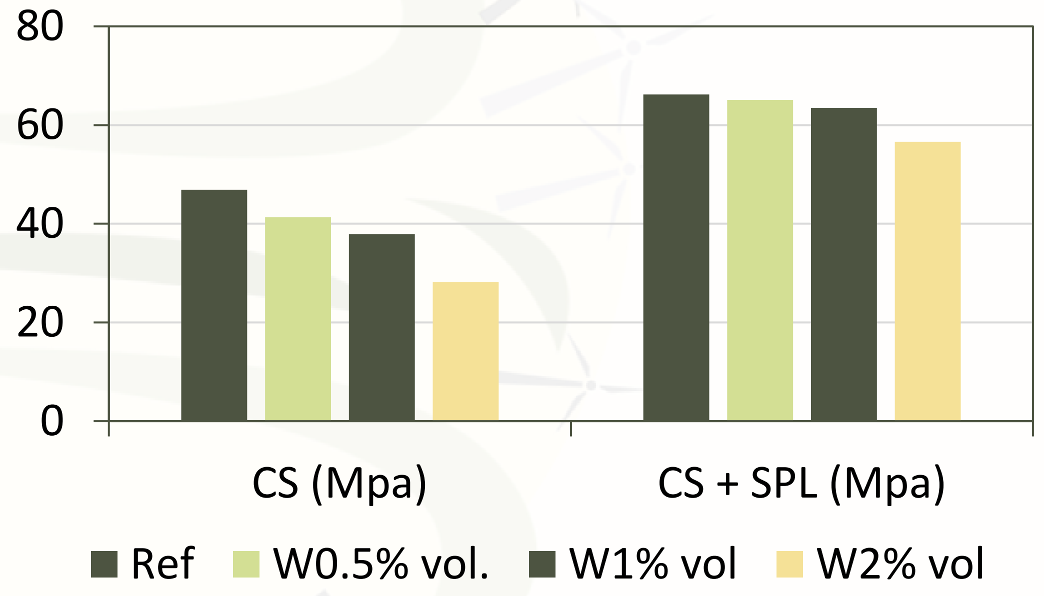


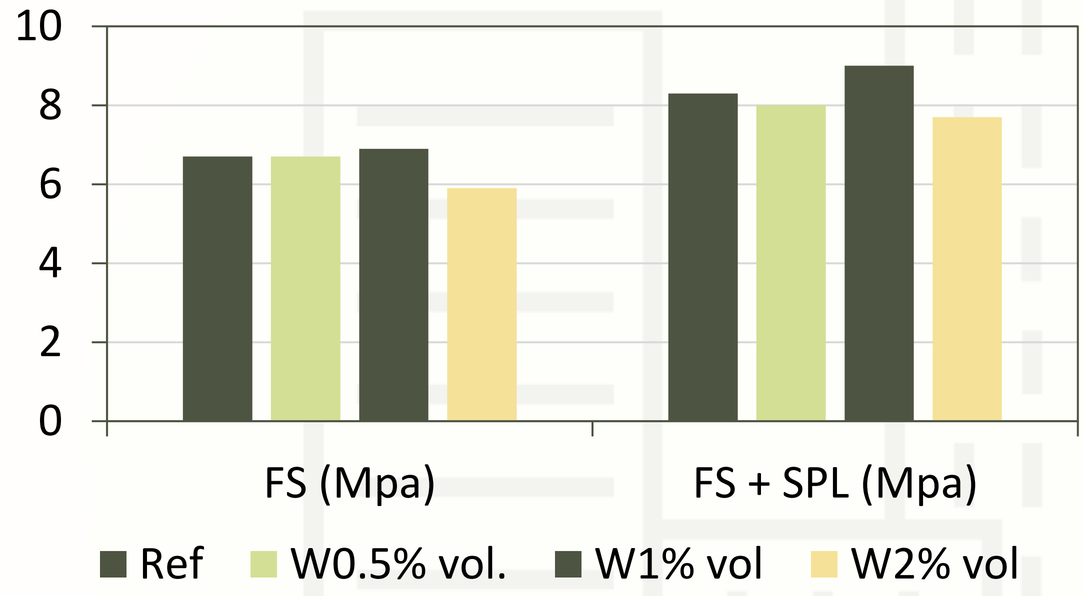
Flexural strength changes by different sizes of WTBW

Funded by the European Union

- Published paper: Impact of wind turbine blade waste fiber size on the properties of mortar: From material characteristics to performance. DOI: 10.1016/j.conbuildmat.2026.146416

4. Reinforcement pathway



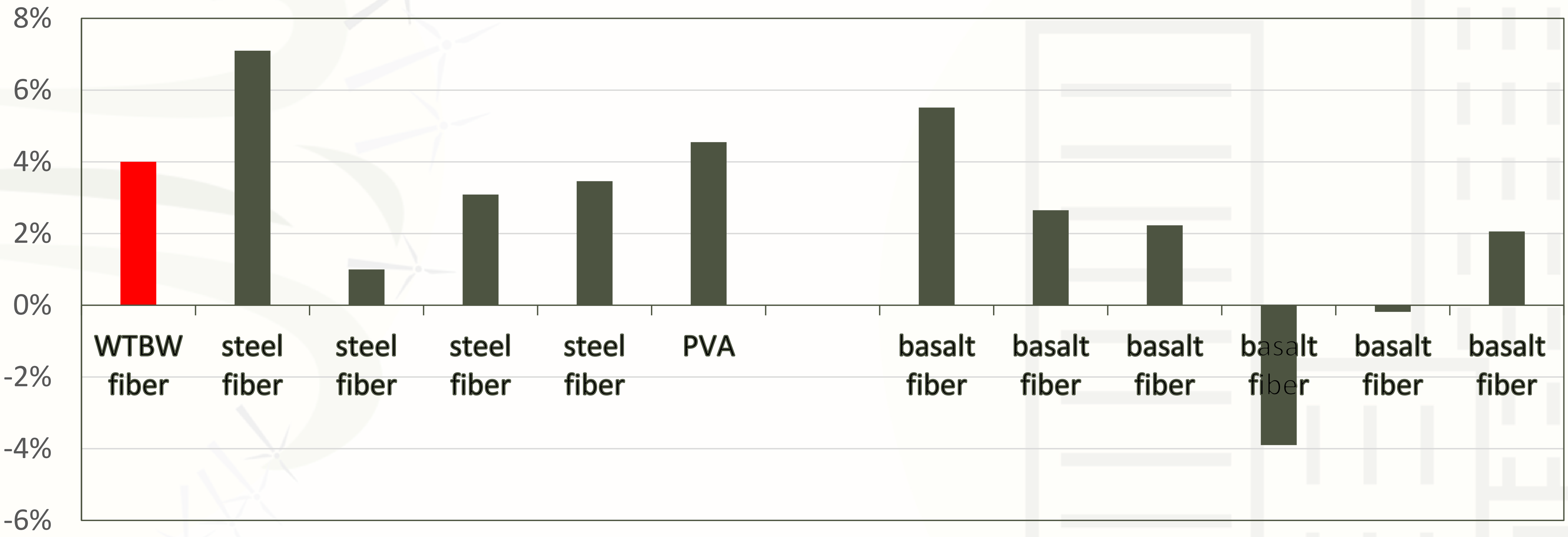


Compressive strength and flexural strength changes by different volume fractions of WTBW (with and without superplasticizers)

Funded by the European Union

- Published paper: Improving mortar properties with waste wind turbine blade fibers and superplasticizer. DOI: 10.1016/j.conbuildmat.2025.140864

4. Reinforcement pathway



Compressive strength changes with different fiber reinforcements at 0.5 vol.%

Funded by the European Union

- Published paper: Investigating the microstructure of mortar systems reinforced with wind turbine blade waste using X-ray computed tomography. DOI: 10.1016/j.conbuildmat.2026.145187

5. Final remarks

- **Repurposing route**: WTBW can enter cement-based composites through reinforcement or replacement pathways.
- **Reinforcement evidence**: Micro-CT and SEM confirm fibers/particles disperse in mortar and interact with pores and matrix.
- **Performance window**: Strength gains depend on fiber size, volume fraction and superplasticizer use; some mixes improve flexural behavior while compressive response varies.
- **Design implication**: Optimize size, dosage, dispersion and binder chemistry to balance mechanical performance, workability, durability and circularity.

