Brewster House and Malting House

Risk Assessment

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Client Address: PO Box 66355, London, E1 4FG

Site Address: Brewster and Malting Houses, Barley Mow Estate
Poplar, London, E14 8DE

Curtins
3 Cwrt-y-Parc, Earlswood Road
Cardiff, CF14 5GH
Tel: 029 2068 0900
www.curtins.com

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Author	Signature	Date
M J Carey BSc, CEng, MICE, MIStructE Senior Engineer		17/12/18
Reviewed	**Signature**	**Date**
John Conway **Director**		17/12/18

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1.0 Executive Summary

- We have reviewed the structural appraisal reports prepared by Wilde Carter Clack and present our own simplified interpretation of their findings for your use as follows:
- The buildings are 14 storey residential tower blocks of large panel system (LPS) construction. They have no conventional framework of beams and columns and are built of large factory made concrete slabs.
- A gas explosion in a similar type of building in 1968 (Ronan Point) revealed that this form of construction could be vulnerable to disproportionate or progressive collapse. A localised small failure could overload adjacent elements leading to collapse above and below the zone of the original accident or failure.
- Piped gas was removed from these and many other buildings of similar construction.
- Scott Wilson Fitzpatrick and SP Christie & Sons assessed these structures in 1988 and their strengthening recommendations were carried out under the direction of Carter Clack around 1990.
- A new structural assessment is being carried out in connection with plans to renew the over-cladding. Testing has shown the concrete to be in good condition with a low risk of deterioration. The concrete floors slabs have been opened up to examine and measure the reinforcement in two of the residential units.
- The slabs have been checked for strength under normal loading and it has been found that they do not meet the expected standards. Simple calculations prepared by Curtins indicate that the factor of safety is reduced to about 75% of the value required by current standards. The slabs appear to be even more overloaded by the standards of the 1960's.
- The Building Research Establishment (BRE) have produced a document for assessing LPS buildings for accidental loads. Wilde Carter Clack and BRE have prepared an assessment of the buildings and found that in the case of a gas explosion; the bending strength of the walls is satisfactory (except the top 2 floors), bedroom floor slabs are satisfactory with assistance from non-loadbearing partitions, kitchen/living room floor slabs fail under explosion loads, the connection between the base of walls and slabs is satisfactory except for the top 2 storeys which carry less weight.
- In the event of a gas explosion which damaged the kitchen/living room slab lateral support to the outside wall would be lost with the likelihood of debris falling from above overloading the structure below, this is very similar to what happened at Ronan Point.

- Wilde Carter Clack have recommended that further investigations be carried out in more flats to confirm their initial findings. The BRE commentary in the Appendix to their report suggests that full scale laboratory testing or more sophisticated computer analysis might be considered also. A recommendation has been made to remove all potentially explosive items from the buildings as an urgent precaution pending implementation of structural safety measures.
- The preliminary structural safety proposals focus on strengthening the kitchen/living room floor slabs and strengthening flank wall and non-loadbearing partition connections to limit the spread of damage in the event of an explosion or other accidental loading. Strengthening of internal walls at the top 2 storeys is also proposed.
- We understand that the advice on removing potentially explosive items from the buildings has been acted upon.
- We confirm that the proposed strengthening works may be carried out with the residents in place with appropriate Risk Assessments/Method Statements being implemented. There *will* be times when temporary exclusion of residents is necessary from certain areas subject to arrangements between the contractor and Tower Hamlets Homes.

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- In May 2019 a contractor and specialist sub-contractor had been appointed to develop the design proposals for the strengthening and to carry out trial installations.
- Much of the work can be carried out from the exterior. The internal works will require management of the exclusion of the residents from the work area. In general the residents on other levels may remain in occupation.
- We have made reference to and commented on other accidental loadings including vehicle impact at low level or the small risk of aircraft impact.
- We have pointed out the possibility of unauthorised or inadequately planned building alterations and maintenance which might increase risks. These factors should be within the control of Tower Hamlets Homes.

2.0 Introduction and Background

- Brewster and Malting Houses are similar 14 storey residential tower blocks of large panel system (LPS) construction dating from the 1960's. They have no conventional framework of beams and columns, but they are built of large factory made concrete slabs.
- A gas explosion in a similar type of building in 1968 (Ronan Point) revealed that this form of construction could be vulnerable to disproportionate or progressive collapse. A localised small failure could overload adjacent elements leading to collapse above and below the zone of the original accident or failure.
- As a result of the Ronan Point incident much research has been done and guidance prepared. Many buildings were strengthened in the aftermath of Ronan Point and piped gas supplies were removed. Brewster and Malting Houses were strengthened before they were occupied, and the gas supply was removed.
- Structural safety reviews were carried out in the late 1980's with further strengthening works in the early 1990's.
- Further structural safety reviews were commissioned by Tower Hamlets Homes (THH) in early 2018.
- Desk studies and intrusive surveys have been carried out leading to recommendations for significant strengthening works to be carried out.
- Curtins were initially approached by Tower Hamlets Homes in September 2018 to provide a proposal to undertake a third party risk assessment on these buildings and to review the relevant documentation. The fee proposal was forwarded on 3 October 2018 and subsequently accepted by Tower Hamlets Homes on 24 October 2018 with the issue of two orders.

