



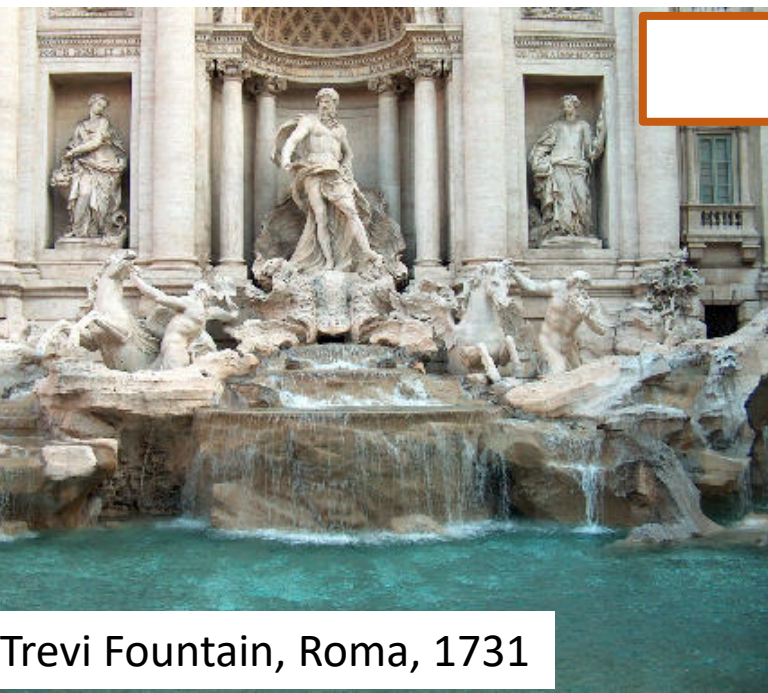
# Italian Travertine in Building Heritage

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# Travertine in the world



Trevi Fountain, Roma, 1731

Travertine is one of the most common stone for building construction used in many countries starting from ancient times.



Jin Mao building, Shangai, 2000

It's a durable stone despite the weathering caused by air pollution. It is observed in urban areas that the facades may be covered with a black crust where gypsum and calcite are the main minerals .



Los Angeles Museum , Paul Getty, 1997



Colosseo , Roma, Italy, 80 d.C.



## Aim and methodology of research

**9 different types of travertine from Tuscany and Umbria (Italy) have been investigated:**

**From Tuscany quarries (Italy) :** MB, MCN, MGE, RC, RV, RS, Sc, Si

**From Umbria quarry (Italy) :** MM

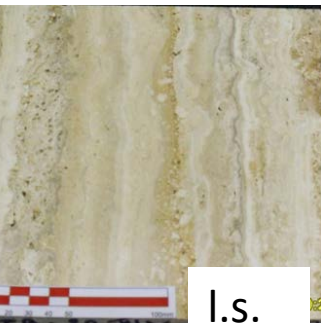
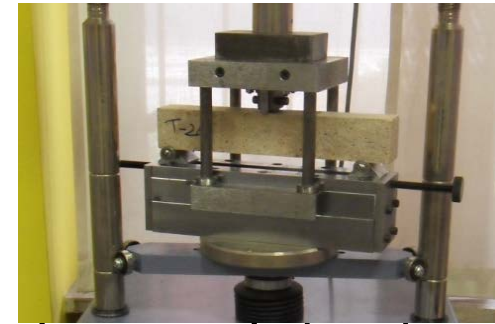
**Technical determination executed:**

Characterization Test:

Petrographic analysis, water absorption, porosity (o.p.), flexural strength (F.S.), compression strength Artificial ageing test :

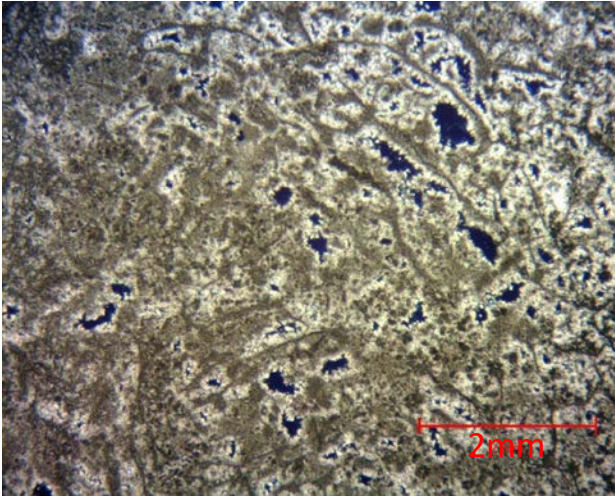
Freeze thaw ,Thermal shock resistance have been performed.

