CONSUMER GUIDE

Reinforced autoclaved aerated concrete (RAAC)

A clear, impartial guide

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Introduction

Reinforced autoclaved aerated concrete (RAAC) is a lightweight building material that was widely used in the UK between the 1950s and mid-1990s, particularly in public buildings like schools and hospitals.

At the time, it was seen as a practical and affordable alternative to traditional concrete. However, RAAC is now recognised as having some inherent weaknesses that can be exacerbated by poor maintenance, raising safety concerns.

During 2023 and following some well-publicised cases, problems with RAAC became national news as scores of schools and other buildings in the UK were forced to close pending structural investigations.

While a majority of cases involve buildings in public ownership, some local authority-built housing stock in Essex and Scotland is known to have been constructed using RAAC, although the precise number of cases is unknown. Most of these buildings will be managed by councils and housing associations, who by now will have (or should have) carried out surveys to identify whether RAAC exists in the property or not. But many homeowners will still have concerns about RAAC, particularly since the material was in widespread use for many years.

By comparison with the total building stock, the existence of RAAC is very small, but that does not diminish the impact upon people directly affected.

This consumer guide provides straightforward information on a technical subject; it is no substitute for professional advice from an experienced construction professional, and the reader is urged to take further advice if RAAC is found or strongly suspected.

RICS is the largest organisation for professionals working in property, land and construction worldwide. RICS members may be involved (but not exclusively) in all types of surveying, including defect surveys, pre-purchase building and home surveys and the valuation process for secured lending – which is potentially a further consideration if RAAC exists in a property.

How an RICS member can help

As the world's largest professional body for chartered surveyors, RICS offers clear, impartial, expert advice on the issues raised in this guide.

RICS members can help property owners in a variety of ways, so whether you want expert advice and a professional assessment of your issue, an opinion on costs, representation or a professional to manage a project for you, visit Find a Surveyor to find an RICS member in your area.

Using the services of RICS members offers confidence because:

- they give you clear, impartial and expert advice
- they are tightly regulated and have strict rules of conduct to protect you – including appropriate insurance
- they have to update their skills and knowledge throughout their careers, so you can rely on their expertise and
- you are further protected by RICS' complaints service and access to independent redress.

Why was RAAC used?

In the UK, RAAC panels became popular in the 1950s; there was a huge demand for buildings during the post-war reconstruction period, and demand for new homes, factories and civic buildings was outpacing supply. Traditional building is a hungry consumer of time, money and raw materials, and the difficulties of meeting the demand resulted in the need to find alternative ways to build. Traditional building was often not an option.

As well as its insulating and fire-resistant properties, one of the things that made RAAC attractive to designers and builders at the time was its light weight; this made it easy to use and allowed corresponding savings in the structure that was needed to support it. The product could be cut quite easily with power tools, which meant that it was easy to accommodate small changes in the design. Large, ready-made planks or panels could be brought to site, lifted and placed in position quickly and cheaply, minimising construction times and allowing following trades to start work immediately without having to wait for the concrete to harden.

The advantages of RAAC led to it being used in buildings where the repetitive nature of the design could make the best use of standard-sized parts.

How is RAAC different from normal concrete?

Ordinary concrete is a very heavy and dense material. It is often made by mixing cement, sand and small pieces of stone or crushed rock, which are known as fine and coarse aggregate, respectively. Concrete has been used successfully around the world for centuries, dating back to Roman times. While it is incredibly useful, it is heavy and can be expensive to produce.

In contrast, autoclaved aerated concrete (AAC) was first developed in the early 20th century. It is made using smaller ingredients like sand, lime and cement, and later included pulverised fuel ash – a fine powder that is a byproduct of coal-fired power stations.

By adding a small amount of aluminium powder, a chemical reaction creates thousands of tiny bubbles in the mixture. When this mixture is baked in a steam oven (called an autoclave), it hardens into a lightweight material that can be cut into block shapes for building. The resulting blocks are light because they contain a lot of air – about 70% of an AAC block is air. This makes them useful in walls to help reduce heat loss and keep buildings warm.

People sometimes confuse AAC blocks with breeze blocks, but they are not the same. AAC blocks are recognisable by their light grey or white colour and bubbly texture, rather like an Aero chocolate bar. They are easy to cut or drill and are widely used in building projects around the world. When used correctly, AAC blocks are safe and pose no risks to health or to the buildings they are part of.

While AAC blocks are primarily used for walls, the same concrete mixture could also be made into larger structural elements, such as floors and roof panels. However, like regular concrete, AAC is not very strong on its own and needs steel rods for reinforcement. If reinforcement is added we have reinforced autoclaved aerated concrete, or RAAC – the material that is now a source of concern.

How and why does RAAC go wrong?

