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Appendix 1: From IStructE publication "Assessing higher-risk buildings under the Building Safety Act: a compendium of structural typologies"

https://www.istructe.org/resources/guidance/assessing-higher-risk-buildings-under-the-building/

Existing Building Assessments

LPS system build

Construction Type	LPS (Large Panel System) build
Period	LPS buildings were popular for low-cost housing for blocks of flats in the mid to late 1960s. Some housing blocks were also built in precast post and beam in the 1950s and are likely to share some similar defects, although are often found to be better designed and built.
Code of Practice	• *CP 3: Chapter 5: 1944: Code of functional requirements of buildings. Chapter 5: Loading* • *CP 3: Chapter 5: 1952: Code of functional requirements of buildings. Chapter V: Loading* (AMD 1, 3 Feb 1958; AMD 2, 28 Apr 1965; AMD 3, 28 Dec 1967) • *CP 3: Chapter 5: Part 1: 1967: Code of basic data for the design of buildings. Chapter V: Loading. Part 1: Dead and imposed loads* (AMD 141, Nov 1968; AMD 587, Sep 1970; AMD 1024, Sep 1972) • *CP 3: Chapter 5: Part 2: 1970: Code of basic data for the design of buildings. Loading. Part 2. Wind loads* (AMD 645, 30 Nov 1970) • *CP 3: Chapter 5: Part 2: 1972: Code of basic data for the design of buildings. Loading. Part 2. Wind loads* (AMD 4952, Jan 1986; AMD 5152, Mar 1986; AMD 5343, Jun 1986; AMD 6028, Sep 1988; AMD 7908, Sep 1993) • *CP 3: Chapter 4: 1948: Code of functional requirements of buildings. Chapter IV: Precautions against fire (Houses and flats of not more than two storeys)* • *CP 3: Chapter 4: 1962: Code of basic data for the design of buildings. Chapter 4: Precautions against fire. Part 1: Fire precautions in flats and maisonettes over 80ft in height* • *CP 3: Chapter 4: Part 2: 1968: Code of basic data for the design of buildings. Chapter 4: Precautions against fire. Part 2: Shops and departmental stores* • *CP 3: Chapter 4: Part 3: 1968: Code of basic data for the design of buildings. Chapter 4: Precautions against fire. Part 3: Office buildings* • *CP 3: Chapter 4: Part 1: 1971: Code of basic data for the design of buildings. Chapter 4: Precautions against fire. Part 1: Flats and maisonettes (in blocks over two storeys)* • *CP 114: 1948: The structural use of normal reinforced concrete in buildings* • *CP 114: 1957: The structural use of reinforced concrete in buildings* (PD 5463, Feb 1965; PD 6151, 25 May 1967; AMD 1241, 31 Aug 1973) • *CP 114: Part 2: 1969: The structural use of reinforced concrete in buildings. Part 2: Metric units*

	• *CP 115: 1959: The structural use of prestressed concrete in buildings* • *CP 116: 1965: The structural use of precast concrete* (PD 6152, May 1967; AMD 218, Feb 1969; AMD 1253, 24 Sep 1973 which renames this as *CP 116: Part 1: 1965: The structural use of precast concrete. Part 1: Imperial units*) • *CP 116: Part 2: 1969: The structural use of precast concrete. Part 2: Metric units* (AMD 1239, 1 Sep 1973; AMD 1550, 30 Aug 1974; AMD 1924, 31 Mar 1976; AMD 2306, 29 Jul 1977) • *Addendum no 1 (1970) to CP 116: 1965 and CP 116: Part 2: 1969: Large panel structures and structural connections in precast concrete* • *CP 110: Part 1: 1972: Code of practice for the structural use of concrete. Part 1: Design, materials and workmanship* (AMD 1553, Aug 1974; AMD 1881, Feb 1976; AMD 2289, May 1977)
Materials	Reinforced precast concrete panels with in-situ concrete stitching at the joints
Description	Large panel system (LPS) dwelling blocks are gravity structures, as are traditional masonry constructed buildings. LPS dwelling blocks typically comprise precast reinforced concrete floor and roof components spanning onto storey-height structural precast concrete wall panels. The precast concrete components are connected by various forms of joints made on site. Vertical loads are carried to the ground through the structural wall panels, which also provide stability against lateral loads. Walls orientated across the short dimension of the building are usually called cross-walls, or flank walls if they are the exterior walls located at the ends of the building or in re-entrant zones. The structural walls orientated along the long dimension of the building are often referred to as spine-walls
Defects	The Ronan Point inquiry in 1968 recommended that LPS buildings over 6 storeys be checked for resistance to disproportionate collapse (in a fairly similar way to modern buildings; the LPS site panel to panel connections were often particularly poor due to a combination of cost savings and poor workmanship) and also for resistance to both fire and wind loading (in fact all buildings over 100ft of whatever form of construction were to be checked for wind, noting that the wind code was deficient at the date – effectively not intended for the taller buildings which were starting to be built). This was repeated in the very detailed 2012 BRE MHCLG guidance document (but the height of buildings to be checked for disproportionate collapse was changed to match modern day regulations, and no reference was now made to checking the buildings for fire or wind loading). Recent checks carried out on quite a large number of LPS buildings built using different precast systems seem to confirm that many of the buildings were not adequately strengthened for disproportionate collapse (and so didn't follow the Ronan Point enquiry recommendations) and also that some taller buildings of the date in general still have deficient wind resistance

