Please note the contents of these documents contain detailed descriptions and diagrams of Grenfell Tower. This could be upsetting for some.

This version of the document has therefore been created with any photographs of fire damage or the interior of the Tower removed to minimise the amount of potentially upsetting or distressing information within it. A copy of the original documents with photographs can be provided on request.

Please take care when reading or circulating these documents.

The Grenfell Health & Wellbeing Service is a free and confidential local NHS service for children and adults affected by Grenfell. To talk to someone, you can get in touch by phone on 020 8637 6279 or by e-mail Grenfell.wellbeingservice@nhs.net.

This document and its contents have been prepared for the Ministry of Housing, Communities, and Local Government. For further information, please contact GrenfellTowerSite@communities.gov.uk

SNC-LAVALIN

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Member of the SNC-Lavalin Group

Grenfell Tower

Summary Note

Ministry of Housing, Communities and Local Government

05 May 2021

5186876-ATK-XX-XX-RP-SE-000009

Notice

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This document has 11 pages including the cover.

Document history

Document title: Summary Note

Document reference: 5186876-ATK-XX-XX-RP-SE-000009

Revision	Purpose description	Originated	Checked	Reviewed	Authorised	Date
Rev 1.0	For Issue	[redacted]				18 Feb 2021
Rev 2.0	For Issue	[redacted]				22 Feb 2021
Rev 3.0	Addendum added	[redacted]				05 May 2021

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Executive Summary

There is unanimous agreement and unambiguous advice from all the technical experts and engineers involved in the Grenfell project that the Tower should not be propped for the medium to long-term but should be deconstructed at the earliest possible opportunity, with deconstruction commencing no later than May 2022. This advice is based on protecting the safety of those working in and living around the Tower.

1. Introduction

This short report has been prepared for the Ministry of Housing, Communities and Local Government (MHCLG) to:

- provide an overview of the structural systems pre-fire and post-fire
- summarise the work that has been undertaken to date to stabilise the Tower
- describe the current situation with the structure
- advise of the next steps and best ways to mitigate the residual risks

In the context of this note short-term relates to the time up to the completion of supplementary (Stage 3) propping installation due to complete in May 2022.

2. Pre-fire structural system

This section briefly describes the pre-fire structural system to enable a comparison with the post-fire structural system.

The building is primarily constructed from reinforced concrete. The structural frame is comprised of central core walls, columns and floor slabs. Reinforced concrete fire walls connecting to the central core walls separate the individual flats. Refer to **Figure 1** for the structural layout.

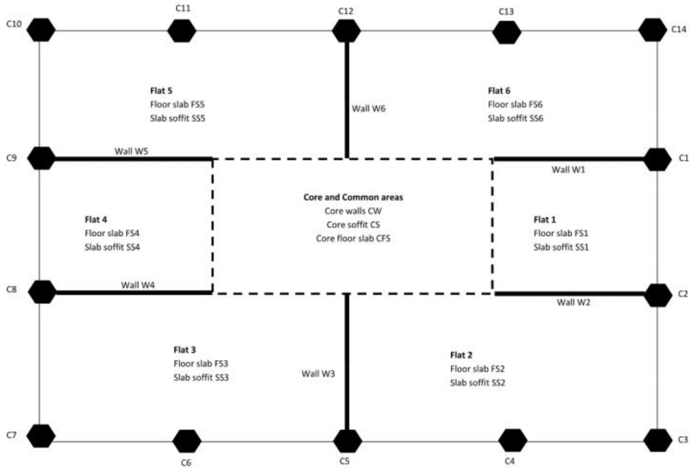

Figure 1 – Floor layout

The horizontal wind pressures on the building were designed to be transferred to the central core through the floor slabs. The central core walls were designed to resist these horizontal forces by cantilevering from the foundations. The vertical loads from self-weight and building occupancy were designed to be supported by the floor slabs spanning between the walls and columns, which in turn carry the load to the foundations.

Pre-cast reinforced concrete panels are located around the building perimeter at each floor level. These are known as spandrel panels. One panel type is located under the windows, spanning from column to column and the other is a storey high facing to the columns. The spandrel panels may have provided additional support around the perimeter of the building as well.

