National Federation of Demolition Contractors
Voice of the Global Demolition Industry

DECONSTRUCTION OF STRUCTURES FROM THE TOP DOWN
GUIDANCE NOTES

www.demolition-nfdc.com

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INTRODUCTION

The National Federation of Demolition Contractors (NFDC) is represented on the British Standards subcommittee which prepares the code of practice for demolition (BS6187) and is, along with the Institute of Demolition Engineers (IDE), the voice of the UK demolition industry.

Founded in 1941 to help spearhead London's post-Blitz clean-up campaign, the NFDC's members are responsible for more than 90% of all demolition that takes place in the UK.

Today, the NFDC is committed to establishing safe working practices for its members and to represent their interests in areas such as training, safety, the environment, waste management, industry guidance, legislative changes and codes of practice.

The Federation has taken the previously published "Guidance for Deconstruction of Tower Blocks floor by floor/piecemeal", which covered multi-storey structures of 18m and above, and updated them to produce appropriate guidance for demolition methodology entailing the demolition and/or dismantling of all structures using top-down methods.

Other Guidance notes are available from the NFDC, including High Reach Demolition and Exclusion Zones. The Federation will consider additional guidance in the future for alternative methods.

It is considered that the guidance should be of benefit to all parties involved in this type of activity, especially for clients and contractors.

The principals and procedures in the guidance notes are based on the practices recommended by the Demolition Code of Practice [BS6187] and Guidance Notes prepared by the Health and Safety Executive. The NFDC is grateful for the assistance and advice given by the Health and Safety Executive in the preparation of this guidance.

The guidance is advisory and is based upon previous guidance and practical experience of several of the Federation's corporate members.

It is to be remembered that Clients, CDM Principal Contractors and Contractors, must be flexible in their approach in the light of all the circumstances, including the many variations that can be encountered as a result of the design, construction and materials used in multi-storey buildings. The guidance is not prescriptive and discretion in the application of the Demolition Code of Practice remains with those concerned with each specific project. Accordingly, the National Federation of Demolition Contractors accept no liability whatsoever for any loss, injury or damage howsoever caused to any property or person as a result of the deconstruction of any structure, nor for any errors or omissions that the guidance may contain.

Details of NFDC publications are available at **www.demolition-nfdc.com**

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WORKING GROUP:

The National Federation of Demolition Contractors would like to express their thanks in producing these guidance notes to the following individuals and members:

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Anglian Demolition, Lowery Demolition Ltd, Safedem Ltd, Dem-Master Demolition Ltd, Despe, Keltbray Ltd, Central Demolition Ltd, McCormack Demolition, P P O'Connor Group Ltd, Hughes And Salvidge Ltd, DSR Demolition Ltd, Bloom Demolition & Excavation Ltd, Wring Group Ltd, Garvey Demolition Ltd, Armac Demolition Ltd, THSP, Total Recalims Demolition Ltd, AR Demolition Ltd, T R Demolition (UK-International), Prichard Demolition Ltd, Portsmouth Demolition & Salvage Ltd.

Plus:
John Rimmer (Cantillion), **Stuart Accleton** (Erith Contractors Ltd), **Chris Turok-Hallam** (Erith Contractors Ltd), **Mark Goodenough** (McGee Group), **Nick Taylor** (McGee Group), **Gary Robinson** (Platinum Workforce & Platinum Training Services).

The National Federation of Demolition Contractors would also like to express their thanks to all parties that were involved in the production of the previous guidance notes; "Guidance for Deconstruction of Tower Blocks floor by floor/piecemeal".

1 General

1.1 SCOPE OF GUIDANCE

The scope of this guidance is to define the roles, safe working practices and acceptable levels of control required to carry out 'top-down' deconstruction/demolition.

The deconstruction/demolition works must be carried out in accordance with all relevant and current legislation. As legislation is subject to change, this guidance refers to current legislation at the time of publishing.

As such, this document should be used purely as a guide to the works and is not intended to be a specific method statement and/or risk assessment for any particular works. Contract-specific methodology, as required by the Construction (Design and Management) Regulations 2015 [CDM 2015], must be produced and should take note of any issues pertaining to each structure and prevailing site, environmental and regulatory conditions, as noted in the Code of Practice for Demolition BS6187.

The guidance has sought to avoid being over prescriptive as this might limit the scope for innovation and the development of cost-effective solutions. Furthermore, this guide is an enabling document and does not form a code of practice. The guidance does not in any way limit the responsibilities and statutory duties of those parties involved in the design, specification and deconstruction/demolition processes. The notes refer to the technique of "Top-Down Demolition" and other forms of demolition required to take place prior to top-down demolition should be done so, such as soft strip etc.

This guide cannot deal with every eventuality, structural inconsistency and/or site condition and as such this guidance note cannot offer recommendations on the methods described in this document for specific structures. Good practice can only be of value where it is applied to careful planning, and with sufficient attention paid to information, instruction, training and competent supervision to control and monitor the works. All stakeholders should exercise their own knowledge, experience and judgement in all matters when carrying out these type of works.

Other methods should be considered when choosing the appropriate demolition methodology. These should include, but not be limited to, the use of high reach demolition techniques and the controlled use of explosives. These methods are covered in separate guidance and therefore will not be include in this document.

This guidance note has no specific recommendations on the type of structures that can or cannot be demolished using the methods described within this document.

1.2 OBJECTIVES OF GUIDANCE

The primary objective of this guidance is to define and promote the safe working practices and levels of control needed to carry out the deconstruction of structures from the top down.

Compliance with all relevant legislation is essential with the appointment of experienced consultants, CDM Co-ordinators and contractors to carry out the works in accordance with the Construction (Design and Management) Regulations 2015 (CDM 2015).

High-rise and multi-storey buildings vary in size, shape and construction. Together with the additional difficulty often posed by the locations of these buildings, such as high-density or remote areas, this means that each building must be individually assessed, and the deconstruction/demolition methodology will therefore vary accordingly. These types of building present a high risk to health and safety and require a high level of competence to assess and understand the appropriate safe deconstruction/demolition method. Previous experience of dealing with these types of structures should be provided by appointed parties and advisors from the outset of a project. It is important to ensure that the correct methodology for deconstruction/demolition is advised as opposed to simply the methodology that contractors/clients prefer, or are better equipped for.

It is recommended that only specialist demolition contractors who are able to demonstrate suitable technical competence and experience be involved with this type of work. The factors to be considered are:

- NFDC membership.
- Previous proven experience in the type of work (size and type of structure).
- Experienced management staff (engineering and site teams).
- Sufficient resources (financial, management, operatives, plant and equipment).
- Training procedures.
- Industry-trained workforce with relevant CCDO cards, and appropriate Demolition plant scheme cards.
- Selection of methods.
- Accident record statistics and enforcement history.
- Appropriate demolition insurances.
- Independent accreditation of management systems.
- Audited accreditation.
- Ability to provide structural analysis by a competent Structural Engineer.

This guidance has been prepared to assist all parties in understanding safe working methods and the many variables faced when carrying out deconstruction/demolition from the top down.

It is also advised that contractors should pay attention to the required completion date and if it is realistic. If there are time-sensitive penalties involved, then this could lead to unnecessary risks being taken.

1.3 RESPONSIBILITIES

The client has a duty to appoint a team of consultants, one of which will be the CDM principal contractor. Demolition contractors can be appointed directly by the client or via a main contractor. The demolition contractor or the main contractor can also be the principal contractor.

It is important that contractual arrangements and the respective roles of the various parties should be clearly understood with the responsibilities and liabilities of all parties clearly defined and recorded in the relevant contract conditions. This guide does not extend or affect such responsibilities and liabilities.

Construction (Design and Management) Regulations 2015 (CDM 2015).

These regulations provide a framework within which the management and co-ordination of health, safety and welfare is planned for all stages of a construction project, including design, construction, in-service maintenance, alteration and demolition.

The regulations apply to all demolition work and it is anticipated that the “Construction Phase Plan” developed by the principal contractor, will become the main tool in the planning and management of any demolition project.

The principal duties of each of the main parties named in these regulations are summarised as:

- The **CLIENT** must ensure that only competent people are appointed as principal designer and principal contractor. They must ensure that sufficient resources, including time, will be allocated to enable the project to be carried out safely. They must maintain and review the management arrangements throughout the project duration. The client must also provide pre-construction information and hazardous materials survey to every designer and contractor either bidding for the work or already appointed to the project. These duties do not apply to domestic clients.

- The **DESIGNER** must ensure that structures are designed to avoid, or where that is not possible, to minimise risks to health and safety while they are being built, maintained, used and eventually demolished. Where risks cannot be avoided, adequate information should be provided to enable other designers and contractors to be aware of those risks and to take account of them. Design will also include the preparation of specifications.

- The **PRINCIPAL DESIGNER** must plan, manage, monitor and coordinate health and safety in the pre-construction phase. They must take account of relevant information (such as an existing health and safety file) that might affect design work carried out both before and after the construction phase has started. Help and advise the client in bringing together pre-construction information.

- The **PRINCIPAL CONTRACTOR** has overall responsibility for health and safety issues when preparing and presenting tenders, method statements, risk assessments or similar documents. They are responsible for producing a Construction Phase Plan and for ensuring it is adhered to. They should liaise with the principal designer, designers, and contractors throughout the duration of the project.

- **CONTRACTORS & SELF-EMPLOYED** must co-operate with the principal contractor and provide relevant information on the health and safety risks created by their work or others and how it will be controlled. They also have duties to plan, manage and monitor their own work to make sure that workers under their control are safe from the start of their work on site, including any induction if not covered by the principal contractor. They must satisfy themselves that they and anyone they employ or engage are competent and adequately resourced.

1.4 HEALTH AND SAFETY LEGISLATION

The Health and Safety at Work Act 1974, Construction (Design and Management) Regulations 2015, The Regulatory Reform (Fire Safety) Order 2005, Control of Asbestos Regulations 2012 and the Code of Practice for Demolition BS6187: in particular apply to all aspects of demolition work and are recognised in the applied methodology within this guidance note.

