

## Rebrick

### Project based on the Production of Compressed Earth Blocks Using Cigarette Butts and Recycled Paper

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## Contextualization

In the ambit of the subjects of Biology and Chemistry, and using Project Based Learning as pedagogical methodology, 12<sup>th</sup> grade students, working in partnership with the Engineering Department of the University of Minho, produced compressed earth blocks using sustainable based materials, such as cigarette butts and recycled paper.

## Introduction

It is commonly known that the premature depletion of the planet's natural resources and pollution are two of the biggest contemporary problems, which has lead society to look for viable solutions for these. In fact, cigarette butts are one of the biggest pollutants of everyday life, and it is pertinent to consider how to process and dispose this waste. In addition, cement is one of the main responsible for the emission of CO<sub>2</sub>, contributing, during its manufacture, to about 8% of the total CO<sub>2</sub> expelled to the atmosphere. Therefore, and having as main concern the valorization of residues and contributing to the necessary reduction of environmental impacts, the project entitled "Rebrick" was developed with the main purpose of building compressed earth blocks (BTC) for the construction application, where cigarette butts would be incorporated and the cement use would be minimized.

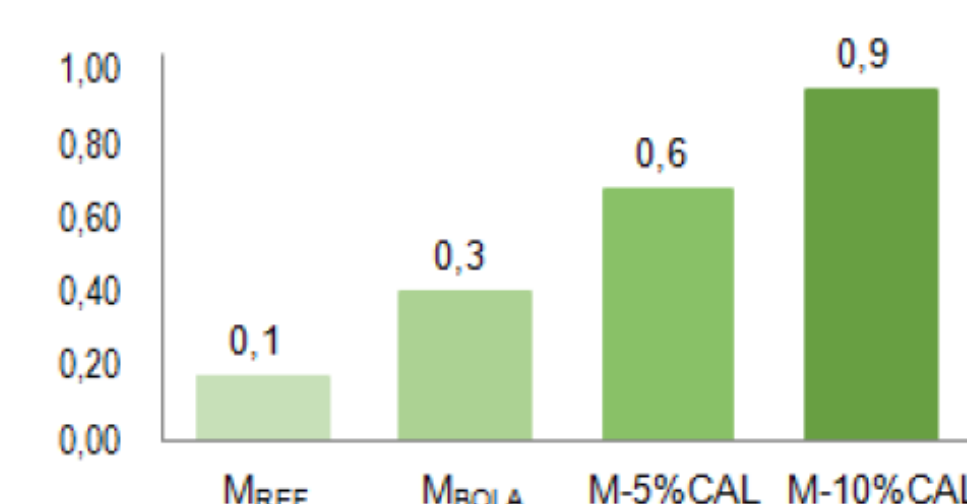
## Methods and materials

In order to achieve our goal, the necessary materials for the manufacture of BTCs were characterized (soil, cigarette butts and recycled paper), the way of producing them was evaluated, the optimization of the formulation of the mixture was considered (it was agreed that each compound of the brick would have to be submitted to individual tests. With that being, the most favorable percentage of water in the brick, as well as the incorporation of cement, lime and cement or only lime, combined with soil would have to be studied to achieve the previous), and we would determine its main physical and mechanical characteristics that would allow validating the hypothesis of use in real cases.

