THE
香港工程師學會 HONG KONG INSTITUTION OF ENGINEERS
Structural Division

EXPLANATORY HANDBOOK
to
CODE OF PRACTICE FOR DEMOLITION OF BUILDINGS YEAR 2004

FOREWORD

This Explanatory Handbook to the Code of Practice for Demolition of Buildings Year 2004 ("the Code") published by the Buildings Department is prepared for use by practitioners in the design, planning, management and implementation of demolition works, and as a very useful reference for undergraduate students and young engineers.

The Explanatory Handbook is a technical complement to the Code with an aim to help practitioners better understand and make full use of the Code.

The Explanatory Handbook follows the format of the Code to facilitate easy cross reference. It provides worked examples of good practice from real demolition projects. Most importantly, the worked examples have demonstrated on how to minimize the risks of causing injury and damage to adjoining building structures, the health and safety of site personnel, and the damage to the neighbourhood environment. Where appropriate, the Explanatory Handbook also gives the rationale behind various clauses of the Code to elucidate its intended requirements.

I believe the Explanatory Handbook will also enable new ideas and approaches in carrying out demolition works in much proper and safe manner.

Lastly, on behalf of the Structural Division of the Hong Kong Institution of Engineers, I would like to express my heart-felt gratitude to the Working Committee, led by Ir Thomas WONG Kam-chuen, for his team's dedication and professionalism in writing up the Explanatory Handbook which I believe would be of great benefit to everyone in various perspectives of the industry in demolition works.

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1. GENERAL

1.1 Scope

This Explanatory Handbook (hereafter referred to as the 'EH') serves as a practical suggestion and interpretation of the Code of Practice for Demolition of Buildings Year 2004 (hereafter referred to as the 'Code').

The materials presented contain background information and considerations taken into account during the preparation of the Code. The EH aims to provide guidance on the practices used for the planning and implementation of demolition works.

Users should exercise their professional judgment in the application and use of the Code and EH, based on engineering approach.

1.2 Definitions

Please refer to the Code.

2. PLANNING

2.1 Building Appraisal and Demolition Plan

Unauthorized Building Works ('UBW') are generally constructed without the engagement of the Authorized Person(AP)/Registered Structural Engineer(RSE) and the approval of the Buildings Department. The presence of UBW should therefore be identified in the building survey for further assessment of their structural= integrity and method of removal.

2.1.1 Building Survey

(A) Record Drawings

If record drawings are not available, an on-site survey and, if necessary, material testing should be conducted. A structural appraisal and check should be carried out to assess the structural adequacy for the method of demolition. For pre-stressed concrete work (either post-tensioning or pre-tensioning), a site investigation of the tendon details may be required to identify and confirm the strength of the structure. Drainage records should also be included if available.

(B) Survey Items

The survey should include a check list for items (1) to (13) as described in the Code, and other items the AP / RSE may consider necessary.

(3) A log record identifying areas inaccessible for inspection should be made.

(5) The presence of chimneys or illegal structures, if any, should be recorded.

(C) Hazardous Materials

(2) In particular for industrial buildings, the study of the business nature of the occupants in the various building units could give an indication of the possible presence of hazardous materials, such as halon or other chemical or toxic gas cylinders.

(3) Refer also to PNAP APP-10 ie. Oil Storage Installation-Building(Oil Storage Installations) Regulations.

2.1.2 Structural Survey

(A) Record Drawings

The presence of UBW should be identified and recorded.

(B) Survey Items

Apart from the items described in the Code, the following should also be covered:

(12) The presence of chimneys with or without supporting frames, and external frames supporting air conditioners or cooling towers in industrial and commercial buildings.

(13) The presence of UBW should be surveyed and checked for structural stability. A method statement for removal of the illegal structure should be prepared and accompanied with the submission.

(14) Special architectural features, if any.

(C) Special Structures

(5) Chimneys with or without supporting frames, and external frames supporting air conditioners or cooling towers, particularly in industrial and commercial buildings, should be identified and included in the survey.

2.1.3 Demolition Plan and Stability Report including Calculations

A. Demolition Plan

The Demolition Plan should include the following:

(1) A plan showing:

(d) The distances from the building to be demolished to its adjacent buildings, streets, structures and significant street furniture.

Consider also:-

i. If building to be demolished is on boundary line abutting adjacent buildings:- Check if adjacent buildings have their external walls removed illegally. The intrusion of neighbour's property into the site or vice versa may involve commercial issues requiring unexpected long periods of negotiation.

ii. If building to be demolished is on or near boundary line but not abutting adjacent buildings:- Check if the owners of adjacent buildings would permit the trespass or projection of scaffolding / catch fans into their building lots during the course of demolition .