Reinforced concrete works by resisting compression forces in the concrete and tension forces in the steel reinforcement. The steel reinforcement has to be embedded in and bonded to the concrete otherwise the structural integrity is compromised. Refer to **Figure 2**.

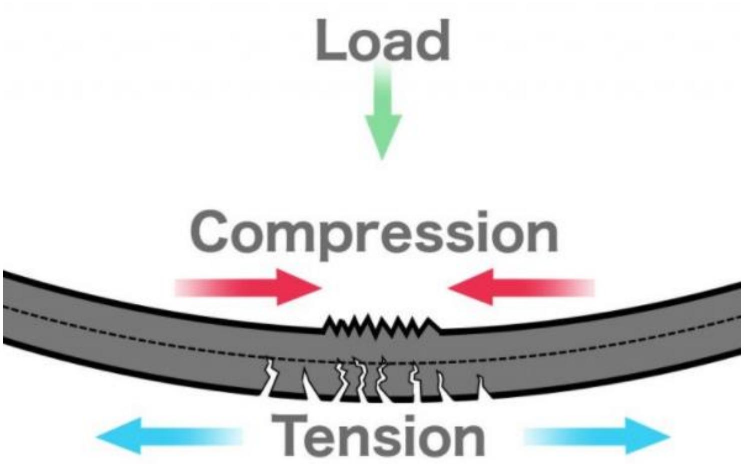

Figure 2 – Reinforced concrete load and resistance

3. Post-fire structural system

Whilst there has been fire damage to some of the walls, columns and perimeter spandrel panels, the most widespread impact has been to the floor slabs from 10th floor upwards, which have suffered significant damage from spalling concrete (where concrete comes away from the reinforcement), as shown in **Figure 3**, and subsequent deflection (vertical movement) . Consequently, the building was classified as a dangerous structure after the fire.

Figure 3 – Spalled concrete and debonded reinforcement

The horizontal wind pressures on the sheeting which encloses the perimeter scaffolding structure are now transferred directly into the walls and not into the damaged slabs. With respect to vertical load, several load paths (the way that the loads are transferred through the structure) are in effect. Prior to the propping system being introduced the floor slabs were self-supporting under their own self-weight plus the fire damaged building contents. However, given the magnitude of the slab deflections in some locations it is likely that the slabs are now acting as a tensile membrane ‘draped’ from the undamaged areas of slab around the perimeter of the flats, rather than as stiff slabs supporting load as indicated in **Figure 2**.

Temporary propping has been installed throughout the building in two stages. Stage 1 propping was installed immediately following the fire to the most obviously damaged areas observed at that time to enable emergency response. A proprietary Stage 2 propping system, as shown in **Figure 4**, was then installed to provide additional reassurance and to facilitate the investigative processes, inspection and monitoring access and ‘debris’ removal.

Figure 4 – Stage 2 propping

The propping designer (Cantillon) designed the propping to distribute loading across several floors, utilising the residual strength of the undamaged floors. Because of the amount of plant in the basement and obstructions at the lower levels it was not practicable to extend this propping into the basement.

Except for the column in the northwest corner, which has almost entirely failed as shown in **Figure 5**, the columns appear to have retained much of their integrity with respect to load transfer. The northwest corner column has been substantially propped and has not deteriorated significantly, however it is assumed that the weight of the building which would have been supported by this column before the fire is now being supported by the adjacent parts of the building.

Figure 5 – Column at north west corner of 10th floor

Comprehensive movement monitoring is in place throughout the building which sends automatic alerts 24/7 to the engineering and site management team in the event of any movement beyond set trigger levels.

The props currently installed within the Tower and the external scaffolding are checked on a continual basis. This inspection and maintenance regime will need to be maintained as long as there is propping within the Tower and scaffolding surrounding it.

4. On-going structural deterioration

The fire had the effect of spalling concrete from the underside of the floor slabs, most widespread from 10th floor upwards, and also from many columns and areas of wall. As a result, the reinforcement is left exposed in many areas. This spalling occurred due to the reinforcement expanding in the heat of the fire relative to the concrete, which resulted in the concrete being pushed away from the surface.

As a result of exposure to the elements, spalling of concrete will continue, through the expansion of corroding reinforcement and absorbed water freezing in the winter months. Without this concrete in-place, the reinforcement becomes increasingly ineffective.

