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Guy Braithwaite
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Our Ref: CARE 14/004
Your Ref:

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Dear Geoffrey

**Cambridge, King's College Chapel (Diocese of Ely)**
**Installation of PV panels**

Thank you for seeking the Church Buildings Council's further advice on the proposals for King's College Chapel, which you notified to us on 23 August. This follows the Council's advice at pre-application stage (letter of 22 December 2021 from Jacinta Fisher to Poppy Crooks). The present advice was considered at the meeting of the Council on 20 October. It follows the site visit on 9 September which I made to view the sample panels in place before the temporary roof was installed. This was also attended by Christina Emerson of SPAB and we were met by Gethin Harvey, of Caroe Architecture, who kindly facilitated the visit and answered our questions. I was grateful for the opportunity to view the panels that day given that the formal meeting as intended was not possible, owing to the period of State Mourning.

This advice concerns the solar PV proposal only. In its 2021 advice, the Council was happy to defer the proposal to replace the lead roof and any associated repairs to the DAC. In this regard, it notes that the Nicholson post supports for the PV panel track and frame would be retrofitted once the roofwork is complete, by cutting holes in the lead, fixing the posts and dressing the upstand with lead. The PV proposal can therefore be considered separately from the re-roofing which is presumably now under way.

The Council was also content to defer the details of the scaffolding and temporary roof to the DAC.

In line with its advice at pre-application stage, the Council is supportive of the principle of solar PV generation on the chapel roof. Harnessing renewable energy as a means of reducing reliance on fossil fuels is a direct expression of the fifth mark of mission. In view of the imperative of the

2030 Net Zero Carbon target adopted by General Synod and the commitment shown by young people to tackling the climate crisis, such a project in a university institution would be powerfully symbolic. Given the prominence of King's and the chapel in particular, both in this country and worldwide, the project offers the opportunity to demonstrate to a wide audience an exemplary approach to designing a renewable energy installation for a highly significant heritage building in a highly sensitive location (a grade II* registered park and garden, a conservation area and in a place which forms part of the setting of numerous other highly-graded listed buildings). It will gain a lot of attention. It is therefore essential that the project clearly satisfies the tests necessary for faculty as well as those required by other authorities.

The Council's guidance *A brief guide to solar panels and faculty* and the related note *A brief guide to solar photovoltaic (PV) panels* are directly relevant. The following advice has been framed according to the tests or questions set out in the first of these. The Council noted that the DAC's Environmental Advisor used the same approach in his commentary and that the applicants responded in the same format.

***Suitability***

*Have the basics been dealt with?*

The guidance states that 'Solar panels should be part of an integrated package of measures; the 'icing on the cake' when heat loss has been tackled and other systems have been made more efficient.' The solar PV proposal is intended to follow the repair of the main roof structure and replacement of the lead currently under way. Other fabric repairs, less critically urgent, are planned. It is clear that there is very little scope to improve the thermal efficiency of the intrinsic fabric of walls and windows.

In terms of energy use, the chapel lighting has been replaced with LEDs. The chapel has underfloor heating which the submission indicates is likely to be due for renewal in the medium term. The *Decarbonisation report* (Max Fordham LLP, May 2022) proposes a district heating system for the King's site to be based on heat pumps serving different zones on the college site. One of these would replace the chapel's fossil-fuel boiler. The Council accepts that the chapel is atypical of churches under the faculty jurisdiction in that it is an integral part of a college estate and that the programming of works needs to be seen in a wider context. It is therefore reasonable that the solar PV installation be considered before the heating system replacement which is dependent on that wider investment programme. However, whilst the submission is rich in detail on the possibilities for energy saving and generation across the site, there is no statement from the college in terms of a strategy or action plan which has been adopted by the governing body.

On this basis, the Council is minded to accept that the proposal addresses the need to counter heat loss and promote energy efficiency but it would welcome an explicit statement of intent about the college-wide net-zero carbon strategy and the chapel's place within that. The point that the urgency of the roof repair provides an opportunity which brings forward a solar generation project which might otherwise be implemented later and at greater expense is well made.

*Is the roof sound?*

The Council accepts that the repair project will put the roof structure and covering in sound order before any PV installation goes ahead. It defers to the DAC the issue of the ability of the structure to bear the load of the PV array, including any ballast required to keep it in place.

