



Defence
Infrastructure
Organisation

Safety Alert Part's A, B & C

Subject: Failure of Reinforced Autoclaved Aerated Concrete (RAAC) Planks

Ref No: SA 2023-01 (revision of SA2019-01)

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WHO Should read this Safety Alert?

This Safety Alert is to be read by the following so appropriate action(s) can be taken:

1. DIO's Maintenance Management Organisations and their Supply Chains
2. DIO Regional Delivery Manager (or equivalent for non-FDIS contracts)
3. Head of Establishments or similar
4. Top Level Budget Holders
5. Health & Safety Advisors
6. Others interested in the content of this Safety Alert might include:

Equality and Diversity Impact Assessment

This policy has been Equality and Diversity Impact Assessed in accordance with the Department's Equality and Diversity Impact Assessment Tool against:

This document has been Equality and Diversity Impact Assessed in accordance with the Defence Equality Analysis Guidance 2018.

Foreword:

This Safety Alert is published by Defence Infrastructure Organisation (DIO) for Mandatory application across all areas of the MoD. This document is mandated for all contracts including USVF, overseas and PFI arrangements.

1. Aim:

This safety alert aims to highlight concerns relating to the potential risks from Reinforced Autoclaved Aerated Concrete (RAAC). This update is to alert responsible persons and duty holders to the developments in information and guidance since the last safety alert. Of note are the following points:

- RAAC was known to be used in construction in the UK dating from the 1950s to the 1990s.
- Recent failures have shown little to no warning of failure.
- RAAC has shown low strengths following water ingress, the misplacement of reinforcement bars and/or insufficient end bearing.
- RAAC planks have an estimated service life of 30 years.

2. Introduction:

Compliance with the contents of this Alert will enable compliance with the Health and Safety at Work etc Act 1974 and its subordinate Regulations.

The appropriate MOD officer shall arrange for the Maintenance Management Organisation (MMO) contractor to carry out actions in accordance with the alert. Specialist contractors may be required to carry out some of the work identified by this safety alert.

Contractors and MMOs are to keep informed the establishment Health, Safety and Environmental Protection Adviser and 4Cs Duty Holder on behalf of the Head of Establishment regarding progress of actions required of this Safety Alert.

Any work required as a result of this Safety Alert must be carried out in accordance with JSP 375.

On MOD Establishments occupied by United States Visiting Forces (USVF), responsibility is jointly held by USVF and DIO (USF). At base level this jointly managed organisation is to take appropriate action to implement the contents of this Alert. Where the Alert contains procedures, which differ significantly from USVF practice DIO (USF) code of practice will be issued.

3. Background:

In the 1990s, there were cases of RAAC plank failure. The Building Research Establishment (BRE) inspected several roofs reporting concerns of cracking, excessive displacements, and poor durability. Many planks were replaced with alternate structural members or had secondary supports installed. However, many planks remain in service.

In 2019, the Defence Infrastructure Organisation (DIO) issued a safety alert to establishment owners regarding RAAC roof planks following several recent failures. This included a collapse in a school building and a partial failure in a retail unit.

Following the school failure, the Local Government Organisation (LGA) and Department for Education (DfE) contacted all school building owners. The critical information from this was, that there was little-to-no warning prior to the collapse.

In the subsequent investigation, there was evidence of shear cracking adjacent to a support and possible indications of tension reinforcement stopping short of the support.

In the case of the partial failure at the retail unit, while the planks did not collapse, there were localised issues, including spalling of concrete. The damage was thought to be caused by water ingress.

Since the 2019 DIO safety alert, reports and further information has since become available regarding the construction of RAAC planks outside the original advised period. It is now known that planks have been used in buildings from the 1950s to the 1990s.

Currently, research is being conducted by a multi-disciplinary team lead by the University of Loughborough. Further guidance will be made available following any updates from the research team. Until this guidance is available, a cautious approach is recommended during the inspection and evaluation of RAAC.



Figure 1 – Example of RAAC (cited DfE 2022)

The following characteristics of RAAC planks should be understood:

- RAAC has a low compressive strength, around 10-20% of traditional concrete (2-5 N/mm²).
- RAAC is very porous and highly permeable. This ability for water ingress means that the steel reinforcement is less well protected against corrosion than traditional concrete. This may lead to further reduced material strengths.
- The reinforcement within RAAC is connected to the concrete surrounding it via secondary reinforcement. The lack of bond between the concrete and the primary reinforcement can lead to reinforcement slip and high deflections. Subsequently, the positioning of this reinforcement is critical to the capacity of the RAAC. This placement is known have been incorrect in samples of RAAC.
- RAAC is subject to high displacements due to reduced stiffness characteristics.
- The end bearing of RAAC planks is often insufficient (compared to current standards), which in combination with limited quality control, can lead to sudden failure.