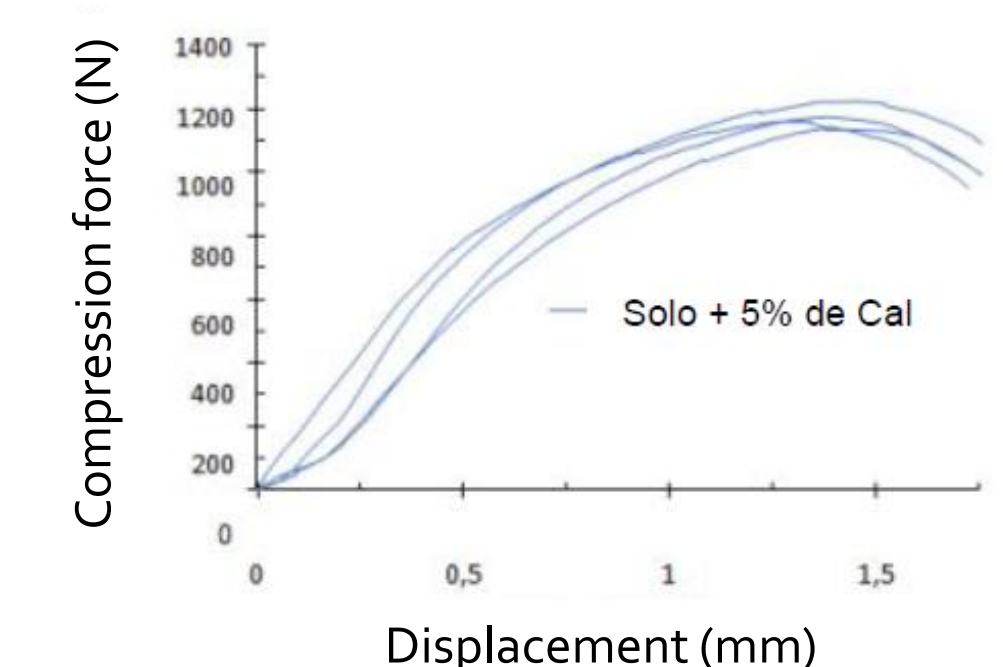
## Results

Mixture	Water content (%)	Test pieces	Dimensions (mm)		Volume (mm <sup>3</sup> )	Mass (g)	Density (g/cm <sup>3</sup> )	Force (N)	Compression stress (MPa)	Average compression stress (MPa)
			Height	Diameter						
M <sub>REF</sub>	12	1	100.27	50.34	199566.35	322.0	1.61	407	0.20	0.17
		2	101.13	50.53	202800.25	324.60	1.60	303	0.15	
		3	101.29	50.50	202879.99	326.70	1.61	240	0.12	
		4	100.38	50.49	200977.67	326.40	1.62	385	0.19	
		5	100.60	50.72	203257.39	325.80	1.60	383	0.19	
		6	101.19	50.51	202759.97	326.50	1.61	388	0.19	
		7	101.27	50.79	205176.26	326.80	1.59	361	0.18	
		8	102.30	50.70	208629.19	327.80	1.59	263	0.13	
		9	102.58	50.45	205057.15	326.40	1.59	277	0.14	
M <sub>SOIL</sub>	26.3	1	89.17	50.49	178533.36	299.60	1.58	642	0.32	0.38
		2	88.49	50.96	180485.75	350.00	2.02	924	0.45	
		3	88.79	51.16	185521.91	306.10	1.58	783	0.38	
M-5% of lime	26.3	1	89.42	50.34	177971.71	297.00	1.67	1542	0.77	0.65
		2	89.95	50.74	181904.46	298.20	1.64	1565	0.77	
		3	91.47	50.37	182268.85	299.00	1.64	1173	0.59	
		4	95.83	50.41	191260.27	311.30	1.63	1220	0.61	
		5	91.40	50.38	182201.69	298.80	1.64	1161	0.58	
		6	91.68	50.33	182397.28	299.90	1.64	1137	0.57	
M-10% of lime	26.3	1	94.77	50.52	189971.06	300.50	1.58	1801	0.90	0.91
		2	95.15	50.38	189877.14	301.30	1.59	1931	0.90	
		3	95.70	50.48	191531.63	301.20	1.57	1860	0.93	
		4	96.19	50.44	192207.34	302.50	1.57	1777	0.89	
		5	93.36	50.52	187144.65	302.80	1.62	1836	0.92	
		6	95.51	50.58	191909.46	301.10	1.59	1736	0.86	