Condensation forming on the structure surfaces exacerbates this deterioration. Better ventilation is being considered to mitigate this but with the building being effectively open to the elements it is not possible to entirely prevent condensation and moisture from entering the Tower. Additionally, seasonal thermal movement of the building and other environmental factors also contribute to the on-going structural deterioration.

Weekly surveys record evidence of this degradation. Additionally, a specialist (RSK) undertakes detailed inspections of the building condition on a monthly basis, which have also recorded this degradation.

The rate of deterioration and expected life of the building is very difficult to quantify with any degree of certainty, however, what can be categorically stated is that the condition of the building is worsening.

5. Supplementary (Stage 3) propping and deconstruction

The propping designer (Cantillon) has advised that the Stage 2 propping is nearing the end of its design life and it has therefore become necessary to introduce a supplementary and more robust propping system. This supplementary propping system has been designed to minimise risk of collapse and facilitate the floor by floor deconstruction of the building at the appropriate time following a decision. Installation will commence in summer 2021.

Two supplementary propping designs have been developed. One design has props from 4th floor to roof level and relies on the less damaged slabs supporting the damaged slabs. The second design has props from basement to roof level which carry more of the damaged slab loads to the foundations, but still rely in part on the less damaged slabs supporting the damaged slabs. The former will be employed if a decision is made by July 2021 to commence deconstruction (or partial deconstruction) of the building in May 2022 and will obviate the need to prop to the basement. However, for either supplementary propping solution the propping will need to have been completed by May 2022.

Installing propping to the basement has associated safety risks and cost implications since it involves removing equipment from the basement and installing props within a confined space. In the absence of a decision by July 2021 to commence deconstruction (or partial deconstruction) of the building in May 2022, it will be necessary to prop to the basement since the less damaged slabs will inevitably degrade in the medium to long term.

Propping to the basement, as reflected in **Figure 6**, which shows the supplementary (Stage 3) propping system, only mitigates the risk of degradation in the medium term. Hence, although the building may be stable it cannot be considered safe, as the risk of further spalling potentially injuring site personnel remains. This risk increases the longer the damaged parts of the building remain standing and will also make the deconstruction of the Tower more difficult and dangerous.

In **Figure 6** the blue props represent the supplementary (Stage 3) propping and the pink props indicate the Stage 2 propping that has to be retained adjacent to the heavily damaged column in the northwest corner.

There are options to partially deconstruct the Tower (to 10th floor as a minimum) but even partial retention of the structure will retain some safety risks and significant cost implications.

We anticipate that it will take around three years to prop and then subsequently deconstruct the building.