(3) Illegal structures, chimneys with or without supporting frames, large air conditioner or cooling tower supporting frames, sign boards, etc. should be identified and their structural condition assessed. A method statement of removal should be included.

(5) The number and capacity of mechanical plants should be specified. Having the brand name of these mechanical plants along with a catalogue containing technical and physical information from the manufacturer would be useful to the engineers.

The lifting of mechanical plants to the roof or top level of a building can generally be carried out by a mobile crane or derrick system. If a derrick system is used, it may require the strengthening of the roof structure for the transfer of the forces generated by the derrick system during the hoisting. The strengthening system, if proposed by the contractor, should be submitted to the RSE for checking and approval before putting into operation. The system should be tested and certified by a competent registered professional engineer.

Structural alterations are often required to facilitate the demolition, e.g. temporary structural strengthening to allow early removal of any cockloft, mezzanine or first-floor structure to permit vehicular ingress and egress movement at ground floor level. A temporary transfer structural system to support the propping loads from the upper floors should be designed and incorporated in the Demolition Plan, if necessary. The design should also take into account of the maneuvering of vehicles at the gantry.

The disposal route of concrete debris through either lift shaft or refuse chute should be planned carefully when preparing the Demolition Plan. The location of the gantry should be determined to give the best routing for vehicular ingress and egress. In some cases due to unavoidable site conditions, the hoarding gantries have to be located in front of walls that blocking the columns or transformer room of a building, access to the site. Access to the site would then require the planning and design of a transfer system immediately above the ganting for vehicular movement as mentioned in the paragraph above.

The removal of part of a building structure at ground level in the above situtation would generally be carried out at a very early stage after receipt of approval and consent of the Demolition Plan from the Buildings Department. With careful planning, this allows for better site management for the delivery of materials for temporary safety precautionary work and removal of debris off-site before actual demolition starts.

2.2 Utilities

2.2.1 Termination of Utilities

(E) Drainage

The Building (Demolition Works) Regulations, specifies that the last manhole shall be properly plugged. For the disposal of wastewater, a separate means of discharge of surface and foul water should be arranged with the relevant license obtained from the Environmental Protection Department (EPD). For a large open site or site with slopes and/or different levels, special attentions should be paid to the provision of temporary site drainage system for disposal of waste water.

2.2.2 Effects of Demolition on Utilities

Please refer to the Code.

2.2.3 Common Utilities

Please refer to the Code.

2.2.4 Maintenance of Certain Utilities

The Building (Demolition Works) Regulations, specifies that lifts and escalators are to be demolished in compliance with the requirements of the Electrical and Mechanical Services Department on removal of lifts and escalators.

Lifts may be removed before or in conjunction with the demolition works.

2.3 Hazardous Material

2.3.1 Asbestos Containing Material (ACM)

Referring to the Factories & Industrial Undertakings (Asbestos) Regulation and Air Pollution Control Ordinance, asbestos consultant shall prepare and submit to the Environmental Protection Department a proposal for removal of high-risk ACM, including precautionary measures, handling, storage, disposal, etc., for agreement prior to asbestos removal works.

According to the PNAP ADV-1 - Asbesto, the requirement of the further services of an asbestos consultant may be exempted for some asbestos abatement works involving only low-risk and readily-identifiable, non-friable ACM upon confirmation of each by the specialist consultant.

The AP should ensure that the Asbestos Investigation Report (AIR) and Asbestos Abatement Plan (AAP) reports prepared and submitted by the asbestos consultant have been approved by the EPD before a demolition contractor starts to carry out any safety precautionary works, including the removal of fixtures in the building such as piping, air conditioning ducts, other fixtures, etc., that may disturb or affect the removal of asbestos materials later. In some cases, the EPD may stop all activities of removal in a demolition site for further investigation if the contents of the AIR and AAP submission do not meet EPD's requirements for approval. It is always a good practice to have the AIR and AAP reports submitted and approved by the EPD prior to the commencement of demolition works if the existence of asbestos in a building would very likely to be found.

For these buildings, the EPD may require the submission of the existing E & M drawings, which will be used to identify the layout details of services and utilities to determine whether any asbestos materials may have been used for insulation and fire-proofing purposes, particularly in jointing, in the building's original design.