In 2019 the partial collapse of two school roofs, in Kent and Bolton, changed the industry viewpoint that RAAC would grow old gracefully, and it was realised that RAAC could fail suddenly. Subsequent investigations by Loughborough University and the Institution of Structural Engineers have identified many of the reasons for the problems that have occurred.

While it's not necessary to understand every detail of how RAAC fails, having a basic grasp of some key engineering terms can help. Let’s start with two important concepts: bending and shear.

Bending

Imagine placing a long plank of wood between two chairs. The plank will naturally sag (deflect) a little in the middle. How much it deflects depends on the distance between the chairs (the span), the weight of the plank itself and how strong the material is. If you stand in the middle of the plank, it will sag more. Your weight introduces what engineers call a live load, increasing the plank’s deflection. Engineers set a safe limit for how much the plank can bend before it risks failure. Structural elements usually do bend to some extent, but RAAC tends to bend more.

If another person joins you on the plank, it might sag even further and possibly break. This is known as bending failure and is one of the ways in which RAAC can go wrong.

Shear

Now, think about moving the chairs closer together. The plank will feel stiffer and sag less in the middle. However, if you and perhaps several others stand on it and the combined weight is too much, the plank might snap suddenly where it meets the chair. This is called shear failure, which happens due to a slicing-like action at the supports. Shear failure was the primary mechanism in the Kent and Bolton school collapses.

Now let's consider a third factor, bearing. Going back to our example of a plank, the term bearing refers to how much of the plank rests on the chairs. If the plank rests on the entire seat, then all well and good; but if it's balanced on the edge of the chair seat there is a possibility that the whole thing will collapse when you stand on it.

The shorter the length of plank sitting on the chair, the greater the pressure the plank exerts. In other words, if you are standing on the plank, your weight spread over a large area is okay, but if it's spread over a small area, it's more likely to cause a problem. RAAC planks are similar – if the bearing width is not sufficient to ensure that the steel-rod reinforcement is correctly placed, shear failure can occur.

Bending and shear failures are obviously dangerous, but bending tends to happen over a longer period – you may get some warning that things are going wrong. Typically, with a flat roof the warning signs might be that large puddles of water are now collecting (termed 'ponding'). The greater the amount of water that collects, the heavier it becomes; the roof planks bend a little more and collect more water, which adds more weight – a vicious cycle.

Shear failure can be sudden; you don't necessarily get the warning signs first.

When installed in buildings, RAAC planks may bend under their own weight and any loads applied to them. For example, on a roof, loads could include waterproofing systems, snow or rainwater on the top side, and anything fixed to the underneath, like lights, ventilation ductwork and cable tray runs. If the bearing ends of the planks are also insufficient, shear failure can occur.

Were RAAC planks built to be strong enough?

In theory, if you reinforce the lightweight concrete with steel bars, you can control the amount of bending and prevent the concrete failing at the ends of the planks where they are supported by the walls of the building (or by a steel or concrete beam).

However, there are several reasons why RAAC planks have become problematic.

- To prevent shear failure, it was very important to include what is called 'anchorage' reinforcement at each end of the planks. Poor quality control in the factory could have resulted in the reinforcement being in the wrong place or omitted.
- RAAC is easy to cut with power tools, allowing builders to cut the planks down if they were too long. However, doing this might mean that vital reinforcement could be cut off altogether.
- If the planks have been allowed to become wet (for example due to a leaky roof), they become weaker and heavier and the risks of deterioration are much higher.

The risks of failure are also influenced by the age of the planks – some of the early production runs were not checked as thoroughly as they are now.

Most buildings containing RAAC roof decks will have been re-roofed at least once in their lifetimes; this could have changed the overall weight of the roof or the way the roof reacts to changes in temperature, both of which can influence long-term performance.

Sadly, due to budgetary constraints, some buildings have suffered poor levels of maintenance over the years, and this in turn affects the long-term performance of RAAC.

In summary, the main risks for RAAC planks are:

- shear and poor bearing
- bending
- poor maintenance.

Each case must be assessed individually, as not all planks in a roof or floor system are necessarily compromised. In some cases, only one plank may be at risk of failure.

How do I spot RAAC in my building?

If your building was constructed or altered between the 1950s and 1990s, it may contain RAAC.

Signs to look out for include the following.

The style of building

Although it is dangerous to make general assumptions, a Victorian villa or a 1930s semi is most unlikely to contain RAAC unless it has been extended. Traditional-style houses with pitched, tiled or slated roofs are unlikely candidates.

If the house is of later construction (post-war) and contains a flat or shallow pitched roof, it would be appropriate to check, particularly if it is one of a series of similar houses that were built as part of an estate. Typical RAAC roofs might have a deep wooden fascia around the outside.

It's not unknown for one-off, architect-designed homes to contain RAAC, but some local authority housing utilised a system type in which the roofs, floors and walls were made of RAAC. A number of these estates have now been redeveloped.