	(especially those with soft storeys at low level which was a common architectural theme at the time). These same buildings also have inadequate slab cover for fire resistance, due to the poor understanding of concrete fire resistance in the codes at the time. This combined weakness to disproportionate collapse and fire (i.e. that fire could precipitate a collapse) needs to be carefully considered on a case-by-case basis.
Design	• Lack of Robustness Matthews, S. and Reeves, B. (2012) *Handbook for the structural assessment of large panel system (LPS) dwelling blocks for accidental loading (BR511)*. Watford: IHS BRE Press • CROSS (2020) *CROSS Safety Report: Disproportionate collapse assessment of large panel system buildings*. Available at https://www.cross-safety.org/uk/safety-information/cross-safety-report/disproportionate-collapse-assessment-large-panel-885 • Poor design and construction generally
Construction	As a response to the housing shortage following the Second World War, the government encouraged local authorities to build new housing quickly and efficiently. Residential blocks for up to 22 storeys, were given additional grants. As a result, the building industry developed a system of construction for dwellings formed of panels of precast concrete walls and floors. The panels produced were generally larger than previous precast concrete elements manufactured in a factory for new buildings. The new systems therefore became generally became known as large panel systems (LPS). The panels were delivered to site by trucks and lifted into place by crane with only the need to form the joints between them on site. It was unclear to the designers from the contemporary codes of practice how well tied together the panels needed to be and different systems dealt with this important issue in different ways. The consequences of a gas explosion within such a block were not formally considered in codes of practice at the time. The factory produced panels were generally strong but the effectiveness of connections between panels was dependent on dimension tolerance, particularly tie bar locations in different elements matching. Poor workmanship and lack of supervision on site was also a concern. In practice, and unlike load bearing brickwork structures, the integrity of LPS buildings was more dependent on those joints than on the walls and floor units themselves.
References	• Ministry of Housing and Local Government. *Report of the inquiry into the collapse of flats at Ronan Point, Canning Town*. London: HMSO, 1968 • 'The implications of the report of the inquiry into the collapse of flats at Ronan Point, Canning Town'. The Structural Engineer, 47(7), July 1968, pp255-284 • BRE (1985). *Large panel systems: the structure of Ronan Point and other Taylor Woodrow-Anglian buildings (BR63)*. Garston: BRE

- BRE (1987) *The Structural adequacy and durability of large panel system dwellings (BR107)*. Watford: BRE
- Hotchkiss, A.R. and Edwards, M.J. (1987) *Reema large panel system dwellings: constructional details (BR116)*. Watford: BRE
- Hotchkiss, A.R., Edwards, M.J. and BRE (1988) *Bison large panel system dwellings: constructional details (BR118)*. Watford: BRE
- IStructE (1989) *Guidance note on the security of the outer leaf of large concrete panels of sandwich construction*. London: IStructE
- Cooke, G. 'Large sandwich panel fire resistance assessment'. *The Structural Engineer*, 83(19), 4 October 2005, pp18-21
- The Institution of Structural Engineers (2010) *Appraisal of existing structures*. 3rd ed. London: IStructE Ltd
- Matthews, S. and Reeves, B. (2012) *Handbook for the structural assessment of large panel system (LPS) dwelling blocks for accidental loading (BR511)*. Watford: IHS BRE Press
- Matthews, S. and Reeves, B. 'Structural assessment of existing large panel system built dwelling blocks for accidental loads'. *The Structural Engineer*, 90(8), August 2012, pp42-55
- Matthews, S. and Reeves, B. 'Large panel system dwelling blocks - updating structural assessment guidance'. *ICE Proceedings, Forensic Engineering*, 165 (FE1), 2012, pp21-37