Illegal structures and chimneys usually contain asbestos materials. Removal of the structures should not be carried out until an AIR has been conducted and approved by the EPD.

The existence of vinyl floor tiles with mastic adhesive in a building may have an asbestos content exceeding 1%. Although the removal of vinyl floor tiles with mastic is an EPD-exempted asbestos work item, it is a good practice to test the asbestos content of the existing floor tiles to ensure that the percentage of asbestos content is at proper levels. When removing a large quantity of vinyl floor tiles, workers should ensure the tiles are not being broken into pieces. Breaking the tiles may emit and spread dust containing asbestos. This is harmful to the health of workers who breathe in the dust. Proper protective gear should be worn by workers to avoid breathing in harmful dust. Adequate water-spraying is also a means of reducing the spread of dust generated during the removal process. Proper low or non-toxic solvents should be employed for the de-bonding of floor tiles and removal of mastic. Removed floor tiles should be bagged and treated properly and disposed of as chemical waste.

2.3.2 Soil Contamination Material

Attention should be paid to material with soil contamination caused by the presence of oil tanks or other activities involving the use of industrial oil.

Soil underneath factory buildings has a high probability of being contaminated.

Firstly, a Contamination Assessment Plan (CAP) including the criteria for identifying contamination hotspots, suspected areas of potential contamination, investigation methods (e.g., trial pits, boreholes, etc.), soil and ground water sampling procedures and proposed testing parameters for laboratory analysis should be submitted by specialist for EPD's review.

Subsequently, a Contamination Assessment Report with Remediation Action Plan (CAR & RAP) including the location of contaminated soil, method statement for treatment of organic and/or heavy metal contaminated soil, laboratory testing requirements of soil sample for confirmatory test, etc. shall be submitted to EPD for approval prior to the implementation of remedial works.

The whole process from submission of CAP to approval of CAR & RAP by EPD may take as long as six to nine months. This should be allowed for in the programme and planning of the entire demolition works.

In most cases, remedial action takes place after the completion of demolition of all super-structures.

2.3.3 Radioactive Contamination Material

A specialist contractor should be appointed to remove radioactive installations/equipment such as smoke detectors designed at early years. These products were generally registered with the Radiation Board under the Radioactive Substance License and must be disposed of in accordance with the requirements of the Health Department.

Dealing with radioactive smoke detectors should be the responsibility of the licensee, who normally is the owner or management of a building. A specialist contractor should be assigned to remove and dispose these items.

2.3.4 Oil Contaminated Material

For the demolition of oil tanks, the inside surface of the oil tank would generally have to be cleaned with chemicals to remove residual oil. A license for the dumping of contaminated waste is required for the disposal of the demolished tank if it contains traces of oil.

Demolished concrete structures such as ground slab, tank base, and oil collection manhole, etc. should be treated and handled as chemical waste.

3. PRECAUTIONARY MEASURES

3.1 General
Please refer to the Code.

3.2 Hoarding and Covered Walkway

3.2.1 Requirements for Hoarding, Covered Walkway and Catch Platform
In case of open area (e.g. football court, etc.) adjacent to the site, designer should pay special attention to provide proper hoarding and covered walkway for the protection of the public. Consideration of temporarily closing the open area may be required if high risk activities are anticipated. Such closure may be required for the period of hoarding construction, demolition of some critical structures at the facade of the building to be demolished, or throughout the entire process of demolition operation.

In general, hoarding for demolition work should be closed-board type to prevent the spreading of dust. Consideration should be given to the gap between the upper and lower deck. Single-layer bamboo scaffolding with tarpaulin sheet and heavy duty net or a layer of corrugated sheet may be installed to separate the building to be demolished from outside.

(A) to (E) Please refer to the Code.

However, special consideration should be given to the following conditions.

(a) When the building to be demolished is not abutting or near the boundary line and the buildings of the adjacent sites are also not abutting or near the boundary lines:-
  - i) Hoarding between two building lots where a fence wall from each lot is present.
  - ii) Hoarding between two building lots where only a fence wall is present:
    - a. a common fence wall belonging to both sites, or
    - b. a fence wall belonging to the demolition site, or
    - c. a fence wall belonging to the adjacent site.

(b) Pre-war or post-war buildings
  - i) With cantilevered balcony built over pavement and edge of balcony alongside curb line of pavement,
  - ii) With balcony built over pavement plus columns supporting balcony and built along curb line of pavement.

  Consideration should be given to the method of demolishing the columns at ground level and structures above the covered walkway.