*Is the roof suitable?*

The chapel is oriented almost due east and has a low-pitched roof, making the south slope a good candidate for PV generation. The shading from the corner turrets and parapets has been assessed but, following previous discussions with the DAC and consultees and the adjustment of the position of the panels, the Council would welcome confirmation that the outputs have been recalculated. It notes that additional circuitry to overcome the impact of differential shading on the overall efficiency have been added to the technical specification.

The north slope is a different proposition. It is rare to see a proposal for a north-facing aspect given the lower outputs achievable. The submission shows that this has been factored in and, although it would generate only around 60% of the energy the south slope will, the college considers it worthwhile. On the basis of the sheer amount of energy that it could produce – albeit less than the south side – the Council accepts that it could be suitable, though this will not normally be the case for a north-facing roof. Whether it is worthwhile financially or in carbon terms is considered below.

*Is the installation affordable?*

No information is put forward on this but the Council is content to accept that the project will be affordable for the college. It notes that the college stands to make a saving on scaffolding access and will achieve some economies of scale, given that this is a fairly large installation, at least for a rooftop array.

*Is enough energy being used to make the installation worthwhile?*

As noted above, it is reasonable to consider the chapel as part of a complex of buildings. The intention is to use all of the energy generated on the chapel roofs within the King's site rather than export any excess not needed by the chapel to the National Grid. This will minimise transmission loss and contribute to a long-term energy security goal. While the electricity generated might outstrip the present daytime needs of the chapel, it is likely to be more in line in future, when it is heated by a heat pump which in turn relies on electricity.

*Does the environmental impact make it worthwhile?*

This is not clear. The *Decarbonisation report* (p34) estimates that the chapel roof PV array would reduce the college carbon emissions by an average of 23 tonnes a year over the next 30 years: a large amount in itself an in relation to the chapel's usage but a small proportion of the college's overall carbon footprint. The Council's guidance recommends that proposals consider the embodied carbon of the installation, including manufacture, transport, installation and maintenance, in order to arrive at an estimate of when it will break even in carbon terms. This is distinct from the financial payback calculation. This calculation is lacking in the submission and should be supplied. This will need to distinguish between the north and south slopes since it is

not clear that the panels will have a long enough lifespan to give a realistic carbon saving on the north side. Should that be the case, it may be necessary to limit the proposal to the south slope.

***Considerations for historic and listed churches***

*Will the solar panels be visible from the ground?*

It has been acknowledged since the pre-application stage that the panels would be visible. The Council's earlier advice stated that glimpses of the panels from ground level should not have to dominate the views of the chapel, particularly if the panels are made from non-reflective materials and the scale of the lead bays is maintained. It was clear from the site visit that the chosen panels were visible and that they noticeably reflected light. The base colour is black but the material is sufficiently reflective that the apparent colour varies considerably under different light conditions, from white (reflecting white cloud), to mid-blue (reflecting cloudless sky) to dark blue-grey (under partly-obscured sun). By contrast, the range of variation of the adjacent lead was far less, varying from pale grey to mid grey and grey-blue. All these effects were seen on the site visit, which took place between noon and 1pm on a mostly sunny day with fast-moving white cloud and some duller intervals. The Council accepts that the sometimes glaring contrast between the lead and the panels is not the issue since, when installed, almost the entire visible surface of the roof would be covered by panels such that the lead would not be visible. Neither is the base colour itself the obvious problem. The issue is the reflectiveness of the panels.

In terms of size and arrangement, the panels are a reasonable match for the lead bays, the thin lines where they meet mimicking the rolls and lap joints of the lead bays. The resemblance is less convincing at top and bottom. There is nothing along the top edge that imitates the upstand of the roll along the ridge while the shadow under the bottom edge of the array is distinctly visible, both by being so dark and because of the contrast with whatever colour the panels are displaying. Attention is drawn to this in particular from about 50m away in the Great Court, where the shadow makes the bottom of the tracery piercing very noticeable next to the rest of the parapet openwork through which the panels can be seen, especially when they are reflecting paler colours. This effect is also visible on the north side from Trinity Lane and perhaps from some other vantage points on Clare and Trinity College premises but the impact is arguably less in these locations because the views are more incomplete and constrained by adjacent buildings. A selection of photographs illustrating the appearance of the panels from various locations and under different light conditions is included at appendix 1.

The Council noted that the panels are to be set on a new layer of sarking boards laid on top of the old ones thus raising them and the ridge higher than we observed. This is likely to make the shadow line at the bottom edge a little higher as seen through the parapet openings, although the shadow line will remain the same depth. Consideration could be given to lowering the posts to minimise the height of the top surface, subject to any consequential impact on the weatherproofing of the roof, especially in snow conditions.

