sustainability MDPI

Supplementary Information Document

1. Geometrical characterization of EoL WTB segments

The subdivision of the blade to be scanned into three subsequent 2.5 m was required due to transportation constraints and scanner limitations. Scanning the full 7.5 m segment in a single pass would lead to accumulated errors and reduced accuracy, and handling such a large structure during a single scanning session would be impractical. Conversely, dividing it into more than three sections would in-crease the number of seams, introducing potential misalignments and increasing post-processing complexity.

2. Design of the demonstrator

Specific design objectives for the PV-floating structure:

- Structural stability –provide adequate buoyancy and stiffness to support the weight and distribution of the PV modules and their associated structural frame, while maintaining floatation equilibrium in static water conditions.
- Functional Integration – accommodate the mounting of commercially available PV panels, tilt angle optimization for solar incidence, and minimizing self-shading effects.
- Material Circularity – minimize the need for reprocessing, cutting, or reinforcement of the original composite structure, thereby preserving the embodied energy, reduce associated emissions and limit waste generation.

Several constraints arise from these objectives. From a geometric perspective, the original shape, twist, and thickness variation along the WTB length must be considered to identify segments with the most suitable surface topology for mounting all necessary components. Mechanically, the repurposed segments must retain sufficient stiffness and strength after the first service-life, extraction, transport, and handling. The selected design strategy must therefore be inherently robust and modular, ensuring compatibility between repurposed WTB segments and newly added structural elements. Environmentally, exposure to water and UV radiation requires that protective measures be incorporated with minimal material addition.

Figure S1 details the connection points between beams. The angled supported connection (**Figure S1**a) is single attached to promote easy positioning. At the structure's base, the boundary beams require a wider connection point due to their larger contact area, therefore, a steel plate is employed for this interface (**Figure S1**b). The horizontal beams are connected to the vertical posts using steel L-shaped brackets, each drilled for a two-bolt connection per face (**Figure S1**c and **Figure S1**d). To improve bending resistance, the beams are oriented with their cross-section's taller dimension aligned with the direction of the bending moment, thereby increasing the section modulus and enhancing structural rigidity. The L-shaped brackets feature a symmetrical bolt hole pattern, a design choice that balances the forces on both sides of the bracket under bending loads, reduces stress concentrations, and contributes to the overall rigidity of the connection.

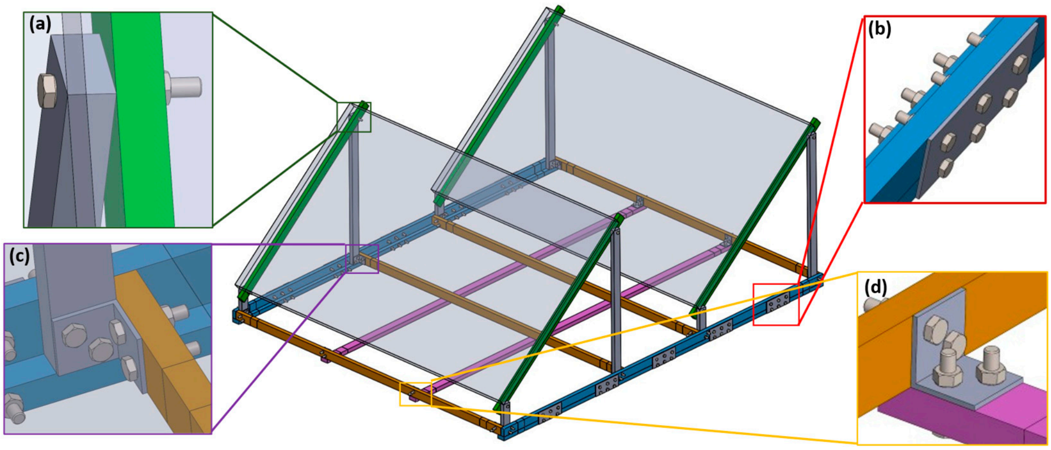

Figure S1. Connection points between beams with (a) angled support connection; (b) steel plates; (c) and (d) steel L-shaped brackets.