(c) Narrow pavement where the provision of a covered walkway is not possible.

  In this case, part of the covered walkway may have to be constructed over the carriageway.

  However, in some cases, the carriageway may be so narrow that the construction of part of the hoarding on the carriageway would not be permitted by the Highways Department under such circumstance. Therefore, the catch platform may have to be erected at a higher level as a cantilever with a protective enclosure layer as vertical fence boarding / cladding underneath it.

3.2.2 Dimensions

Please also see PNAP APP-23 for reference.

Performing a Temporary Traffic Impact Assessment (TTIA) is suggested if reduction of the width for covered walkway is required; implement a Temporary Traffic Management System (TTMS) if necessary.

Table 3.1 - Width of Covered Walkway

Although exemption may be considered if the pavement is of insufficient width, due consideration should be given to the fact that the clear width of a walkway should provide adequate passage for pedestrians, bearing in mind that the required minimum reference width is 1.5m. In some cases, permission may be granted to extend the hoarding onto the carriageway based on the TTIA.

In extreme cases where the minimum width of a passage cannot be provided, diverting pedestrians to the opposite side of the road may be implemented in the TTMS.

3.2.3 Design Criteria

Design criteria are also stipulated in PNAP APP-21. Design examples of covered walkway, catch platform and gantry are given in Appendix B of PNAP APP-21.

A wind load of 0.67kPa (i.e., 37% of the design wind pressure of 1.82kPa, as given in the Code of Practice on Wind Effects in Hong Kong 2004) can be adopted for checking the stability of temporary structures.

For a covered walkway with a clear width of 1.5m or less, in order to satisfy the safety factor governing overturning under the requirements of the current Code of Practice on Wind Effects in Hong Kong, the dead weight of the hoarding would have to be increased to achieve the balance requirement or the hoarding would have to be tied back to the building structure. One method that has been commonly used is to place concrete blocks or steel plates on top of the lower deck of the hoarding. This, however, is not recommended. The Factor of Safety (FOS) of the hoarding against overturning with the raised centre of gravity of the load pattern is much reduced when taking into account the side sway of the hoarding due to any horizontal impact load generated. It would be more effective if the hoarding is tied back to the structure of the building. The hoarding may then be modified to suit site conditions when the demolition work has reached the mezzanine or first-floor level.

Unless unavoidable, breaking up the existing pavement to construct a hoarding footing below pavement level is not recommended. It is likely that there are considerable utility services underneath the pavement. The diversion of any one type of utility would take substantial time, not to mention the required co-ordination with each utility company and related government departments. Applying for an excavation permit is also time consuming.

For scaffolding facing a street or back lane and sitting on top of a covered walkway, the engineer must take into account the estimated loading of the scaffolding that would be transferred to and supported by the covered walkway. Consideration should be given to constructing additional catch fans within and between the scaffolding and the face of the building to collect any debris that may fall onto the deck of the covered walkway. The noise generated from falling debris onto a steel deck may cause a nuisance and is hazardous to pedestrians walking under a covered walkway.

3.2.4 Proper Use of Covered Walkway

Consider providing waterproofing over the deck, particularly in busy areas with high volumes of pedestrian flow.

3.2.5 Construction

In some cases, provision of waterproofing for the roof deck of covered walkway may be required.

3.2.6 Lighting

Lighting in public area at a height less than 2.21m should be of 110 volts.

The lighting standard for covered walkway is also stipulated in PNAP APP-23.

Referring to the Code of Practice for the Electricity (Wiring) Regulations, lighting operating at 110 volts may be obtained by the use of an isolating transformer having the centre tap of the secondary winding earthed such that the normal voltage of circuit to earth does not exceed 55 volts.

3.3 Scaffoldings and Screen Covers

3.3.1 Scaffoldings

(A) Scaffolding Construction and Work Platform Requirements

For building in excess of 15m, it is recommended to include the supporting system of the scaffolding in the Demolition Plan submission, indicating details including spacing of anchor / tie and brackets, etc.