It is understood that water ingress can greatly exacerbate the degradation of RAAC planks. Maintaining waterproof membranes and building gutters can help prevent some of the issues.

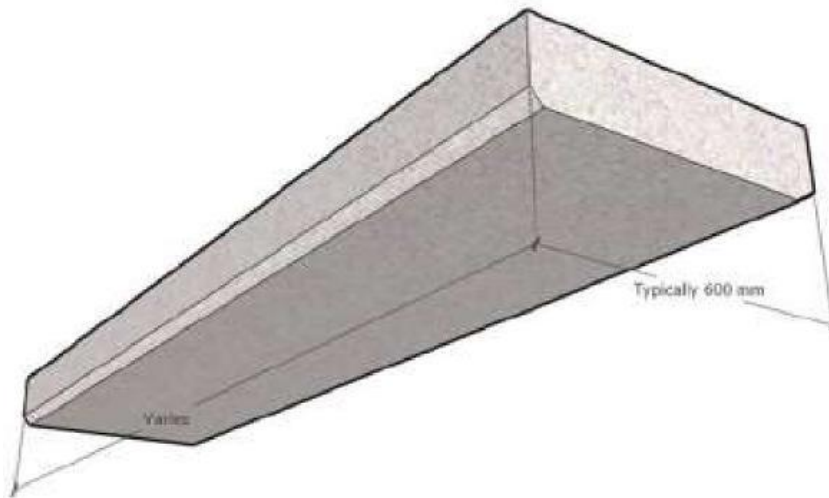


Figure 2 – Typical RAAC panel geometry (cited DfE 2022)

4. PART A – details the aspect of concern and identifies the number and location of affected assets, and any immediate measures necessary to make safe. A Part A SA will be issued in all cases (except Industry Derived SAs) as the priority is to expediently alert individuals to a potentially unsafe condition and to provide guidance upon how to mitigate the danger.

The DIO Service Manager (or equivalent), is advised to direct the Maintenance Management Organisation (MMO) (or equivalent), to initiate the following tasks:

- Identify buildings with flat roofs constructed, or flat roofs, modified between the **1950s and 1990s**.
- Investigate as built information or construction records for use of RAAC planks or investigate if any similar buildings are known to have RAAC planks.
- Confirm any roof re-surfacing works which may hide defects or increase the loading on the roof.
- If there is doubt as to the potential for RAAC, it should be considered as RAAC until confirmed otherwise.
- If there are any immediate risks to life, then the building must be vacated until suitable measures can be put into place. Any temporary propping must be installed under advice from a competent structural engineer.
- It is strongly recommended to maintain gutters and drains on all buildings, with a particular focus on those containing at risk members (such as RAAC).

The issues to be considered with respect to RAAC include:

- Deflection in roof panels, which exceed span/100, could indicate the panels are close to capacity.
- Reinforcement corrosion is a risk and the impact of corrosion on RAAC is far higher than in traditional concrete.
- Modifications to panels, such as cutting or service penetration, either during or post construction may cause overloading and are of high concern.
- Surveys and testing have shown concerns regarding the placement of reinforcement, quality control and end bearing capacity.
- Visual surveys can help assess the condition of panels, however, not all defects are visible. This includes corrosion and the misplacement or omission of reinforcement.
- Failure can be sudden and has occurred in a small number of reported cases.



Figure 3 – Differential Deflection of Roof Planks

The MMO (or equivalent) is to notify the DIO Service Delivery Performance Management Team, DIO SD-Perf Mgt Team (MULTIUSER) account, through their respective points of contact.

The following information is required to be collected and reported:

- A list of buildings (with SPEC024 reference) showing any current confirmed cases of RAAC planks.
- A list of buildings (with SPEC024 reference) showing any further suspected cases of RAAC planks following the widening of the known installation period.
- A list of buildings (with SPEC024 reference) showing any buildings identified as not containing RAAC planks, with the methodology of confirmation (e.g., desk study, initial survey, or testing).