The Council recommends that the applicants review the choice of solar collector. Rigid framed panels might not be the only option. The market should be checked for different colours and surfaces as there may be less reflective products or ones which could be laid directly on the leads. Technological improvements may have been fast enough since the proposed panels were

chosen that better-performing solar collectors might now be available. In addition, the applicants should look at ways to reduce the contrast as seen through the parapet tracery, for example by the addition of mesh.

*Have alternative locations been considered and clearly presented?*

Other locations in the college have been considered, some already implemented and others in prospect for future installations. The approach is to exploit which ever roofs are appropriate rather than choose one to power the chapel. The Council is satisfied that the chapel roof is worth pursuing as a location if the conspicuousness of the installation can be reduced, as discussed above.

*Have all possible roof locations been considered?*

The only viable roof slopes on the chapel are those under consideration. Following previous feedback, the applicants have reconsidered where the panels would be placed on the roofs in question and the Council is satisfied with the positioning chosen, as long as the visibility issues can be mitigated.

*Does the appearance or significance of the roof and its covering contribute directly to the significance of the church?*

The roof covering does not make an overt contribution to the significance of the building in aesthetic or architectural terms other than by acting as a foil. To the extent that a design intent can be surmised after five hundred years, it would appear that the intention was to build a roof as unobtrusive as possible, hence the low pitch and the parapet design, though – unless the pitch or height of the roof has been altered since construction - the slopes have always been partly visible through and above the parapets. Lead laid in flats is a self-effacing material with a uniform colour once oxidised, though it has some reflectiveness when wet.

In summary, the Council remains supportive of the principle of solar PV generation. It recommends the following:

- That a rapid review of the choice of solar collector be made; the options appraisal carried out at the inception for the project (not seen by the Council) could be revisited with a view to identifying the most unobtrusive system suitable for this location;
- That consideration be given to options for screening or toning down the bottom edge shadow;
- That the embodied carbon of the proposed installation (and any alternative proposal) should be assessed and supplied, with an indication of the likely break-even point;
- That any faculty submission should include a clear statement of college policy or strategy which supports the proposal and the related projects, such as the intention to replace the chapel heating power source, and a timetable for implementation;
- That a statement of needs be provided; this need not be long or complex but, among other things, would usefully cover the two points above.

The Council would be happy to discuss these issues further with the college and its professional advisers.

Yours sincerely



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John Neale, Historic England



