Comparing Coatings for the Conservation of the 3–D Printed, Magnesia–Based Cement Sculpture *Rygo*

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Introduction

The purpose of this research was to determine the suitability of coatings for a 3-D printed Mg-O cement outdoor sculpture by evaluating aesthetic changes and changes to water absorbency. *Rygo*, designed by Bathsheba Grossman, was printed in 2012 by Enrico Dini using D-shape 3-D printing technology. When first displayed in Vancouver, it was the largest 3-D printed sculpture in North America. It has since developed significant degradation including cracking, delamination, and a non-uniform discoloration. Due to the a-typical nature of both the cement and method of manufacture, testing was necessary to establish compatibility of industry products before conservation intervention.

Experimental

Material examination:

- 22 samples of original material already disassociated from *Rygo* were collected.
- 2 samples representing 2 different colours were examined under the microscope and analyzed through colour spectrophotometry, X-Ray Fluorescence and X-Ray Diffraction.
- All other samples were imaged and divided into 5 groups based on visual similarities; 1 sample from each group was assigned to an experimental set for product testing.

Samples	Set 1	Set 2	Set 3	Set 4
Coating	Prosoco Siloxane PD	Prosoco Siloxane WB Concentrate	Evonik Protectosil Chem-Trete BSM 400 Water Repellent & Protectosil Antigraffiti	Uncoated

Sample Preparation and Analysis:

Samples were dry cleaned, supported vertically, and coated using a low-pressure spray applicator following product guidelines. Sample Set 3 was coated with two different products following the recommendation of a company representative. Samples were artificially aged by the National Centre for Preservation Technology and Training in a QUV accelerated weathering tester for 45 days, representative of one year of outdoor exposure. Analysis with colour spectrophotometer, glossmeter and water drop tests were used to assess impact of coating 24 hours after application and after artificial ageing.

Images of sample 1-I-02 after treatment with Siloxane PD.
Fig. 1. Recto
Fig. 2. Side view.
Fig. 3. Side view annotated with pink to indicate areas where coating was applied.

Fig. 1

Fig. 2

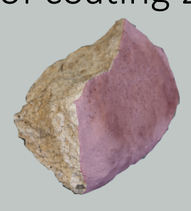

Fig. 3

Fig. 4. Image of *Rygo* in current display conditions

Results & Discussion

Results of analysis with the colour spectrophotometer and glossmeter indicated no significant change in colour or gloss after the application of the coatings in Set 1, 2 or 3. The water drop tests performed after the application of coatings and after artificial aging indicated that all coatings had successfully reduced the absorbency of the sampled material.

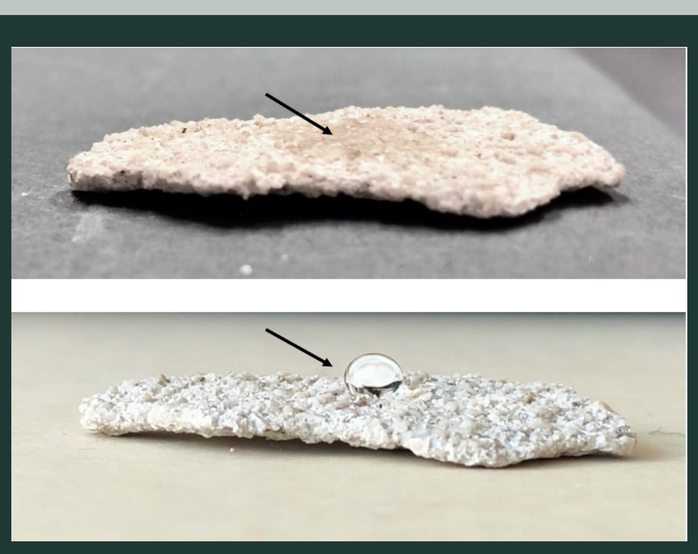

Fig. 5. Water drop test before and after coating

The most significant reduction in absorption occurred in sample Set 3. These results were in line with expectations as samples set 3 was coated with twice the material as other sets. Sample Set 2 was the more effective between Set 1 and 2. These results indicated that all coatings tested were aesthetically compatible and effectively reduced water absorbency.

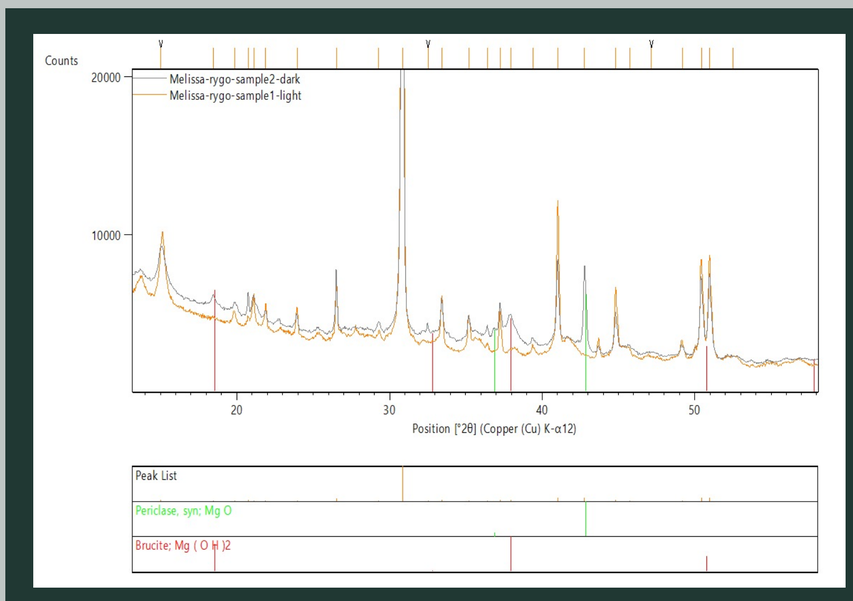

Fig. 6. Image of XRD spectra with variation in peaks indicating heighted periclase and brucite in darkened samples possibly indicative of dehydration reaction

X-ray diffraction patterns of the two samples selected from *Rygo,* as representing the lighter and darker areas of the sculpture, indicated dolomite as the dominant component. Comparison of results between samples indicated that the higher levels of iron in conjunction with water exposure had led to leaching of magnesium chloride in some areas of the sculpture resulting in their darker colouration.

Conclusions

This research suggested that all the coating materials tested were compatible with the magnesia-based cement sculpture printed with D-Shape 3D printing technology. None of the coatings applied resulted in a significant aesthetic change based on colour values, gloss values and visual examination. All coatings decreased the water absorbency of tested samples, with Sample Set 2 and 3 demonstrating the most dramatic change after coating and after artificial aging.

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