Reinforced autoclaved aerated concrete: The history and development of the product, its characteristics, uses and shortcomings

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Trevor Rushton

Chartered Building Surveyor and Chairman, Watts Group, UK

Trevor Rushton

Trevor Rushton *is a Chartered Building Surveyor and Chairman of Watts Group Limited, a company he joined upon qualifying in 1983. His specialisms include building pathology, to which he brings a passion for his subject and enjoys the challenges of investigation and diagnosis of difficult problems. Trevor has enjoyed technical due diligence and has worked on many prestigious developments and historic structures as well as commercial, industrial and residential building stock over the last 40 years. He regularly presents seminars on building defects and surveys and has produced numerous articles and technical papers for the* Built Environment Journal *and other publications. He served on the editorial panel of ISURV at its inception and has been a member of the editorial team for the Journal of Building Survey, Appraisal and Valuation for many years. He has served as an external examiner at Kingston University and recently represented the Royal Institution of Chartered Surveyors (RICS) on radio and television news broadcasts. Trevor has produced two textbooks: one on the subject of deleterious materials and the other on defects in industrial and commercial property. Since 1983 he has edited the Watts Pocket Handbook.*

Watts Group Ltd,
1st Floor, 42 Trinity Square,
London EC3N 4TH,
UK
E-mail: trevor.rushton@watts.co.uk

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Abstract

The media frenzy following the sudden closure of several schools in the summer of 2023 drew attention to the use of reinforced autoclaved aerated concrete (RAAC) in many public buildings in the UK, in turn spawning political debate as to why remedial action had not been taken sooner, whether chronic underinvestment was to blame, or whether successive governments had systematically cut corners by using cheap and short-life materials. Throughout this period the Royal Institution of Chartered Surveyors (RICS) and other professional institutions attempted to maintain a reasoned approach based upon factual analysis and developing knowledge as to the long-term performance of RAAC and the practical implications of its use. Despite poor experiences in the UK, RAAC has been, and still is, used extensively throughout Europe, the Americas and the Far East seemingly without the litany of failures identified in this country. This paper attempts to explain the history and development of the product, its characteristics, uses and shortcomings. Comment will be given on survey methodology, risk assessment and remedial works along with potential legal implications for surveyors and other practitioners.

Keywords: RAAC, AAC, Aircrete, aerated cellular concrete, deflection

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THE PRODUCT

Reinforced autoclaved aerated concrete (RAAC) is a term used to describe a variant of autoclaved aerated concrete (AAC) containing steel reinforcement. AAC will be familiar to many in the form of insulating lightweight blocks, a material that is in widespread use and need not be of concern to us.

AAC was first produced commercially in the early 20th century, sometimes known as aerated cellular concrete (ACC) or autoclaved lightweight concrete (ALC).[1] Early formulations involved aerating concrete using CO_2 but by 1914 aluminium powder and calcium hydroxide was being used to create a porous form of concrete. In 1923, Axel Eriksson, a Swedish architect, refined the process and discovered that when the wet mix was autoclaved, rapid hardening took place coupled with low shrinkage. Materials such as pulverised ash were used instead of lime/cement.

The Yxhukts Stenhuggeri Aktibolag factory in Sweden launched its Yxhult AAC product on a commercial scale in 1928, later changing the name to Ytong.[2] The brand name Durox commenced production in 1932, but the first development of reinforced product came in 1937 under the brand name Siporit, later Siporex, supplying roof and floor panels and lintels.

Hebel, a German manufacturer, established itself as a leading supplier after the Second World War, bringing alternative curing and cutting techniques. RAAC was first introduced to the UK in the late 1950s; its use extended at least until the early 1990s with Siporex, Durox, Ytong and Celcon being active suppliers. It is thought that the bulk of the floor and roof panels were marketed between 1963 and 1968,[3] although there are reports of structural issues with RAAC installed in a building as late as 1998.[4] Unrelated reports also identified RAAC panels in the pitched roof of a hospital building dating from 1991.[5]

BRE Report 445 (published in 2002) refers to the possibility of a UK manufacturing plant that was due to manufacture RAAC panels from spring 2002, although the success of this venture is unclear. H+H Aircrete, however, now manufacture what are in effect RAAC wall panels for use as the inner leaf of a cavity wall in domestic housing.[6] These panels are lightly reinforced to resist handling loads. Variations include RAAC used as a flooring material placed on conventional timber joists. It is important to note that these modern products are made to much tighter quality standards than early RAAC panels and being used in different ways do not necessarily raise concerns. According to Chris Goodyer at Loughborough University, 'RAAC is still manufactured and installed all over the world and can be an appropriate construction material if properly designed, manufactured, installed, and maintained'; however, 'research has shown that this is often not the case for RAAC panels constructed in the 1950s, 60s and 70s'.[7]

RAAC is identical to AAC save for the provision of steel reinforcement to withstand transportation and handling loads. Panels are usually cast on their side — a factor that can have implications in their later performance. After the autoclaving process, the panels can be used as soon as they have cooled down.

