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Ultra High Durability Concrete

Rethinking coastal defence and Green-energy Service infrastructures through enHancEd-durAbiLity high-performance cement-based materials

WP8. Validation and proof of concepts in real site durability conditions

EGP (Leader)
Ruggero Bertani (Francesco Animato)
Partners participating: POLIMI, CMW, STRESS, NAFEN, RDC, BaPreC, API, PENETRON, UPV, TUD, CSIC, BGU, UM

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WP objectives

- Demonstrating, through long-term monitoring in 6 pilot-scale applications designed with DAD, that UHDC structures achieve at least a 30% enhancement of durability in real conditions for both repairing existing and building new structures.
- Applications are grouped to cover a significant set of application exposed both to XS and XA conditions (according to UNI 11104). Strategic field of potential economic interest is highlighted:
  1. Building a water collection basin below a cooling tower, and a mud treatment basin in a drilling platform, including loadings induced by surrounding soil pressure for underground tanks.(GREEN ENERGY)
  2. Precast elements for coastal defence (breakwaters) in two conditions (Mediterranean conditions near Spain and Atlantic Ocean around Ireland) (CLIMATE CHANGE)
  3. Precast mussel raft to be installed offshore and floating offshore wind structure element (BLUE GROWTH)
  4. Retrofitting a water tower in Malta (Mediterranean conditions) (HERITAGE CONSERVATION)

***DAD**: Durability Assessment-based Design ; **UHDC**: Ultra High Durability Concrete*
***XA**: Chemical attack ; **XS:** Corrosion induced by chlorides from sea water*

WP objectives
Strategy

- This will allow:
  - ✓ the scalability from material production (WP4)
  - ✓ Performance evaluation and prediction (WP5/WP6) to assessment and evaluation of the improved durability performance of real elements in real conditions
  - ✓ Validation of the application of innovative structure concept (WP3) and business opportunities (WP7).

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WP objectives
Demo Table

No	Site, Owner, Type	Concept, Site/Facility	Pilot Mock Up	Picture
1 XA	LARDERELLO (Italy) Monterotondo Geohermal Power Plant Cooling Tower Water Basin (EGP)	Cooling tower fluid collection basins are critical from the point of view of construction and maintenance in geothermal power plants. Besides the fluid aggressiveness, envi-ronmental risks due to fluid leakage may occur.	Reduced size basin (7x20m) close to an operating basin, feeding the pilot basin with a side stream. Different material solutions will be for the different basin facets, to compare their behavior. Singularities will be included to emulate the behavior of a real basin. **Acid Attack**	
2 XA	Monterotondo 2 (Italy) Drilling Platform Mud collection Basin (EGP	In drilling sites a residue basin is used during the mud recycling procedures. Usual size is about 200m3 (5x12x2,5 m). Basins are chemically and mechanic-ally stressed due to frequent cleaning activities.	A suitable drilling site will be identified, compatible with the project timing, where a new basin will be built with developed UHDC. **Acid attack**	
3 XS	Valencia Coast (Spain) Offshore wind floater (CMW+OE)	Floater for offshore wind turbines, full scale size of 10 m diameter, 30 m height, and 50 m of arm length	Reduced size floater for offshore wind turbines. Pilot application will be approx. 2 m diameter, 6 m height, and 10 m of arm length. **Cl induced attack Mediterranean sea**	
4 XS	Valencia Coast (Spain) Aquaculture mussel raft (RDC	2015: design/patent UHPC mussel farming raft; 2016: awarded project SELMUS-738777 Phase 2 SME Instrument in the field of Blue Growth.	Full-scale 20 x 27 m mussel farming raft in Valencia Port: UHDC precast pre-stressed beams 20x0.35x0.23m3 (6) and 27x0.21x0.23 m3 (11). **Cl induced attack Mediterranean sea**	
5 XS	Malta Public abattoir Damaged water tower (UM)	Concrete water tower (first half of the XX century, with severe degradation, mainly on the side exposed to the sea due combined action of chloride rich air and erosion from air-borne sand grains)	UHDC textile reinforcement (tank) and highly flowable UHDC (support columns) will be used. Monitoring with follow-up (training events). **Interest by Malta ministry of sustainable development.**	
6 XS	Irish west coast (site to be determined) (BaPreC)	Precast breakwater elements along the British Isles coast. Current design foresees high strength concrete (with low w/c ratio for low porosity) and high covers to protect steel bars from corrosion.	6 x 3 m breakwater elements, about 1.2m deep for no-tipping will be produced. Reduction of thickness is expected, with further benefits in terms of reduced transportation and installation costs. **Northern sea Cl and frezee induced attack**	

WP 8 timeline: M12-M40

TASK	year 1				year 2				year 3				year 4			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
8.1 KPI and monitoring assessment of performance																
8.2 Geothermal Pilot Validation																
8.3 Off-shore Pilot Validation																
8.4 Marine Infrastructure Pilot Validation																
8.5 Structure retrofitting pilot validation																
8.6 Validation and proof of concepts results collection and presentation																

Demo Tasks

WP8 effort: 148PM

EGP (30), POLIMI (11), CMW (22), STRESS (4), NAFEN (6), RDC (14), BaPreC (12), API (5), PENETRON (2), UPV (10), TUD (1), CSIC (10), BGU (1), UM (20)

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WP tasks and partners

Task 8.1: KPI and monitoring assessment of performance.
(lead: **CSIC**) [M12-M24]