2 Project Planning

2.1 PRE-TENDER PLANNING

It is recommended that the following minimum level of information is included in any pre-tender stage health and safety information, which the client and/or principal designer should ensure is prepared for the principal contractor.

- Description of the works.
- Programme restraints and requirements.
- Contractual requirements.
- Contractor pre-qualification and competence.
- Details of structure to be demolished.
- Details of existing services and utilities.
- Details of previous uses of the building and site.
- Details of asbestos and other hazardous materials.
- Details of site environment.
- Details of survey reports.
- As-built drawings.
- Pre-demolition audit.

2.1.2 DETAILS OF STRUCTURE TO BE DEMOLISHED

Sufficient information should be provided, as per CDM 2015 and BS6187, to allow a contractor to develop a suitable, site-specific, demolition method.

This should include:

- Original construction drawings that identify the structural fabric of the building, detailing the nature of the structural frame, including any special forms of construction, including but not restricted to, re-bar specifications, cantilevered elements, pre-stressed, pre/post-tensioned elements, type of roof and cladding systems.
- Details of how overall structural stability is maintained e.g. shear walls, braced bays and shear cores.
- Evidence of any gross structural defects in the building or known major alterations since construction.

Some key issues to consider, which may not be shown on archived drawings are floor movement, diaphragm strength reinforcement issues (not tied/un-bonded edges), and refurbished roof coverings.

2.1.3 CONSTRUCTION ERRORS

In the current environment, it is expected that every structure is constructed as designed and drawn, as this is demonstrated by signed-off inspection checks at every stage. In fact, very few structures are constructed exactly as drawn and capturing the changes remains a major challenge in assuring the quality of the recorded information. Reference should be made to as-built drawings. All details should be confirmed on site and recorded.

It is usually not the main elements that are missing from the information, but rather the smaller details like connection points and additional supports. Errors in construction should always be kept in mind at all stages of the process. It is recommended that investigations into connection points, joints etc. take place prior to demolition starting.

2.1.4 DETAILS OF EXISTING SERVICES AND UTILITIES

All existing services should be clearly identified including building operation and maintenance manuals (O & M's) and:

- Electricity; underground cables, overhead lines, building supply, meters, ancillary equipment and transformer rooms.
- Gas mains and meters
- Oil and other fuel lines.
- Hydraulic pressure mains and district heating systems.
- Foul and storm water services including drainage.
- Telecommunications equipment and fibre-optic cables.
- Radio and TV cables.
- Fire suppression systems.

2.1.5 DETAILS OF PREVIOUS USES OF THE BUILDINGS AND SITE

It is important to understand the details of the buildings previous use and the crucial details needed are:

- Any previous use of the building/site, that may indicate any existing hazards e.g. contamination, underground cellars or voids, and tunnels or underpasses.
- Any previous use of site, which may give rise to a physical or health hazard, influence selection of the demolition method or plant e.g. contamination of land.
- The extent to which the facility has been decommissioned and request a copy of any decommissioning plan, which should itself be checked against the current state of the facility.
- Ordnance, where potential ordnance hazards have been identified, sufficient investigations should be undertaken so that tenderers can be suitably informed of the risks.

2.1.6 DETAILS OF ASBESTOS AND OTHER HAZARDOUS MATERIALS

Surveys should be carried out to identify hazardous materials and these may include, but are not limited to, the following:

Asbestos

- Lagging to pipes and boilers.
- Fire insulation.
- Wall boards and partitions.
- Insulation under windowsills.
- Linings to ducts and airing cupboards.
- In-room heaters.
- Floor and ceiling tiles
- 'Dry riser' water pipes.
- Insulation within curtain wall cladding.
- AIB or asbestos cement used as shuttering material

Hazardous Materials

- Chlorofluorocarbon (CFC)
- Pentachlorophenol (PCP)
- Polychlorinated Biphenyls (PCB)
- Man-made mineral fibre (MMMF)
- Fluorescent tubes and bulbs
- LED lamps
- Lead paint
- Contaminated wood

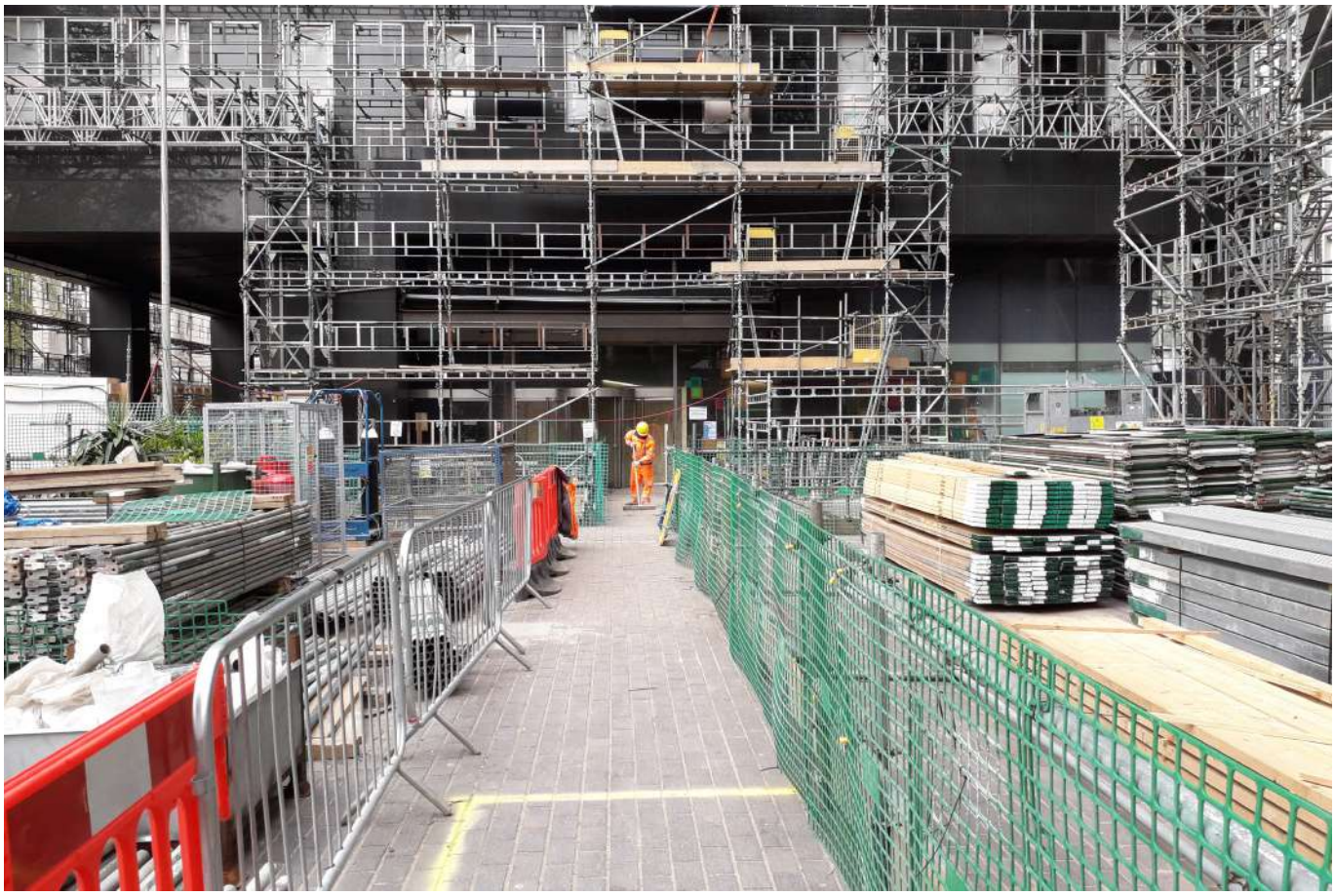
Others

- Used syringes and hypodermic needles.
- HBCD
- POPS
- Pigeon droppings
- Rodent infestation
- Human excrement
- Contamination of air conditioning tanks – Legionnaires' disease
- Ozone-depleting substances
- Emergency lighting systems (acid batteries)
- Smoke detectors (radioactive)

Any such hazards should be identified by survey. Only suitably trained and competent personnel should undertake this survey work, which should be completed prior to any other investigations in order to minimise the risk of accidental exposure.

The removal of such materials should, where appropriate, be undertaken in advance of and in isolation from, any deconstruction operations, with adequate time allowed for removal.

2.1.7 DETAILS OF SITE ENVIRONMENT



Sufficient information is to be provided to assist in the development of demolition methods, which could include the following:

- Environmental Management Plan (EMP) to include details of adjoining/adjacent buildings, environmental requirements, working hours, noisy work restrictions and waste disposal requirements.
- Existence of flora, fauna and ecology and any requirements for their protection.
- Highways, transportation systems, watercourses and service runs.
- Crime and vandalism rates in the area, with instructions on minimum levels of security (hoardings, watchmen, etc) to be provided to ensure site security.
- Archaeological requirements.

2.2 POST CONTRACT AWARD

2.2.1 CONSTRUCTION PHASE PLAN

Under the Construction (Design and Management) Regulations 2015, the principal contractor will be responsible for the development of the Construction Phase Plan. The plan will include the key dates relating to each phase of the programme of works, comprehensive risk assessments together with detailed method statements, and disconnection of the services.

Prior to commencement on site, it is imperative that adequate welfare facilities are provided and in place.

Dependant on the size and complexity of the project, it is recommended that the contractor receive a minimum of six weeks lead in time, although this may not always be possible, and dates may change due to other circumstances.

2.2.2 NOTIFICATION OF THE PROJECT

The HSE are required to be notified of the project works, via form F10, signed by the client. A copy of the F10 is required to be clearly displayed on site.

Other notifications will/may include, among others: Local Authority – Section 80(2) Notice and Section 81(2) response from the local authority Building/Demolition Warrant for Scotland.