Effectively, AAC is made up of about 70 per cent air pores and 30 per cent solids, hence the now popular trade term 'Aircrete'. It demonstrates some anisotropic tendencies, meaning that its properties may be slightly different between the vertical and horizontal directions (this is related to the rise of the 'cake' during manufacture).

Aircrete is highly resistant to frost damage and freeze–thaw tests show no strength reduction under these conditions.[8]

The compressive strength of RAAC is typically in the range of 2-5N/mm^2 while the aerated structure and lack of coarse aggregate means that the elasticity and creep characteristics of AAC are inferior to those of conventional concrete.[9]

AAC does not provide corrosion protection and so during manufacture it was necessary to coat the steel with bitumen or cement-loaded latex. Because of its low strength, AAC does not anchor the reinforcement in the way that occurs in normal dense concrete and the anti-corrosion coatings tended to make the situation worse. In order to provide adequate anchorage, it was essential to provide anchorage reinforcement welded to the main tension bars and at right angles to them.

PRODUCTION METHOD

AAC is produced in a large cylindrical autoclave into which steam is fed up to a pressure of circa 800kPA and 180^{0}C.[10] Unlike most other concrete applications, AAC is produced using no aggregate larger than sand, with a wide range of materials being used, commonly Portland cement, pulverised fuel ash (PFA), lime and silica sand. Gypsum is sometimes added and although the production process varies slightly between manufacturers, the basic product is similar and characterised by its porous aerated structure. AAC made from ground sand tends to be white in colour, while that which uses pulverised fuel ash tends to be grey. Earlier Swedish formulations involved alum slate, a material containing low levels of uranium, which can produce radon gas. The production of AAC using shale is understood to have ceased in 1975 following concerns about radon concentrations in homes in Sweden.[11]

By varying the amount of aluminium powder, the density of the final product can be controlled. For RAAC panels a density in the 500-700kg/m^3 is usual — around a third of the density of ordinary concrete.

The raw ingredients are mixed and poured into a mould, where they gradually stiffen to form a weak 'cake' (sometimes termed 'green cake'). The cake then rises as a result of the formation of hydrogen gas bubbles which create the cellular structure (see Figure 1). The product is removed from the mould and cut with oscillating wires to the required length/size before being autoclaved for 8–12 hours. The combination of high pressure and steam forms a calcium silicate binder in the product.

USES IN THE UK

By far the largest use of RAAC panels was in the construction of school and healthcare buildings, but many other public building types are known to have used it, from Ministry of Defence (MoD) establishments to civic buildings, court buildings, libraries and so on. RAAC has been known to exist in shopping centres and retail units in private ownership.

RAAC panels were commonly around 600mm (2ft) in width (other sizes were produced), around 150–175mm thick and up to about 6m in length. The bottom edges are usually chamfered, and the top edges rebated to accommodate continuity reinforcement that would be added once the panels had been fixed and then grouted in. This continuity reinforcement did not result in the roof or floor acting as a complete unit — more a series of planks that performed individually and not as a complete structural entity.

The product was relatively cheap and being lightweight, meant that savings could be made on supporting structure. Coupled with good fire-resisting properties and the ability to adapt and cut the panels onsite made RAAC an attractive option for industrialised building methods — effectively a modern method of construction (MMC) of the day. (Given the widespread use elsewhere in the world, RAAC remains a versatile material for MMC use.)

Uses in both private and public sector housing are known: the former tending (it is believed) to be more used in bespoke designs than volume production; the latter more commonly used by local authorities as part of an initiative to combat housing shortages.