To accommodate the buoyant WTB segments, the support structure is fastened at designated attachment points within the spar cap region, where it is found the stiffest WTB zone. The design allows for straightforward assembly and disassembly, thereby reducing complexity during installation and maintenance operations. Furthermore, the approach supports circular design principles, enabling easier material recovery and reintegration at the EoL stage of the PV-floating system. On one side of the structure, the two vertical posts supporting the PV panel are connected by an additional rectangular profile beam, secured with a single bolted connection.

3. Numerical Simulation

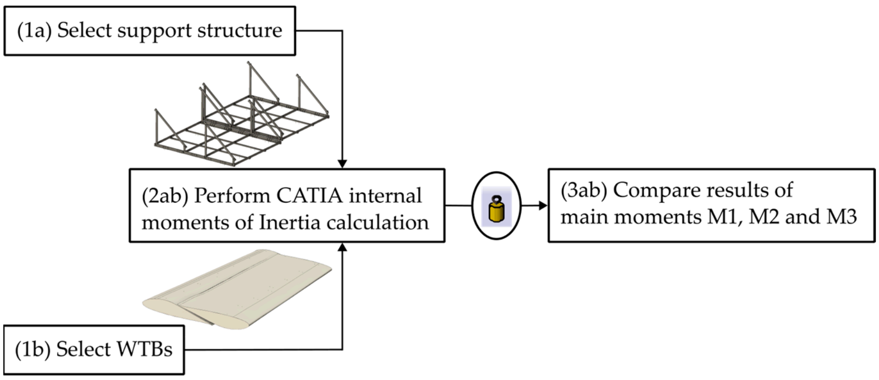

Figure S2. CATIA moment of inertia calculation approach.

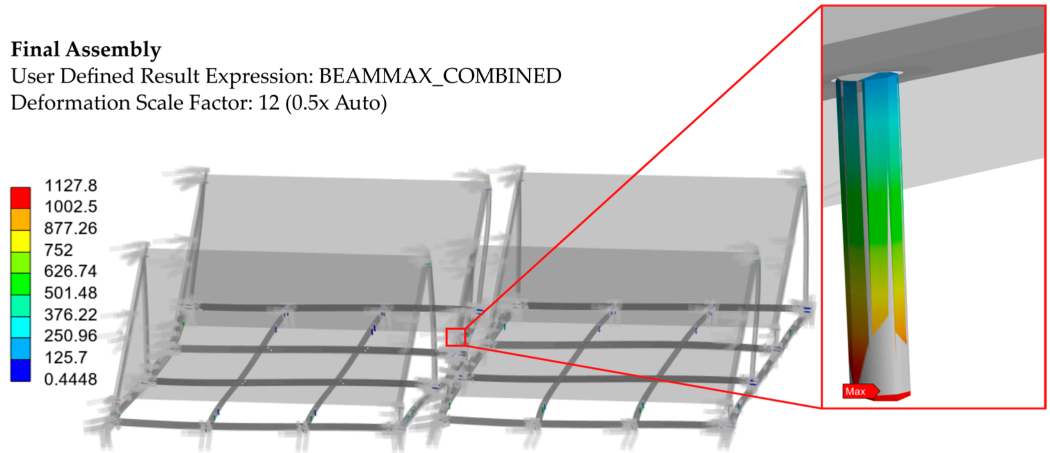

Figure S3. Maximum combined stress in the connecting beam elements [MPa].

Table S1. Maximum translational and rotational acceleration and their corresponding configuration origin.

DoF	Max Acceleration	Configuration	Time to Max [s]
X [mm]	95904.5615 mm/s²	Oblique	1.6200
Y [mm]	44737.5756 mm/s²	Frontal	1.2600
Z [mm]	40012.7664 mm/s²	Frontal	1.6200
RX [rad]	0.0526 rad/s²	Lateral	0.9000
RY [rad]	0.1309 rad/s²	Oblique	1.2600
RZ [rad]	0.0362 rad/s²	Oblique	1.2600