(B) Bamboo Scaffold

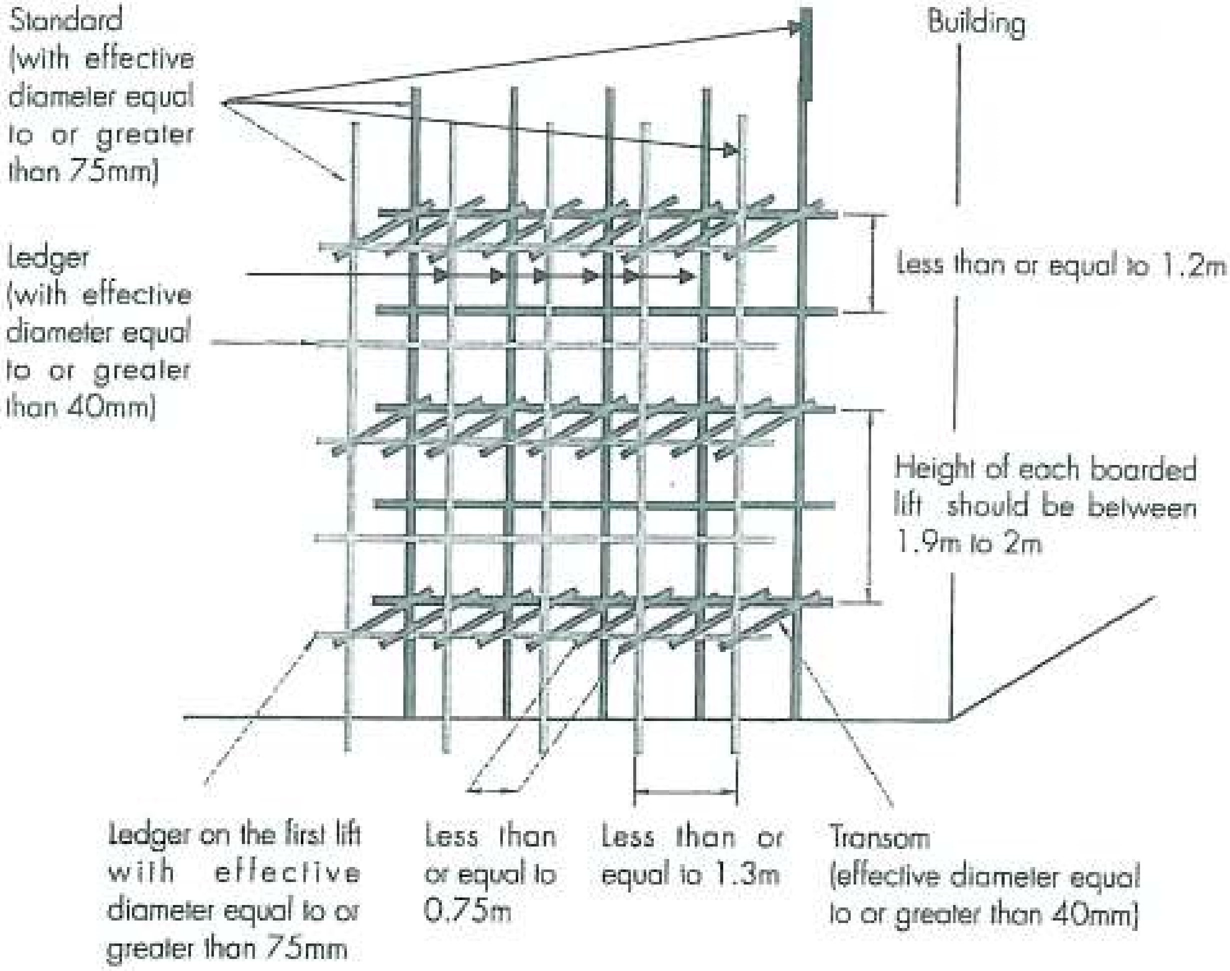
Labour Department has issued a Code of Practice for Bamboo Scaffolding Safety. The Buildings Department has also issued a publication known as the Guidelines on the Design and Construction of Scaffolds. For safety issue, the Labour Department's Code of Practice should be referred to. For the Design and Construction of Scaffolds, the Buildings Department's Guidelines should be followed.

Figure 1 (extracted as LD-Figure 1 below) of the Code of Practice for Bamboo Scaffolding Safety issued by the Labour Department shows a typical arrangement of a double-row scaffold with recommended erection standards for scaffolding in the construction industry. This figure provides a safe approach to bamboo scaffolding from safety point of view. However, the Guidelines on the Design and Construction of Scaffolds issued by the Buildings Department stipulates the detailed structural design and requirements of each structural element of the scaffolding.

For demolition works, an alternative suggestion of arrangement of the bamboo standards generally adopted is shown in EH-LD-Figure 1.