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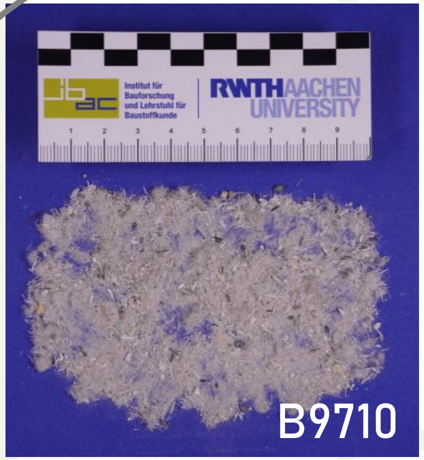
WTBW – Materials

Mechanically treated (from PreZero, HIC, ELDAN)



Sample no.	B9530	B9531	B9532	B9533	B9534	B9041	B9644	B9710
Density[1)] in g/cm³	1.99	1.95	2.00	1.99	1.94	1.87	1.78	2.03
Loss on ignition (LOI)[2)] in M.-%	36.7	36.8	34.7	33.9	41.1	29.9	43.0	34.1

[1)] Double determination, Helium Pyknometer
[2)] Ignition loss at 600°C 1h, pre-ashed for 30 min at 600°C

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WTBW – Materials

Chemically treated (from NTUA)

Sample no.	B9657	B9658
Density[1] in g/cm³	2.72	2.71
Loss on ignition (LOI)[2] in M.-%	0.22	0.12

[1] Double determination, Helium Pyknometer
[2] Ignition loss at 600°C 1h, pre-ashed for 30 min at 600°C

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WTBW – Materials

Thermally treated (from NTUA)

Sample no.	B9659	B9660
Density[1)] in g/cm³	2.73	2.68
Loss on ignition (LOI)[2)] in M.-%	0.02	0.24

[1)] Double determination, Helium Pyknometer
[2)] Ignition loss at 600°C 1h, pre-ashed for 30 min at 600°C

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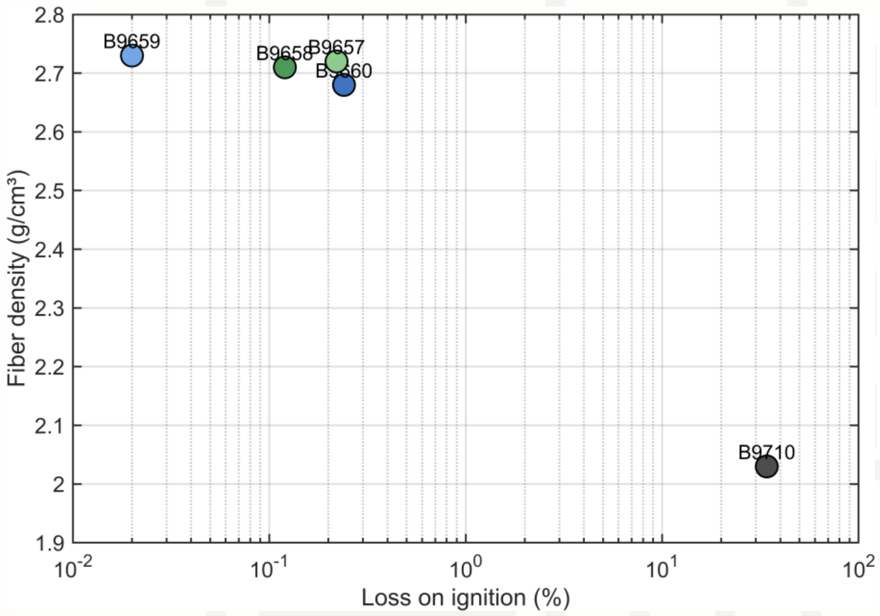
Mortar Mixture

Standard Mortar Mixture (DIN EN 197-1)

- 450 g CEM I 42.5 R
- 1350 g CEN-standard sand
- 225 g water
- 8 g WTBW ≈ (1.8 M.-% binder content)



WTBW-Mixtures

- Reference, without WTBW
- B9710 are mechanically treated WTBW
- B9659, B9660 are thermally treated WTBW
- 9657, B9558 are chemically treated WTBW

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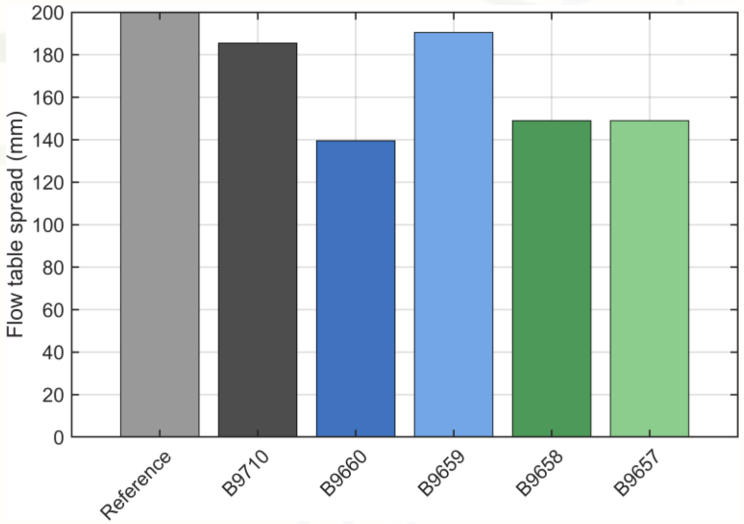
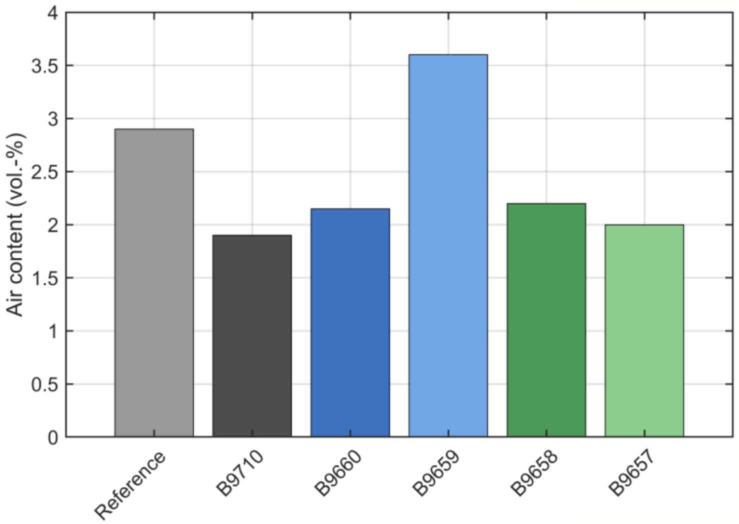
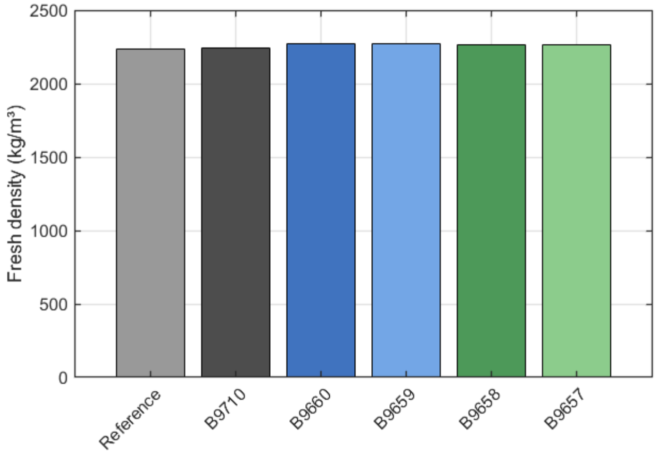
Fresh mortar properties







→WTBW incorporation mainly affected workability, with B9660 and chemically treated WTBW showing a reduced flow table spread compared to the reference mixture

→Fresh mortar density remained comparable for all mixtures, while the increased air content of B9659 may explain its reduced compressive strength.

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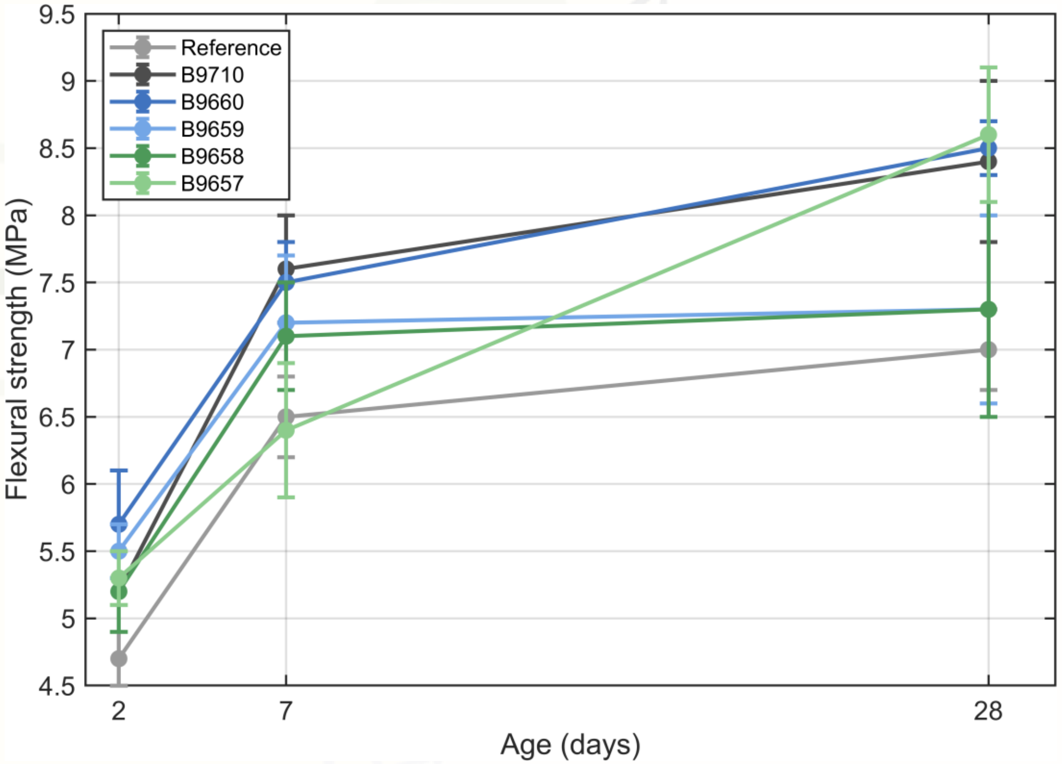
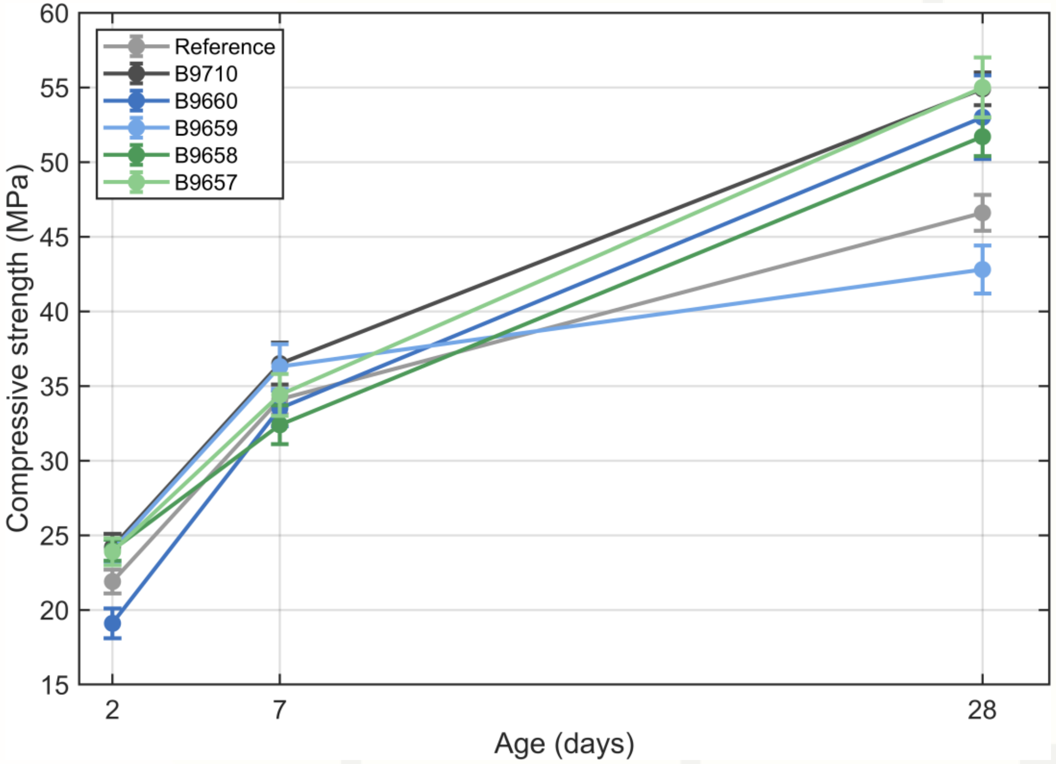
Hardened mortar properties – strength development





