

ASSESSMENT & REPORT ON THE LEAD ROOFING CONSTRUCTION

TO THE

KINGS COLLEGE CHAPEL CAMBRIDGE

ON BEHALF OF

PHILIP ISAAC DOMUS BURSAR



ΒY

MR ALLAN ANDERSON (Assisted by Carl Bream)

DATE: 19th May 2021

ON BEHALF OF

THE LEAD CONTRACTORS ASSOCIATION

36 London Rd, East Grinstead RH19 1AB

INDEX

1. Introduction & Site Inspection Page 3

2. Observational Notes & Technical Comments Pages 4 - 7

3. Conclusions Page 8

4. Photographs Pages 9 – 18

IN ATTENDANCE

Allan Anderson - Technical Consultant/Writer (AA)

Carl Bream - Norfolk Sheet Lead (UK) Ltd (CB)

Philip Isaac – Domus Bursar Kings College (PI)

Gethin Harvey – Caroe Architecture (GH)

1. INTRODUCTION & SITE INSPECTION

The Lead Contractors Association were requested by Philip Isaac the Domus Bursar from Kings College to carry out a Scale 2 Site Visit and provide observations as to the possible reasons why the lead roof covering may be the likely cause of water ingress. An opinion was also requested as to the general condition of the roof leadwork.

Kings College Chapel, Cambridge is of great historical importance and recognised as one of Europe's finest, late medieval buildings.

Allan Anderson (AA) specialises in all aspects of leadwork and fully supported metal roofing. He has worked in the lead roofing and construction industry for over 45 years and amongst other projects been commissioned to work on historical monuments and buildings.

The Site Inspection was carried out on the 15th of May 2021 starting at approximately 10am. The weather was dry but cloudy, the temperature was approximately 10 degrees centigrade. Carl Bream (CB) and Gethin Harvey (GH) were in attendance with the assistance of Philip Isaac (PI), providing entry and access though to roof level and enabling lifting roof areas where possible.

Access to the roof areas was by internal access only.

2. OBERSERVATIONAL NOTES & TECHNICAL COMMENTS

Gutters. see photos 1,2,3,4 for annotated details. Most of the lead bays to the gutters are oversized and are approximately 3.4m long and 850 – 900mm overall girth in sand cast lead. Bay sizes should be fixed with code 9 lead. The thickness appears to measure approximately code 6 lead. Please see Table 13 below taken from The Lead Contractors Association Ultimate Guide to Best Practice (LCA UGtBP) for recommended sizes to be used.

Table 13: Gutter Dimensions			Table 14: Gutter Drip/Step Heights	
BS EN 12588 Code No.	Maximum Length Between	Maximum Overall	BS EN 12588 Code No.	Minimum Drip or Step Height (mm)
	Drips/Steps (mm)	Girth (mm)	4	55
4	1500	750	5	55
5	2000	800	6	55
6	2250	850	7	60
7	2500	900	8	60
8	3000	1000	0	00
Q*	3500	1000	9*	70
10*	4000	1000	10*	70
11*	4500	1000	11*	75
11	4000	1000	10*	75
12*	5000	1000	12	C 1 0
*Additional codes available to special order			*Additional codes available to special order	

1. Drip heights are too small - see Photograph 4, steps measuring 40mm - see recommended Table 14.

- 2. The falls appear to be good without signs of ponding and generally there are no signs of fatigue, possibly due to the boarding in Photograph 1 protecting them from the sun. Our thoughts are that these gutters have been replaced at some time but difficult to establish.
- 3. The flashing between the gutter and the main roof in some areas is oversized but does not appear to have failed. Where the height exceeds 300mm this should have welted not lapped joints.
- The lap between the pitched roof and the gutter should be longer, currently 50-55mm see Photograph 3. This ideally should be 100mm.
- The sumps/catchpits/outlets, appear to be in good condition but without access to the outside it is not possible to comment further. The lap into these sumps should ideally be longer, circa 100mm see Photograph 2.
- 6. Another concern is there are no visible signs of ventilation to this area which may attribute to underside corrosion. Please see DWG 1, for standard venting detail from (LCA UGtBP).



Sloping Roof North Side.