Extract from

Code of Practice for Bamboo Scaffolding Safety

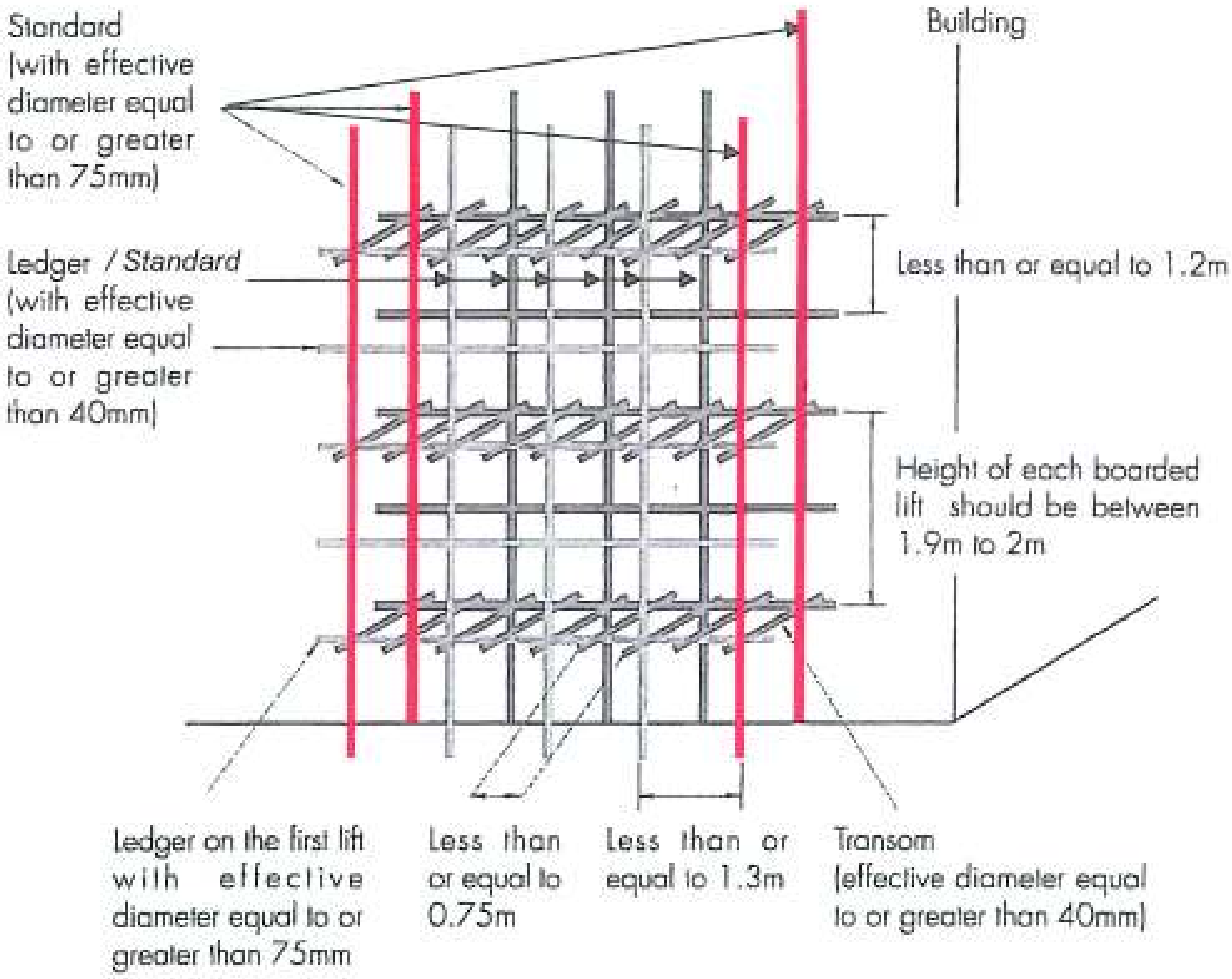


Note:
For all standards and the ledgers on the first lift of the scaffold, the wall thickness of these bamboo members should not be less than 10mm.

LD-Figure 1
Double-row Bamboo Scaffold with Recommended Erection Standards (not to scale)

Extract from

Code of Practice for Bamboo Scaffolding Safety



Note:

For all standards and the ledgers on the first lift of the scaffold, the wall thickness of these bamboo members should not be less than 10mm.

EH-LD-Figure 1

General Practice of A Double-row Bamboo with Arrangement of Standards in Demolition Works

Clause 4 5.3.2(n) of the Code of Practice for Bamboo Scaffolding Safety issued by the Labour Department is repeated as follows:

"For a scaffold greater than 15m in height, it should be designed and approved by professional engineer."