Some London Boroughs require a Demolition Management Plan to be submitted and approved prior to works commencing. Some have even produced their own template.

Works in Scotland will require a Demolition Warrant.

Any adjoining/adjacent buildings will require notification under the Party Wall Etc. Act legislation.

Other interested stakeholders may include:

- Utilities
- Police/Fire
- Underground/Rail networks
- Environment Agency/Scottish Environment Protection Agency
- Network Rail
- British Waterways
- Holders of wayleaves
- Emergency services
- Heritage societies

2.2.3 METHOD STATEMENTS

Method statements should be prepared for all works following completion of an initial risk assessment and should form part of the construction phase plan.

Method statements and risk assessments should be communicated to all site personnel as part of a structured induction process. Photographs, pictorials and drawings can also be an effective way of communicating the safe method of work to the site personnel.

It is imperative that all persons receiving an induction to safe working should acknowledge understanding of the whole process and that this communication is recorded and retained on site. No deviation from the method statement should occur unless such a change has been amended and agreed by the author or other authorised person.

Method statements should take into consideration all aspects described in Section 2.2 – Post Contract Award, of this guidance.

Daily task briefings should be carried out, and effective means of communication with non-English speaking workers must also be implemented and recorded.

2.2.4 TRAINING

The National Federation of Demolition Contractors strongly recommends that all demolition operatives engaged in work covered by these guidance notes should have, or be under training to obtain as appropriate:

1. CSCS/NDTG/CCDO Certificate of competence – Demolition Operatives/Supervisors
2. CPCS/NOCN/NPORS or other appropriate Plant certification – Plant Operatives

Induction training specific to that project must be given to all personnel before the commencement of work on site.

All demolition plant operatives must be trained and experienced, particularly regarding the application of skid steer loaders and mini breakers working at height.

It is recommended that only trained and experienced operatives undertake demolition/deconstruction of structures from the top down.

2.2.5 STRUCTURAL SURVEY & STABILITY MONITORING

Structural survey and design works should be undertaken by a suitably qualified and experienced temporary works engineer and or an experienced structural engineer. The survey will supplement, confirm and extend the information given at Pre-Tender stage and based on direct observation, testing and examination of existing drawings, it will have minimum requirements of:

- Confirm the form of construction.
- Provide information on the floor loading, to include debris, plant and other, which may be safely carried by the existing structure so that any propping arrangements may be designed.
- Confirm the size of all elements to determine the crane lift requirements.
- Provide sufficient information to ensure that the structural integrity of the building is maintained in order to prevent an unplanned collapse during the sequence of demolition.
- Ensure weather proofing is installed to party walls as work progresses
- Provide information on the structural integrity of party walls to determine if structural support is required to those walls before demolition.
- Provide identification of any vandalism, damage, or corrosion to the building.
- Provide information on the condition of special elements such as pre-stressed/post-tensioned elements.
- Provide information on any changes to the structure during its lifetime.
- Core tests may be required by the structural engineer to provide information of the quality of concrete on the floors and walls as well as reinforcing arrangement.
- Monitor the structure for defects and record them.
- Monitor the structure during the course of works ensuring that stability is maintained

2.2.6 TEMPORARY PROPPING AND SHORING

Any temporary propping and shoring should be carried out in line with the Code of Practice for Temporary Works BS5975, the Code of Practice for demolition BS6187, and the separate guidance notes for temporary works.

Where a structural engineer or a temporary works designer is required for the design of a temporary propping and shoring system to the building floors and or walls, it will be necessary to take account of the following:

- Provision of temporary works co-ordinator and temporary works supervisor.
- Plant and equipment load on floors including the weight of any attachments. (True weight should be ascertained)
- Debris loads on floors or against any wall, including the perimeter wall. Debris should not be allowed to accumulate to such an extent that it imposes loads on the structure in excess of that which it has been calculated to carry safely.
- The arrangement of the structure and its safe load capacity.
- Changing structural form e.g. from original load path design to one of temporary support, could affect the safe loading capacity of floors.

The structure should be subject to continuous monitoring during the demolition process to ascertain that load transfer is occurring as designed and that vibration from the work is having no significant effect on floors below the working floor or on neighbouring or adjacent properties, and that props are effective in their role.

Where lift shafts are used for rubble removal, the structural engineer should consider the need to provide additional external support to the shear walls against bulging or fracturing.

The arrangement and design of propping for lateral support must take into account the floor panels. The latter require support during pneumatic/hydraulic breaking out from their wall supports. Similarly, each wall panel should have a minimum of two points of propping to prevent the sudden collapse by twisting or buckling. The props and fixings for wall units must be capable of resisting push/pull forces, which occur during breaking out. Diagonal props to wall panels are particularly advantageous against this movement.

The proposed floor loading calculations by a structural engineer should take into account the loading likely to be imposed by plant equipment and arising demolition debris and it is recommended that back propping is provided as appropriate.

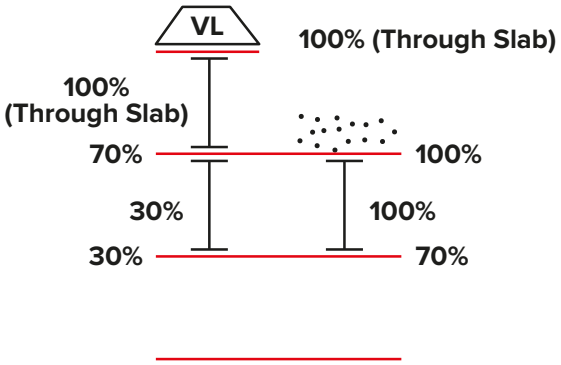
Where there is uncertainty regarding the structural integrity of the floor and walls immediately below the operational level, it is recommended that at least two or more floor levels should be propped. During the breaking out of the upper floor level, edge protection for the prevention of falls will need to be considered. The work should be planned in such a manner that no free walls are left standing. Where this is not practical or possible, additional propping should be provided to ensure stability for prolonged periods or overnight.

The design program should take into consideration the form and condition of the structure. The presence of post-tensioned concrete and the possible structural effects of cutting the stressing tendons e.g. ejection of tension bolts or anchor blocks, tendon acceleration causing injury/damage, structural breach.

All design details should be passed to the site in easily understood and clear forms, such as annotated drawings and relayed to the working staff as briefings, and a feedback system must be established to ensure that any deviations found to any designs, plans and calculations are passed back to the structural engineer so a reassessment can be undertaken.

Propping Example:

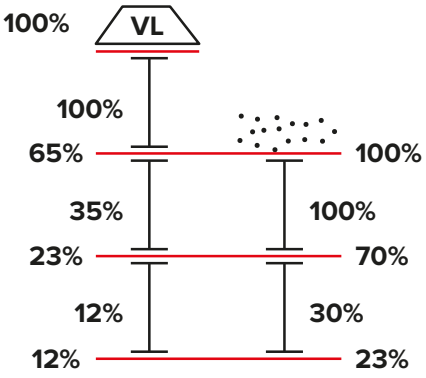
Key:	
Vertical Load (Equipment etc.)	VL
Arising Debris	



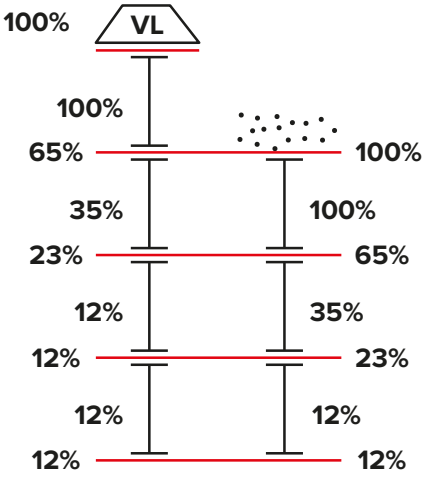
Percentage denotes load value through floor slab/prop.

One level of back prop leaves the floor load too high prior to prop reinstatement.

Damaged or sacrificial props should not be used



Two levels of back props keeps the load spread prior to the reinstatement of the props at the level below.



To maintain an adequate margin of safety, three levels of back props are required to ensure the increased floor loads remain within safe limits.

NOTE: At all times it is required to clear all arisings from the floor slab to prevent overloading.

NOTE: All calculations must be carried out by a competent person and be complient with CDM 2015 2015, Reg 19, 356189:2011 Section 16, and BS5975:2008

2.2.7 ENVIRONMENTAL CONSIDERATIONS

The following considerations should be in line with the (Environmental Impact Assessment) Regulations 2017.

The pre-tender information must be taken into consideration when assessing the environmental impact of deconstruction/demolition operations and in determining appropriate methodology.

It is recommended that effective public liaison is carried out with all those likely to be affected by the project prior to and throughout the works. Specific procedure may be outlined by the relevant local authority, client or main contractor.

The principal contractor will develop the Site Environmental Management Plan (SEMP), which will normally include any specific environmental requirements of the local authority.

The production of arisings should be controlled, so as to separate at source the individual material streams, with the intent of maximising recycling and any reclamation opportunities.

Due consideration should be given to traffic management (vehicle and pedestrian) and protection of the public for the project duration.

Dust Control

Provision should be made for an adequate supply of water and/or other appropriate measures for the suppression of dust arising from the works, particularly where local water pressure is low. Wherever possible, water consumption should be kept low. Consideration should be given to water run off and possible water capture systems.

Consideration should be given to the monitoring of dust emissions throughout the works.

Noise Control

A section 61 application should be applied for before commencing any work.

Control measures should be put in place to reduce noise pollution, which may affect the public and neighbours. These may include appropriate methodology and time limits on the use of plant and equipment. May also include acoustic barriers for example, to protect the public.

Following noise assessments, the correct personal ear protection must be provided to all site personnel who are affected by the works. Appropriate signage must be in place to alert personnel to the affected areas.

Consideration should be given to the monitoring of noise emissions throughout the works.

Vibration Control

Demolition Methodology should consider vibration caused by the works and monitoring may be required.