**Different textures (identified as l, n.l. , l.c., l.s) have been identified in order to correlate TRAVERTINE DURABILITY and petrographic features.**

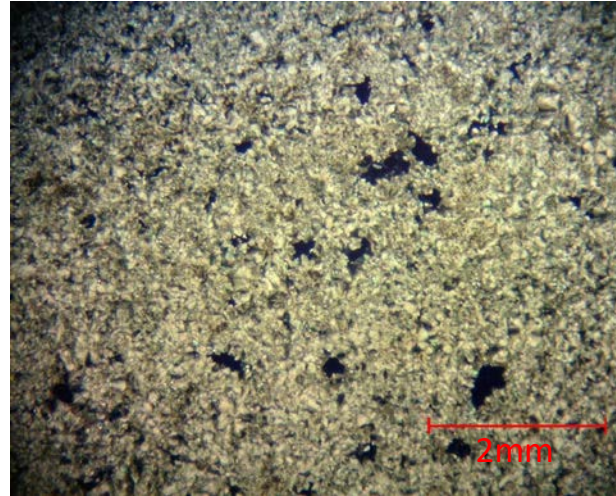




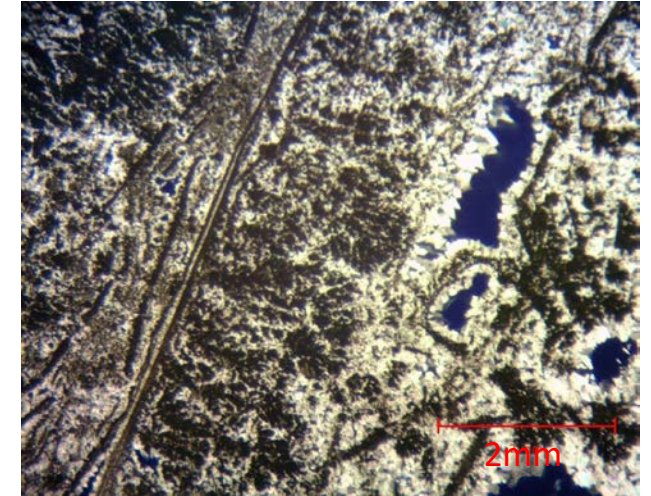
# Italian travertine and their physical mechanical features - 1