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- At the request of Tower Hamlets Homes (Serge Corti) on 21 May 2019 additional commentary on carrying out the strengthening works has been included.

3.0 History of Reviews

- A desk top study report was prepared by Wilde Carter Clack (WCC) in January 2018. This company have worked on Brewster and Malting Houses previously as far back as 1990.
- Their report provides a list of the known history of design and previous structural assessments and includes copies of some the previous reports.
- The original designs were prepared by Phillips Consultants using the Larsen Neilsen/Taylor Woodrow Anglian LPS system for the upper storeys and more conventional reinforced concrete for the podium levels. Strengthening works were carried out just after the main construction phase and before occupation due to the Ronan Point incident.
- In August 1988 Scott Wilson Fitzpatrick and Partners (SWK) were instructed to prepare a structural assessment on Malting House and Risby House in a short timescale. The works were prompted by the proposals to build the nearby Limehouse Link road tunnel. Risby House, which was close to the new tunnel, has since been demolished.
- SWK received the original design calculations but details were not included in the WCC document. SWK deduced, without including evidence, that the floor slab reinforcement appeared to be adequate for normal loads. They assessed the risk of disproportionate collapse in the event of a gas explosion (non piped gas, pressure 17kN/m^2) and concluded that the floor slabs in the end bays would fail. SWK went on to say that the floor below would be capable of supporting the debris from the collapsed floor above and that progressive collapse would not follow. They expressed doubts about the restraint fixings between the floor slabs and walls which could cause a progressive failure under accidental loading.
- SP Christie and Partners prepared a report on Malting and Risby (now demolished) Houses in September 1988. This was commissioned in connection with proposals for the Limehouse Link road tunnel. A few technical details of the construction were included based on a visual survey. They reported on cracking and some distortions in mainly non-loadbearing elements. They advised that the buildings were not inherently robust but had been strengthened to resist abnormal loading.
- Carter Clack Partnership were engaged in 1990 to follow up the recommendations of the SWK and SP Christie reports on Brewster and Malting Houses. Drawings and a specification for structural strengthening were prepared in 1991.
- The works comprised strengthening the steel angle connections between floor and wall panels, packing the defective joints between some panels with mortar and dealing with gaps and overstress in the essentially non-loadbearing window wall panels. The external and internal leaves of the outer wall panels were tied together. Access improvements were also made at the podium level to Brewster House at this time.

- The Building Research Establishment (BRE) documents which provide guidance on the assessment and management of LPS blocks recommend visual inspection of such buildings at 5 year intervals, durability testing at 15 year intervals and full structural assessment at a period not to exceed 30 years.
- Wilde Carter Clack recommended that, as the buildings are approaching 50 years of age with 30 years or so since the last structural assessment, a full re-assessment should be carried out to determine plans for the future management of Brewster and Malting Houses.

4.0 Recent Reviews

- Wilde Carter Clack have prepared a structural appraisal report on Brewster and Malting Houses dated July 2018. As part of their work WCC commissioned detailed internal and external concrete condition testing reports from Martech. Martech carried out visual surveys with in situ and laboratory testing to confirm the strength and durability of the concrete.
- There were no significant indications for the poor strength or likely deterioration of the concrete.
- In two unoccupied flats opening up was carried out to determine the size and distribution of the reinforcement in the floor slabs.
- Specialist testing company Socotec carried out in situ hardness testing of the exposed reinforcement and reported that the results were consistent with mild steel, not the higher grade of steel used for pre-stressing wire.
- Calculations prepared by WCC concluded that the amount of reinforcement in the floor slabs was insufficient for normal service loads. That is, the reinforcement would be overstressed.
- Due to the critical nature of this finding WCC recommended further investigation of the reinforcement in floor slabs for confirmation.
- An assessment of the resistance to a non-piped gas explosion was carried out. They found that the walls met the criteria except for the top two storeys. The central or bedroom floor slabs met the collapse resistance requirements as long as the non-structural concrete partition wall between bedrooms provided additional support. The kitchen/living room floor slabs would fail in the event of a non-piped gas explosion. This would lead to destabilisation of the flank wall and likely progressive collapse of part of the building.
- Consequently, WCC have recommended further evaluation of the size and strength of the reinforcement in the floor slabs and the removal of pressurised gas containers from the buildings.
- If the findings on the floor slab weaknesses are confirmed then strengthening of floor slabs, flank walls and connections are required plus strengthening of walls at the top one or two levels.
- WCC report that BRE have assessed the floor slabs by an alternative method and found them to be sufficient. They have also suggested that full scale mock up testing or specialist computer modelling might be considered.