Risk assessment and personal monitoring is required for any persons exposed to vibration, on or above that recommended with the Control of Vibration at Work Regulations 2005, which could cause Hand-arm Vibration Syndrome.

Consideration should be given to the transference of vibration to adjoining structures, and separation cuts formed where appropriate. Perimeter vibration monitoring should be considered if appropriate.

2.2.8 ASBESTOS AND OTHER HAZARDOUS MATERIALS

Prior to demolition a 'refurbishment and demolition' survey must be undertaken to identify all asbestos materials within the building. Asbestos materials will either be notifiable (requiring a licensed contractor), non-notifiable (not requiring a licensed contractor), or notifiable, non-licensed works (NNLW). In all cases a method statement and plan of work is required by law and this must be specific and current. Where the asbestos is notifiable, form ASB (5) must be completed by the licensed contractor and submitted to the HSE 14 days prior to commencement of any works.

Other hazardous materials may include chemicals, pigeon guano, PCP's, PCB's, gases in refrigeration and air conditioning systems (CFC's), lead and 2 pack paint, and galvanised steel. Contaminated wood is likely to be added to this list in due course. Although these are not notifiable to the HSE, appropriate safe systems of work and disposal must be prepared to deal with their removal.

This may also include health monitoring for persons directly involved in the operation e.g. blood lead testing for operative cutting steel covered in lead-based paints.

2.2.9 SERVICES AND UTILITIES

A survey should be taken wherever practical and possible to:

- Verify the information given at pre-tender stage.
- Physically check and locate the routes of all notified incoming services to the site.
- Physically check that no unidentified services remain in the building or cross the site.
- Understand the sequences and time scales required to safely plan and programme the works (these may include notification and payment to the utility companies).
- Locate shut-off valves outside of the site perimeter, where possible, and mark on service drawings.
- Companies to comply with USAG guidance when operating machinery near live services.

Any live services that are to remain should be accurately located, marked and protected or diverted, as necessary. All services should be recorded.

Provision should also be made for temporary power supply to the site for the duration of the works.

2.2.10 SCAFFOLDING AND PROTECTION

All scaffolds must be designed by qualified scaffold designers, who will provide scaffold drawings and calculations.

Scaffolding and protection are a critical part of the deconstruction of multi-storey buildings and as such, careful consideration must be given to the design, with the following information made clear at the design stage:

- Elevations requiring scaffold and the width of those scaffolds.
- Whether or not external access is required at each working level.
- The risk presented by falling debris to site personnel and the general public, should be controlled by ensuring the lifts are close boarded to prevent any debris falling down the face of the building. In addition, the installation of scaffold fans or protection gantries should be considered.
- Scaffolds may include emergency escape provision such as external ladder or HAKI style staircase access to all levels.
- Provision of protection to exposed leading edges during partial demolition of sections to the building/structure.
- Provision of boarding up external openings in order to contain dust and debris.
- The design of exclusion zones, to areas where large plant is operating that is sufficient to allow the safe operation of that plant.
- Edge protection around openings created during demolition such as drop zones, well holes, lift shafts, stairwells and the like.
- Measures which can be put in place to control dust and noise.
- Guardrails and toe boards should protect all openings and edges, including those that are created at stairs, floors and lift shafts. Other forms of protection will be required where guardrails and toe boards are not possible.
- Where the use of flame retardant (such as Monarflex), plastic sheeting, tarpaulins or banners is required, the design should take account of the wind loadings.
- Risk assessments should establish the necessity of Reinforced Plastic Sheeting (RPS). It is considered best practice not to utilise debris netting at high levels, airflow RPS will alleviate some problems associated with high wind pressures. Standard RPS may be used at lower levels to lessen the spread of dust and debris. In all case the RPS must be overlapped to ensure debris containment. Flame-retardant RPS should be used where hot works are likely to be employed.
- Where lift shafts are used for tipping materials, further substantial protection should be provided when using mechanical methods. The bottom of the lift shaft should be regularly cleared to prevent lateral pressure against the shaft walls. An exclusion zone will be required, and a safe working system **MUST** be implemented for personnel undertaking the clearance of debris at the bottom of the lift shaft.
- The design should ensure that there are a sufficient and suitable amount of tie backs securing the scaffold frame to the main structure and include the method of securing.
- A systematic and safe programme for dismantling the scaffold should be arranged to coincide with the removal of the structure being dismantled. The maximum amount of scaffold should remain above the floor being removed in order to prevent ejected material but tie patterns must be sufficient to maintain the integrity of the scaffold at all times.
- Provision should be made on scaffold platforms to prevent small-sized debris from falling to lower levels.
- Fire-retardant sheeting should be used when enclosing the scaffolding.
- Safe access and egress systems including emergency access plans (HSG168 LPS12) should be used. Calculations should be made as to the maximum number of people that may need to use the egress route on the scaffold in the case of an emergency.

Where scaffold protection fans are used, all boards should be securely fixed down and any materials on the fans should be cleared progressively.

The erection and dismantling of all scaffolds (including ladder access) should be carried out by a competent scaffolding contractor and a formal handover certificate should be produced. The scaffold will be subject to continuous inspection throughout the works. Scaffold tagging systems should be used and seven-day mandatory inspections should be carried out throughout the works.

Inspections should be carried out daily, prior to the starting of the shift, to ensure that there is no debris on the platforms.

The scaffolding contractor should re-arrange the edge protection on each floor, before demolition starts and after the previous floor has been demolished. As a general rule, no more than two levels of scaffolding should be in place above the working floor area. Any flame-retardant sheeting in this area must be removed or slashed to prevent further wind loading.

In virtually all cases the health and safety risks will dictate the use of scaffolding with sheeting prior to and during deconstruction/demolition. If a total enclosure of the scaffold is not to be employed, careful planning and execution of the works will be required to ensure safe edge protection is fitted and effective at all times. Neither personnel, tools nor materials should be at risk of falling.

Protection of personnel and the public at ground level and of personnel at heights must always be a priority. External, independent, tied, tube and fitting scaffolding is preferred and will provide safe access for breaking out joints between pre-cast wall units, external brick wall panels and a safe means of supporting protective screens.

The NFDC have produced separate guidance on scaffolding, and these should be referred to for more in-depth detail.

2.2.11 SELECTION AND USE OF CRANES

There are many types of crane that include telescopic, crawler and tower cranes. A project may require the use of more than one type of crane. All craneage works are subject to LOLER regulations and as such, all lifts have to be planned. A qualified appointed person will produce a lift plan. All slinging must be carried out by trained, competent and authorised slingers, experienced in the type of lifting operation required. Emergency procedures MUST be in place prior to any lift taking place.

It is recommended that crane specialists are consulted throughout the process of crane selection. They will need to consider the location, lifting radii, size of load, centre of gravity of load, adjacent buildings, proximity hazards, potential collapse and others.

Consideration must be given to the lifting capacity of the crane to prevent potential overturn and collapse. Account should also be given to the lifting hook and chains etc. as they must be included in the weight to be lifted. The height of the crane must allow for the safe clearance of loads over the structure and scaffolding above the working floor level and the clearance for slings/chains etc. beneath the hook.

Where tower cranes are used, the base of the crane should always be designed by a structural engineer and constructed to the engineer's specifications to ensure stability of the crane. On no account should old tower crane bases be used unless they have been checked and approved by a structural engineer.

Where telescopic and crawler cranes are used, the ground conditions must be suitable to remain stable during the works. This may include designed extra strengthening to distribute the load, which must be checked by a structural engineer. Particular consideration must be given to underground services, voids, basements and the like.

Restrictions should be placed on jib lengths to prevent loads being moved over public highways or adjacent properties. Alternatively, the use of slew limiters should be employed to protect adjacent property and the public. Effective communication between crane driver and the slinger/signaller is imperative and it is recommended that a dedicated crane co-ordinator is employed. Handset radio communication is recommended in preference of hand signals.

Where more than one crane is in use, it is essential that co-ordination is established and closely monitored to avoid crane collision.

All cranes and associated equipment are subject to regular testing and inspection. These should be noted and allowed for if the crane is planned to be on site for a significant duration. The inspections must be recorded under LOLER and PUWER.

When cranes are not in use suitable measures must be taken to prevent any unauthorised access.

When cutting and lifting during demolition, the centre of gravity must be correctly ascertained and the weight of the item to be lifted must be within the lifting capacity of the crane. To prevent overturn and collapse of the crane, it is considered reasonably practicable to allow spare capacity when lifting to allow for errors in underestimating weights. An estimated weight and the actual weight could be some way apart. Therefore, it must be recognised that is there is an element of doubt, a factor of safety of twice the estimated load should be allowed for all lifts.

It is important to establish the position of cranes to ensure safe working loads are not exceeded. Frequently, tower cranes are preferred for work on multi-storey buildings, particularly in urban and confined city areas. It may be necessary to undertake a ground survey to ensure that the crane can be positioned in certain areas.

2.2.12 SCHEDULE OF CONDITIONS/DILAPIDATION SURVEY

It is recommended that pre-contract and post-contract conditions/dilapidation surveys are commissioned on the immediate adjacent properties, roads, pavements and haul routes.

These may be distributed to the local authority Highways Officers, party wall surveyors or any other relevant parties. Whilst working on party wall projects, conditions should be noted as work progresses.

2.2.13 PROTECTION OF THE PUBLIC FROM NUISANCE

Attention should be paid to adjacent buildings and adjoining buildings, and their uses. It is necessary to provide protection against nuisance and damage to these buildings during the deconstruction/demolition of the structure.

Due consideration must be given to pedestrians beneath scaffolding in city centre locations and allowance must be made for temporary hoardings, diversion routes, ramps and lighting etc.

Certain sites/works may have additional requirements for scaffold gantry protection. There may also be a requirement for temporary barriers, temporary pedestrian lights and possibly a requirement for pedestrian marshals.

All public interface areas must be inspected regularly as determined by site operations.