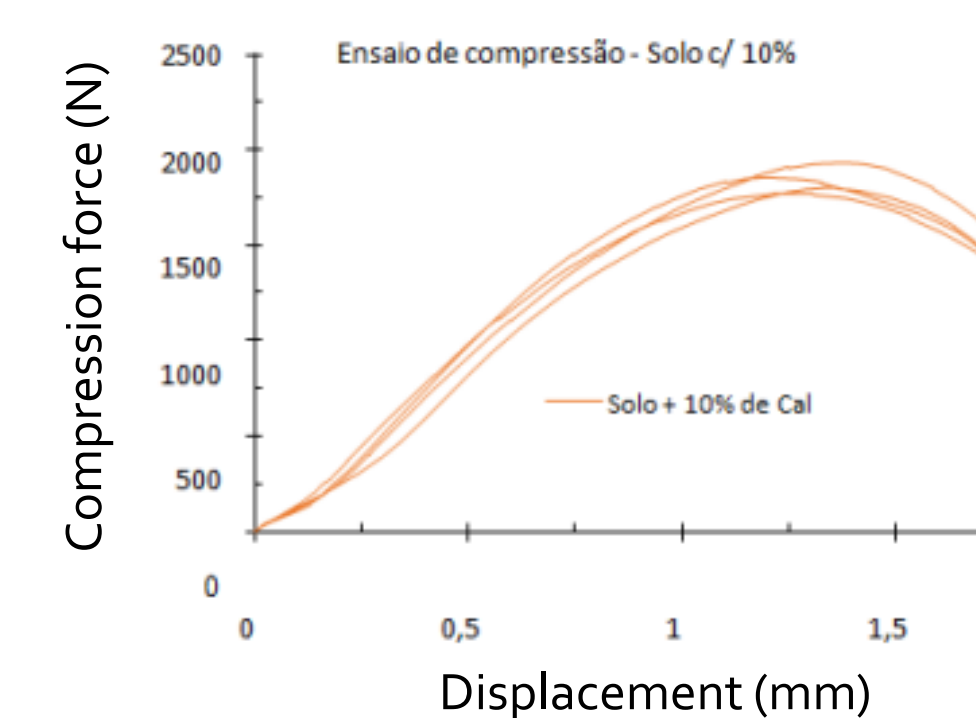
Chart 1- Obtained results



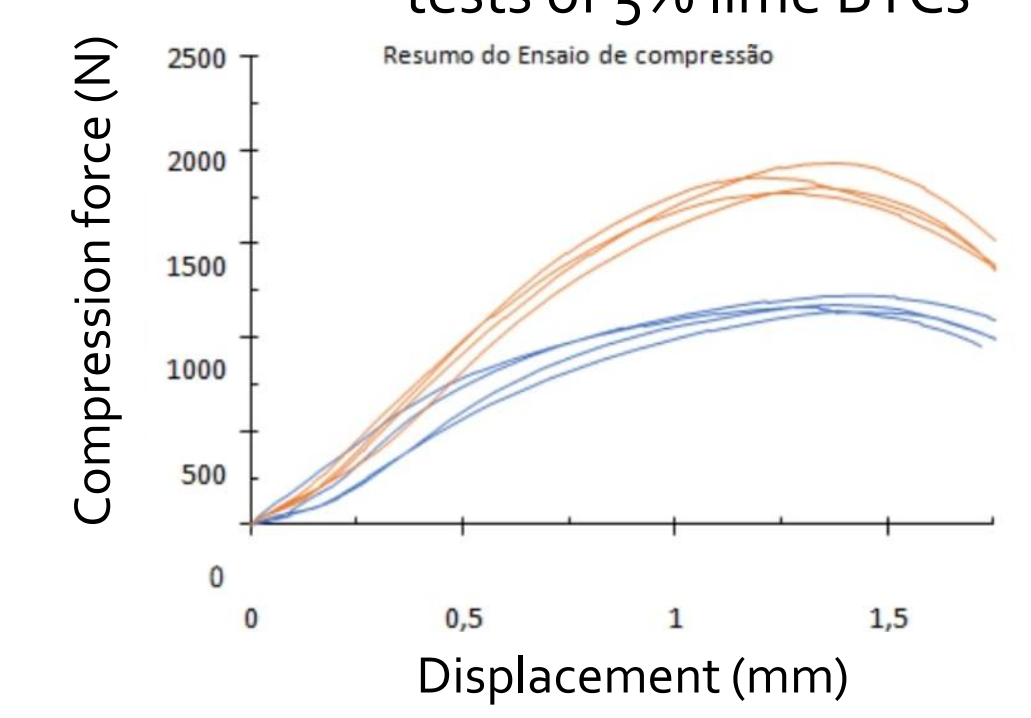
Graphic 1- Compression test summary



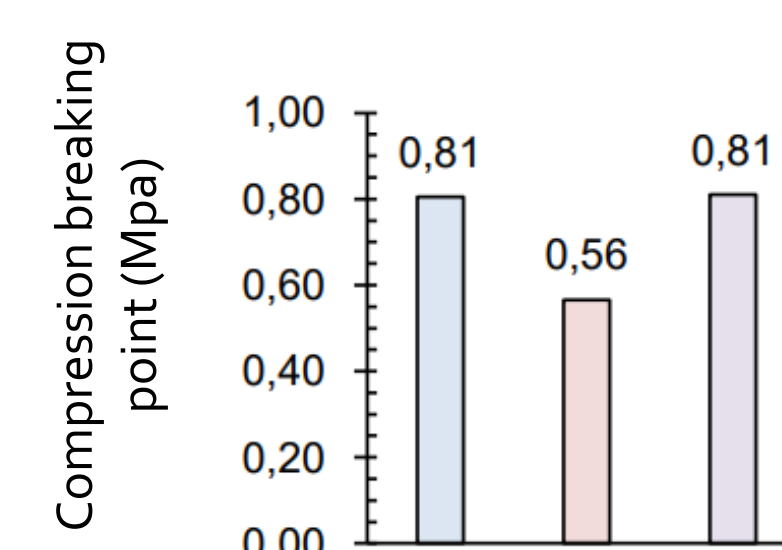
Graphic 2- Obtained curve for the compression tests of 5% lime BTCs



Graphic 3- Obtained curve for the compression tests of 10% lime BTCs



Graphic 4- Comparison between the obtained curves in the compression trials for BTCs with 5% lime and 10% lime



Graphic 5- Compression trials summary for the final BTCs

BTC's	Curing Temperature (°C)	Time of cure (days)	Dimensions (mm)			Mass of test pieces (g)	Density (kg/m <sup>3</sup> )	Breaking force (N)	Breaking Stress (Mpa)
			Width	Height	Length				
Reference	Room temperature	7	105	99	218	3476.2	1533.99	18430	0.81
Reference soil			105	109	221	2011.9	796.42	13110	0.56
Reference soil with fibers			105	106	220	2598.2	1061.10	18800	0.81

Chart 2- Obtained results

## Conclusion

To sum up, thanks to the conducted studies, we were able to conclude that the recycled paper slightly decreased the brick's resistance, due to its less resisting nature, however, when cigarette butts fibers were added, the compression breaking point from the reference BTC was recovered. Thus, we proved that incorporating cigarette butts fibers is quite advantageous and promising, so it should be the object of further studies and improvement.

## References

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Fig. 1- Collected cigarette butts



Fig. 2- Leaching of the cigarette butts



Fig. 3- Shredding of the cigarette butts



Fig. 4- Shredded fibers in the oven



Fig. 5- Construction of test pieces



Fig. 6- Reference specimens (soil)



Fig. 7- Test pieces in the compression test



Fig. 8- Ball method



Fig. 9- Putting the mixture for the construction of the final test pieces in the mould



Fig. 10- One of the final building blocks



Fig. 11- Final blocks: block with soil, block with soil and 10% lime and block with soil, 10% lime and cigarette butts fibers



Fig. 12- Compression tests of the final blocks