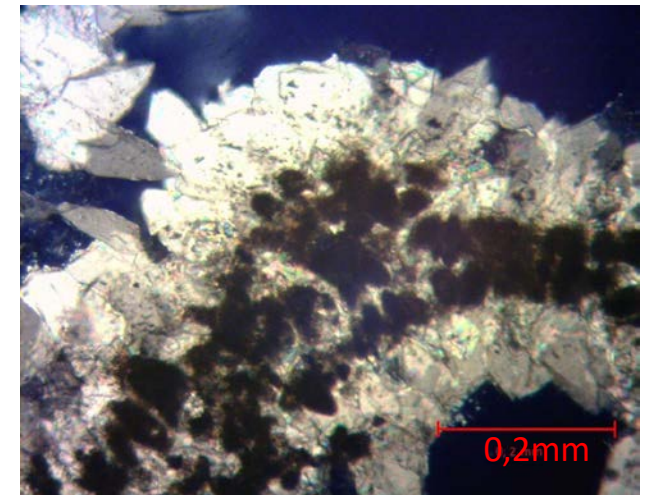
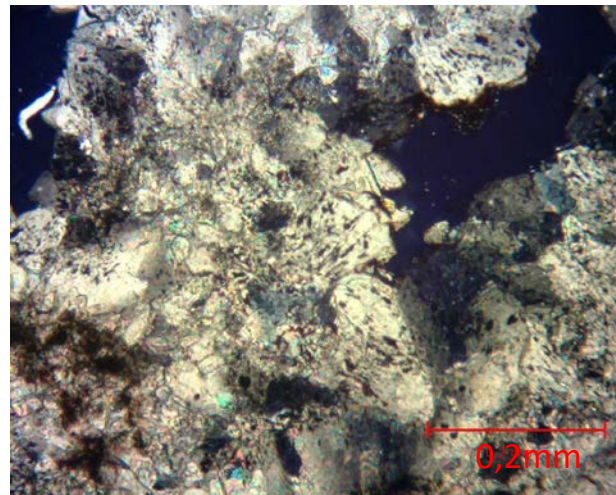
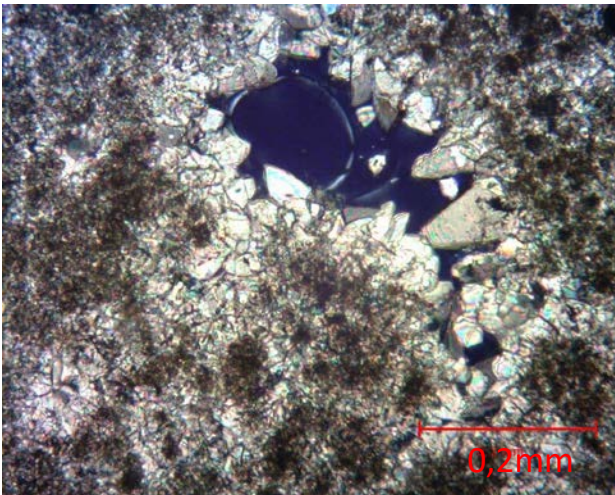
**MB** - Not laminated  
o.p. : 7,38% - F. S: 10,6MPa



**MCN**- Not laminated  
o.p. : 6,43% - F. S: 12,4MPa

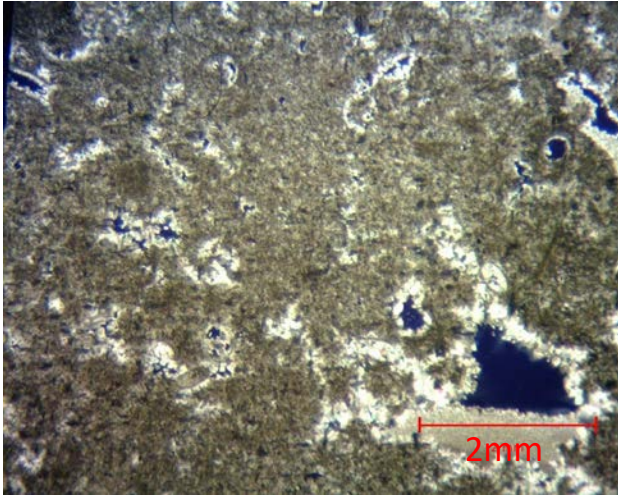


**MGE**— l. concentric sheets  
o.p. : 10,8% - F. S: 11,1MPa

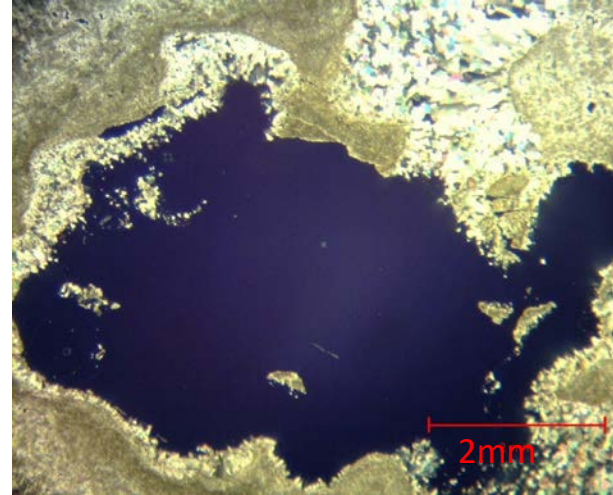
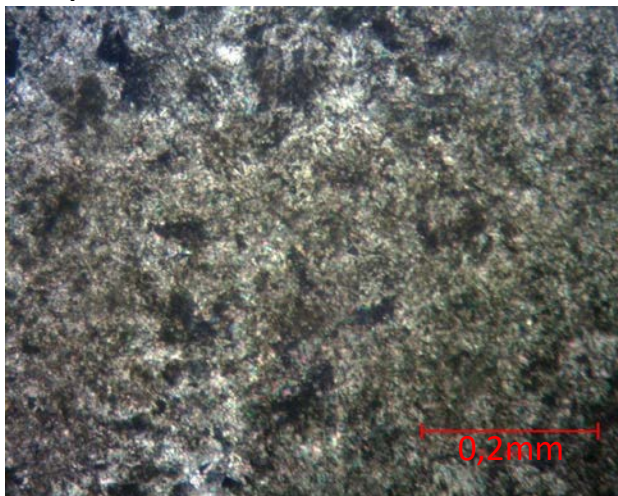