2.2.14 SITE SECURITY

Site security should be considered on an individual basis and is subject to risk assessment. The following aspects are recommended to be considered:

- The site boundary should have secure fencing/hoarding of no less than two metres high (which is the general requirement) unless the site is secured by existing structures such as boundary walls.
- The fencing/hoarding should enclose all demolition/deconstruction operations with appropriate secure entrances to prevent unauthorised entry to the site.
- Suitable statutory safety signs and notices must always be prominently displayed throughout the duration of the project.

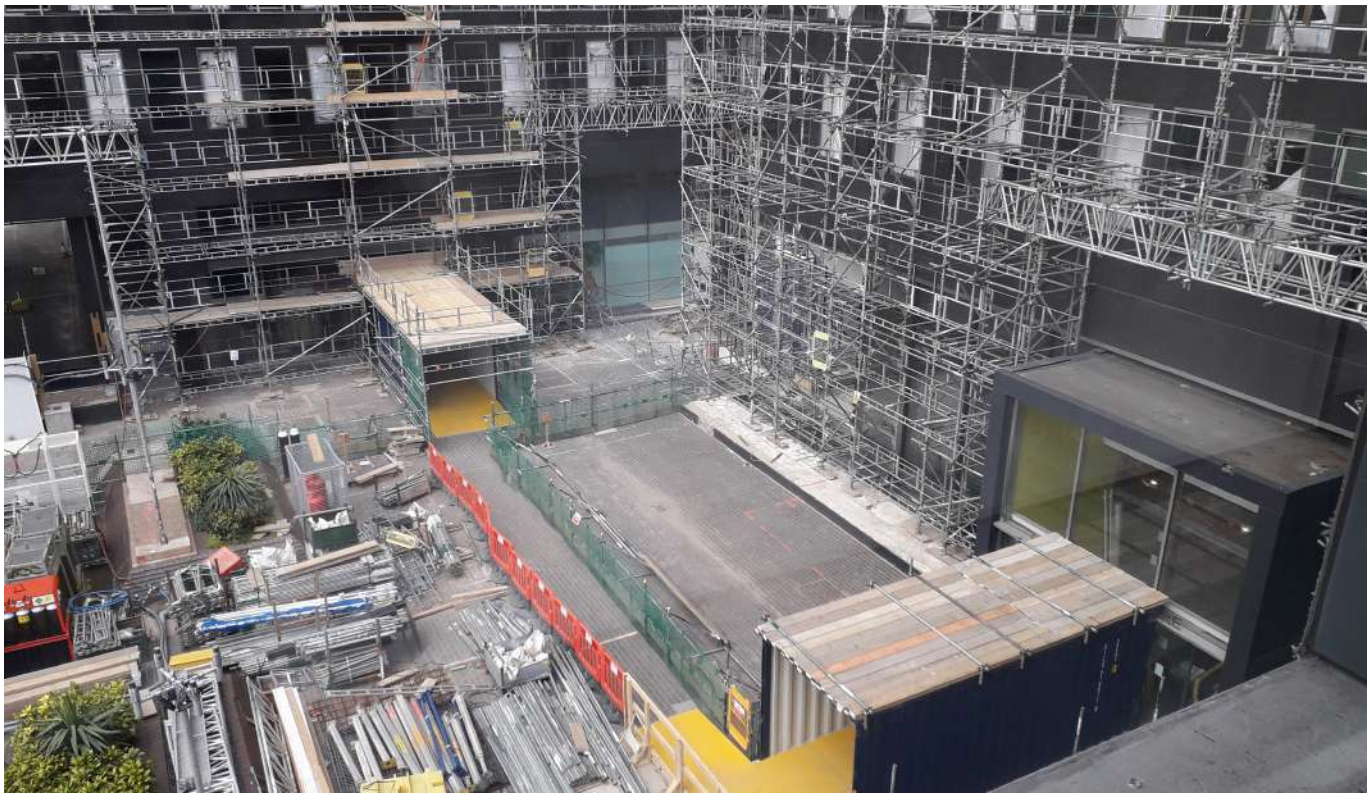
In addition to the above, it is prudent to consider the following:

- Security of the building/structure out of working hours.
- Provision of security personnel, including out of hours.
- Site entry/exit gates and their security.
- Reporting arrangements for visitors and any PPE requirements for visitors.
- Immobilising of plant when it is not in use.
- Provision of CCTV.
- Prevention of unauthorised access to tower cranes, hoists, and other plant.
- Scaffold alarm systems.
- Site lighting.
- Regular inspections.

2.2.15 PREDICTABLE BEHAVIOURS

Predictable behaviours should always be taken into consideration and allowed for. There can be any number of points that need to be understood as predictable behaviour and as such should be addressed, usually as risk assessments.

Predictable behaviour can include, but are not limited to, working near leading edges or holes, or working near to moving plant. These will often have risk assessments and be covered during toolbox talks.



2.2.16 EXCLUSION ZONE

The NFDC have separate guidance for exclusion zones that should be referred to as they will cover the subject in much greater detail.

Exclusion zones should be established on site to ensure that personnel are protected. There are likely to be several exclusion zones on a site when using the top-down method of demolition/deconstruction, all of which will need to be clearly identified and communicated to all personnel on site.

Exclusion zones, once established, may be altered as the work progresses. A drawing should be provided as part of the site-specific method statement to illustrate the required zones, highlight any restrictions to the zones and any specific risk sections.

When planning an exclusion zone, the following should be considered:

- What is the purpose of the exclusion zone?
- Who or what is the exclusion zone designed to protect?
- What hazards are you excluding exposure to?
- How do you ensure that others cannot enter the exclusion zone?
- If exclusion zones are changing regularly, how is this being communicated to all personnel?
- Are the required temporary works designs, approvals, and checks in place for the barriers or fencing being used.

Exclusion zones should be set up on site for the following, but not restricted to:

- Falling debris from outside the structure.
- Falling debris via lift shafts etc.
- Working radii of any cranes.
- Populated plant movement.

Any changes made to the exclusion zones during the project should be amended on the site-specific method statement by the author of said method statement or by an authorised person.

There will also be the requirement for Restriction Zones. These are areas that are potentially hazardous but require access to carry out the works. They should be controlled under a safe system of work and manned by a traffic marshal to prevent unauthorised access.

Examples of restriction zones are noise-restricted zones, soft-strip demo works and plant movement to exclude all but the machine operator.

Exclusion zones should also be partitioned off with acceptable barriers such as fixed scaffold handrails, clipped Heras fencing and timber hoar. Wonder Wall, Chapter 8, Metal crash barriers or plastic expandable barriers are deemed unsuitable for exclusion or restriction zones, unless they are for short-term zones, in which case they should be clearly signed and marshalled.

Consideration should be given to the use of an alarm system within an exclusion zone. This would ideally be both visible and audible.

Restriction zones are often required to have marshalling such as when clearing the debris from lift shafts and chutes. This can be done via two-way radio, making sure that the radios are on a different channel to the main radios, or via traffic light systems. All personnel should be made fully aware of the systems being used.

Inner-city sites can sometimes have so little space that several exclusion zones are not possible to implement. It may be necessary for restriction zones to be implemented with the use of barriers and marshals to overcome this. This should be clearly highlighted and toolbox talks should regularly cover this.

2.2.17 ACCESS AND EGRESS

Safe access and egress should always be maintained, using the existing facilities whenever possible. Materials should not impede safe access and egress to all floor levels, including the floor being dismantled. The designated routes for access and egress must be checked regularly and routinely. Routes should be clearly marked and communicated.

A second, alternative safe means of access and egress must be maintained at all times for emergency use. Means of emergency escape from working areas to a safe point should be kept clear of materials progressively (HSG168 & LPS12).

A traffic management plan must be created to ensure that pedestrians, moving plant and vehicles are segregated throughout the works. Trained site access traffic marshals should be used when moving plant and general public can come into contact.

Provision should be made for recovery of any personnel in an emergency, who are unable to exit the roof or top floors unaided. The provision should be communicated to all personnel prior to the demolition starting. Rescue plans should be discussed.

2.2.18 FIRE PLAN

A Fire Risk assessment should be carried out and precautions should be taken to prevent the risk of fire and explosion caused by gas, combustible dust or vapour. The following items should be considered by the principal contractor and appropriate emergency procedures established and included in the Construction Phase Plan:

- Establish fire assembly points and escape routes.
- Provision of fire-fighting equipment at critical locations (appropriate number and type of fire extinguishers including maintenance regime).
- Adequately trained personnel.
- Means of raising the alarm.
- Evacuation plan.
- Regular fire evacuation drills.
- Establish correct hot work procedures, including a permit to work system.
- Provision of a dedicated mains water supply where possible.
- Maintenance of the high-rise water supply during any prolonged period of cutting with gas/oxygen cutting equipment.
- Provision for early removal of flammable material.
- Provision for falling sparks from hot cutting to floors below and onto debris sheeting.
- Floors with little or no natural light may require emergency lighting.
- Materials likely to release toxic fumes in a fire should not be overlooked.
- Maintain compartmentalisation to ensure stairs remain protected.
- Retention of fire doors.

These plans would be brought to the attention of all persons on site via site induction and/or toolbox talks and must be clearly displayed on site.

Directions to the nearest hospital A&E department should be displayed on the site notice board.

2.2.19 CONTROL OF FLOODING

Water from the damping down during demolition as well as surface water will find its way to the ground floor and basement areas eventually. That is why it is important to identify and implement adequate controls to prevent the site from flooding.

This means that sump pumps may need to be set up in the basement areas and they will need to be connected to settlement tanks before being discharged into the main drainage outlets. The re-use of water for damping down should be considered.

The ground floor and basement areas should be checked and monitored continuously, and water levels noted to control flooding. Attention must also be given to cranes on site that are reliant on ground structure that may be compromised by flooding.

