SEISMIC RETROFITTING TECHNIQUES BASED OF INNOVATIVE METALLIC MATERIALS

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CONSOLIDATION REQUIREMENTS

- Reversible Mixed Technologies (RMT) are based on the integration of structural members of different materials and/or construction methods into a single construction.
- The basic feature of RMT is that, that is reversible, if required.
- REVERSIBLE
  - their application should always be completely recoverable
  - application of a better techniques (when will be applicable)
  - minimum impact on the consolidated work
- MIXED
  - the best exploitation of material and technology features,
  - optimize the structural behavior under any condition.

- Metallic materials suits perfectly at this demands

METAL BASED CONSOLIDATION TECHNIQUES OF EXISTING BUILDINGS

- Steel advantages given by his structural characteristics:
  - reversibility (connection)
  - prefabrication,
  - high mechanical strength,
  - mechanical isotropy,
  - reduced dimension and weight,
    - ease of transportation,
    - ease of application,
    - ease of manoeuvring in tight spaces,
    - workability,
    - commercial availability,
  - prefabricated steel of different shapes, dimensions, mechanical characteristics,
  - recyclable.

THE STRUCTURE – MATERIAL RELATION

New composite materials						
Structure to be consolidated		Materials used for consolidation				
		Metal	Concrete	Masonry	Wood	FRP
	Metal	XX				X
	Concrete	XX	X			X
	Masonry	XX	X	X	X	X
	FRP	XX			X	X

MODERN METALLIC MATERIALS

- Modern metallic materials have not yet found an ample application in the field of civil engineering and especially in the consolidation domain.

Material	γ (g/cm^3)	E (kN/mm^2)	$f_{0,2}$ (N/mm^2)	f_t (N/mm^2)	ε_t x100 (A_5)	α x 10^6 ($^oC^{-1}$)
Mild carbon steel	7.85	210	235÷365	360÷690	10÷28	12÷15
Low yield steel	7.85	200	90÷100	300÷350	40÷60	12÷15
Stainless steel	7.8	196	200÷650	400÷1000	10÷40	17÷19
Aluminum alloys	2.7	65÷73	20÷360	50÷410	2÷30	24÷25
Titanium alloys	4.5	106	200÷975	300÷1100	8÷30	6÷7
Copper	8.2÷8.9	88÷118	70÷400	170÷720	6÷50	18
SMA Ni-Ti	6.5	28÷75	100÷560	750÷960	15.5	6.6÷11

STAINLESS STEEL

- Stainless steel is obtained by adding chrome, nickel and nitrogen to weak alloyed carbon steel forming an invisible protective layer (Cr_2O_3).
- Added together there are over 60 types of stainless steel - he most common alloy is that of austenite category
- By using stainless steel in the field of consolidation we have the possibility to hide the strengthening elements, without being at risk of reduced performance during its lifetime.
- This proves to be very useful in the case of statues, columns or other stone elements for which any surface systems would be incompatible with the aesthetic aspect of the monument.

ALUMINUM ALLOYS

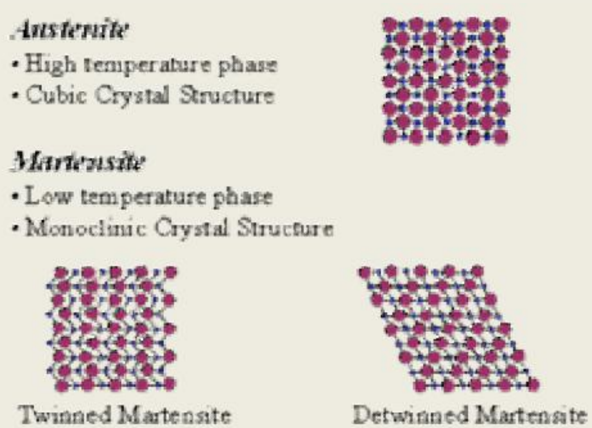
- The strong point of this material lies in its reduced weight (approximately one third of that of steel) and its good resistance to corrosion, leading to a minimal increase in mass and in the same time reducing maintenance problems.
- The alloys used are obtained by adding pure aluminum, magnesium elements, silicone magnesium, copper, zinc, manganese etc.
- By using aluminium alloys can be obtained great freedom and a wide range of intervention solutions.
- Aluminum was used mainly in the addition of storeys and intermediate light storeys.

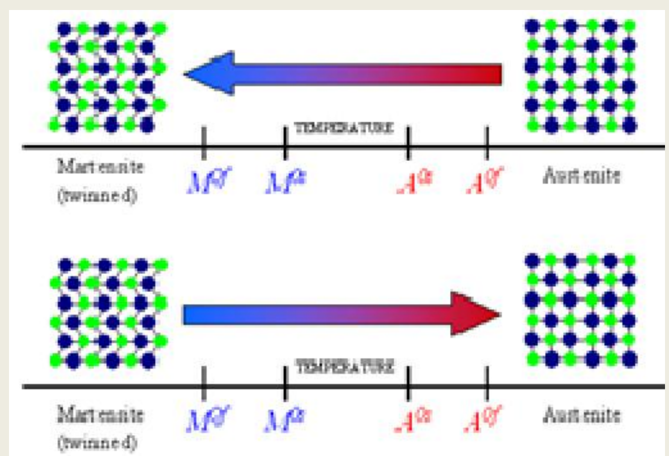
TITANIUM ALLOYS

- Titanium alloys are obtained by mixing molybdenum, vanadium, aluminum and steel.
- They are divided into three categories: Alpha alloys –Alpha-beta alloys – Beta and non-beta alloys
- All titanium alloys have very good corrosion resistance and can be used in the extrusion process.
- The most important property in the field of consolidation is to have a small thermal expansion coefficient, very close to volcanic or metamorphic rocks like granite or marble.

SHAPE MEMORY ALLOYS

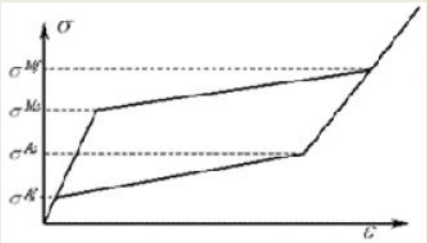
- Shape memory alloys (SMA), most Ni-Ti or Cu-Al-Zn, can be regarded as „intelligent” materials, because both the yield limit and the elastic modulus increase as the temperature rises up to the transformation temperature.
- This temperature corresponds to a solid transformation between the martensitic phase and austenitic state





SHAPE MEMORY ALLOYS

- The behaviour is super elastic and leads to the complete disappearance of deformations following the unloading. Because of the different steps of loading-unloading, an amount of energy is dissipated during this cycle.



- When the material is prevented from deforming freely, high internal stresses can be reached due to the high rigidity of the material in the austenic phase. In the field of structural consolidation can be used when it is desired to introduce or maintain an initial state of tension in an element