EVALUATION OF MULTILAYER SYSTEMS FOR CERAMIC FLOORINGS

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1. INTRODUCTION

This study addressed the development of laboratory scale methods for the evaluation of the ceramic system in its entirety, defining a methodology for simple characterisation in which different materials in the same system or different systems can be compared. It was intended thus to maximise the performance of the assembly and hence reduce the risk of pathologies emerging.

The aim was also to help develop, assess, and implement applications of ceramic systems as yet not widely found in the market, such as dry tile installation.

2. EVALUATED CERAMIC SYSTEMS

The most widespread indoor ceramic flooring systems were first identified. Several were then chosen after assessing their feasibility for conducting the tests.

It was sought to choose representative systems of different construction techniques and functionalities. Three new building work systems (referenced ON1: system with acoustic sheet; ON4: radiant heating system; and ON7: traditional system with decoupling layer), in addition to two refurbishment systems (referenced R1: system on a rigid base; and R5: system on a flexible wood base), were evaluated.

The systems were also combined with different types of ceramic floor tiles (porcelain tile, stoneware tile with water absorption 3>E>6%, and 6-mm-thick ceramic slab).

3. EXPERIMENTAL DEVELOPMENT

Different characteristics or requirements categorised as critical, significant, or secondary were evaluated.

Point load (critical requirement)

Construction system	Surface tile		
	Porcelain tile	**BIIa stoneware tile**	**6-mm slab**
ON1	22.5	14.1	5.1
ON4	7.8	6.7	3.9
ON7	--	14.6	--
R1	69	71	57.2
R5	19.5	17.4	17

Table 1: *Resistance to point loading (MPa)*

Construction system	Surface tile		
	Porcelain tile	**BIIa stoneware tile**	**6-mm slab**
ON1	10.7	9.1	6.7
ON4	12.8	11.2	3.6
ON7	--	2.2	--
R1	0.4	0.6	0.7
R5	1.0	1.1	0.8

Table 2: *Failure strain (mm)*

Comments on the results: Tile type influenced resistance to point loading but had no relevance for system strain. The systems with more rigid lower layers exhibited greater strength.

Compression (critical requirement)

Construction system	Compression strength (MPa)	Failure strain (mm)
ON1	7.2	11.4
ON4	3.2	19.5
ON7	2.9	5.0

Table 3: *Compressive strength and failure strain of BIIa stoneware tile*

Comments on the results: The type of construction system affected maximum load and failure strain. The systems with more rigid intermediate layers withstood greater loads and the systems with less rigid layers deformed more readily. The systems were evaluated using a single type of tile as it was assumed, to start with, that the influence of the type of tile was less significant than the influence of the construction system.

Resistance to "hard" impact (critical requirement)

System	Top layer	Catastrophic failure height h_f – cumulative impacts	Catastrophic failure h_f – direct impact	Level h_f – direct impact
ON1	6-mm slab	600 mm	No	1
ON4	6-mm slab	500 mm	No	1
ON7	BIIa stoneware tile	800 mm	No	2
R1	6-mm slab	1000 mm	No	1
R5	6-mm slab	300 mm	YES	4

Table 4: *Summary of hard impact test results*

Comments on the results: The systems with more rigid lower layers (R1 and ON7) displayed catastrophic failure at greater height (h_f) after the cumulative impacts. In the systems with a lower catastrophic failure height (R5 and ON4), the steel ball did not rebound. All the kinetic energy was transferred to the system. Comparison of the results of the systems in which the lower layers were more rigid (systems ON1, ON7, and R1) indicates that stoneware tile BIIa exhibited a greater level of deterioration on direct impact than the slab. This is possibly because a glazed product was involved.

Acoustic performance (significant requirement)