5.0 Current Proposals

- Wilde Carter Clack have provided a series of preliminary drawings outlining the proposals for structural strengthening works and investigation of the floor slab in flat 12 of Brewster House.
- The drawings show the installation of external steel framing on the flank walls to increase the bending strength of these walls and provide effective vertical ties in the event of a loss of support to provide alternative load paths and restraint.
- Preliminary details requiring further development show strengthening and tying in of the floor slabs to the kitchen/lounge areas.
- The details show additional steel at the top of the non-loadbearing bedroom partitions to make use of their benefit in case of explosion. The addition of steel straps applied to the face of internal cross walls at the upper levels is shown to increase their bending resistance.
- These drawings *were* in the early stages of development, but the principles and intentions are clear.

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- In May 2019 a contractor and specialist sub-contractor had been appointed with responsibility to develop the repair details and we understand some practical changes have been made and small scale site trials undertaken.

6.0 Recommendations

- We have reviewed the reports prepared by Wilde Carter Clack and their supporting information and agree with their conclusions that further investigation of the floor slab reinforcement be carried out. Also that the risk of gas explosion should be mitigated by the removal of gas or other volatile substance containers from the blocks.
- The structural strengthening works outlined in the preliminary drawings provided should be carried out particularly if the low levels of reinforcement in the floor slabs is confirmed.
- Based on the technical details provided by Wilde Carter Clack we have prepared our own assessment of the strength of the floor slabs to carry normal floor loadings.
- Using BS8110, Structural Use of Concrete in Buildings we have determined that there is insufficient reinforcement by this relatively recent standard. The normal factor of safety is reduced to about 75% of the recommended value.
- We also carried out an assessment using BSCP114, the design standard from the 1960's. This uses a different approach, but we determined that the factor of safety by this method was between about 0.9 and 1.1. That is, the steel was close to yield stress under normal service loading.
- There have been no reports of excessive deflections or signs of distress in the floor slabs.
- The Building Regulations, BRE guidance and Eurocode documents have created categories for classifying different types of buildings according to size and use and the number of people likely to be put at risk of harm.
- Brewster and Malting Houses are in Class 2B as residential buildings not exceeding 15 storeys. The requirements for resisting disproportionate or progressive collapse can be met by; providing horizontal and vertical ties or by showing that removal of a wall or structural element will cause only limited damage. If this is not the case then structural parts should be checked as 'key elements' to show that they can resist the pressure of a gas explosion. In the case of buildings without piped gas the pressure to be resisted is 17kN/m^2.
- Since the floor slabs are believed to be under-designed for normal service loads they cannot resist the upward pressure from an explosion or the downward pressure from explosion or the weight of falling debris from the slab above.
- We agree that further investigations and strengthening works should be carried out.
- The preliminary details prepared by Wilde Carter Clack need to be developed.
- We are of the opinion that the works can be carried out safely with the residents in place subject to proper Risk Assessments and Method Statements being implemented.
- There *will* be times when temporary exclusion of residents is necessary from certain areas subject to arrangements between the contractor and Tower Hamlets Homes.

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- Much of the work to strengthen the flank walls and strengthen the kitchen/living room floor slabs can be undertaken from the exterior.
- The works to strengthen the internal walls on the 11th and 12th floors and to install the strengthening frames in the bedrooms and lobby areas will require access to the flats. The period of exclusion of the residents from the working area is a matter for discussion between the contractor and Tower Hamlets Homes.
- The contractor can make better progress with full possession of a flat, but it may be possible during some phases to take partial possession of a flat during the working day.
- As stated above the works can be carried out with the residents of the block remaining. Special temporary exclusion measures are only necessary at the levels where the internal works are taking place.