Task 8.2: Geothermal Pilot Validation
(lead: **EGP**) [M12-M48]

Task 8.3: Off-shore Pilot Validation
(lead: **CMV**) [M12-M48]

Task 8.4: Marine Infrastructure Pilot Validation
(lead: **BaPreC**) [M12-M48]

Task 8.5: Structure retrofitting pilot validation
(lead: **UM**) [M12-M48]

Task 8.6: Validation and proof of concepts results collection and presentation
(lead: **PoliMi**) [M30-M48]

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Expected interactions within WPs

Input /Output:

- Circular interaction with **WP3** for the definition of the design approach;
- Input from **WP4** about the choice of materials and from **WP5** about choice of sensors and properties/performance to be monitored.
- Feed-back from **WP8** to **WP6** (Task6.5) for LCA and DAD and to **WP7** for LCC and SLCA;

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Deliverables and Milestones

DELIVERABLES/ MILESTONES*	year 1				year 2				year 3				year 4			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
MS 12 pilots built - M27																
MS 13 first/final monitoring assessment of pilot performance M40/M48) - fulfilling SO1																
D 8.1 - Key Performance Success Indicators, and common testing conditions - M24 (CSIC)																
D 8.2 - Geothermal Pilot validation report - M28/40/46 (EGP)																
D 8.3 - Offshore structure Pilot validation report - M28/40/46 (RDC)																
D 8.4 - Marine infrastructure pilot validation report - M28/40/46 (BaPreC/CMW)																
D 8.5 - Retrofitting validation report - M28/40/46 (UM)																
D 8.6 - Summary of validation activities - M48 (EGP) – demonstration of achieved SO1																

***Participation to MS 4**

Strategy to reach the objectives

Demo Task structure (T8.2 – 8.5)

The task will consist of the following activities:

- Final identification of specific test site and of the pilot objectives
- Pilot design: structure and monitoring system
- Pilot construction and commissioning
- Pilot monitoring phase and data collection
- Pilot final life valorization and/or decommissioning

Pilot reports will be updated three times during the pilot lifetime: The first after the pilot building and commissioning, the second one at the middle of the experimental campaign, the third at the end of the pilot activities.

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Strategy to reach the objectives

Task 8.1

- Selection of the most promising and suitable monitoring and sensor systems, as from WP5-Task 5.2 results, to be employed in pilot scale validation, according to the scenario of the operating conditions.
- Specification of the measurable goals, minimum target values, and success criteria to be used for the validation in real conditions, starting from the laboratory test results (WP5) and with reference to UHDC mixes from WP4.
- Identification of common testing conditions, where applicable, as a function of the scenario main durability indicators, and operating conditions.
- Identification of the timing of monitoring and location of sensors within each Pilot demonstrator.

CSIC will lead the task, coordinating contribution from EGP, UPV, UM, BaPreC, CMW, RDC to select monitoring systems solutions and define testing conditions. STRESS will contribute to the definition of KPI.

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Strategy to reach the objectives

Task 8.6

Site visits and collection of information from involved partners; reports and recommendations. Update of the KPI definition report (Task 8.1) with the return on experience and feedback from the pilots.

Definition and implementation of mitigation actions in case of not valid results and/or insufficient data for proper cost benefit analysis.

Results will be fed to WP7 for final techno-economical evaluation and business plan definition.

PoliMi will lead the activity, with contribution from EGP and UOM. STRESS will contribute with focus on the data from the pilots to produce feedbacks for LCA/LCC and SLCA studies and for the business plan definition.

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Risks in WP8

No.	Description of risk	Likelihood	Consequences	Involved WPs	Mitigation Measures/ Contingencies Plan
1	Functionalities not producing the desired performance	Medium	Medium	WP4/ WP8	Producers involved in the project will improve them. Products have already been tested at lab scale. Combination of products will reduce the risks. Alter-native products may be used in case.
2	Test methods not able to evaluate durability differences	Medium	Medium	WP4/ WP5/ WP8	Several methods will be used to minimize the risks. Sensors will be tested at lab scale previously to their use in the pilots.
3	Models not able to extrapolate results to long term scenarios	Medium	High	WP6/ WP8	Emphasize WP8 as a further testing of the long-term durability in real scena-rios/service conditions. Variety and one of a kind characteristics of the pilots
4	Subcontracting not effective	Medium	High	WP8	Selected subcontracting partners already with experience and early bid. Total amount of subcontracting amounts to a mere 6.5% of the project budget
5	Monitoring of pilots is not able to give sufficient information within the duration of the project	High	Low	WP8	Partners commit to continue the monitoring activities three years after the completion of the project. Live broadcasting the monitoring of the pilot durability performance and comparing with modelling prediction. Possibility of “re-working” the simulation through a real-time machine learning from the monitored data
6	Reduced significance of the results from the pilots	Low	High	WP8	Avoiding “follow-up” as a mere decla-ration of intent: emphasize its link to educational part of the institutional activities of partners. Multiply the value of follow-up: ORD and clustering.

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Coordination in WP8

- Mailing list with all task leaders and partners
- **Coordination meeting to start activities at M12**
- ***Task Leaders***: T8.1 (CSIC), T8.2 (EGP), T8.3 (CMV), T8.4(BaPreC), T8.5 (UM), T8.6 (PoliMi)
- **Skype meetings on monthly basis**: progress work review and contingencies respect WP
- **Visit organization to site tests**

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