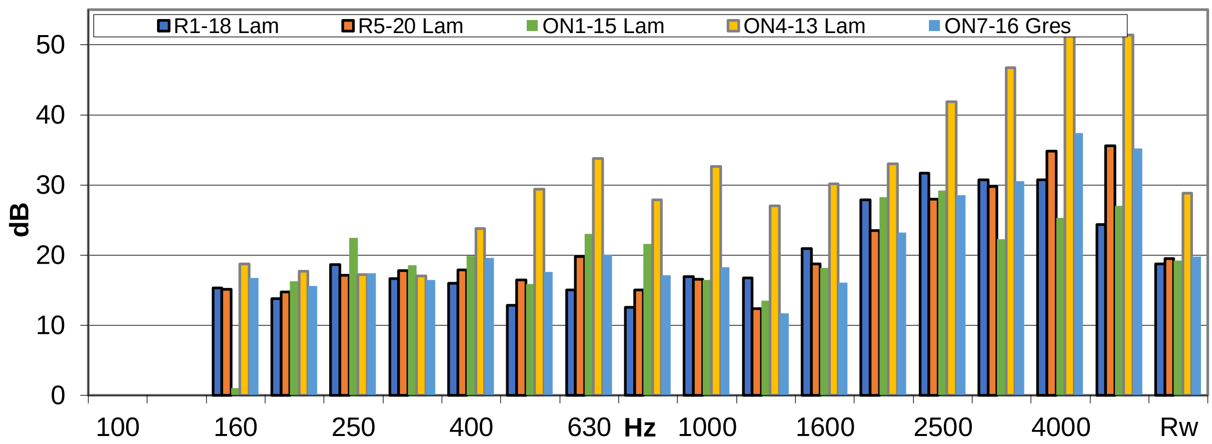

Table 5: *Results of acoustic insulation to airborne sound by frequencies and with respect to the weighted index Rw*

Comments on the results: The test method is still being fine-tuned. However, the results obtained to date suggest that the system that exhibited the best results of acoustic insulation to airborne sound was the ON4 system (flooring on a stable deck with radiant heating), in which the layer involving the sheet with installed heating nodes seemed to play an interesting acoustic role. Current data do not allow the type of covering that exhibited the best acoustic performance to airborne sound to be specified. However, the ceramic covering did not seem to have a significant influence, which is reasonable, taking into account the low mass that the ceramic covering contributed to the entire system.

Thermal performance (secondary requirement)

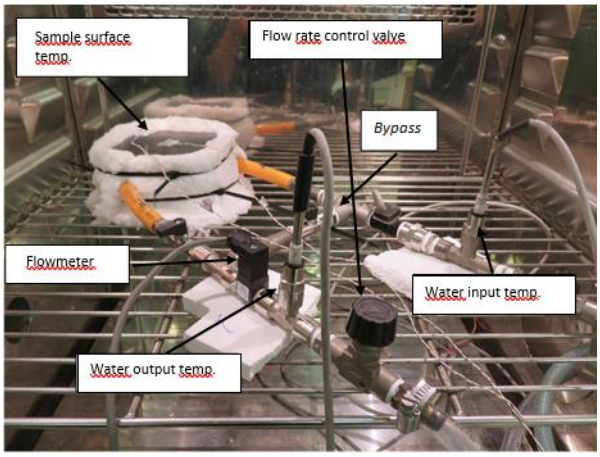

***Figure 1**. Experimental assembly*

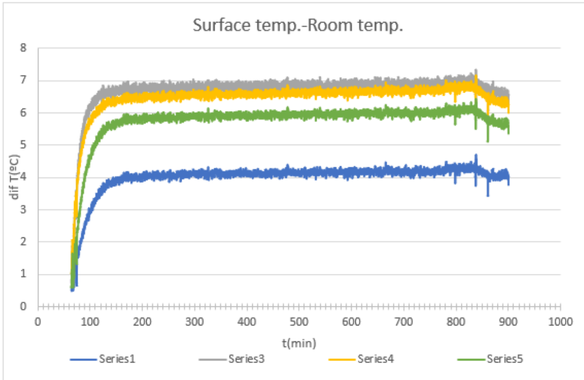

***Figure 2.** Heating test*

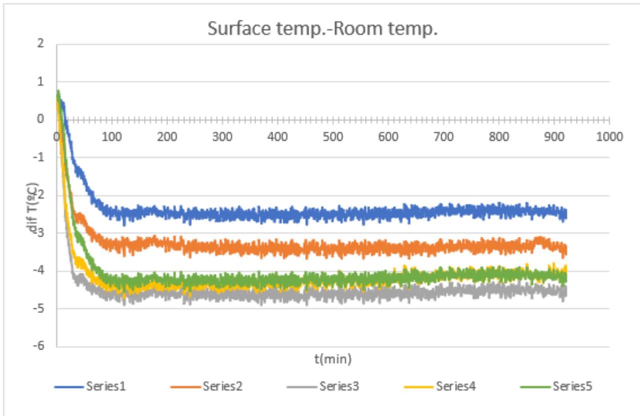

***Figure 3.** Cooling test*

Comments on the results: The validity of the test method for monitoring the cooling and heating processes was evaluated. The method allowed comparative analysis between different types of ceramic coverings.

4. CONCLUSIONS

A complete laboratory-scale characterisation methodology of ceramic systems for floorings in their entirety has been defined. The methodology differs from the current model that characterises each individual layer or material in a system, and it helps validate new systems and/or new materials within a given system. This methodology can help develop and evaluate systems for industrialised construction, the next milestone in today's construction.

5. ACKNOWLEDGEMENTS

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6. REFERENCES

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