One such system was the Siporex 6M designed and constructed by Costain. 6M

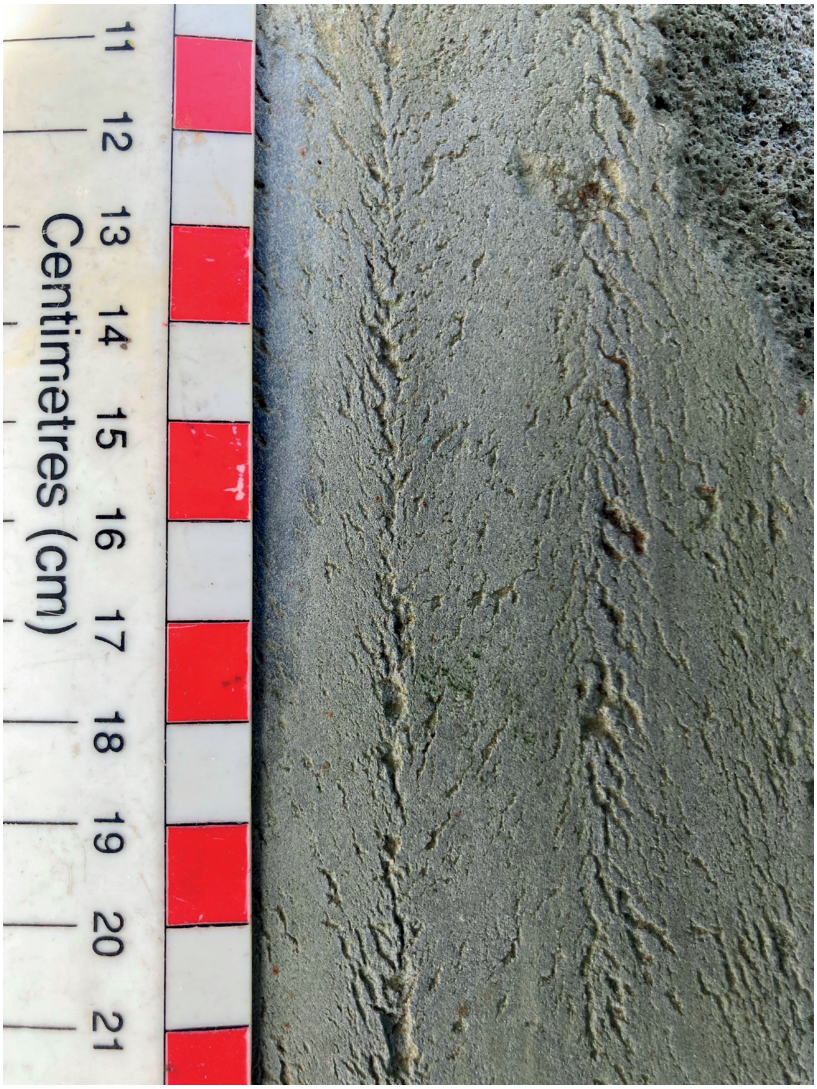

Figure 1: The cellular structure of AAC

referred to the 2ft design module. Altogether, some 900 of these bungalows and 2–3 storey terraced houses were built during the 1960s. The houses typically comprised external walls of storey height 2ft x 8ft panels joined with ¼ inch galvanised steel dowel bars and ¼ inch continuity reinforcement. Upper floors and roofs were of 6in RAAC planks laid to a shallow monopitch and often finished with bituminous felt or asphalt finishes. Some dwellings had infill panels of either timber, aluminium cladding or tile hanging.[12]

While much has been done to gather data on the extent of RAAC in the UK, there is no central database and no clear record of buildings containing the material. This lack of data breeds considerable uncertainty as to the scale of the problem.

DESIGN CODES

Over the years the design of RAAC components and structures has evolved and while modern-day commentators may be critical of its use, it is fair to say that design can only be progressed according to knowledge available at the time. In the UK, the Institution of Structural Engineers (IStructE) published, in 1961, articles on the structural use of reinforced concrete, while limited information and guidance was contained within Code of Practice CP 116-2:1969, CP 110-1:1972 and later BS8110:1985. Technical knowledge gradually increased with the publication of further guidance by the Concrete Society in its Technical Report TRCS 3 1966 — work undertaken by the International Union of Laboratories and Experts in Construction Materials, Systems and Structures (RILEM). Later prEN 12602 was drafted, followed by the standard itself, although by that time RAAC panels had fallen out of favour in the UK.

TIMELINE

By the early 1990s, some concern was being expressed over the in-service performance of panels constructed before 1980. During 1991, and again in 1995, the British Research Establishment (BRE) undertook site investigations and laboratory testing of a number of 20-year-old RAAC roof panels obtained from a housing development, along with further panels manufactured in 1995.

In 1994, the then Department for Education (DoE) requested BRE to investigate two school roofs in Essex where ponding of the flat RAAC roofs was also accompanied by deflections of up to 1/100 of the span. IP10/96 provided guidance on the tests conducted at that time.[13] Some evidence of reinforcement corrosion had been identified and although BRE 'considered it wise' to inspect RAAC floor components there was no evidence at that stage that RAAC posed a safety hazard to building users.

In 2002, BRE published a second report (Report BR445 2002) on the use of RAAC. It identified, among other things, voidage in the vicinity of reinforcing bars due to gas bubbles coalescing on the surface of the steel. Panels are usually cast in a vertical configuration, which means that in service voidage can form a horizontal plane of weakness at the level of the reinforcing steel.