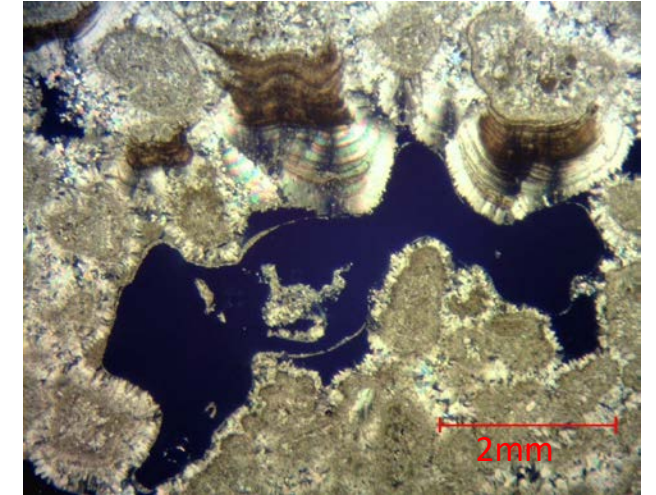
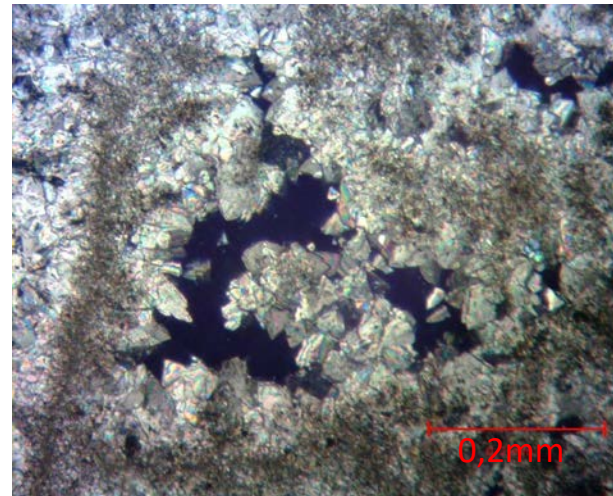
## Italian travertine and their physical mechanical features - 2



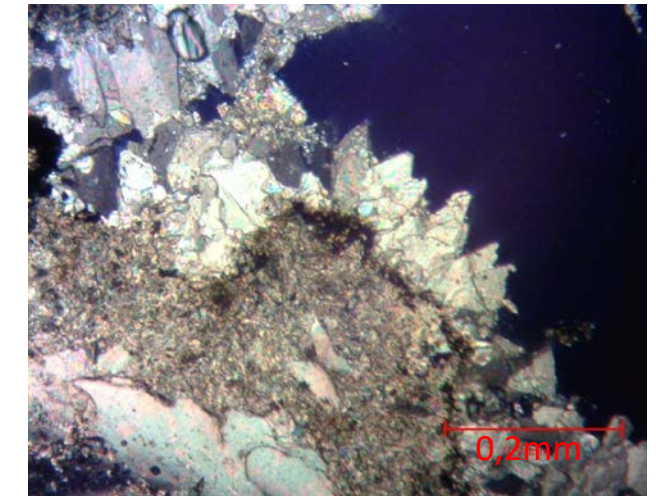
**RC** - Not laminated  
o.p. : 6,48 % - F. S: 13,2 MPa