→Recovered glass fibers maintained or improved mechanical performance compared to the reference mixture, independent of the recycling route.

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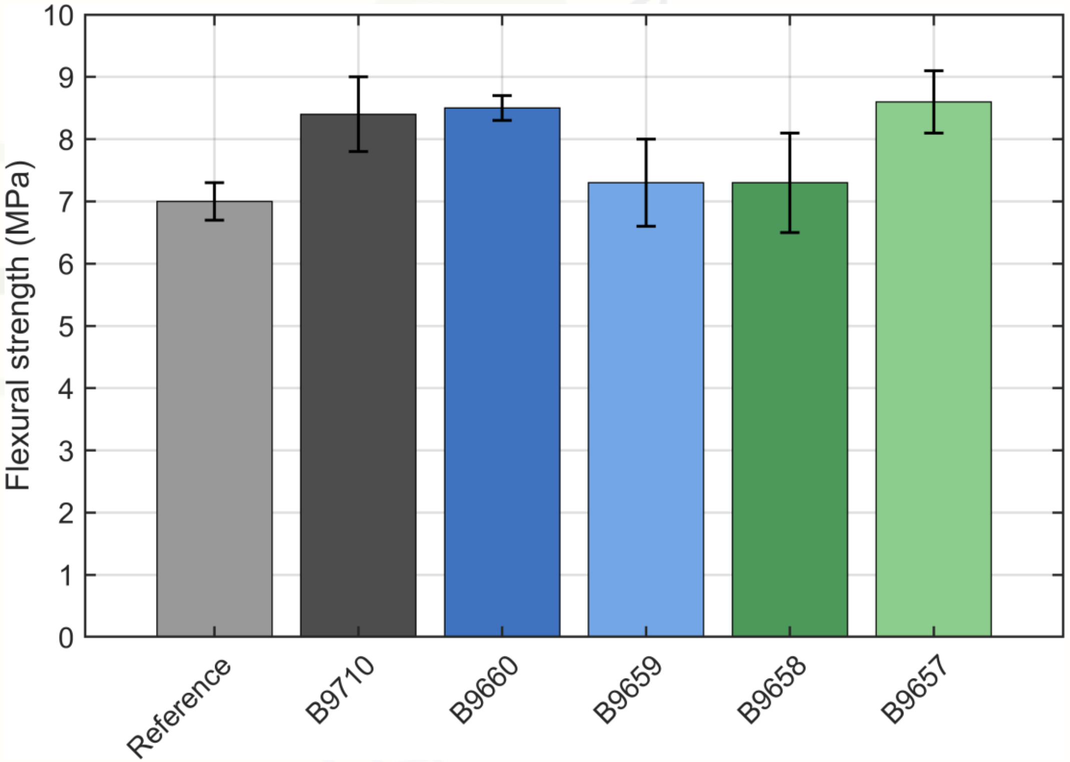
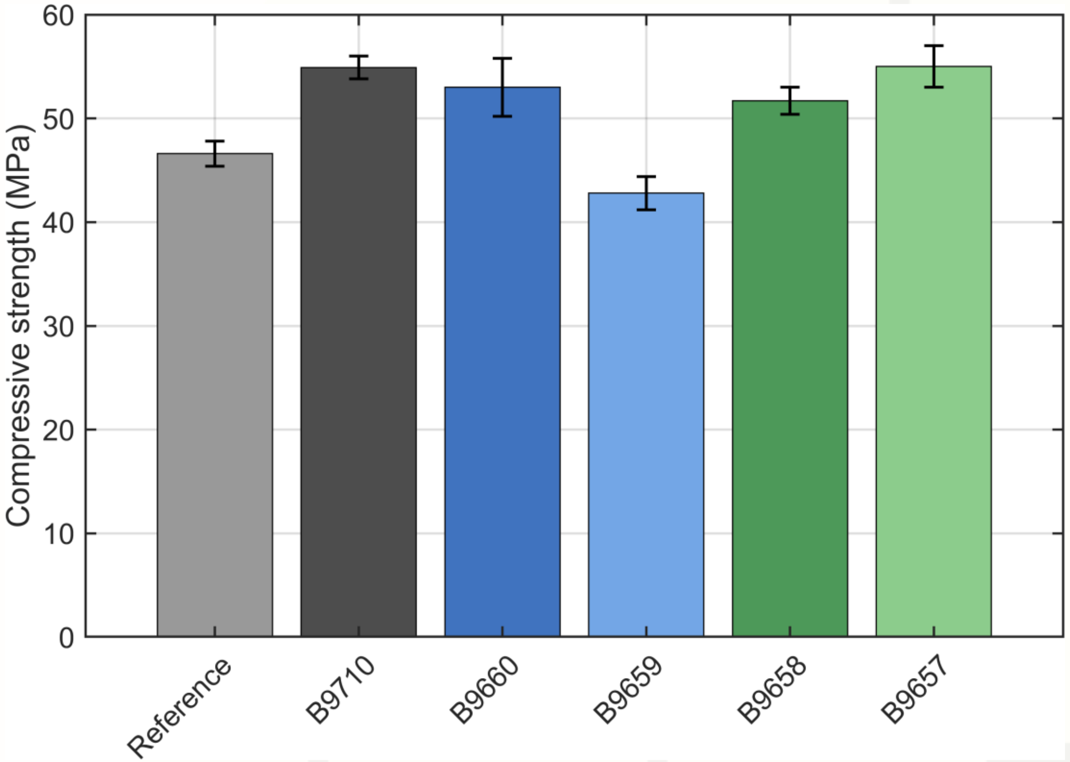
Hardened mortar properties – 28 days





→All WTBW-mixtures achieved comparable or improved flexural strength compared to the reference, confirming the reinforcing potential of WTBW.

→Most WTBW-mixtures exceeded the reference strength, while B9659 showed reduced compressive performance, likely related to increased air content and matrix effects.

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Summary

→The recycling process strongly influenced WTBW characteristics: thermal and chemical treatments significantly reduced organic residues (LOI <0.3%) and increased fiber density compared to mechanically recovered fibers.

→All recovered fiber mixtures exhibited comparable early-age strength development, indicating no negative impact of residual fiber components on cement hydration.

→Differences at 28 days, particularly for B9659, suggest that mechanical performance is mainly influenced by mixture-specific parameters such as air content and fiber characteristics rather than LOI alone.

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MORTARS

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Thank you!