The last paragraph of Section 2.1 for Double-layered Bamboo Scaffolds of the Guidelines on the Design and Construction of Scaffolds issued by the Buildings Department is also repeated as follows:

"For a scaffold greater than 15m in height, it should be designed by a design engineer. Diagram 4 shows for the design engineers' reference the layout of a 19m high double-layered bamboo scaffold with a post spacing of 3m."

The above, however, should not be interpreted to mean that for a building 40m high, for example, scaffold can be split into three separate sections of less than 15m each so that design by a professional engineer is not required.

The Buildings Department's Guideline also permit deviation from the prescribed details subject to professional engineer's justification with a performance-based design approach.

The Technical Report No.23, Design of Bamboo Scaffolds by the Hong Kong Polytechnic University may also be used as a reference.

When designing the fixing bracket and wall ties for the scaffold, attention should also be paid to the requirements described in the Guidelines on the Design and Construction of Scaffolds.

Details of anchor bolts for steel wire and wall tie should be clearly specified on the demolition plan. The anchor bolts shown in Figure 3.3 of the Code is an indicative intent of purpose. For shear wall-type perimeter wall thickness of say 500mm, the details shown in Figure 3.3 should be adjusted to reflect the actual site conditions. However the use of a U fixing bolt drilled through the wall as the fixing eye for the wall-tying wire should be used when situation warrants. EH-Figure 3.3-1 and 3.3-2 show some alternative suggested details of bamboo catchfans.

(C) Please refer to the Code. An amendment to the Code of Practice for Metal Scaffolding Safely will be issued in the near future.

(D) Dismantling
In practice, temporary guy ropes are used to replace the wall ties in the portion of structure under demolition, followed by removal of tarpaulin sheets and scaffold. This is particularly the case where the façade has heavy cladding panels.

3.3.2 Screen Covers

The Code specifies that two layers of protective screen, tarpaulin sheet and nylon net, shall be placed over the scaffolds to completely enclose the building structure.

(A) Requirements
Please refer to the Code.

(B) Ties
Please refer to the Code.

(C) Nets

Table 3.3 of the Code stipulates that minimum requirements for polyethylene net shall be of 1mm string diameter 16plys and 20mm mesh grid opening. Such requirements may not be applicable for heavy duty net. PNAP APP-102 – Superstructure Works Measures for Public Safety mentions that heavy duty nylon net should have thread diameter not less than 3.5mm and a maximum centre to centre spacing of 50mm.

As a good practice, an additional layer of heavy duty nylon net, say, of minimum 3.5mm diameter with mesh grid opening 50mm may be provided at the inner face of the scaffold.

(D) Tarpaulin

The Code specified that fire retardant tarpaulin should be used in demolition works. The risk of fire hazard in a demolition site is extremely high both during the preparation of safety measure and the demolition period with the frequent use of oxygen and acetylene hot work cutting for removal of metal works including scrap steel reinforcing bars.

Fire retarding tarpaulin is approximately two times the weight of ordinary tarpaulin sheets. Fire retarding tarpaulin sheet for construction industry are generally not readily available in the market. Allow ample time for ordering if required.

When designing the scaffold supporting system, the weight of the heavy duty nets, fire retardant tarpaulin, and possibly concrete debris accumulated on the catch fans should be considered. The use of heavy duty nets and fire retardant tarpaulin sheets should be specified on the demolition plan with description of requirements.

The Code specifies that fire retardant characteristic of the tarpaulin shall meet either one of the following requirements:

(1) Class B material as specified in British Standard 5867; may be tested on site in accordance with the recommendation of British Standard 5852.

This standard was issued many years ago and intended for the testing of indoor domestic fabrics for curtains and drapes. This is generally used indoor for domestic purpose in small quantities and thus has a different degree of safety requirement.

(2) Flame retardant test for certain items, light weight cloths methods, provided by the Fire Retardant Regulations for Protective Canvas for construction, Japan Ministerial Ordinance of the Ministry of Home Affair; or

(3) Any equivalent standard criteria or testing.

When specifying the standard of test to be carried out, care should be taken to assess the appropriate test to be chosen because the standard issued and required from different countries varies. Other countries or places such as PRC, USA, Canada, Australia and Europe also have standards on tarpaulin sheets.

