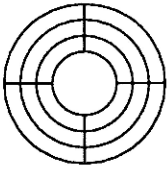


Manchester Building and Testing Laboratories Limited



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Ian Lowe,
MC Facilities Services,
Hoyle Street,
Unit 1,
Manchester,
England
M12 6HG,

09 April 2021

Dear Ian,

re: Alleged defects in Render Sample from Manchester Opera House

Instruction

Ian Lowe : MC Facilities Services

Site Address

Manchester Opera House

Initial Interim Synopsis

A sample of render was submitted to our laboratories for testing and comment. The sample weighed 159 grams and was single coat thickness approximating to a mean of 30 mm as 1 coat.

- 1) Mix proportions were found to be 1:6.6 both by weight and by volume (as bulk density of OPC and recovered sand were similar). A mix with that particular poorly graded sand should have been at least 1:5.
- 2) The sand used in the render was much too fine and poorly graded. It will probably cause a lot of shrinkage cracking, loss of adhesion and hollowness.

- 3) Render should have been applied in a *minimum* of two coats to a minimum thickness of 16 mm each coat. The render sample was applied in just one coat at a nominal 30 mm which is far too thick in one coat placing far too much stress on the render interface. Clause 32.4 of BS 5262 states that a maximum of 16 mm should be applied (in one Coat) of undercoat which is the main component in a render, normally 8 mm to 12 mm is the target for each coat of two coats. Two undercoats largely protect from liquid water transfer by capillary attraction from one coat to the other by forming a capillary break at the joint interface.

- 4) I must stress that *health and safety considerations* are of paramount importance. If largish lumps of render are cracked and not adhered then if it falls from a significant height on to the public or pavement below it can cause serious injury or even worse, with all the possible ramifications of negligence etc.

- 5) Analysis appears to have shown some potential or possible sulphate expansive contamination from the substrate probably old fashioned clay brick possibly clamp fired.

- 6) On the evidence so far, this appears to be only marginal. Normally sulphate added to cement during manufacture to prevent flash set are around 2.5% to 3% when expressed as a percentage of the cement content.

- 7) Analysis of the render showed that sulphates have increased to 4.2% from 2.5% to 3% as a percentage of cement content. Expansion and eventually disintegration could possibly occur if the source persists. See Item 6 above.

- 8) In BS 4551 Annex A 4 states “Analysis of cement-based mortar showing an SO₃ to cement content higher than 4% indicates the possibility of the mortar having been exposed to attack by sulphates.” This normally takes the format of expansive stress where the formation of tricalcium

sulphoaluminate ($3\text{CaO} \cdot \text{Al}_2\text{O}_3 \cdot 3\text{CaSO}_4 \cdot 31\text{H}_2\text{O}$.) can double in molecular volume under such potential attack.

- 9) At this stage such a possibility was found to be only marginal but at 4.2% it should not be ignored and possible further consideration is vital. See Item 8 above.
- 10) A black coating on the surface of the render indicated potential water ingress problems. Normally this is a bituminous coat but in this case no bitumen was found by analysis. It must be a proprietary product but appears to pull-off the surface of the render when examined.
- 11) At this stage there are many significant points to evaluate and discuss and I would not be in a position to recommend patch repair as a viable suitable project without further consideration.
- 12) I would recommend a COVID-19 safe meeting either in person or by Zoom etc. to discuss the pros and cons of the proposals to address the situation.
- 13) If this is not possible then a further extension to the above expanded bullet points may be the best alternative.
- 14) I stress that from a health and safety consideration this really does need bottoming out before any acceptable remedial action is considered or taken.

Sample Numbers	Sample	BS 1199 Type A
Recovery and Grading of sand	---	---
Mesh size	---	---
6.30 mm	100	100
5.00 mm	100	95 – 100
2.36 mm	99.2	60 – 100
1.18 mm	98.7	30 – 100
600 µm	97.1*	15 – 80
300 µm	72.8*	5 – 50
150 µm	10.2	0 – 15
75 µm	6.8	≤ 5

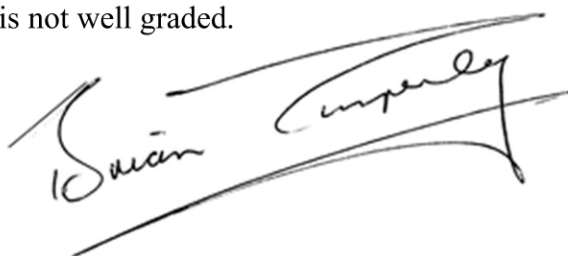
Note:- BS 5262 recommends two undercoats coats and not less than 16 mm total combined

Table one would recommend mix designation III

Mix proportions of designation III should be 1 : 5 to 6

Note:- With fine or poorly graded sands the lower volumes of sands should be used. Quality of sand clause 5 BS 5262 “The various size of particles of which a sand is composed should be uniformly distributed throughout the mass.” There is insufficient number of major fractions contained in the recovered sand and it is not well graded.

Brian Timperley



Manchester Building & Testing Laboratories