



ALMA MATER STUDIORUM  
UNIVERSITA DI BOLOGNA



**The Materials Science and Technology Unit  
@ UNIBO:  
research activities and collaboration opportunities**

# RESEARCH ACTIVITIES IN MATERIALS SCIENCE AND TECHNOLOGY UNIT

- ✓ **ALKALI ACTIVATED MATERIALS (GEOPOLYMERS) FOR BUILDING CONSTRUCTION**
- ✓ **SUSTAINABLE CONCRETE, RECYCLING AND ENVIRONMENT**
- ✓ **CORROSION AND PROTECTION OF METALS**
- ✓ **MATERIALS AND TECHNOLOGIES FOR ARCHITECTURAL RESTORATION**
- ✓ **POLYMERS AND ADVANCED COMPOSITE MATERIALS**

# SUSTAINABLE CONCRETE, RECYCLING AND ENVIRONMENT

Valorisation of **wastes and industrial by-products** for the production of **sustainable building materials**

building demolition products  
ceramic industrial by-products  
end-used tyre rubber  
glassy incinerator fly ashes  
cullet from glass separated collection  
polymeric waste from end-used electrical cable  
wash-water from ready-mix concrete plants  
etc.

ordinary and self-compacting concrete

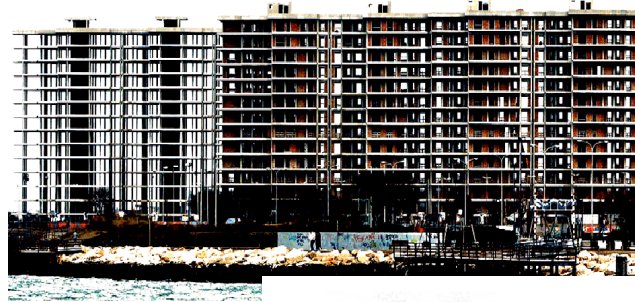
particulate and fibre composite materials

rubberised concrete

sulphur conglomerates

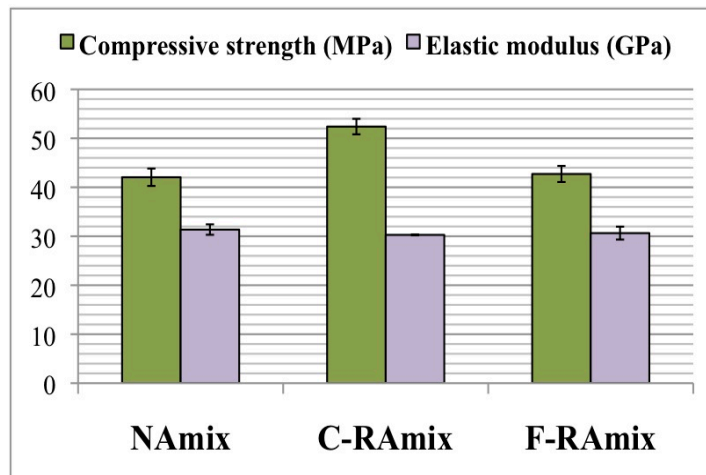
'eco-cements'

# NEW STRUCTURAL CONCRETE WITH C&DW: SHORT AND LONG-TERM BEHAVIOUR OF RECYCLED CONCRETE

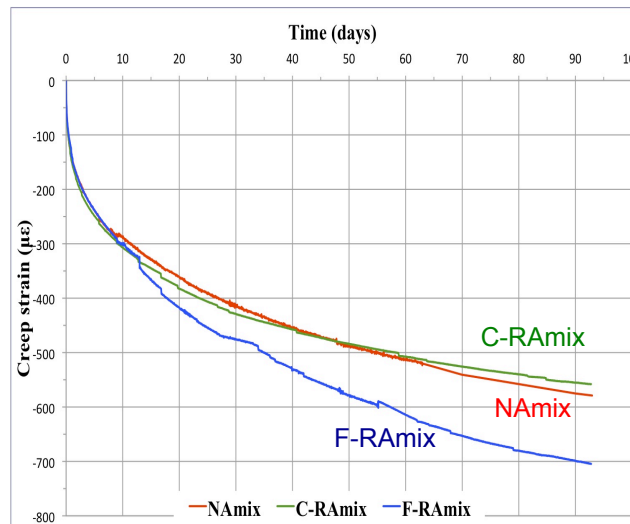


*Use of C&DW from the demolition of concrete buildings in Punta Perotti (BA), ITALY*