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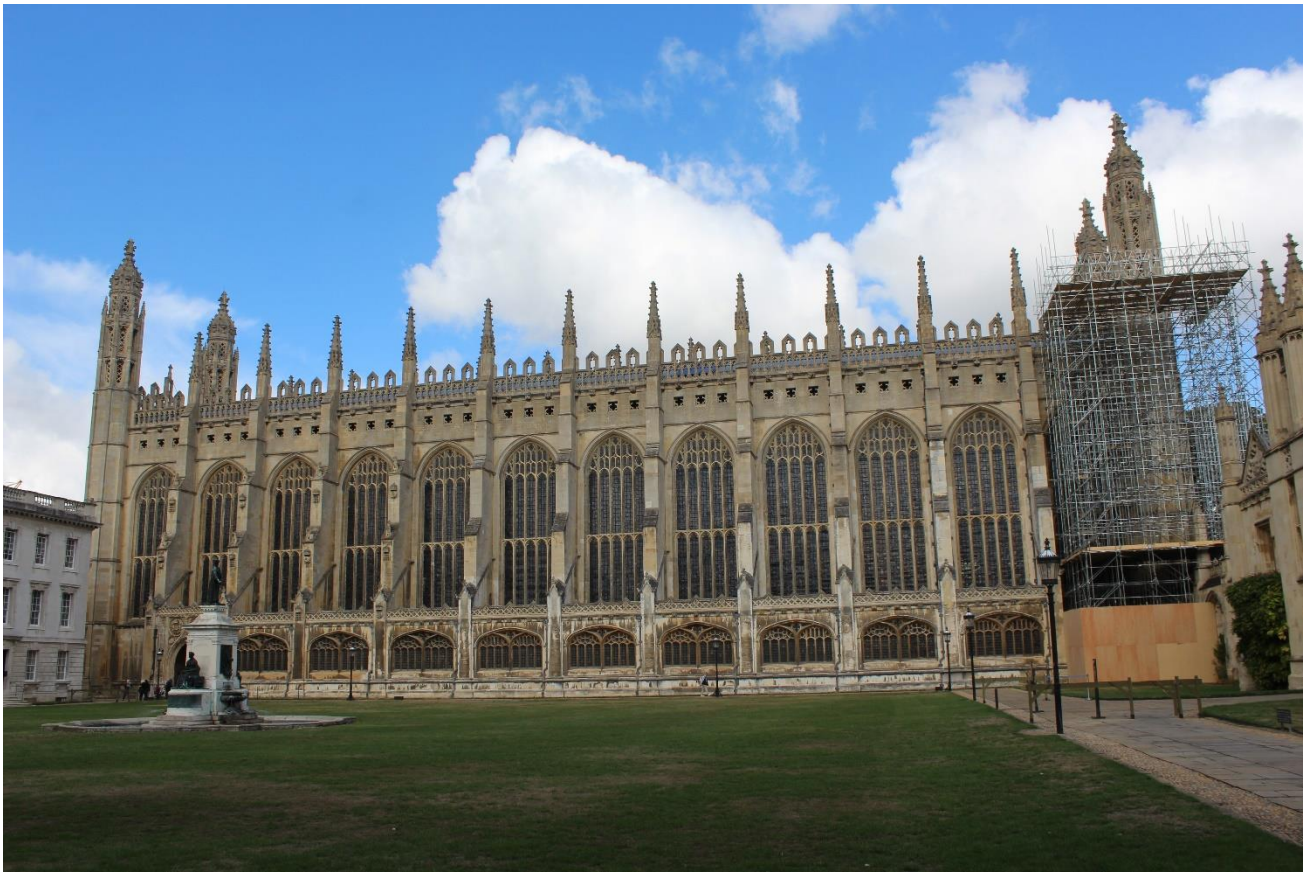
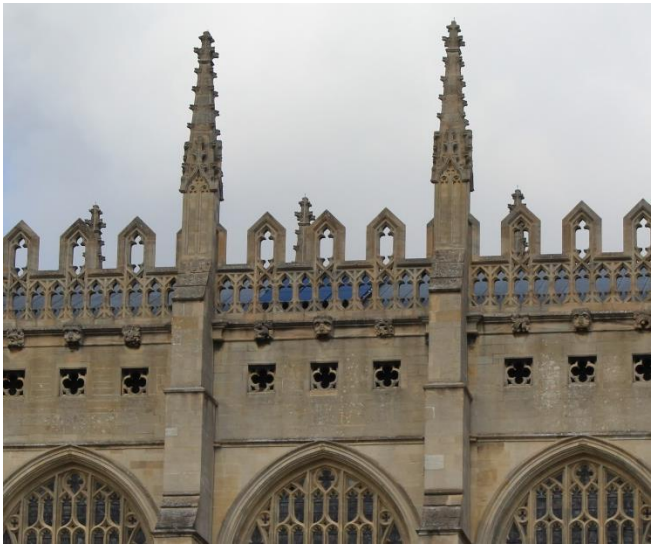
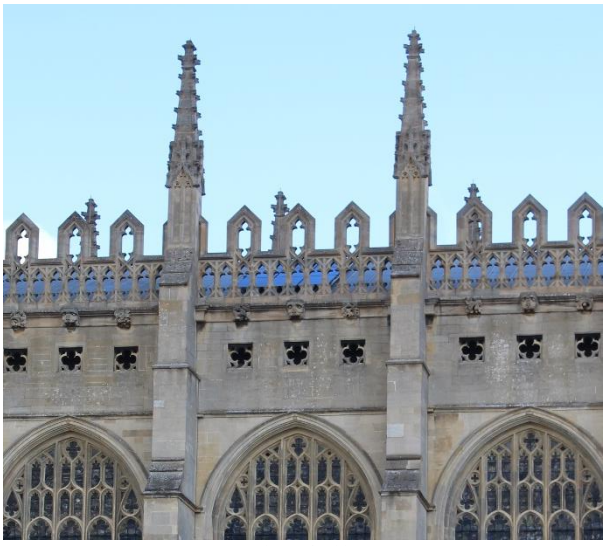
**Appendix 1**