2.2.20 WEATHER

It may well be necessary to consider the possible effects of seasonal weather when planning the works. Risk Assessments should take the following into consideration:

- Wind speed and direction for lifting operations.
- Inclement weather for personnel working outside and/or at height.
- Wind loading on scaffolding when fixed with protective sheeting.
- Visibility due to fog.
- Dust and small particles picked up by high winds and deposited onto adjacent occupied site areas.
- Slippery surfaces due to heavy rain or freezing temperatures.
- Wind direction when setting up and using dust suppression.

Many of the weather factors may not be relevant at the time of initially writing any method statements or risk assessments, however, delays to project starts can bring adverse weather conditions into the equation. As can other delays such as archaeological or ecological. Consideration may need to be given to the securing of materials.

3 Deconstruction Process

3.1 LARGE PANEL SYSTEM

3.1.1 GENERAL

The use of large precast concrete wall and floor units was employed in the construction of high-rise buildings during the 1960's and 1970's. The system was particularly prevalent in high-rise blocks designed for domestic dwelling developments. This type of construction used the reinforcement in the connections and cross walls for framing support.

The structures were built on a floor-by-floor basis and assembled using appropriate craneage. Shear loadings were applied via the reinforced in-situ concrete stairs and lift cores. Structural integrity depended upon the panels being joined and secured by bolted and concrete grout infill connections, which, over the years, have been found to be inconsistent in terms of quality and must not be relied upon during deconstruction/demolition.

The process of floor-by-floor erection entailed lifting each unit by the in-built lifting eyes and bolts. Propping of the wall panels was necessary to stabilise them in position before bolting and infilling with concrete was completed.

The simple multi-box structure was brought under official and professional engineering scrutiny by the collapse of a high-rise block at Ronan Point, London, in 1968. A local gas explosion, within one of the flats, blew out the walls of the flat thus removing the support for the upper storeys causing a progressive collapse. As a result of the ensuing enquiry, many similar buildings were structurally reinforced, but some have remained the same. This catastrophe was pivotal in the implementing of the Mandatory Standard for Disproportionate Collapse.

Information regarding any such reinforcing on subsequent projects of this nature will need to be ascertained before work commences.

Numerous serious accidents occurred during the erection of the structures, of which three causes in particular have been identified. The prime cause of injuries was as a result of persons falling from edges where guard rails and toe board protection were non-existent. The second-largest cause was a failure of the propping systems either through insufficient props or the inadequacy of their fixings. The third-largest cause was a failure of the various components of lifting equipment, including the lifting eyes, which were built into the panels.

These issues should be considered at the demolition design stage and will be required to be covered within the method statement and monitored throughout the works.

It is important that an accurate assessment of the weight of all component panels and of the design of their reinforcement is necessary to ensure that the design of any lifting equipment and crane capacity is adequate for the task.

3.1.2 SEQUENCE

One complete storey should be removed at a time if and where possible. However, there may be occasions when the floor removal will need to be staggered to aid demolition. All work at that level should be completed before moving on to the next. This will certainly apply to all precast elements. Where cast-in-situ areas are established, such as stair and lift cores, the order of work must be arranged to ensure that edge barriers are maintained around the areas at floor levels under demolition.

Typically, works to ready the panels for lifting using small demolition plant will involve the following:

- Removing the roof, including motors, lift units, air condition units, ducting etc.
- Chasing panels to free holding bolts.
- Forming holes for lifting.

The practice of lifting concrete walls and floor panels by slings and the positioning of lifting points should be carefully considered in relation to the original design of the lifting points. The old lifting points should not be used as their integrity cannot be guaranteed. The exact positioning of the new lifting points in the panels and the method of slinging should be clearly shown in the lifting plan and referred to in the method statement. Particular attention should be paid to panels that have door or window openings.

Particular attention should also be given to:

- Installation of push/pull ropes or diagonal braces to vertical panels prior to chasing of joints.
- Removal of panels in sequence working towards the stair/lift core (edge protection must be provided in these areas).

It is recommended that all structural demolition, so far as is reasonably practicable, should be carried out by demolition machines working adjacent to the floor being demolished and with a demarcation line clearly marked.

It is also recommended that floor slabs should be broken from the floor below to prevent leading edges.

Removal of the complete floor should take place and the process then repeated down to the required level.

Areas of floor remote from the cores, at the next level below, may commence whilst work on the in-situ elements above is being carried out to completion.

3.2 FRAMED SYSTEMS

3.2.1 GENERAL

Framed systems can be constructed of steel or reinforced concrete. These may have infill panels of brickwork, blockwork, no-fines concrete, or precast concrete cladding.

Stability depends upon individual elements consisting of steel or concrete beams and columns with fixed-end connections. Concrete beams and columns may be pre-tensioned, connected either by pre-stressing steel or structurally bolted/welded connections.

Alternatively, the design may depend upon a concrete or steel core in the centre of the building. Structural beams extend from the core to the external columns. The core incorporates lift shafts, staircases and service risers. Floor construction and external cladding will vary in their design.

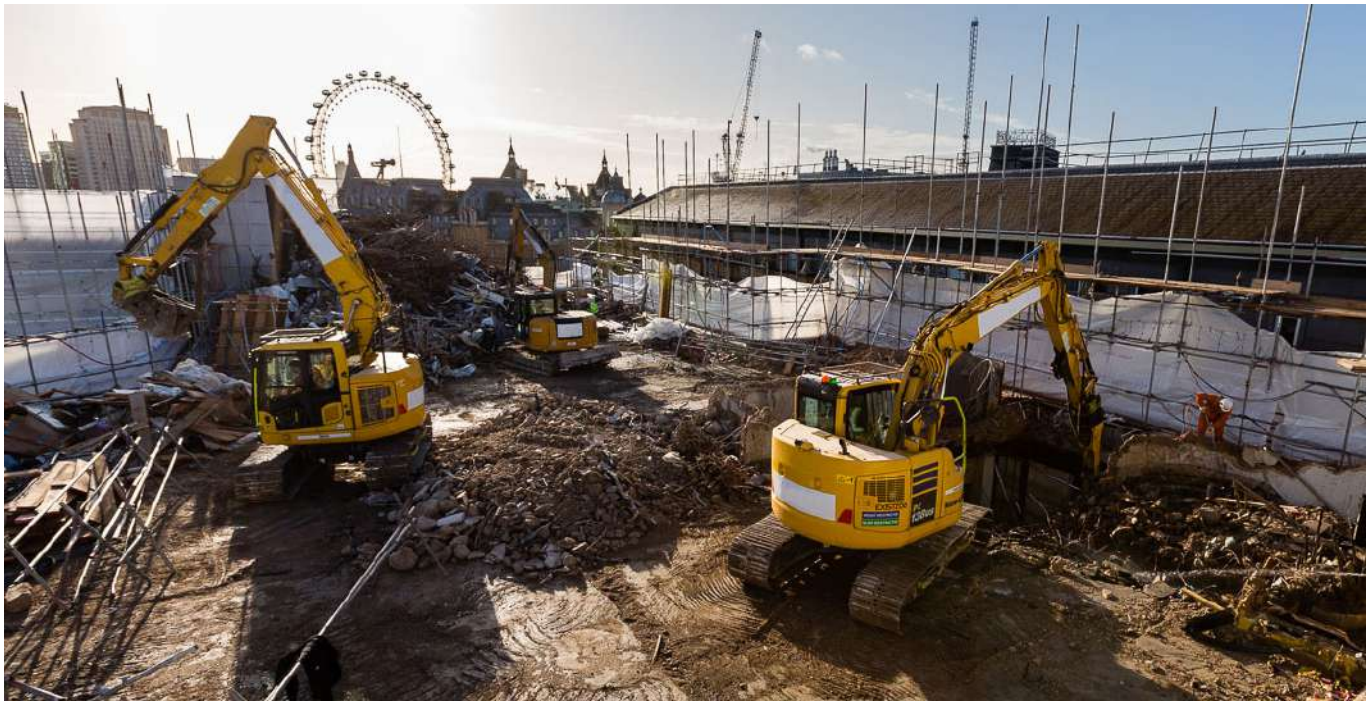
Floors can be in-situ reinforced concrete, infill clinker, hollow pot, composite units or precast concrete units with concrete infill at joints and would usually provide a degree of diaphragm strength in lateral movement.

External walls usually consist of infill curtain walling systems. Less frequently, they consist of concrete panels with window openings incorporated. Occasionally, some may be low-density (no-fines) concrete or infill brickwork.

3.2.2 SEQUENCE

The general method of sequence is:

- Remove the roof including motors, lift units, air conditioning units, ducting etc.
- Removal of cladding.
- Divide the structure into panels/sections dependant on the lift capacity of the crane(s) and the supporting structural design of the building. If the survey reveals a need for propping, the system should be designated to support and secure the perimeter floor beams. In the case of flat slab construction, a strip of slab should be left in place to maintain the stability of the perimeter wall panels below.
- Where external masonry panels have been used, these should be removed ahead of the floor removal. Operatives working from the safety of the scaffold should demolish them from top down, course by course, depositing the debris on the adjacent floor.
- Cut the floor in panels, working towards the core, in a pre-determined cut sequence away from the floor area being broken out. Where the crane is employed to lift these sections clear, each panel should be suspended from a crane before exposing and cutting the reinforcement. After cutting the reinforcement, the panel can be lifted and removed to a designated drop area for breaking.
- Rubble arisings on the floor below should be cleared progressively to keep the areas clear and avoid a build-up.
- Rollover (dropping to the next level down) propping of floors must be completed before any heavy plant is transferred to the next level. Loose debris arising from the demolition should be removed via the drop zones or by boat skips lowered by crane.
- Operatives working from access scaffolds will generally demolish perimeter brickwork panels by hand. All debris should be directed inwards onto the floor for subsequent removal.
- Columns and beams should be removed in a pre-determined sequence.
- Beams should be suspended from a crane, preferably at two-third points along their length, before breaking away the ends from column node points and cutting the reinforcement. After cutting the reinforcement, the beam can be lifted and lowered to a designated drop area for breaking.
- Columns should be removed in a pre-determined sequence together with the beam removal. It is important to note that before exposing any column reinforcement, the columns must be attached to the crane to prevent collapse. After cutting the reinforcement the column can be lifted and lowered to a designated drop area for breaking.
- All debris should be cleared progressively to prevent a build-up of excessive loads on floors and lateral pressure on walls. Where risers or lift shafts are used to deposit rubble down, containment in lower floors must be provided and exclusion zones determined and set up at each floor level (lift shaft door openings should be sealed where possible).
- Remove core and repeat process down to the required level.