- Lifting some of the lead bay fronts to see laps and fixings see Photograph 7, evidence of considerable underside corrosion was observed. Please note that the corrosion element is highly toxic and must not be inhaled or ingested. Underside corrosion is also detrimental to the structure and longevity of the lead sheet.
- 8. Considering the lead work has lasted approximately 158 years, it is challenging to assume that there is a problem. However, it is evident that some areas have been replaced and many temporary patches have been installed. See Photograph 5.
- 9. The lead sheet gauges to approximately code 6 lead, the bottom bay sizes are 2,270mm plus the laps. The laps vary from 150mm to 180mm in places and down stands approximately 55mm. The higher bays appear to be an average of 1,960mm, roll centres are 750mm, this being slightly wider than 675 mm that is recommended see Table 10 below.

and including 60° - Spacing of Joints				
BS EN 12588 Code No.	Maximum Spacing of Joints with fail mm	Maximum Length mm		
4	500	1500		
5	600	2000		
6	675	2250		
7	675	2400		
8	750	2500		

Table 10: Roof Slopes above 10° up to and including 60° – Spacing of Joints

- 10. The head fixings are corroded and inadequate which is allowing the lead sheet to slip.
- 11. The bays are also fixed along the entire length of the under cloak which restricts thermal movement and is detrimental to the lead sheet. This is evidenced by the appearance of cracks and in some instances failures see Photograph 8. Bays should only be fixed for the first third.
- 12. The wood core rolls are small, approx. 30mm. Please see Photograph 9, and diagram D39 below from (LCA UGtBP).



13. The laps are incorrect for the pitch of the roof - see Photograph 10, which we observed to be approximately 23 degrees. Please see Diagrams 36, 36a from the (LCA UGtBP). There would also be a benefit from the installation of clips to the free edge to avoid wind lift.



Sloping Roof South Side

- 14. This section was replaced in 1958 see plaque Photograph 11. The condition of this elevation is poor and worse than the North Side with noticeable issues on nearly every bay see Photographs 12,13,14. There have been many temporary repairs to this section of roof. Naturally the South facing side will be subject to greater extremes of climate to that of the North.
- 15. There are issues with the fixings, as with the North Side, being insufficient and corroding at the head. There are too many fixings to the under cloak which has restricted thermal movement and may have caused the many cracks and failures that are visible.
- 16. The laps are not long enough and maybe the cause of water ingress. See Diagram 36 above.
- 17. The Ridge, lead bays have been carried over from one side to the other with wood core rolls. In some instances, it appears they are being dragged down the roof by their own weight. See Photograph 15 and page 18 diagrams D220, D221, D222, from (LCA UGtBP). Clips have not been fitted to avoid wind lift. On lifting one of the laps the underside was found to be very wet see Photograph 16. The dampness could be due not just to the inadequate laps but also condensation, which we believe should be investigated further.
- 18. The gutters and slopes to the South Side are almost identical to the North Side but the gutters are 100mm wider. We understand that recently there has been extensive repairs to these areas see historical Photographs 17,18,19,20,21,22 supplied by Gethin Harvey from Caroe Architecture. The report on the 21st April 2021 shows timber decay. There appears to be no ventilation to this area. Please see DWG 1 for venting details.

3. CONCLUSIONS

There is considerable evidence that the roof has been extensively repaired and indications of underside corrosion. There is also concern about inadequacy and the corrosion of fixings to the lead sheet.

It is felt that it would be ineffective and possibly not practical to undertake further repairs to the roof.

Due to the condition of the lead and fixings with the presence of underside corrosion, it is recommended that the lead covering be replaced with the correct code of lead sheet complying to **BS EN12588:2006** and fitted to comply with **BS 6915: 2001**, onto a roof substructure/substrate designed to have through ventilation to comply with **BS 5052:2011**, providing the required ventilation with consideration to introducing a ventilation at ridge level.

Regulations.

Should it be decided to remove/strip back the lead from the roof, careful and full adherence to CLAW (The Control of Lead at Work act 2002) is recommended.

I confirm that I have made clear which facts and matters referred to in this report are within my knowledge and which are not. Those that are within my knowledge, I confirm to be true. The opinions I have expressed represent my true and complete professional opinions on the matters to which they refer.

Allan Anderson

Technical Consultant

For and on behalf of the Lead Contractors Association.

















This is at the ridge and was very wet when lifted this could be condensation.







Lead welded patches.



Timber work been replaced.



13.6.1 Ridge Ventilation

148

In many situations providing through ventilation of the roof substrate will require the extraction of air through the ridge detail (as described in Chapter 11). Therefore, the design of the ridge will have to comply with BS 5250 2011. D220 gives an example of this but alternative details are available and D221 illustrates a proprietary ridge detail. It is advisable to seek the manufacturers advice when using this product to ensure the maximum efficiency of ventilation is achieved.