In October 2007, the Standing Committee on Structural Safety (SCOSS) (now Collaborative Reporting for Safer Structures [CROSS]) reported on a case dating back to 1970 where some slabs had failed during construction, leading to severe injury to two building operatives. The affected slabs had 3–4mm diameter reinforcement, latex coated, but with anchorage only about 200mm from the bearing ends. SCOSS still adopted the view that the slabs could be expected to continue to creep-deflect under load, but that sudden collapse was not expected to occur. SCOSS added that replacement might need to be considered when they fell outside the serviceability limits for deflection and durability, at that time thought to be around 30 years.[14]

While recommendations for maintenance and inspection had been made by BRE in 1996, the same conclusions regarding the potential for collapse appear to have applied up until 2018, when there was a partial collapse of a school roof in Kent. Fortunately, there were no injuries as the failure occurred over a weekend. The investigations that followed identified potentially serious problems with shear reinforcement at the bearing ends of the planks.

By letter issued in late 2018, the Local Government Association (LGA) and the Department for Education (DfE) contacted all school building owners warning of the risk of sudden collapse of RAAC roofs — a reversal of the previous view that collapse was unlikely. In February 2021, the DfE published a guide to help responsible bodies to identify RAAC, while the LGA advised its members to identify any properties constructed of RAAC and validate the potential risk appropriately. Further, and as an acknowledgment of the frequent poor level of maintenance of buildings in the public sector, it advised consideration and monitoring of the possible impact of reduced maintenance regimes, in particular where RAAC is used.

A further CROSS report covered a previously unreported failure of a school roof in 2017 where the reporter had identified a shear failure due to inadequate bearing following some structural alterations made by the school. The failure was triggered by outfall gutters becoming blocked, which allowed ponding of water on the roof to quickly build up during a storm.[15] The same CROSS report noted a further case, in 2019, of the partial failure of a RAAC plank at another school requiring temporary propping. The defects were thought to be due to historic roof leaks causing the reinforcement to corrode and loose anchorage.

In November 2022, the Office of Government Property issued a letter advising departments, local authorities and other arm's length bodies of the dangers associated with RAAC and the risk of sudden collapse. Organisations such as DfE have been actively compiling information on schools, with healthcare following closely behind.[16]

Currently, the LGA issues unequivocal and direct advice to members and responsible school bodies — note the use of the word 'ensure', which leaves very little room for manoeuvre:

- Ensure that the condition of all their buildings are regularly monitored, taking a risk-based approach that gives due deliberation to the use of the building with consideration given to the possible impact of reduced maintenance.
- Ensure they have identified any RAAC property in their portfolio.
- Ensure that RAAC properties are regularly inspected by a structural engineer including using a cover meter to check the provision of transverse and longitudinal reinforcement, note deflections, check the panels in the vicinity of the support, the width of the support bearing, cracking, water penetration and signs of reinforcement corrosion and any inconsistencies between panels. The frequency of subsequent inspections should be determined by the structural engineer conducting the initial inspection.

LGA also recommended good maintenance procedures, some of which are based upon the advice of BRE in IP10/96:[17]

- Ensure water outlets are clear and are at such a level that allows free drainage of water from roof areas.
- If the internal surface of the planks is to be decorated, use paint which allows moisture vapour to pass through it. Protect external surfaces with a coating which provides an effective barrier against the transmission of liquid water.
- Where appropriate, reduce the dead load on roofs by removing chippings and replacing them with an appropriate solar reflecting coating.
- Ensure that all waterproof membranes are maintained in good condition.
- Keep records of deflections of RAAC planks and inspect the construction regularly.
- Ensure that those responsible for the day-to-day management of any RAAC building know that RAAC is used in the building and where it is used.
- Check regularly for visual signs of cracks, water penetration, deflection to soffits and ponding to roofs.
- Ensure that all staff know to report any cracks and or other identified potential defect issues and are instructed to immediately close off any part of the building where cracks or other material defects appear pending further checks.

Investigations by a working party led by IStructE and representatives from

Loughborough University resulted, in February 2022, in the publication of a new guide on RAAC advising on the identification, characteristics and risks involved and recommendations for repair or other remedial action.[18]

Anecdotal evidence and preliminary investigations by Loughborough University suggests that there is considerable variation in material properties between different RAAC panels, within the same structure, and across different structures, locations and ages.[19]

KEY ISSUES IN THE PERFORMANCE OF RAAC

Current guidance is based around a number of known problem areas:

- *Length of end bearing*: The width of bearing surface has been found to be critical in assessing long-term performance. In many instances a bearing of circa 45mm for roof panels and 60mm for floor panels was specified according to design codes at the time of construction. On masonry the bearing may be more. The greater the length of the bearing, the lower the compressive stress at the bearing end. The bearing length is also coupled with the location of the transverse bars in the panel and these must be located above the bearing. Currently, IStructE recommends a minimum bearing of 75mm, anything less than this being considered sub-standard.[20]
- *Transverse bars*: As noted elsewhere, the low-density AAC is not efficient at locking the reinforcement in place; this, coupled with the anti-corrosion coating, means that transverse bars are essential. The position of the transverse reinforcement is also critical in terms of its relationship with the end bearing and if it is misplaced, or the panels have been cut such that the reinforcement has been removed, the panels will in all likelihood be compromised and shear failure could result. Because RAAC is easily cut with hand or power tools, it is possible that some panels may have been adapted on site (perhaps to accommodate services penetrations) and this could mean that the transverse reinforcement has been removed or reduced. Furthermore, variations in quality control during manufacture might also affect transverse bar positioning; the actual location of the bars could be variable.
- *Water ingress*: Because of the porous nature of the matrix, RAAC can readily absorb water arising from defects in the roof coverings; this may accumulate over time rather than simply working its way through gaps and fissures as it might in conventional construction. Not only does this place the reinforcement at risk of corrosion, but it also affects the weight of the panel and hence, increase in deflection.
- *Deflection*: Long-term creep deflection of panels is common. When constructed, the differences in the coefficient of linear expansion between AAC and steel impart a small degree of prestress in the panels, which in turn can cause a small degree of bowing — often a useful feature that could be used to offset deflection under self-weight and load. Excessive deflections, however, have been found to be a problem with RAAC. The safe limit is usually expressed as l/250 (ie equal length of span between bearings) but deflections greater than l/100 pose a high risk. Further, deflections in roof panels permit water accumulation in the form of ponding, thus increasing dead loads and exacerbating the problem. Coupled with deflection is the creation of transverse cracking in the panels. Issues such as new plant and machinery or re-roofing exercises may have affected the loading on the roof.[21]
- *Age of panels*. Panels manufactured before 1980 are potentially more at risk of failure

owing to lower quality standards, corrosion protection and use-related factors (for example, changes in roof coverings affecting loading and/or thermal cycling). By 2002, the material was considered to have a relatively short life — 30 years or so, but by now many panels will be approaching twice that age.

- *Debonding*: Potential plane of weakness caused by voidage around the reinforcement, corrosion or overloading.
- *Panels cut after manufacture or penetrated after construction*: Cut panels supported on hangers are likely to exhibit inadequate bearing, particularly where transverse reinforcement is not present. This can increase the risk of sudden shear failure.
- *Cracking*: Cracking can provide a warning of excessive deflection, water damage, corrosion, etc. Cracking within 500mm of a bearing could be an indicator of shear failure.
- *Modifications*: Adaptations onsite could have had unintended consequences, particularly where the operatives were not aware of the importance of transverse anchorage reinforcement.

INSPECTIONS

Surveyors will often be called upon to undertake a primary inspection simply to determine whether RAAC exists or not. On a large portfolio, an initial sifting exercise may be appropriate to discount buildings according to the age of development (for example, pre-war, traditional construction, contemporary buildings, nature of building, etc.)

Visual identification of RAAC is straightforward and laboratory testing is unnecessary. Panels are grey or whitish in colour (unless painted) and easily penetrated with a sharp probe. Look also for the characteristic V-shaped chamfer at the longitudinal edges of the planks and slightly rough surface texture.

Frequently the construction is concealed above suspended ceilings or applied finishes. In such cases an intrusive inspection will be needed (unless the building lends itself to non-destructive methods — see below). Cutting in small inspection hatches is a straightforward enough exercise and avoids the need for decorative making good, but the age of affected premises makes them prime suspects for asbestos-containing materials, in which case appropriate care and precautions will be needed.

An inspection of flat roofs may reveal signs of ponding; depending upon the pattern, this could be an indication of deflection and prompt further investigation. A judgment as to the condition of the roof (and thus the potential for harm to any RAAC) would also be useful.

A useful guide to identification was published by DfE in 2022 and updated in April 2024. The non-statutory guide is intended to help responsible bodies from the education sector (school, nursery and college leaders, staff and governing bodies) understand how to identify RAAC, although the document will have relevance to buildings well beyond this subject group.[22]

If RAAC is discovered, engineering input will certainly be required unless the surveyor can demonstrate suitable experience and knowledge. A certain amount of data gathering at this stage will assist the engineering team and help formulate a strategy for further investigation. Bear in mind that an assessment of deflection will be required using levelling techniques and, while a crude assessment might be possible by comparing one panel against another, it will be necessary to arrange larger-scale opening up of ceilings and the like. A string line run between the bearings of a panel may help form a preliminary judgment, but this is neither accurate nor necessarily practicable if a large number of panels are involved.