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DTU/RWTH

www.blades2build.com

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DTU

BLADES2BUILD

Recycle, repurpose and reuse end-of-life wind blade composites – a coupled pre- and co-processing demonstration plant

From Waste to Resource: Circular Innovation in Construction Transformation and LCA

Victor Pacheco
Innovation Project Manager
Holcim Innovation Center

David Hysi, Dr. Rose Mankaa
RWTH Aachen University

06.07.2026 | Teams

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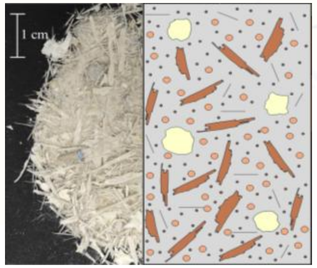
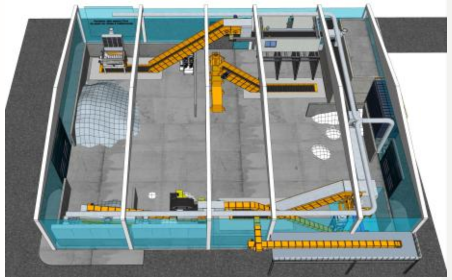
R&D road map

Characterisation of the WTB wastes **and** developed methods on solvosisys and pyrolysis of WTBW



Developed circular building materials with WTB waste



Construction of demonstration plant for **to recycle end-of-life wind turbine blades**

Industrial Scale Concrete Pavements Demonstrators

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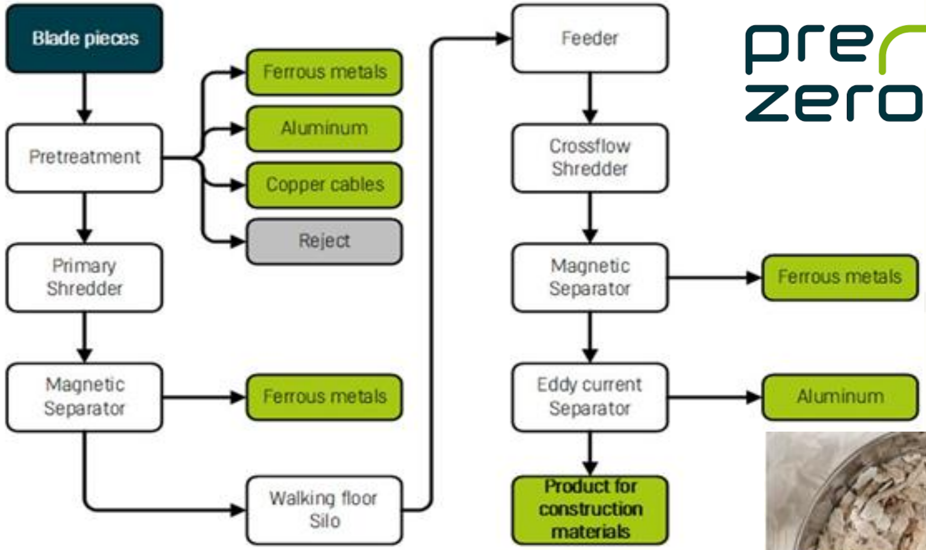
INDUSTRIAL TRIALS

FROM OLD TURBINE BLADES TO RECYCLED AGGREGATES REPLACING NATURAL AGGREGATES

- The old turbine blades are cut into transportable sections and delivered to a crushing facility. There, the composite material is milled into an alternative aggregate
- Through this process, the 0/10 mm and 0/40 mm aggregate were manufactured.
- The Holcim Innovation Center (France) and Holcim Spain Concrete Laboratory created a pioneering formulation incorporating recycled fibers from wind turbine blades with CDM under ECOCycle brand



prezero

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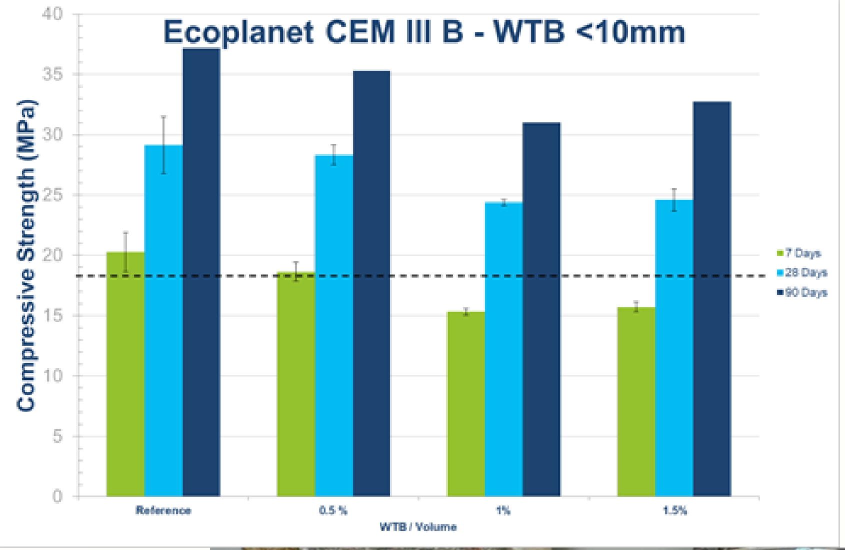
HOLCIM

INDUSTRIAL TRIALS

INDUSTRIAL SCALABILITY TRIAL

- Recycled Content: The final concrete dosage incorporated a content superior to 10% of recycled material using Holcim's ECOCycle Technology expertise
- Adding the material to the concrete can affect workability and strength which has been resolved due to Holcim's mix design expertise



ECOCYCLE

HOLCIM

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INDUSTRIAL TRIALS

ENDESA DEMONSTRATOR

Endesa and Holcim have conducted an industrial trial during the **repowering of Endesa's wind farm** in Aldeavieja (Ávila), using concrete that integrates crushed fibres from dismantled wind turbine blades

ECOPact Concrete range (low carbon- **~30% CO_2** vs. Standard Concrete)- C30/37 S4 to make 44m^2 slab for on-site waste park.

First wind farm in EU reusing its own structural waste to build new infrastructure.

Video

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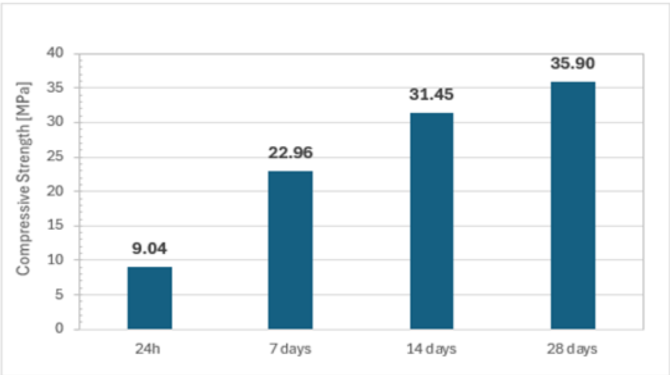
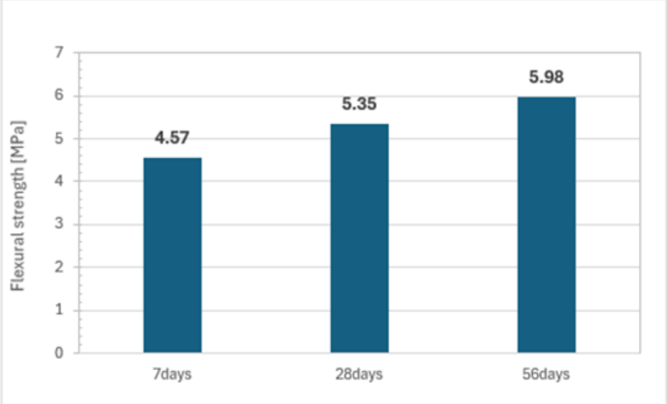
HOLCIM

INDUSTRIAL TRIALS

Industrial Scale Concrete Pavements Demonstrators

The new material is based on Holcim's **ECOPact** concrete with **ECOCycle® technology**, which incorporates 11% recycled content made up of recycled aggregates and, as a novel feature, material from the crushing of wind turbine blades at the end of their service life. Additionally, the prototype includes ECOPlanet CEM V/A (Q-S) 42.5N cement with a low carbon footprint, thanks to its reduced clinker content, resulting in a **49% reduction in CO_2 emissions compared to the reference cement** (sectoral EPD CEM I).





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INDUSTRIAL TRIALS

New Industrial trials with the Holcim ECOcycle B2B concrete in large-scale processes. 4th March 2026.

Location: ACCIONA facilities (Algete)
Concrete mix: Holcim **ECOCycle®** technology with **ECOPlanet CEM III/B**

Goals:

- Proof developed concrete on a real industrial process such concrete curing (HECON formwork developed by PERI).
- Detailed the possible effect on the concrete curing for a real production processes (formwork removal).
- Characterization of concrete maturity to avoid timing limitations on some applications.

Conclusions:

A key achievement of this milestone is proving that more sustainable concrete can be integrated into industrialized construction processes without altering standard production cycles.

- This represents a major step forward to:
    - Scale circular solutions across the construction sector
    - Reduce carbon footprint without sacrificing productivity
    - Accelerate the transition to a more sustainable built environment

BLADES2BUILD

Life Cycle Assessment (LCA) of Wind Turbine Blade Waste (WTBW) shredded composite, and its incorporation into C30/35 structural concrete.

Presenter: **Dr. Rose Mankaa, David Hysi**

From RWTH

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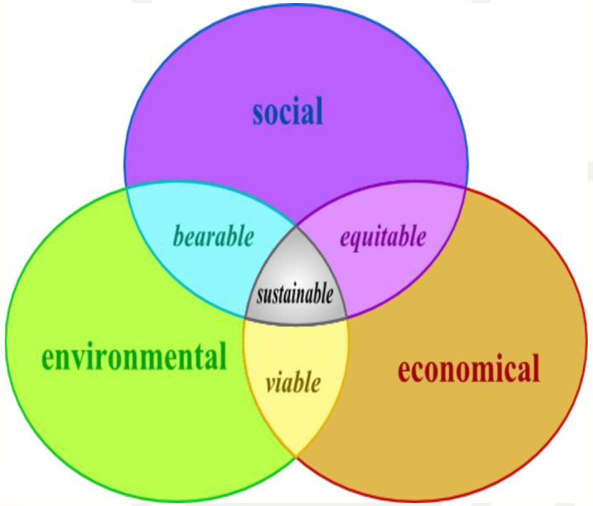
What is SUSTAINABILITY?