7.0 Accidental Actions

- The various reviews and recommendations for strengthening have considered the general robustness of the buildings and their ability to resist disproportionate or progressive collapse. Guidance is given in Building Regulations, Eurocodes and BRE documents. Guidance for LPS buildings is specific in relation to designing for an explosion pressure of 17 kN/m^2 for buildings without piped gas.
- Eurocode Parts 1 – 7 General Actions – Accidental Actions gives guidance on other kinds of accidental actions (or loads) that might be considered.
- Various kinds of impacts are identified including road vehicles and others, e.g. shipping, that are not applicable to these buildings due to their location.
- Brewster and Malting Houses have basement level parking garages. The drawings prepared by WCC show that there are a number of robust in situ concrete walls within the garage areas aligned with the principal loadbearing walls of the residential towers above. We do not have specific details of the construction of the basement areas but we would expect the in situ form of construction to be sufficiently robust to mitigate the risk of collapse from impact by cars and light vans.
- The general arrangement of the approach roads and landscaped surroundings to the buildings will reduce the risk of impact on the robust podium levels from heavy vehicles travelling at speed.
- The risk of impact from aircraft on these tall buildings cannot be discounted. London City Airport is approximately 5km to the east of the site and the runway is on an east – west alignment. However, there are many tall buildings in the east of London and the risk of an individual building being struck by an aircraft may be considered to be very small.
- The various published technical documents advise on risk analysis by identifying and mitigating risks where this is possible and taking design or remedial measures to limit the extent and consequences of any failure. This has been done or recommended by the current reviews.
- A conceivable risk outside the published technical documents is the possibility of unauthorised or inadequately planned structural alterations which might weaken the building. This issue should be within the control of Tower Hamlets Homes to ensure that residents do not make building alterations or that any maintenance or refurbishment, e.g. plumbing, electrical works etc, commissioned by Tower Hamlets Homes pays due regard to structural safety of the buildings.

8.0 Documents Referred to

Technical Publications

- BRE2012
  Handbook for the Structural Assessment of Large Panel System (LPS) Dwelling Blocks for Accidental Loading.
- BSEN1991 – 1-7
  - Eurocode 1 Actions on Structures
    Parts 1 – 7 General Actions – Accidental Actions
  - UK National Annex Part 1-7 Accidental Actions
    Annex A – (Informative) Design for Consequences of Localised Failure in Buildings From an Unspecified Cause
    Annex B – (informative) Information on Risk Assessment.
- BSEN 1990
  Eurocode – Basis of Structural Design

Previous Reports

- Wilde Carter Clack, Desk Top Study on Malting and Brewster Houses, January 2018
  With supporting information from;
  - Martech, Internal Concrete Condition Testing
  - Martech, External Concrete Condition Testing
  - Socotec, Hardness Testing of Steel, Rebar to Precast Concrete Planks
- Set of Preliminary structural strengthening drawings by Wilde Carter Clack
  - S.01
  - S.02
  - S.03
  - S.04
  - S.10
  - S.11
  - S.20
  - S.21
  - S.22
  - S.23
  - S.24
  - S.26

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Our Locations

Birmingham
2 The Wharf
Bridge Street
Birmingham
B1 2JS
T. 0121 643 4694
birmingham@curtins.com

Bristol
Quayside
40-58 Hotwell Road
Bristol
BS8 4UQ
T. 0117 302 7560
bristol@curtins.com

Cambridge
50 Cambridge Place
Cambridge
CB2 1NS
T. 01223 631 799
cambridge@curtins.com

Cardiff
3 Cwrt y Parc
Earlswood Road
Cardiff
CF14 5GH
T. 029 2068 0900

Douglas
Varley House
29-31 Duke Street
Douglas
Isle of Man
IM1 2AZ
T. 01624 624 585
douglas@curtins.com

Dublin
39 Fitzwilliam Square
Dublin 2
Ireland
T. 00353 1 507 9447
dublin@curtins.com

Edinburgh
1a Belford Road
Edinburgh
EH4 3BL
T. 0131 225 2175
edinburgh@curtins.com

Glasgow
Queens House
29 St Vincent Place
Glasgow
G1 2DT
T. 0141 319 8777
glasgow@curtins.com

Kendal
28 Lowther Street
Kendal
Cumbria
LA9 4DH
T. 0153 9724 823
kendal@curtins.com

Leeds
Rose Wharf
Ground Floor
Leeds
L29 8EE
T. 0113 274 8509
leeds@curtins.com

Liverpool
51-55 Tithebarn Street
Liverpool
L2 2SB
T. 0151 726 2000
liverpool@curtins.com

London
40 Compton Street
London
EC1V 0BD
T. 020 7324 2240
london@curtins.com

Manchester
Merchant Exchange
17-19 Whitworth Street West
Manchester
M1 5WG
T. 0161 236 2394
manchester@curtins.com

Nottingham
56 The Ropewalk
Nottingham
NG1 5DW
T. 0115 941 5551
nottingham@curtins.com