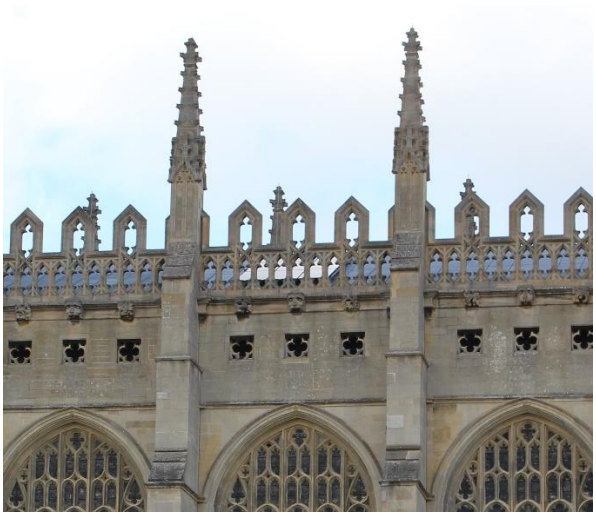
*S façade from the far side of Great Court*



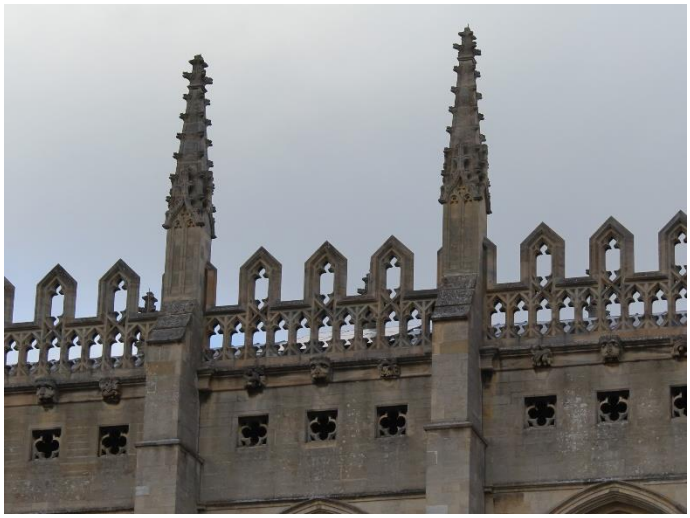
*S side: partial cloud cover*



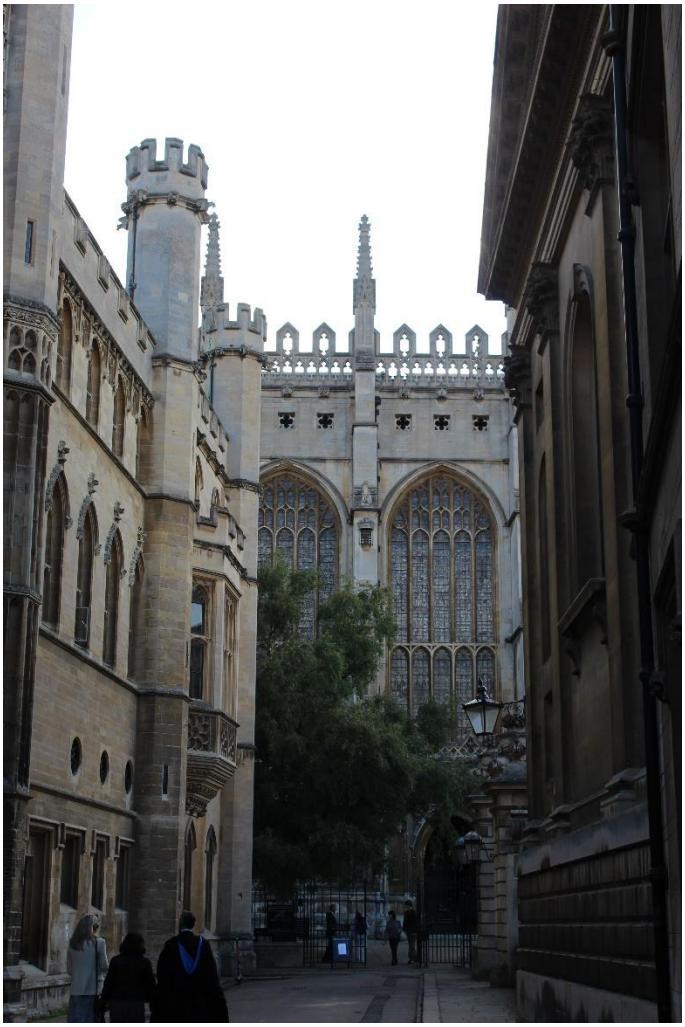
*S side: full sun*



*S side: reflecting cloud*



*S side: vantage point closer to chapel*



*N façade, partial view from Trinity Lane*