This definition was given by the Brundtland Commission:

"Sustainable development is a development that meets the **needs** of the present without compromising the ability of future generations to meet their own **needs**" (WCED,1987).

- In the word "**needs**" are included the three dimensions we need to consider for a decent life:
  economic, environmental and social.
- A long-term view.



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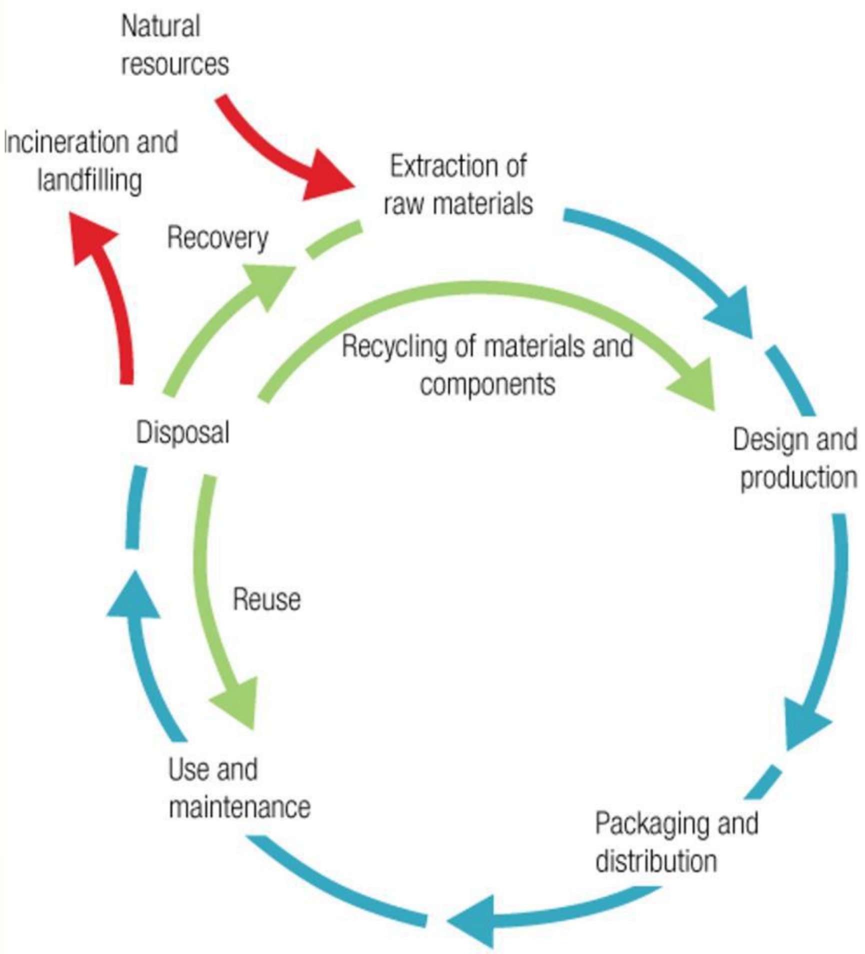
Life Cycle Thinking approach

- **Life Cycle Thinking** (LCT) is about going beyond the traditional focus on production site and manufacturing processes to include environmental, social and economic impacts of a product over its entire life cycle.
- The main goals of LCT are to **reduce a product's resource use and emissions** to the environment as well as **improve its socio-economic performance** through its **life cycle**. This may facilitate links between the economic, social and environmental dimensions within an organization and through its entire value chain.



Source: UNEP Life cycle initiative

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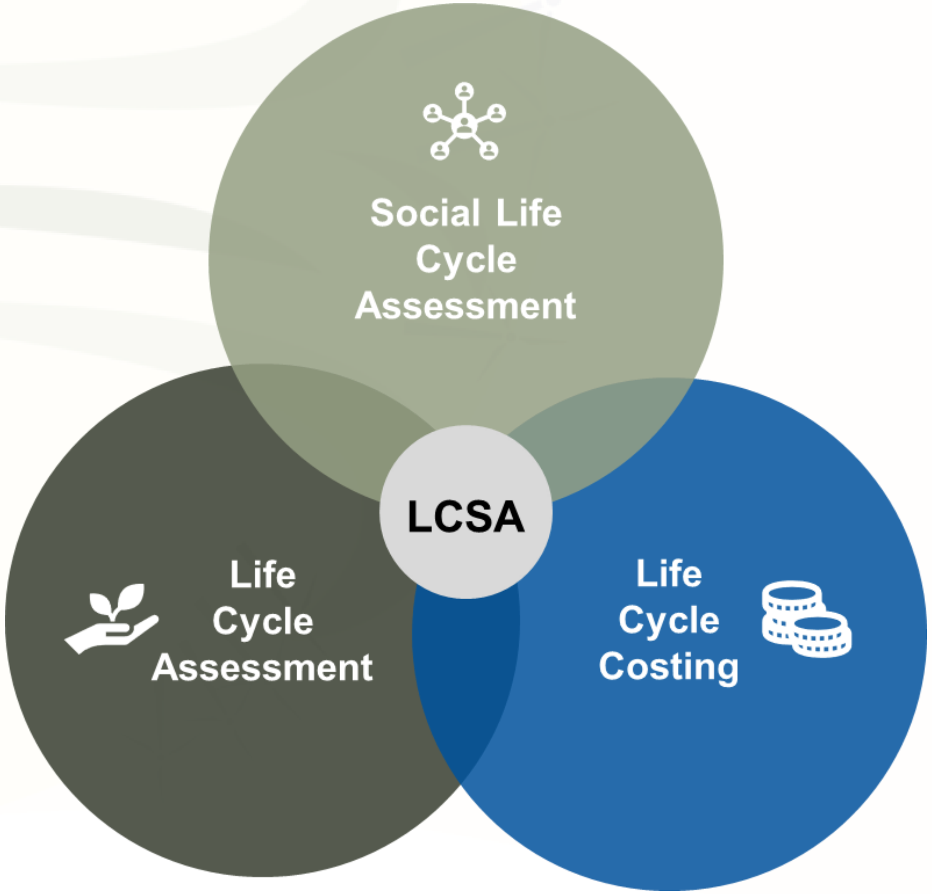
Life Cycle Sustainability Assessment



Social Life Cycle Assessment
S-LCA Guidelines
ISO 14075

Life Cycle Assessment
ISO 14040/44, EN 15804, ISO 21930, EN 15978

Life Cycle Costing
ISO 15686-5

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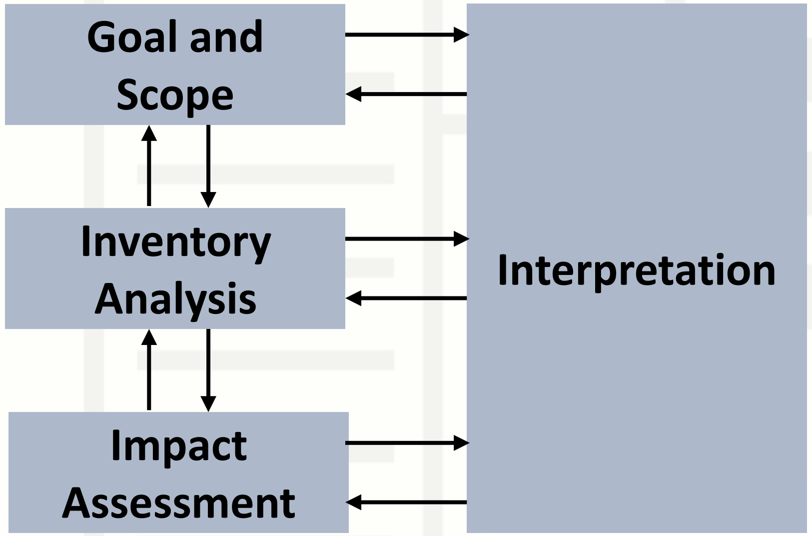
What is Life Cycle Assessment?

"**Compilation** and **evaluation** of the inputs, outputs and the potential environmental impacts of a product system **throughout its life cycle**"

- Life Cycle Assessment (LCA) models the complex **interactions between a product and the environment** from cradle-to-grave.
- Standardized through **ISO 14040:2006** and **ISO 14044:2006**.
- Carried out in four distinct phases.

Framework of Life Cycle Assessment under ISO 14044



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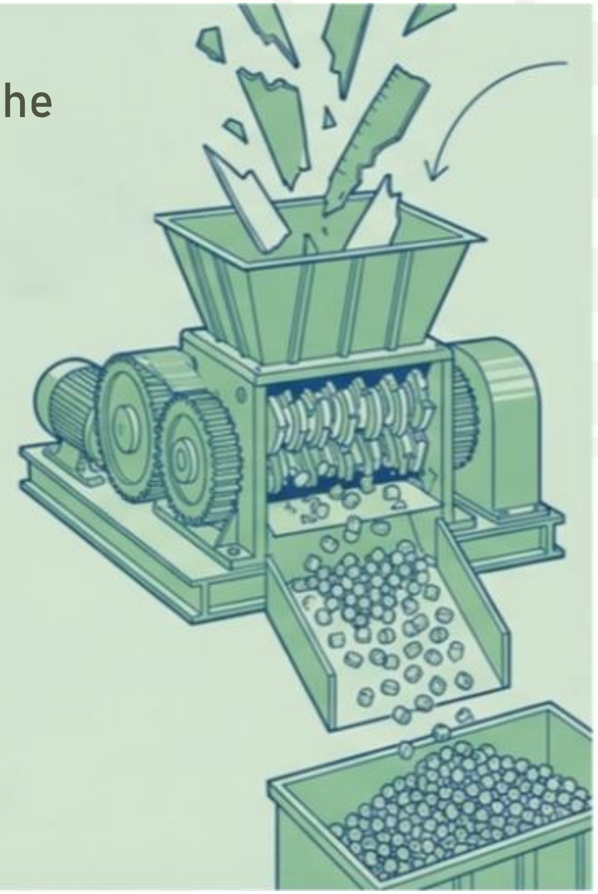
The waste problem

The waste problem

As first-generation wind farms are decommissioned, **massive volumes** of composite materials need to be disposed.