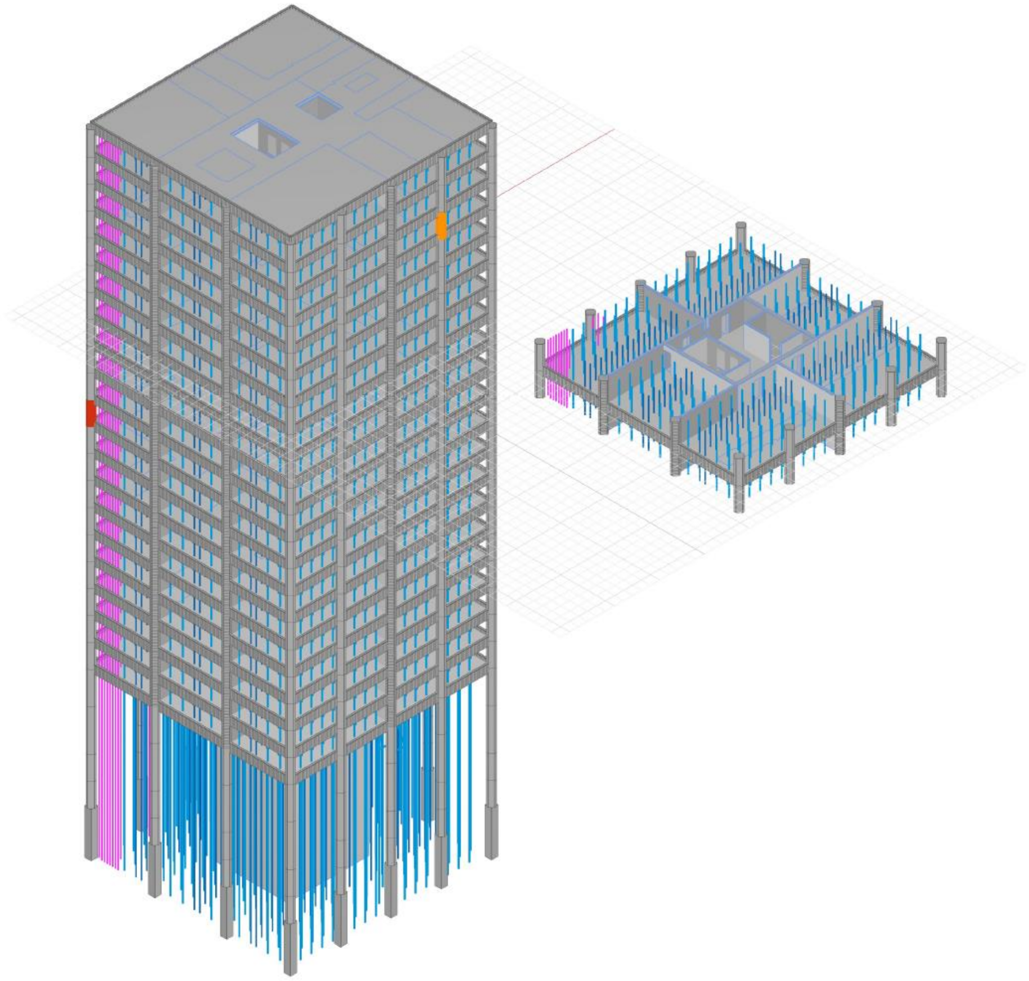

Figure 6 – Illustration of propping

6. Engineers' recommendations

The level of the damage is so extensive that the recommendation of the engineer (Michael Barclay Partnership) in March 2019 was to demolish the building as a minimum down to 10th floor. This advice has been reiterated on a number of occasions including in a letter from the Dangerous Structures Surveyor in August 2020. Subsequently, as Technical Adviser to the MHCLG, Atkins in July 2020 and December 2020 have re-iterated the need to deconstruct the Tower at the earliest opportunity primarily due to the significant fire damage but also as a consequence of the on-going deterioration.

The Health and Safety Executive is aware of these recommendations and is supportive of any action to ensure the stability of the building and the safety of the wider community.

7. Addendum

7.1. Completion of Stage 3 propping

The key point from an engineering perspective is that, if no decision has been taken to move seamlessly to deconstruction at the earliest possible opportunity, currently programmed for May 2022 upon completion of the installation of Stage 3 propping from the 4th floor to roof, then propping to the basement also needs to be completed to a similar timescale, however a slightly later completion date to these works of a few months will not make a material difference. The key issue being that, if required, the propping to the basement will need to be in place by the end of August 2022, namely before the onset of winter. Clearly, this would need to be confirmed with the successful Principal Contractor on their appointment (scheduled for May 2021) as to the latest date they would need to be instructed to commence / complete basement works.

Atkins assessment is that a decision in early autumn 2021 to move seamlessly to deconstruction would accommodate this, however, should the new Principal Contractor deem that an operational decision was needed sooner to meet these revised timescales that would need to be given further consideration.

7.2. Temporary works Design Life

The term Design Life is used within the published engineering reports in relation to the concrete structure of Grenfell Tower.

This term is used solely in its engineering context relating to the design working life of the structure and is defined in the Institution of Structural Engineers Manual for the design of building structures to Eurocode 1 and basis of structural design as the ‘Assumed period for which a structure or part of it is to be used for its intended purpose with anticipated maintenance but without major repair being necessary. The UK National Annex for EC0 gives an indicative design working life of 50 years for buildings.’

Therefore, if a structure is at or beyond its intended design life, it would be expected that structural inspections would be carried out in order to assess the condition of the structure, any remedial work carried out as required, and an updated maintenance and inspection regime created.

As noted, the term is used in a structural engineering context within the reports. However, all elements of a building from its fabric to the mechanical and electrical systems will have their own design life and associated maintenance and inspection plans.

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