Looking for signs of water ingress and checking for signs of disturbance, spalling or cracking around bearings and elsewhere will help inform an initial view — if nothing else, to help explain to the client that additional expenditure is likely.

In assessing the risk, the use of the building will need to be considered, because an occupied classroom would, for example, present a higher risk than an unoccupied store. The results of the condition assessment will inform a management plan and help determine whether replacement needs to be considered and when.

A more detailed examination will involve a certain degree of careful opening up. The position of transverse reinforcement can be identified by a cover meter, an electromagnetic device that measures changes in voltage arising from responses to applied magnetic fields. The location of tension reinforcement should be checked, too, to see that it extends to the ends of the planks. Such reinforcement must be present around intermediate supports, because sagging can occur due to thermal effects. Laboratory analysis of samples will confirm the degree of carbonation, as this can result in degradation such as cracking in the microstructure of the RAAC.

In its publication 'Reinforced Autoclaved Aerated Concrete (RAAC) Investigation and Assessment – Further Guidance', IStructE sets out methodology for the appraisal of risk together with a classification of the risk factors and how these might have an impact on the proposed remediation or action plan.[23] The guidance was primarily intended for use with roof panels but can be used for the assessment of floor panels. Four risk categories are identified:

- *Critical*: Urgent action needed: propping, take out of use.
- *High risk*: Requires remedial action as soon as possible, combined with an awareness campaign for occupants.
- *Medium risk*: Requires inspection and assessment on a regular basis.
- *Low risk*: Occasional inspection and assessment, say at three-yearly intervals.

The risk assessments are then based upon issues such as bearing wider or narrower than 75mm, degree of deflection and whether or not the panels exhibit signs of water ingress.

NON-DESTRUCTIVE TESTING

The measurement of deflections and matters such as the positioning of steel reinforcement lend themselves to non-destructive testing techniques, albeit there appears to be some initial reticence on the part of IStructE towards these methods. As noted earlier, there is anecdotal evidence of wide variations in quality control, which means that panels do not necessarily all behave in the same way. Identifying the condition and repair needs of potentially several hundred or even thousand panels demands methods of more rapid assessment than conventional physical inspection.

The Manufacturing Technology Centre (MTC) has recently obtained funding to enable novel use of non-destructive testing (NDT) to identify RAAC, assess its condition and risk, and enable automated collection and analysis of RAAC data so that in the future, cases can be assessed more rapidly, cost-effectively and safely.[24]

Ground-penetrating radar (GPR) is a long-established technique that is finding some success in its ability to detect transverse and longitudinal reinforcement within RAAC panels; it can also detect water ingress within panels by identifying changes in dielectric properties. MTC is also developing an angled beam GPR system that can be used to detect transverse bars at the bearing end that would otherwise be inaccessible.[25]

Alternative strategies involving ultrasound and x-ray computed tomography are being established to accurately identify RAAC in cases where it might be hidden (for example, by asbestos finishes), to map rebar distribution and evidence of cracking.

REMEDIATION STRATEGIES

The mere existence of RAAC does not mean that remedial work is essential or that immediate vacation of the affected area is required. IStructE have issued guidance on identification and remediation solutions for RAAC planks.[26] Often, the RAAC panels will have performed well in service and will continue to do so; however, a risk-based assessment procedure is required in order to determine the most appropriate strategy. Options include the following:

- Do nothing — not an acceptable option but potentially valid in specific circumstances, particularly where a very low risk is presented (eg unoccupied building in good repair).
- Monitor the performance of the panels — frequency of inspection will depend upon the findings of an initial detailed assessment.
- Reassess the performance of the panels and downgrade the use of the structure.
- Provide temporary support.
- Prevent further deterioration, for example by replacing roof coverings.
- Strengthen all or part of the structure — provision of span breakers, bearing extensions, etc. Note that it may not be necessary to strengthen all RAAC panels; because they tend to work as individual components, some may be at greater risk than others.
- Remove component parts and replace them — for example, remove an RAAC roof deck and replace it with a timber or steel structure.
- Demolish all or part of the building.

The repair of spalled RAAC is problematic; conventional repair mortars have a completely different structure and may not be suitable for anything other than localised patches.

CASE STUDY: WHITCHURCH LIBRARY AND CIVIC CENTRE

The Library and Civic Centre is a two-storey building dating from the 1970s and comprises civic offices, the Whitchurch Library, a market hall and a theatre with a gross area of circa 2,362 m^2. An initial study by Shropshire Council's Property Services Group identified, through desktop research, a potential risk of RAAC, which was subsequently confirmed by intrusive investigations. While various parts of the structure were concealed, the initial findings prompted further opening up, which indicated that the theatre, library and registrar areas contained RAAC. The library and registrar areas were of particular concern owing to evidence of water ingress, modification of planks, reduced end bearings and cracking to walls in non-public areas.