A suggested format for the information required in Parts A-C is contained in:

Annex A. **The information requested above is required by 30 July 2023.**

5. PART B - details the action required. This can be (1) the agreed mitigation, where this is known, for example Manufacturers' recall, or (2) undertake further investigation to identify the underlying issue and propose a repair scheme or (3) undertake full repairs following DIO TS Technical Authority review of MMOs proposed technical solution. Where a Part B (2) is issued, a revised SA detailing the required actions will be released following DIO TS Technical Authority evaluation of evidence provided by the investigation and a review of MMOs proposed technical solutions.

Following the identification of suspected RAAC the following steps are required:

- Inspection by a suitably experienced Chartered Civil/Structural Engineer or Chartered Building Surveyor. Intrusive sampling may be required to provide confirmation of construction, advice on this procedure is still being developed with guidance from other SMEs. Any developments on this will be cascaded out to the estate. If any intrusive sampling is carried out, due consideration must be given to the presence of asbestos within the RAAC plank or any surface coverings.
- All suspected/confirmed cases of RAAC must be risk assessed for the current state of the asset, plus the event of sudden failure. The Head of Establishment or a delegated authority must be made aware and agree upon the risk assessment. This should then be incorporated into the site risk register.
- Any remedial actions identified from the inspection, by the competent person and the risk assessment, should be implemented as soon as possible. This may include emergency propping, enhanced end bearing, remedial supports, removal of panels. These actions may be in conjunction with the evacuation of the building in high-risk cases.

It is recommended to review the Institution of Structural Engineers' (IStructE) latest guidance on RAAC prior to carrying out any inspections. The IStructE's '*Reinforced Autoclaved Aerated Concrete (RAAC) Panels Investigation and Assessment*' - February 2022 provides an outline assessment methodology and guidance.

The following information is required to be collected and reported:

- Any updates to the lists defined in Part A.

- For any confirmed RAAC planks, any cases of visible defects, excessive deflection, water ingress or cut-outs/service penetration.
- Any remedial actions e.g., propping.

The actions identified in Part B must be reported by 01 December 2023.

6. PART C - is the follow up whereby the MMOs confirms that all affected assets have been subject to the inspection/mitigation identified within the safety alert or details of other action taken to ensure safety. Part C requires confirmation that any affected assets are safe and legally compliant for its intended use.

After the confirmation of RAAC and remedial measures the following should be considered:

- Confirmed RAAC should be monitored regularly for any changes or deterioration in condition.
- Any changes to the building, or use, should trigger a new risk assessment for the RAAC.
- Any repairs to, or the removal of, identified RAAC should be reported, and the IMS is to be updated with any relevant technical information. This may include the extent and method of any repairs or the date of removal.
- **Any rapid degradation or failure of RAAC must be immediately reported to the safety alert author DIO-TSStructures@mod.gov.uk.**

7. References / Links – the following documents provide further information

Institution of Structural Engineers (IStructE), February 2022, *“Reinforced autoclaved aerated concrete (RAAC) panels investigation and assessment”*

Building Research Establishment (BRE), December 1996, IP 10/96, *“Reinforced autoclaved aerated concrete panels designed before 1980”*

Building Research Establishment (BRE), 2002, IP 07/2, *“Reinforced autoclaved aerated concrete panels test results, assessment of design”*

Department for Education (DfE), December 2022, *“Reinforced autoclaved aerated concrete (RAAC) estates guidance”*

8. Terms of Reference and Abbreviations

DfE - Department for Education

DIO – Defence Infrastructure Organisation

IStructE – Institution of Structural Engineers

LGA - Local Government Organisation

MMO - Maintenance Management Organisation

MOD – Ministry of Defence

RAAC – Reinforced Autoclaved Aerated Concrete

USVF – United States Visiting Forces

9. Annex A

It is suggested to report the collated information in the layout below (via Excel or similar). Response options are listed below each heading. Existing formats are acceptable if they contain the information required.

Establishment Name	Establishment Tag (SPEC 024)	Asset Common Name	Asset Tag (SPEC 024)	RAAC Identified	Method of Confirmation (for yes and none)	HOE / Delegated Authority agreed risk assessment	Visible Defects
				Yes	Desk Study	Yes	Reinforcement Corrosion
				Suspected	Initial Survey	No	Concrete Spalling
				None	Detail Survey		Deflection greater than span/100
					Intrusive Testing		Service penetrations or cut-outs
							Other