The circular material

Mechanical recycling of the Wind Turbine Blade Waste generates shredded composite that can be used as a secondary material.



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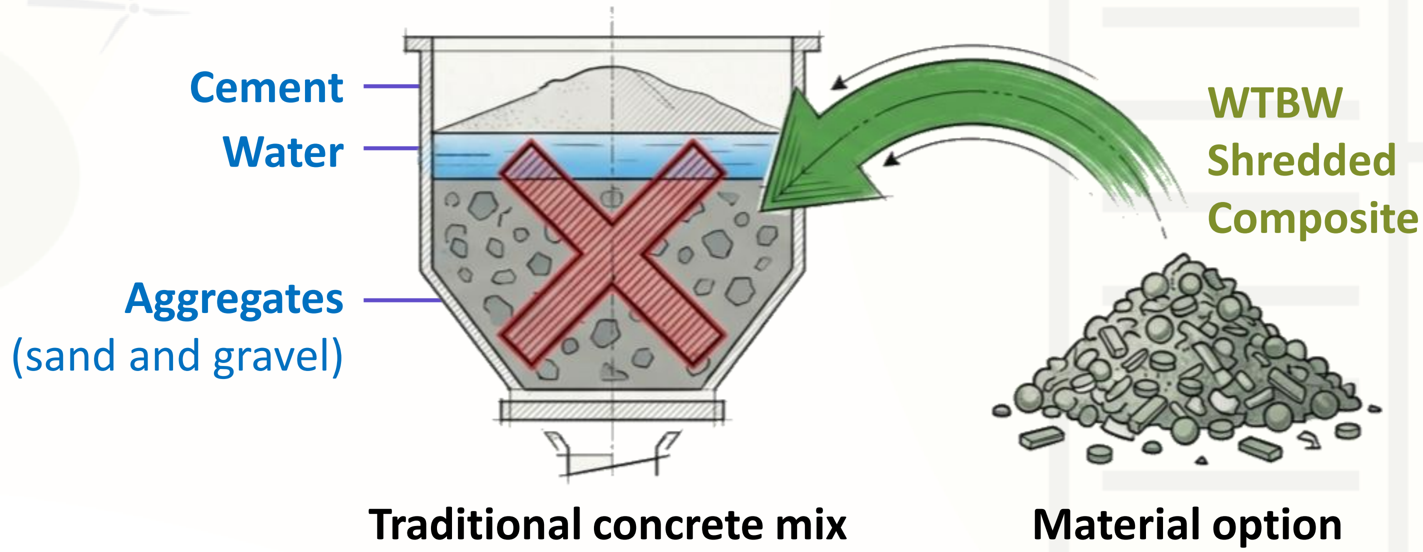
LCA as a decision-making tool

Structural concrete is a multi-material system, each carrying distinct environmental burdens across their respective supply chains.

LCA provides a **systematic framework** for quantifying these impacts and **comparing** alternative material options within a defined system boundary.



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LCA Framework

GOAL

Assessment of the environmental performance of mechanically shredded Wind Turbine Blade Waste (WTBW) at industrial scale (TRL7)

SCOPE

Software	Simapro 10.2.0.0 PhD
Database	Ecoinvent 3.11.
Declared unit	1 ton of WTBW shredded composite at facility gate
System boundary	Gate-to-Gate.
LCIA Method	Environmental footprint 3.1
Impact Categories	EN15804+A2 (13 Impact categories)
Allocation	Economic allocation

The LCA is based on ***conservative primary data*** *based on the first year production of the facility.*

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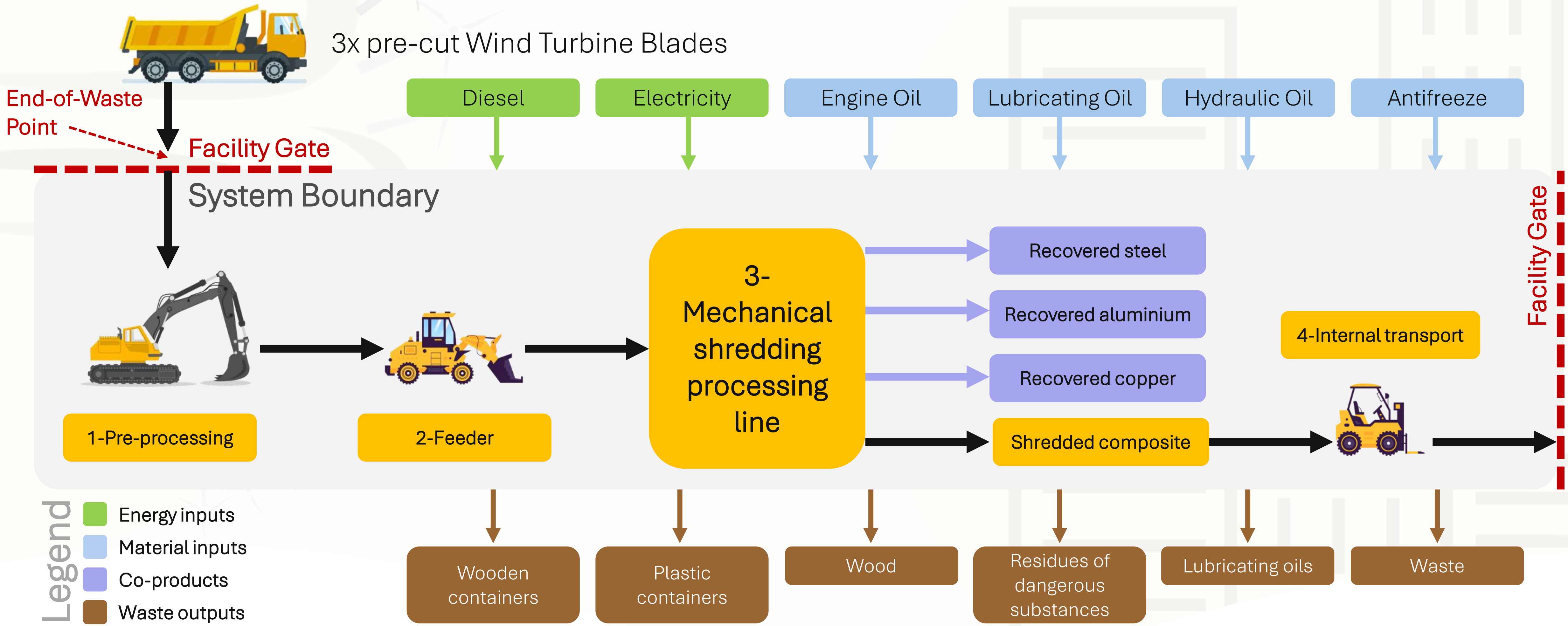
WTBW mechanical recycling – System boundary



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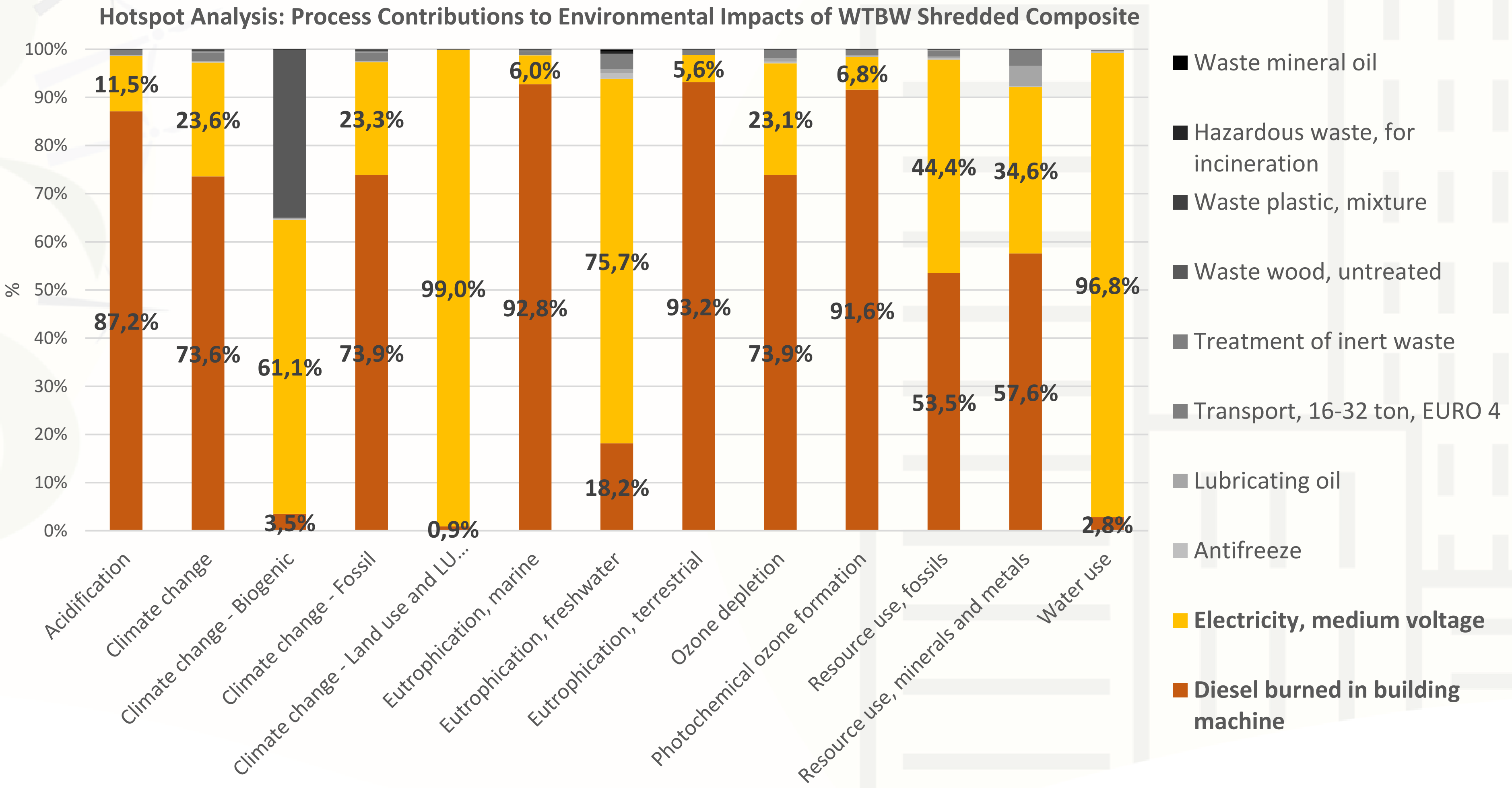
WTBW shredded composite – Hotspot analysis