The subsequent detailed investigations and findings were set out in a detailed and very informative study which not only traces the history and use of RAAC but details the risk assessment process and the results of point-cloud studies to determine deflection.[27]

The investigations identified, among other things, unsupported or inadequately supported planks, adaptations to the detriment of stability, end bearings of less than 75mm, reinforcement compromised due to alteration, deformation and displacement of planks and historic water ingress affecting the condition of the planks.

The report concludes with a range of remedial options from the 'do nothing' approach to full demolition and redevelopment of the site. It is important to remember that even the do-nothing approach carries with it a potential six-figure cost, it being impossible to simply close the doors and ignore the problem; there still remain liabilities as regards safety for persons visiting the site, propping and so on.

LEGAL CONSIDERATIONS: A SURVEYOR'S VIEW

While this paper has demonstrated that the deterioration of RAAC has been in the public domain at least as far back as the early 1990s, the issues were not recognised to any great degree in the general surveying community other than background knowledge or passing interest. Despite recent revelations on the alleged scale of the problem, encountering RAAC in buildings other than schools and healthcare buildings was, and still remains, uncommon; it is hypothesised that relatively few surveyors will have been familiar with the material and its shortcomings.

At what point, however, would a court decide that a competent and experienced surveyor ought reasonably to have knowledge of the product, sufficient to make a recommendation for further investigation? Claims involving RAAC are thought to be relatively few and far between; it is possible that since the events of September 2023 claims might increase.

The author is aware of one such claim involving a private dwelling constructed in the late 1960s. The property comprised a chalet bungalow with a central pitched roof surrounded by asphalt-covered flat roofs and a link-attached garage. The walls were of brickwork with a horizontal band of asbestos cement fibre match boarding at eaves level. The hapless surveyor was instructed to undertake a level 2 home survey and valuation in 2020, which identified the construction as being traditional. Unfortunately, he did not identify the RAAC slabs forming the roof of the double garage and did not uncover a trail of suspicion in relation to the main flat roof, instead making the assumption that it was a conventional timber-framed structure. The purchaser completed on the purchase and lived there until 2023, when the RAAC story broke. Suddenly catapulted into a situation whereby the property would in all probability become unmortgageable and faced with the potential of actual harm to his family, the purchaser commenced a claim in negligence.

The surveyor, a general practitioner, had not encountered RAAC previously and indeed one might have a certain degree of sympathy given the apparent rarity of this material in a one-off architect-designed dwelling. Of course, cases such as this turn on the actual facts of the case; it remains to be seen whether this one will go to trial, but readers might wish to reflect upon their own level of knowledge in 2020 and what they might have recommended.

The above case highlights the potential risks to surveyors; currently the insurance industry has not reacted to the RAAC scare and appears to be taking a 'wait and see' approach to professional indemnity insurance risks. But where may additional risks lie?

Specifiers, designers and contractors will be protected by the standard limitation period within contracts, which is six years from the date of breach; in a design and build contract this would usually be the date of practical completion. The same six-year limitation applies to claims in tort (12 years if executed as a deed). Alternatively, under S14 of the Limitation Act, a claim could be brought within three years from discovering the cause of action and a long-stop date of 15 years. Given that RAAC was more or less discontinued from at least the early 1990s, it is therefore unlikely that claims for inappropriate specification could be brought.

The Building Safety Act now makes it possible to bring a claim under the Defective Premises Act where a right of action arose 30 years prior to the Act being implemented. Effectively therefore the backstop for claims would be 28th June, 1992 — again it seems unlikely that this would create a significant risk for architects, surveyors and engineers.

One needs to examine whether knowledge of RAAC was so widespread that no reasonably qualified professional could possibly have countenanced its use or would have been familiar with its characteristics. One might argue, with some justification, that with the material having fallen out of use together with the general radio silence on the subject between 2002 and 2018, the answer would be no, but this is moot.

As a further illustration of the above point, by 2007 there was a growing reliance on the publication 'Good Practice in the Selection of Construction Materials' in Appointment Documents and Collateral Warranties, generally in preference to the ever-increasing list of prohibited or deleterious materials — such lists generally proving ineffective in practice. The publication was first issued in 1997 but together with the later 2011 edition, did not include any references to RAAC.[28] The author's own work in 2006 identified RAAC not as a deleterious material but one that could be problematic.[29]

The picture could be slightly different when it comes to the conversion of former commercial buildings (especially those formerly in the public sector) into residential use. A former office building converted to residential use at any point from June 1992 could, if it contains RAAC, invite a potential claim if it can be shown that the developer or those employed in connection with the conversion works had known about the issue and failed to address it.