3.3 DEMOLITION OF LOWER STOREYS

The demolition of the lower storeys of the structure will usually be carried out by mechanical means. The level at which the change to mechanical demolition takes place will be based on an assessment of:

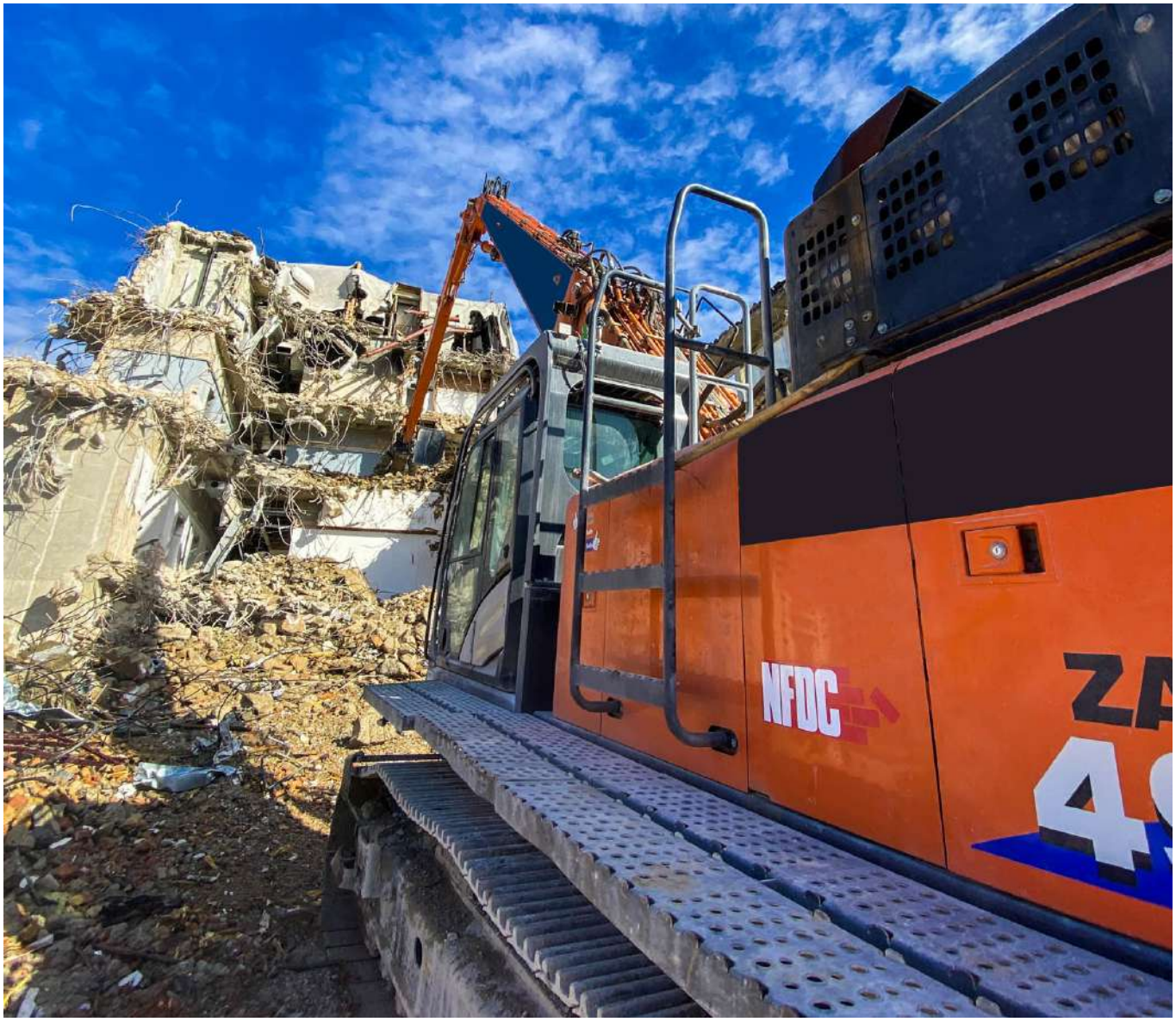
- Ensure the lower level of scaffolding has been designed to be free standing as large sections of the structure will be removed by machine methods leading to unsupported scaffolding lifts. Consider alternatives to scaffolding if appropriate.

- The exclusion zone required for the safe containment of debris, as well as the exclusion zone requirements for the safe operation of large plant. Please refer to NFDC Guidance on Exclusion Zones (DRG:110).

- The proximity of any live or occupied areas around the site previously protected by the scaffold system. The contractor must also demonstrate an ability to adequately control dust emissions.

It is possible that by changing the method of demolition to mechanical, that the scaffolding and protection are no longer sufficient for the structure. This may well be the case if the original scaffolding was of a full wrap around.

Any such changes to the method of deconstruction should be recorded in the method statement, along with any additional propping/shoring that may be required.



3.4 PLANT AND EQUIPMENT

The following are indicative of the common items of plant and equipment used for deconstruction/demolition of high-rise structures:

- Demolition machines including remote-controlled machines.
- Large demolition machines.
- Skid-steer loaders.
- Cranes (tower, crawler and mobile) at ground level.
- Compressors (breakers, drills etc).
- Generators (lighting, small power tools etc).

This equipment should only be operated in accordance with the manufacturer's recommendations, by trained and competent operators experienced in demolition operations.

It is essential that plant and equipment is carefully selected, of suitable size when working on the floors, and is suitable for the nature of work to be carried out.

All plant and attachments should be weighed to ascertain their true weights. These can vary significantly from stated weights and if not known, can affect the crane used for lifting, the floor loading of the structure, and or the propping of the structure.

All plant must be thoroughly inspected prior to use, including checks on relevant certification. Following the initial inspection, all plant should be subjected to daily and weekly checks in line with the manufacturer's recommendations.

The appropriate PPE and RPE should be worn by all operatives.

Careful consideration should be given to live loads placed on the structure during the deconstruction process, particularly where floor integrity may be affected by the induced weight and movement of plant and machinery.

An appropriate risk assessment must be undertaken before work commences. Control measures put into place as a result of any risk assessment process must be monitored regularly for their continued effectiveness.

It is also recommended that mechanical plant be prohibited from working within 2m of the building edge, 1m of any floor openings and any cantilevered structures (there should only be one floor opening at any time). This should be taken into account when planning the work. Markings should be used to identify the mechanical plant movement restrictions and any propping.

It is crucial to highlight to plant operators the movement they are allowed with the plant. They need to understand if they can slew fully or if they can track all over the floor. For example, they may only be able to track parallel to the beams.

If a combination of machines and remote-controlled machines are to be used, then the method statement and risk assessments should clearly show this and make sure all personnel involved are fully aware.

3.4.1 CRANES IN GENERAL

The choice of cranes available to dismantle any high structure is wide. The shape, height and design of the structure, site constraints and economics, ultimately drive the decision on the use of which particular type of crane. BS7121: The Code of Practice for Safe Work of Cranes must be used and followed.

All crane operations used in the deconstruction should be controlled by a crane co-ordinator working with an experienced banksman and slinger. A lift plan should be in existence and the co-ordinator should be working to this plan.

The transfer of plant from floor to floor should be undertaken by cranes, unless a qualified structural engineer has designed and/or approved the use of prefabricated ramps. The use of ramps constructed by debris is not considered best practice.

3.4.2 TOWER CRANES

Stationary and rail-mounted tower cranes offer the greatest control when dismantling. The operator can usually see the load being lifted and can react to hand signals as well as radio directions. The choice of jib type, either luffing, swan neck, or conventional saddle may be decided by site constraints or contractor preference.

Wherever possible, it is recommended that the lowering/set down area be in clear view of the crane operator at all times. The estimated maximum loads and radii to be encountered should be calculated and considered when specifying the suitability of any crane.

One of the most important factors to be considered in the selection of tower cranes is the construction of the building and whether it is capable of offering any support to the mast of the tower crane. It is generally recommended that cranes should not be tied into a structure, but in some cases, it is accepted that there may be no other alternative.

A structural engineer should be employed to produce a suitable foundation design for the tower crane. Old tower crane bases, used to construct the building, should not be used to support further cranes for the demolition element.

The tower crane will usually be powered by three-phase electricity and sufficient time should be allowed to obtain this supply from the electricity suppliers or a suitably sized generator will be required.

3.4.3 CRAWLER/MOBILE CRANES

Conventional or tower-rigged crawler cranes are extremely flexible where site conditions permit, hence they are a popular choice for many contractors. However, it is widely considered that they may be less appropriate for the deconstruction of high-rise or multi-storey structures.

Any crane working at the base of any structure should have a Falling Object Protection System (FOPS) Cab.

Ensure that ground conditions are suitable for the size of crane being used.

3.4.4 EXCAVATORS

Demolition excavators equipped with hydraulic breakers, munchers, or shears are generally the most widely accepted item of plant utilised when dismantling any high-rise/multi-storey structure employing the top-down method.

Pulverizing attachments mounted on excavators can be useful where noise restrictions apply or vibration restrictions. They can, however, be slower on machines than hydraulic breakers. The weight and use of any such equipment, along with any restrictions that may apply, will be determined by the calculated floor loadings of the structure.

Remote-controlled demolition machines, equipped with breakers or shears, are used extensively in work of this type, as they generally have a greater break out force than a comparable excavator of the same weight. They also allow for the removal of the operator from the immediate vicinity of the machine and the work force, thus reducing the risk to the operator. This is particularly the case when hazardous or potentially dangerous situations arise.