**RV** -- Sub parallel sheets  
o.p. : 10,58% - F. S:12,8 MPa

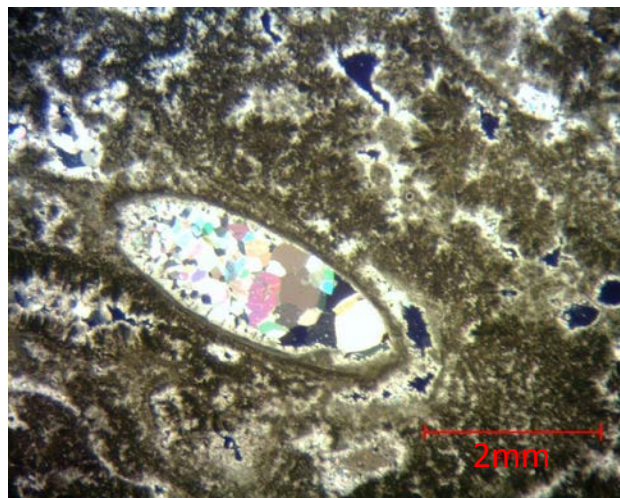


**RS** -- Not laminated  
o.p. :6,71 % - F. S: 9,3 MPa

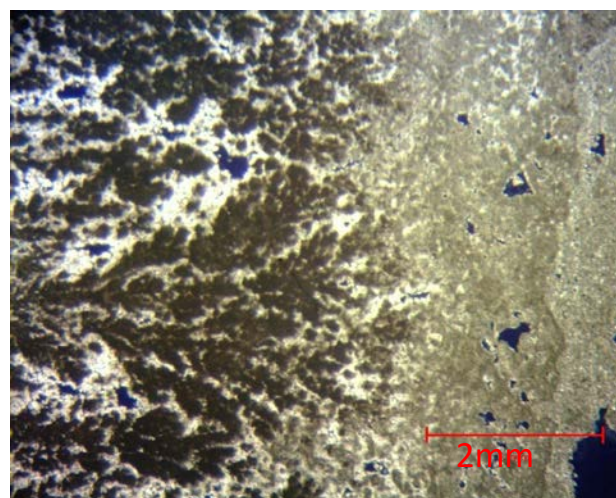
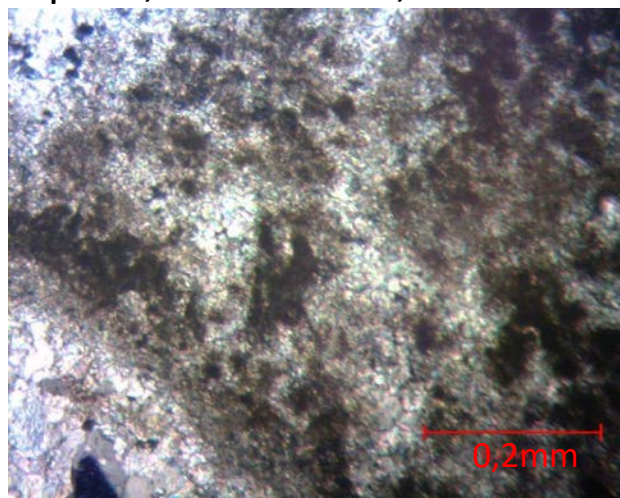