Similarly, valuers might be exposed if a building previously valued at a higher value is expected to incur significant sums in remedial work. (The value of replacement work in the case described above is around two-thirds of the purchase price; it would not be too hard to envisage a significant diminution in value once the existence of RAAC has been discovered.)

Another potential difficulty arises in landlord and tenant law, particularly as regards dilapidations claims. The existence of or age profile of RAAC does not mean that it triggers an automatic need for repair, but issues such as deflection beyond limits, cracking or spalling might do. As to whether misplaced or missing insulation needs attention, this will largely be a question of fact and degree. The construction might be deficient, but if no damage is present, the requirement for repair will not necessarily be triggered. By contrast, damage arising from misplaced or missing reinforcement may create a liability for repair; the fictitious 'doctrine of inherent defects' is unlikely to benefit a tenant in these circumstances.

For building owners and operators, health and safety legislation will be an important consideration, especially with the backdrop of criminal liability if harm is caused. Bear in mind that duties extend beyond occupied buildings; a responsible person will also have duties to maintain the safety of unoccupied buildings that may have been vacated due to the existence of RAAC.

HOW DO WE PREVENT SIMILAR FAILURES IN THE FUTURE?

The natural reaction to the crisis was to criticise successive governments and to blame developers, builders and designers for using short-life, cheap materials of low durability. But it is easy to forget that traditional building could not meet the high demand for schools, hospitals and public buildings and that it was therefore necessary to employ systems and products that could be fabricated quickly, efficiently and simply. Relatively short life yes, but buildings have an economic life as well as a physical one; user requirements change and what may have been needed then may not be the building that is needed now.

While the materials used may not have performed fully as expected, it is fair to say that in general terms the standards of maintenance of public buildings has also been woeful; postponing repairs may satisfy a short-term financial need, but the consequences are often profound. Perhaps a higher standard of maintenance would have mitigated the current crisis. With hindsight, manufacturing standards have improved, as has knowledge of long-term performance of materials, but assessments can only be made with the benefit of knowledge available at the time. Yes, it may be possible to predict performance and long-term weathering effects, but with building, getting it wrong is often the means to getting it right. RAAC is not the first material to be found wanting and it will certainly not be the last.

The obvious conclusion is that to achieve longevity and to avoid future problems one should only adopt traditional construction techniques using tried-and-tested products and materials. But is this really the answer? Stifling innovation is not going to satisfy the current housing crisis; new and better products and methodologies are needed. Managing the consequent risks will involve better use of the knowledge that we do have to predict long-term performance — using what we know to establish what we do not know — as well as ensuring that adequate thought is given to the practicalities of future maintenance.

CONCLUSIONS

For building owners now facing significant repair costs for remediating buildings containing RAAC, the practical problems and costs cannot be underestimated. Precisely why the material has become so blighted in the UK is uncertain, especially when one considers the strength of the markets and popularity of the material elsewhere in the world. That said, there are two important considerations: first, the predominant use being in public buildings (although not exclusively so) and second, decades of underinvestment and poor repair choices.

That RAAC has deteriorated in certain conditions is unsurprising; leaking roofs are bad for any building. Structural problems as a result of timber decay in flat roofs are common, as are deck failures in materials such as woodwool — another common MMC in post-war years. One might argue that RAAC is simply a component of a building and that some components are expected to wear out within the total life of a building. This might hold true for a roof deck, although slightly harder to reconcile if used as an intermediate floor.

Another argument is that the RAAC problem is the product of cheap building and poor investment decisions, but this would be unfair. Over the years there have been numerous attempts to make industrialised building mainstream; simple economic pressures have created a demand for buildings that can only be met by incorporating innovative systems and methods. Buildings have a finite life not only in terms of their fabric but also an economic life; that replacements are now required should not be a surprise.

While AAC continues to be a mainstream product, RAAC is likely to become classed as a deleterious material within the UK; however, the mere existence of RAAC is unlikely to trigger a need for its replacement. Measures such as regular inspection and proper maintenance procedures may be sufficient to achieve a much longer life that the 30 or so years predicted at the outset.

Notwithstanding the above comments, methods of assessment as well as a better understanding of the modes of deterioration and failure mean that care must be exercised in the assessment of risk and the selection of appropriate repair options. Because of the characteristics of RAAC, and what is now seen as a propensity for sudden failure, the risk assessment process is best handled by practitioners with suitable experience. Surveyors have a valuable role to play in the initial assessment process, reviewing large portfolios to identify buildings at risk of having RAAC and then conducting initial inspections to verify its existence, but the actual risk assessment is better handled by suitably experienced structural engineers.

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