Diesel consumption and **electricity** are the dominant contributors across virtually all impact categories!



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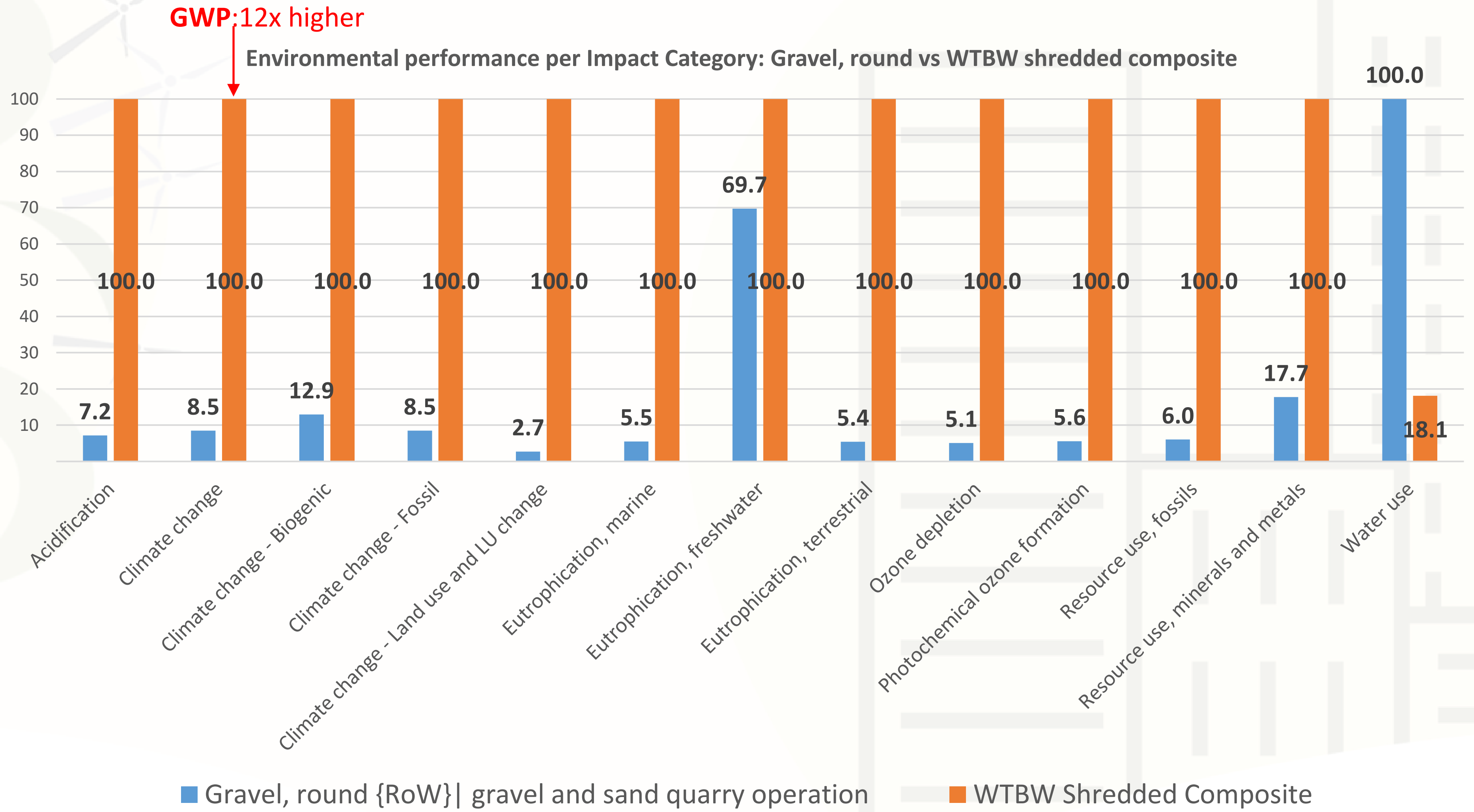
WTBW shredded composite vs Virgin Gravel

At material level, WTBW shredded composite **exhibits higher environmental impacts** than virgin gravel **across 12 of 13** categories.



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But, how do these environmental burdens translate when WTBW shredded composite partially substitutes natural aggregates in construction materials?

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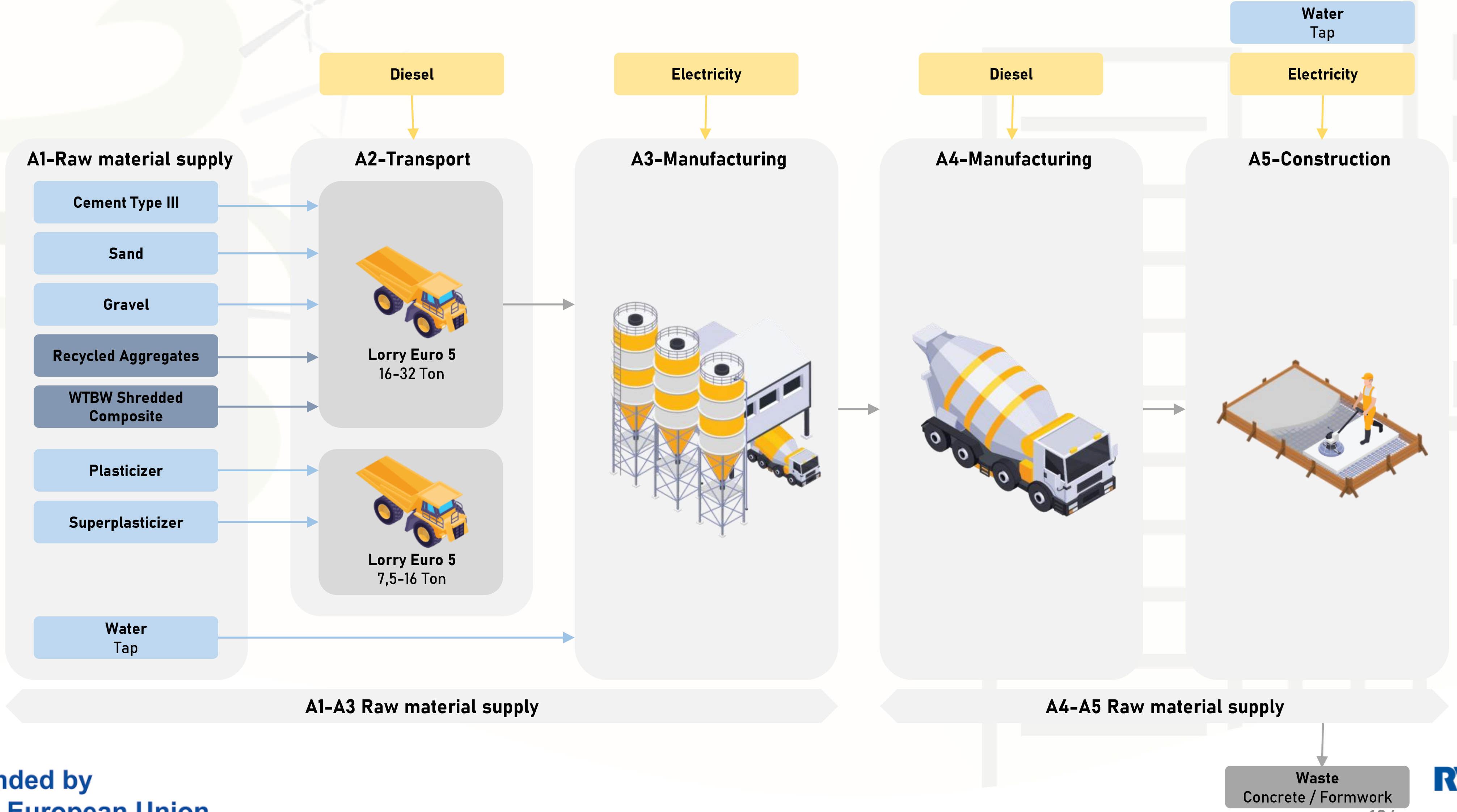
Structural concrete C30/37 - System boundary