RAAC was used extensively in schools and healthcare, Ministry of Defence and civic buildings, etc.; it can also be found in some offices, homes and shops. Owners of homes or buildings that have been converted from earlier uses or former public buildings need to satisfy themselves that RAAC is not present.

Flat roofs

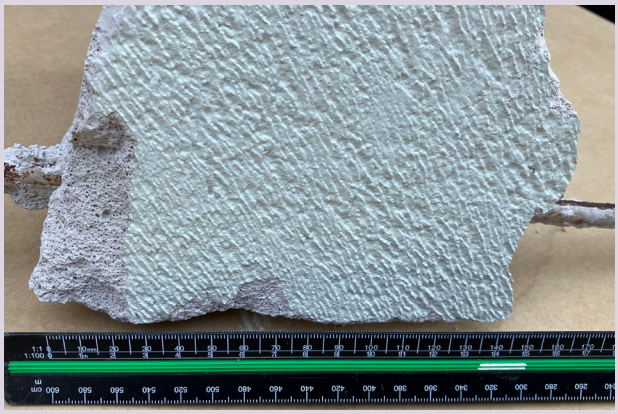
There are many different types of flat roof, but RAAC planks or panels were often covered with roofing felt or sometimes asphalt. You cannot tell simply by looking at the roof, but if you notice that the roof seems solid (i.e. not timber) and water is collecting in regular puddles this could be a sign that the roof deck is bending. This is typical for RAAC, but it does not always occur.

Try to look underneath; it might be necessary to lift false ceiling tiles or to make a small hole in the plasterboard or plaster internally.

Be aware that some textured plaster surfaces could contain asbestos. If you are in any doubt, leave it to a professional to look.

Appearance

If it's RAAC and it's visible, you will see a series of grey or whitish planks, about 600mm wide and with a V-shaped edge. From a distance it can be difficult to spot the difference between RAAC and ordinary pre-cast concrete, but close up, the surface will be textured and easily scored or penetrated with a sharp blade. The bubble-like nature of RAAC is not always apparent from a smooth face, but it's usually possible to see it on close examination, particularly if there is a broken edge.



Upper floors

RAAC was also used to create upper floors; you will probably not see much from the top surface, but you may be able to inspect from underneath in the same way as if it were the underside of a roof.

If you spot what you think might be RAAC, or are simply concerned that it may exist at your property, you should take advice from a chartered building surveyor or chartered engineer.

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Here the RAAC formed the roof of a garage and was seen easily. Usually, the material would be hidden by ceiling linings such as plasterboard, which would need to be cut open to allow inspection. The appearance of the RAAC would be the same whether it was a flat roof or an upper floor.



What should I do if RAAC is found?

Finding RAAC in your building isn't a reason to panic, but it is a sign that action is needed. A professional assessment will help determine whether the RAAC is still safe or if remedial work is required. Possible solutions include:

- regular monitoring – setting up a schedule of inspections to track any changes in the condition of the RAAC
- reinforcement or repair – strengthening RAAC with additional supports
- replacement – removing and replacing RAAC panels, especially if they are severely deteriorated or located in critical areas.

A professional assessment is essential to determine the best course of action.

If RAAC is found, can I make a claim on my household insurance policy?

Most household policies will cover damage arising from what is usually termed an 'insurable event'. Insurable events will usually be classed as such things as storm damage, fire or flood and not the existence of a product or material that has been known to fail.

If a RAAC roof is still performing as it was designed to, it has not failed. Therefore, it will be unlikely that you can claim on your insurance to replace the roof.

Should a collapse occur, your insurer may cover the accidental damage arising but not necessarily the cost of removing any undamaged or remaining areas.

The situation varies according to the specific wording of your insurance policy, and it's best to consult with your broker or insurer on these matters.

What about my mortgage or the prospects for selling if RAAC is found?

The presence of RAAC is a factor that could affect a valuer's professional opinion of value. If a valuer has reason to suspect or encounters RAAC during their visual (non-intrusive) inspection, they may request an independent specialist report (usually from a chartered building surveyor or structural engineer) before a valuation can be provided. The results of that report could have an impact on their opinion.

A valuer will not make any inspection of the condition (structural or otherwise) of the RAAC elements.

The valuer will also have to conform to the instruction and any policy provided by their mortgage lender clients. Mortgage lending policies do vary throughout the mortgage market and vary from time to time. It is not necessarily the case that a property with RAAC is not suitable for a mortgage.

RICS recommends making sure you have all relevant information and documentation on your property maintenance history, including but not limited to the alterations, repair and maintenance to areas with RAAC present. If you are purchasing or (re)mortgaging a property with RAAC present, ensure this documentation is available, as this will assist in any queries received from the valuer, lender or legal representatives.