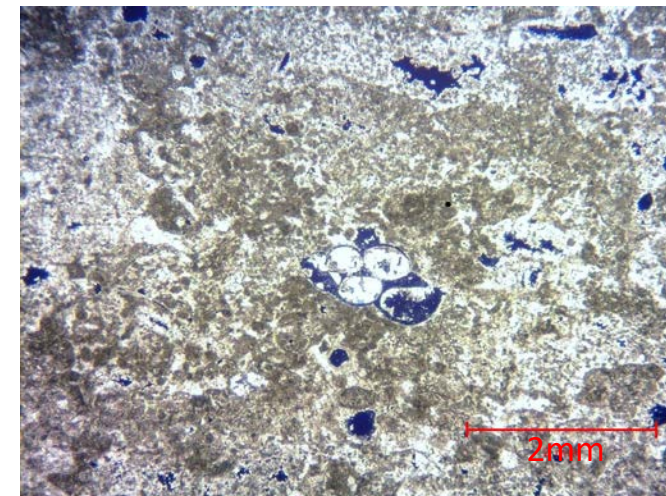
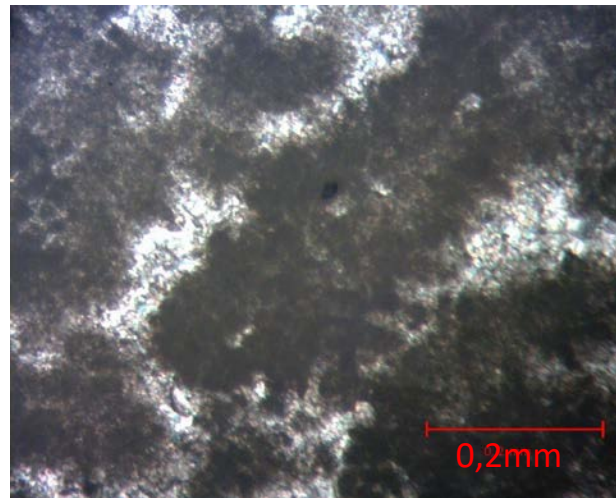
## Italian travertine and their physical mechanical features - 3



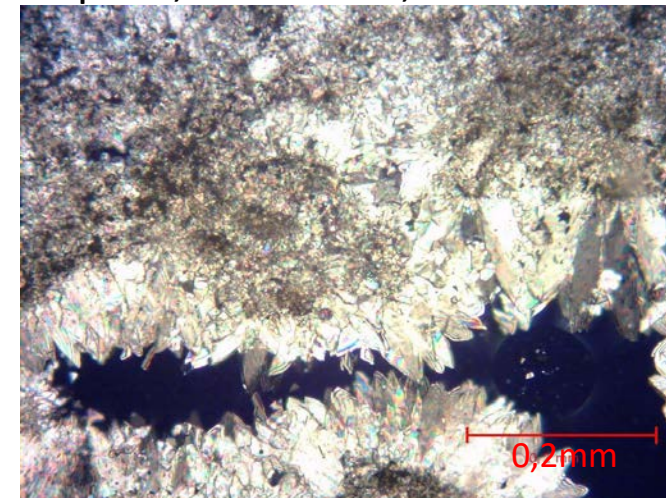
**SC** -- Not laminated  
o.p. : 6,35 % F. S: 13,6 MPa



**SI** - Laminated  
o.p. : 3,23 % F. S: 10,8 MPa



**MM** - Not laminated  
o.p. : 6,5 % F. S: 13,65MPa



# Travertine characterization and Conclusions

Travertine tested	W.A. (%)	Bulk density (kg/m <sup>3</sup> )	Open porosity (%)	Compressive strenght (MPa)	F.s in Natural Conditions (Mpa)	F.S. after artificial ageing (MPa)	Relative variation in F.S. after artificial ageing (%)	texture
MCN	1,0	2520	6,43	71,7	12,4	11,6	6,5	n.l.
MGE	1,4	2340	11,11	64,3	10,8	7,3	32,4	l.c.
RC	1,1	2460	6,48	68,6	13,2	10,5	20,5	n.l.
RV	2,2	2390	10,58	52,9	12,8	11,1	13,3	l.s.
RS	1,4	2490	6,71	70,3	9,3	7,8	16,1	n.l.
SC	0,8	2490	6,35	71,8	13,6	10,1	25,7	n.l.
SI	0,7	2540	3,23	87,1	10,8	7,3	32,4	l
MM	2,6	2470	6,5	70,6	13,65	12	12,1	n.l.

*n.l.: not laminated, l: laminated, l.s.: laminated with sub parallel sheets, l.c.: laminated with concentric sheets.*

Form the data analysis, the Travertine durability is not connected only with porosity and petrographic features.

The analysis of the complex texture of this Heritage stone cannot give a simple and unique relation related to its durability.

**Both compact travertine as SI and those porous as MGE, in laboratory suffered the artificial ageing, but in site this kind of stone can be still defined durable.**

**For this reason the next step should be the recognition of decay form on building where there is the certainty of travertine origin.**