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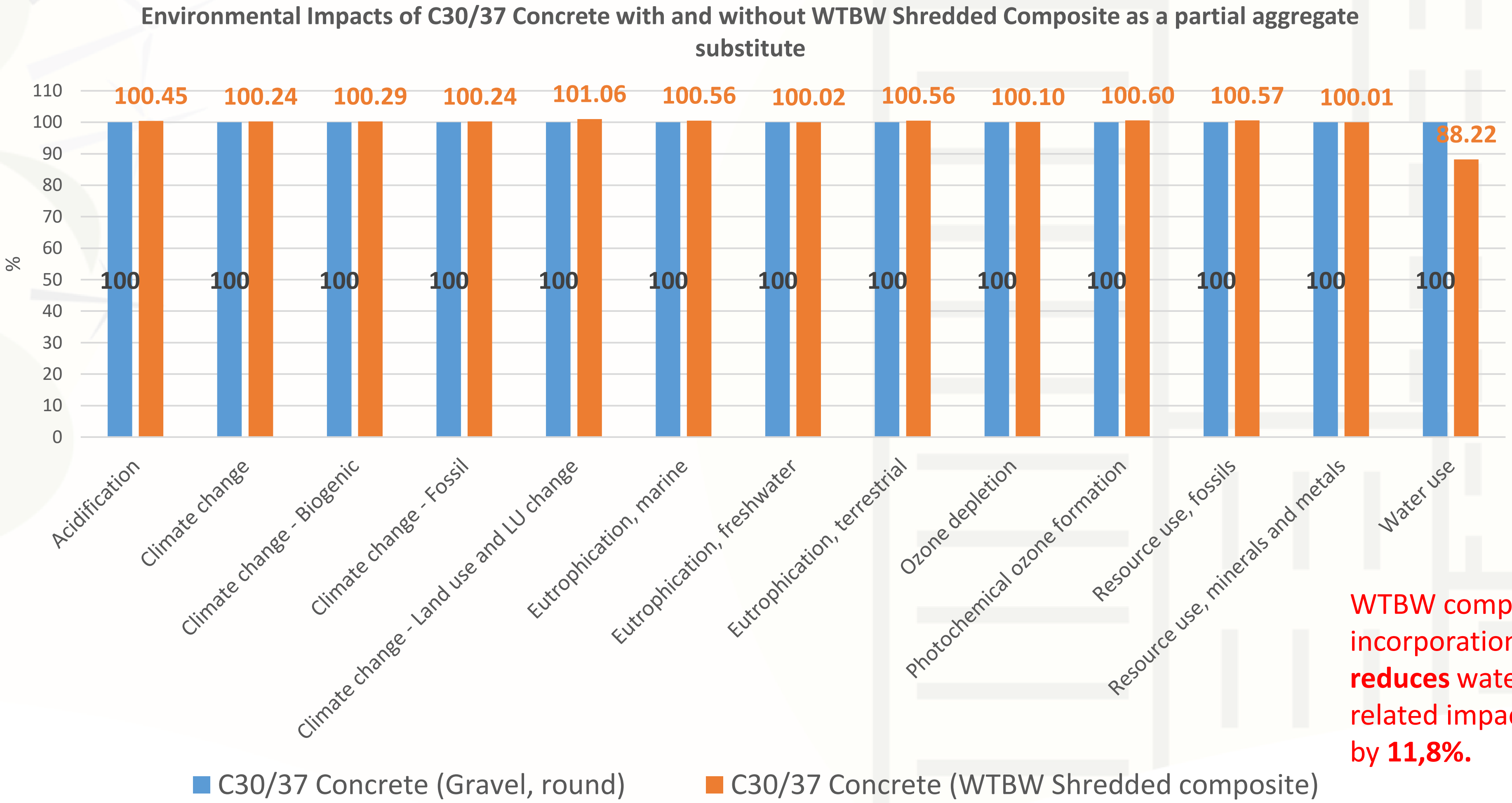
LCA Results – Structural concrete C30/37

Incorporating WTBW shredded composite into structural concrete **introduces no significant environmental burden.**



WTBW composite incorporation **reduces** water related impacts by **11,8%.**

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LCA Results – Structural concrete C30/37

Impact category	Unit	C30/37 Concrete (Gravel, round)	C30/37 Concrete (WTBW Shredded composite)	Difference
Acidification	mol H+ eq	100%	100,45%	+0,45%
Climate change	kg CO2 eq	100%	100,24%	+0,24%
Climate change – Biogenic	kg CO2 eq	100%	100,29%	+0,29%
Climate change – Fossil	kg CO2 eq	100%	100,24%	+0,24%
Climate change - Land use and LU change	kg CO2 eq	100%	101,06%	+1,06%
Eutrophication, marine	kg N eq	100%	100,56%	+0,56%
Eutrophication, freshwater	kg P eq	100%	100,02%	+0,02%
Eutrophication, terrestrial	mol N eq	100%	100,56%	+0,56%
Ozone depletion	kg CFC11 eq	100%	100,10%	+0,10%
Photochemical ozone formation	kg NMVOC eq	100%	100,60%	+0,60%
Resource use, fossils	MJ	100%	100,57%	+0,57%
Resource use, minerals and metals	kg Sb eq	100%	100,01%	+0,01%
Water use	m3 depriv.	100%	88,22%	-11,78%

UP TO +0,6%

Maximum increase across 11 of 13 impact categories, excluding Climate change LULUC and Water Use.

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Conclusions

- The **mechanical shredding** pathway is **viable at industrial scale**, providing an alternative to landfill disposal for end-of-life wind turbine blades
- At material level, **environmental impacts** are higher than virgin gravel **driven by energy, not material.**
  Diesel consumption and electricity dominate across virtually all impact categories, meaning the current environmental profile reflects grid and vehicle fleet conditions, not an inherent property of the recycling pathway.
- At product level, incorporating WTBW shredded composite as a partial aggregate substitute into structural concrete introduces variations of up to +1.06% across 12 of 13 impact categories, well within uncertainty margins, with **no burden shifting, or new environmental hotspots** identified.
- The current assessment of the WTBW shredded composite represents a **conservative baseline.**
  Results reflect first-year production below full capacity, current Spanish grid carbon intensity, existing vehicle fleet and economic allocation of co-product burdens.

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CONCRETE

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Thank you!

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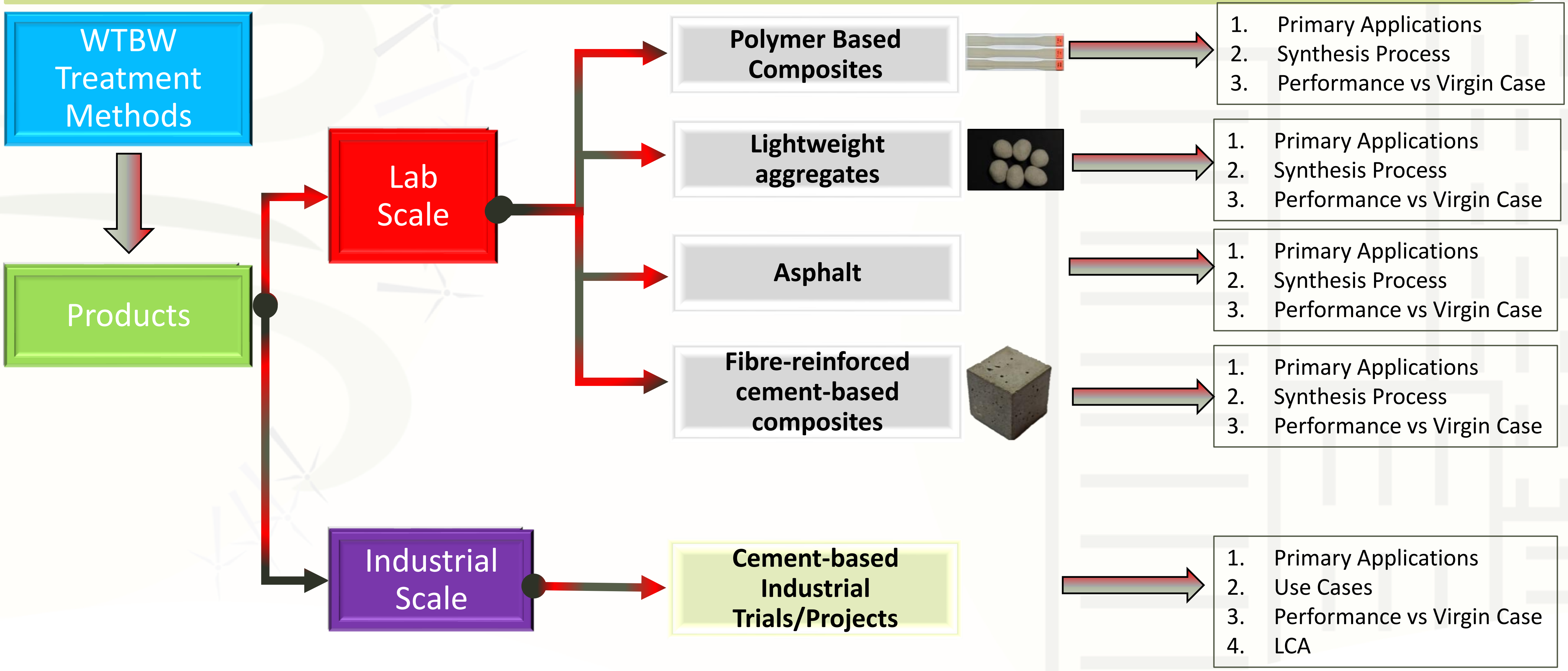
Webinar Structure



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TU/e