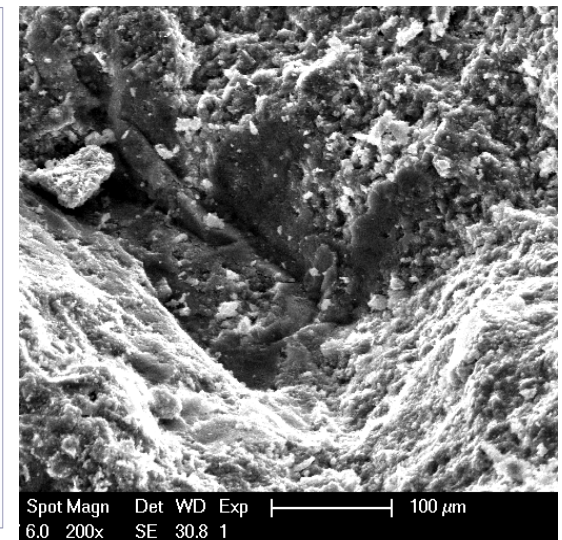
New concrete mix design:  
w/c=0.48; cement= 350 kg/m<sup>3</sup>  
Coarse RA (16-25 mm) = 27%  
Fine RA (0-16 mm) = 36.5 %



**Mechanical properties**



**Creep strains**



**Microstructure of F-RA mix**

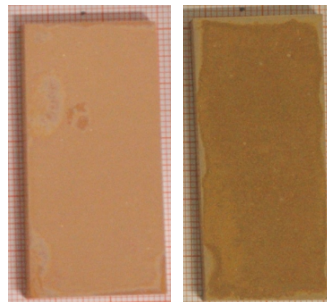


# ALKALI ACTIVATED MATERIALS (GEOPOLYMERS) FOR BUILDING CONSTRUCTION

- ✓ **VALORIZATION OF INDUSTRIAL WASTE AS NEW PRECURSORS** (ladle slag, ceramic waste, Italian fly ash, etc.)
- ✓ **OPTIMIZATION OF PROCESS PARAMETERS FOR THE SYNTHESIS AT ROOM TEMPERATURE** (both setting and hardening process)
- ✓ **MECHANICAL CHARACTERIZATION**
- ✓ **MICROSTRUCTURE CHARACTERIZATION** (by MIP and SEM with EDS and RAMAN probes). In particular, pore size analysis is addressed to (i) check the degree of the alkali activation process, (ii) investigate the relations occurring between process parameters and porosity, (iii) highlight similarities/differences between phases formed during the alkali activation process and during traditional cement hardening.
- ✓ **DURABILITY BEHAVIOUR** determined by aggressive environments exposure, climate chamber and electrochemical techniques (for bar reinforced products).

# CORROSION AND PROTECTION OF METALS

- ✓ **CORROSION BEHAVIOUR OF STEEL REINFORCED CONCRETE/MORTARS** (based on sustainable blended cement or alkali activated materials)
- ✓ **CORROSION BEHAVIOUR OF STAINLESS STEELS FOR CHEMICAL PLANT EQUIPMENTS** (reactors, mixers, pipes, etc. used in chemical and pharmaceutical industry)
- ✓ **ATMOSPHERIC CORROSION OF PATINATED METALS** (in particular weathering steel such as COR-TEN, copper alloys such as bronze, etc.)
- ✓ **ACCELERATED AGING AND ELECTROCHEMICAL MEASUREMENTS** (voltage registration, polarization curves, determination of corrosion rate)
- ✓ **DURABILITY BEHAVIOUR OF ORGANIC AND INORGANIC PROTECTION SYSTEMS** (by means of climate chamber, thermal analysis and salt spray chamber)