If RAAC is found, can I make a legal claim against the builder or architect?

The situation regarding legal claims is complicated and best discussed with a solicitor. It is probable that due to the timescales involved (RAAC being used in UK buildings constructed largely between the 1950s and early 1990s) you will not be able to claim.

However, there is a possibility that if the building was converted to residential use after that date there might be recourse under the Defective Premises Act. The provisions of this Act have recently been extended because of the Grenfell Tower tragedy and the cladding crisis that emerged following this.

Moving forward

RAAC was an innovative material in its time, but its limitations have become clear over the decades. If you suspect RAAC in your building, a thorough inspection, investigations and a risk assessment are critical to ensuring the safety and longevity of your property. With proper management, many RAAC-related risks can be mitigated, allowing you to plan with confidence.

Further information

We hope this guide is useful to you. RICS has also produced a RAAC: Advice and FAQs page that includes links to various articles and industry reports.

Visit our websites

- Consumer guides
- RICS guides and factsheets

Alternatively:
- email contactrics@rics.org
- call **02476 868 555**.

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To find an RICS firm in your area, visit Find a Surveyor, email contactrics@rics.org or call **02476 868 555**.

RICS has been working in collaboration with the Institution of Structural Engineers on this topic, and further information can be found on their website. A structural engineer member of the Institution of Structural Engineers may also be required and can be found here.

Free RICS guides

RICS has a range of free guides available, including for the following property issues.

Home hazards

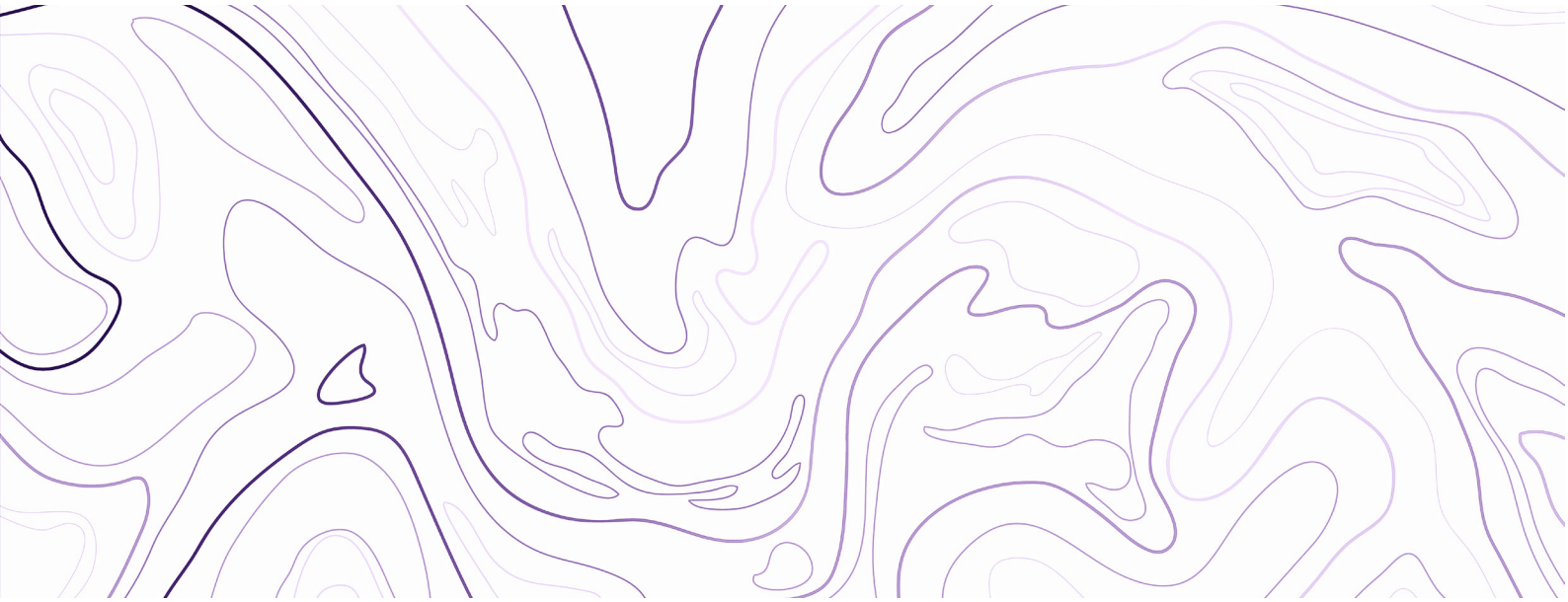
- Dilapidations
- Fire safety for homeowners/occupiers
- Fire safety for landlords
- Flooding
- Subsidence

Neighbour issues

- Boundary disputes
- Party walls
- Right to light

Residential

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