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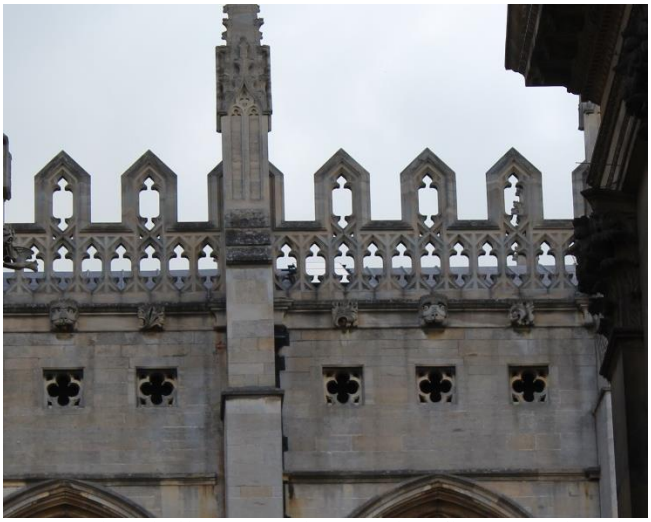
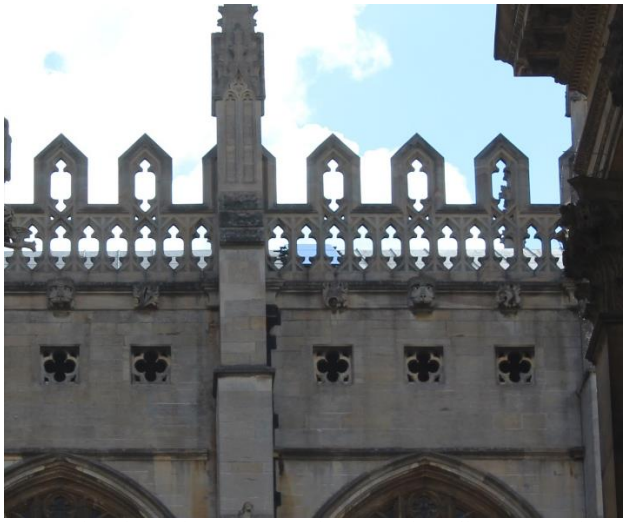
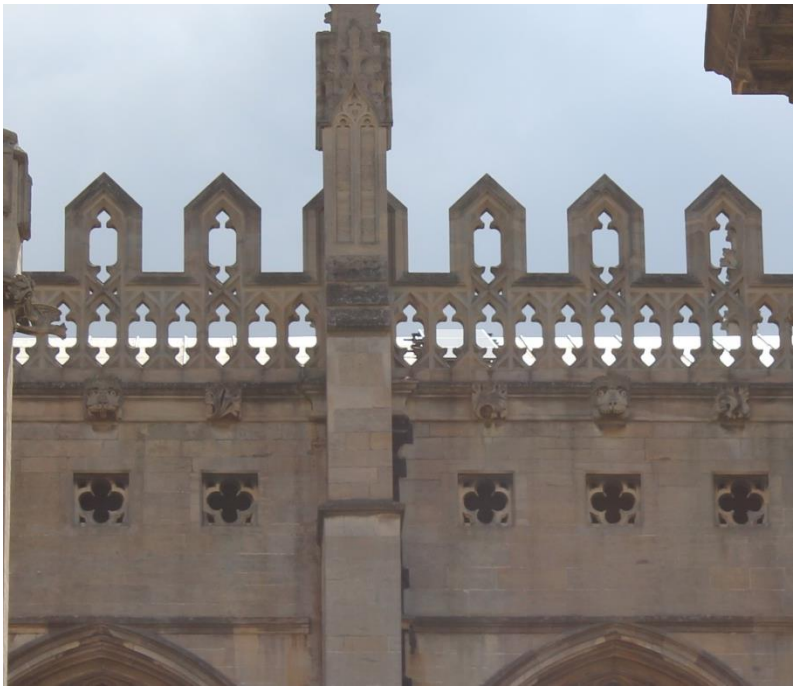


*N side: dull interval, panel reflecting cloud*



*N side: bright interval, panel reflecting sky, cloud behind*



*N side: panel and lead show as very pale grey*



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