Bronze coated by silanes, before and after ageing in climatic



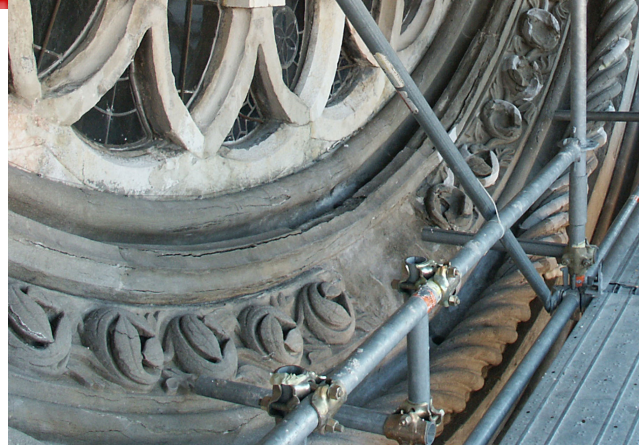
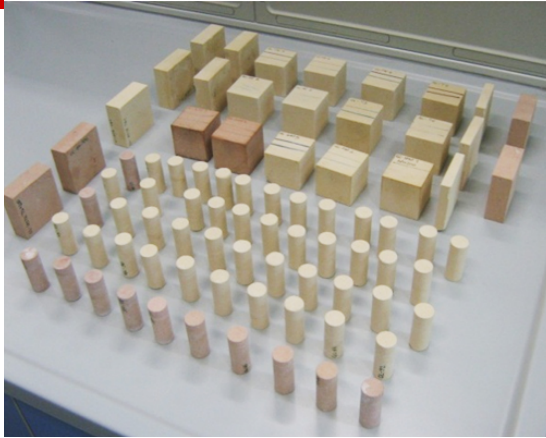
Spray Fog chamber



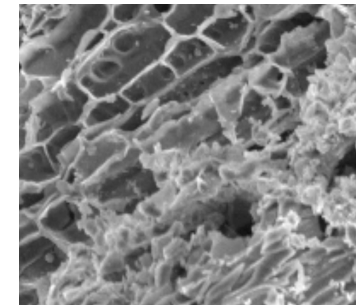
Climatic chamber (T and UV cycles)



# MATERIALS AND TECHNOLOGIES FOR ARCHITECTURAL RESTORATION



- ✓ **Characterization of ancient building materials** (stone, brick, mortar, stucco, metals, wood) and **degradation mechanism in aggressive environment**
- ✓ **Innovative restoration materials** (nano-sized consolidants, phosphatic consolidants, repair mortars, etc.)
- ✓ **Rising damp and salts in old masonries:** measurement, on-site and laboratory research, electrokinetic effects, repair, etc.
- ✓ **Durability and compatibility of materials for conservation**



# POLYMERS, BIOPOLYMERS AND ADVANCED COMPOSITE MATERIALS

- ✓ **SOLUTIONS TO METAL (AND OTHER MATERIALS) REPLACEMENT USING PLASTICS AND POLYMER-BASED COMPOSITES** (substitution of traditional with innovative materials, weight reduction, new functionalities)
- ✓ **MATERIALS SELECTION**
- ✓ **PLASTICS RECYCLING** (valorization of scraps and wastes; development of new products through recycling)
- ✓ **COMPOSITES AND NANOCOMPOSITES**
- ✓ **POLYMER TECHNOLOGY** (support to industrial production for technological and processing aspects)
- ✓ **INNOVATIVE PROCESSING TECHNIQUES** (3D printing, electrospinning, fabrication on the nanoscale via microfluidics approach, ...)
- ✓ **SURFACE MODIFICATION OF PLASTICS** (functional and protective coatings, chemical and physical modifications)
- ✓ **BIOBASED AND BIODEGRADABLE PLASTICS** (bioplastics as innovation tools for sustainability and bioeconomy. PHAs, PLA, starch blends, PBAT...)
- ✓ **POLYMERS FOR BIOMEDICAL APPLICATIONS** (biocompatible / bioresorbable solutions)



**For materials characterisation:** XRD, SEM and EDS, optical microscopy, FTIR-ATR, mercury intrusion porosimetry, water vapour permeability, water and helium pycnometer, thermal analyses (TGA, DSC), chemical analysis, grain size distribution (by both sieves and laser analyser), mechanical tests (compressive, tensile, flexural strength, impact test), ultrasonic tests, on-site tests on ancient timber structures, soluble salts analysis via ion chromatography.

**For materials durability assessment:** UV-exposure apparatus, abrasion test, freeze-thaw cycles, accelerated ageing in aggressive solutions, corrosion measurements.

**For the investigation of moisture in ancient structures:** sampling and moisture determination by gravimetric method, reliable moisture monitoring by a purposely designed protocol (see References), on-site determination by calcium carbide or thermo-balance, electrical resistance measurement on timber structures.



***THANK YOU FOR YOUR ATTENTION!***

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