Adequate propping is required to enable the chosen plant to work on floors above and extensive back propping of floors can often enable larger plant to be used. This must be supported by the design with calculations.

3.4.5 SKID-STEER LOADERS

The permissible size of such equipment is again dependent upon the structure to be demolished and the necessary back propping.

Skid-steers are used to clear broken debris from floors, either into skips, purpose-made discharge chutes or existing discharge chutes such as lift shafts. This means that machines are at risk of falling over a leading edge or into discharge chutes and this risk must be addressed to prevent this from happening. Baulk timbers on the floor together with handrails or purpose-made steel frames with handrails are two such systems that could be employed.

Any such timbers, handrails, or framework will need to be included into any weight loading calculations on each floor.

3.4.6 PNEUMATIC BREAKERS

Handheld tools such as pneumatic breakers are generally used when working from external scaffolds and at particularly difficult locations. Consideration should be given to ensure the appropriate weight of breaker is employed for the task being undertaken.

Breaker types should be assessed for their ability to reduce exposure to hand-arm and whole-body vibration to the user. Personnel should be monitored closely when this type of equipment is being used, to ensure that they are kept within the appropriate action levels.

3.4.7 360° EXCAVATORS

Excavators equipped with specialised attachments and buckets are generally used to process and load away the resultant materials. They work at the base of high-rise structures outside of and within the working radius of the crane. They should be equipped with Falling-object Protective Structure (FOPS), with Falling-object Guard System (FOGS) cab screen guard and with Rollover Protective Structure (ROPS). ROPS is only a requirement with excavators up to a certain weight. The excavator may also be employed to work alongside a crushing unit to process the aggregate arisings into a recyclable and re-usable secondary material.

3.4.8 REFUELLING OF PLANT ON FLOORS

Plant working on the floors will need to be refuelled unless it is electric. The obvious way of carrying out this process is to lift a fuel bowser to the appropriate floors and then refuel the plant.

The bowser and plant being refuelled should be in a barriered-off designated area. Adequate drip trays should be on hand, as should spill kits and the appropriate fire extinguishers.

Fuel bowsers should be included into calculations for the weights of floor loadings. A full bowser can add significant weight if not allowed for. The location of any bowsers should be included into the fire plan / fire risk assessment.

3.5 TOP DOWN WAY®

As with all forms of deconstruction/demolition there is a continual development of new products, new methodology and novel ways to undertake tasks that mean personnel and the public are kept safe and out of harm's way. One such step forward in technology is the TopDownWay®, a modular self-descending platform that surrounds the building being demolished as an alternative to traditional scaffolding. This was designed and built in Italy and has been successfully used in Italy, France and the UK.

The TopDownWay® is an intelligent system that keeps inside everything produced by the demolition including debris, dust, noise and vibrations, whilst at the same time isolating the building from the surrounding environment. There are no gaps between the structure and the platform where debris can escape, and it ensures that there is no impact on the environment or the surrounding buildings.

TopDownWay® protects the exterior from the interior, but also the interior from the exterior.

It is a self-assembling steel grid structure that works hydraulically. It is controlled by an automated system that monitors movement and safety. All machine parts are assembled on the ground. The equipment is hoisted up by a suitable crane and the equipment is dismantled once it has been lowered back down after completion.

This system however does require a significant laydown area, so it is not always possible to use, especially in an Inner-city environment. The area required adjacent to site should be checked for availability.

TopDownWay® is a modular machine whose shape can be adapted to suit any structure. As the safe work proceeds, the platform descends down in a controlled manner and positions itself on the next floor down. The structure is then demolished floor by floor.

3.6 POTENTIAL HAZARDS

There are many potential risks that could occur and many of which have been previously mentioned throughout this guidance. Some of the specific hazards, as a recap are:

Shear Failure

Shear failure may be a significant risk during top-down demolition of flat slab and hollow pot floors. A shear failure generally results in a major, uncontrolled collapse, which may occur where implied loads during the demolition are inadequately controlled resulting in overloading.

Disproportionate Collapse

This is a significant risk in panel-constructed high-rise structures. All due care should be taken by the principal contractor and principal designer to identify this construction method early so that correct controls can be implemented to eliminate this.

Floor Loading

As outlined throughout this guidance, overloading of floors can be a major cause of collapse. Propping should be carried out correctly to temporary works or structural engineer's designs. Debris should be cleared away as soon as possible to prevent build up. Point loading should also be considered where jack legs are involved as is the case with some remote-controlled machines. All floor loadings should be assessed following a non-destructive floor load test.

Lateral Floor Movement

In some cases where floors have not been tied together, the movement of compact machines during slewing or turning movement may cause the floor to shift due to unidentified construction error, which may result in openings appearing.

This may occur with floors constructed with dowelled contraction joints or with floors constructed with starter bars. The Principal Contractor and designer should identify this and ensure that the correct methods for deconstruction are used.

Buckling

Where the effective length of a member is increased by the demolition process, for example, in forming openings for access, the capacity of the member can be reduced. Similarly, when asymmetric loading is applied as a result of changing load paths or partial demolition, members can experience higher bending and so reduced axial capacity. There is also a possibility that when a demolition sequence involves removing stability structures, the remaining vertical elements may become framing elements when they have not been designed to work as such.

Fire

Fire is a constant and immediate risk in demolition, especially where hot works are being carried out. It is therefore imperative to make sure that the necessary precautions are in place. During demolition or structural alteration, it is vital that the fire plan is kept up to date as the escape routes and fire points may alter. It is vitally important that an effective means of raising the alarm in the event of a fire is available throughout the demolition process. All personnel should be continually updated in regard to any amended fire plan. Buildings over 18 metres in height are considered to be high risk.

4 Legislation

4.1 ACTS OF PARLIAMENT

This section lists the principal legislation, British and European standards applicable to demolition operations as this document went to press. It is recommended that contractors ensure they are aware of any updates that may have followed publication of this document. More detailed information on key issues regarding health and safety, and environmental legislation for persons planning demolition work can be found in the Health & Safety Executive's (HSG150) Health and Safety in Construction guidance.

Legislation:

Health and Safety at Work etc Act 1974

Environmental Protection Act 1990 (amended Scotland 2001)

Health and Safety at Work etc. Act 1974

Environmental Protection Act 1990

4.2 REGULATIONS

- Control of Asbestos Regulations 2012
- Control of Lead at Work Regulations 2002
- Control of Noise at Work Regulations 2005
- Control of Substances Hazardous to Health Regulations 2002
- Control of Vibration at Work Regulations 2005
- Construction (Design & Management) Regulations 2015 and Approved Code of Practice
- Electricity at Work Regulations 1989
- Environmental Permitting (England & Wales) Regulations 2016
- Environmental Protection (Duty of Care) Regulations 1991
- Environmental Protection (Duty of Care) (Scotland) Regulations 2014
- Hazardous Waste Regulations 2005
- Health and Safety (Consultation with Employees) Regulations 1996
- Health and Safety (First Aid) Regulations 1981
- Lifting Operations and Lifting Equipment Regulations 1998
- Management of Health & Safety at Work (Amendment) Regulations 2006
- Manual Handling Operations Regulations 1992
- Personal Protective Equipment (Enforcement) Regulations 2018
- Provision of Use of Work Equipment Regulations 1998
- The Regulatory Reform (Fire Safety) Order 2005
- Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 2013 (RIDDOR 2013)
- Special Waste Amendment (Scotland) Regulations 2004
- Waste Management Licensing Regulations 1994
- Waste Management Licensing (Scotland) Regulations 2011
- Work at Height Regulations 2005
- Workplace (Health, Safety and Welfare) Regulations 1992

Previous publications of this guidance referred to Construction (Head Protection) Regulations 1989, which have since been revoked and are now included in Personal Protective Equipment (Enforcement) Regulations 2018.

Notification of Conventional Tower Cranes Regulations was previously included but has also since been revoked and should now be covered under the Construction (Design & Management) Regulations 2015.

4.3 BRITISH AND EUROPEAN STANDARDS

- BS EN 12811 – Temporary Works Equipment
  Part 1 – Scaffolds, performance requirements and general design (2003)
  Part 2 – Information on materials (2004)
  Part 3 – Load testing (2002)
  TG20:08 Technical Scaffolding Guidance

- BS6187 Code of Practice for Full and Partial Demolition (2011)

- BS5974:2010 Code of Practice for the planning, design, setting up and use of temporary suspended access equipment.

- BS7121 Code of practice for safe use of cranes
  Part 1 – General (1989)
  Part 2 – Inspection, testing and examinations (2007)

- BS7212:2016 Code of Practice for safe use of construction hoists

- BS7375:2010 Code of Practice for Distribution of Electricity on Construction and Demolition sites

- BS8411:2019 Code of Practice for the use of safety nets on construction sites and other works

- BS5975:2019 Code of Practice for temporary work procedures and the permissible stress design of falsework

- BS5228-1:2009 + A1:2014 Control of noise and vibration on Construction and open sites (2009) – Noise

- BS5228-2:2009 + A1:2014 Control of noise and vibration on Construction and open sites (2009) – Vibration

These lists are not exhaustive.

APPENDIX 1

CONSTRUCTION PHASE PLAN CHECK LIST

- Scope of Works
- Description of existing structures with existing drawings
- Previous use of structure
- Key dates for various phase commencements
- Site welfare arrangements
- Sequence of works
- Site setup and site security
- Disconnection of services
- External scaffolding and calculations
- Details of cranes, plant, and equipment
- Asbestos and other hazardous material survey and removal
- Storage of gases for hot works
- Safety requirements including risk and COSHH assessments

Method statements to cover:

- Removal of non-load bearing elements and fixtures and fittings.
- Removal of roof structures
- Removal of existing lift cars
- Removal of partition walls
- Temporary propping of walls, panels, and columns
- Removal of external walls
- Removal of floors and propping requirements for plant and debris loads.

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