3.4 Catchfan

3.4.1 Requirements

The Code states that catchfans shall be used only as precautionary measures and shall not be used as temporary support for any anticipated loads. In the industry, generally additional temporary timber catch fans are provided inside the bamboo scaffolding and the gap between the scaffolding and building face to collect and safe guard of falling debris generated during the cutting of slots through the external walls and trimming at the bottom of the columns for felling.

3.4.2 Bamboo Catchfan

(A) Framing

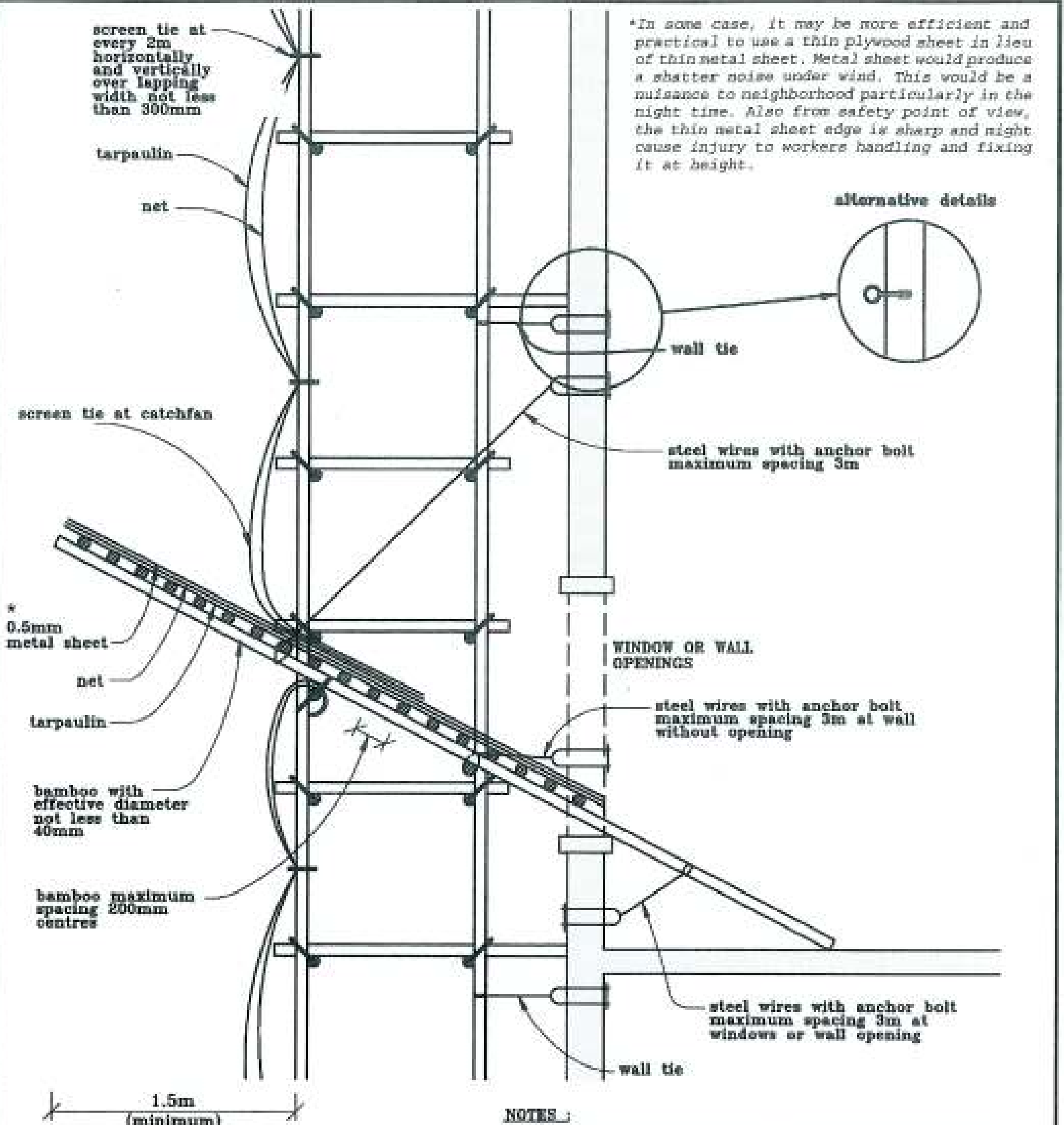
When the bamboo cannot be extended into the building in the case where there is no window or wall opening, additional means of supporting the catchfan should be included and shown in the demolition plan. EH-Figure 3.3-2 shows some alternative suggested details.

(B) Decking

Please refer to the Code.

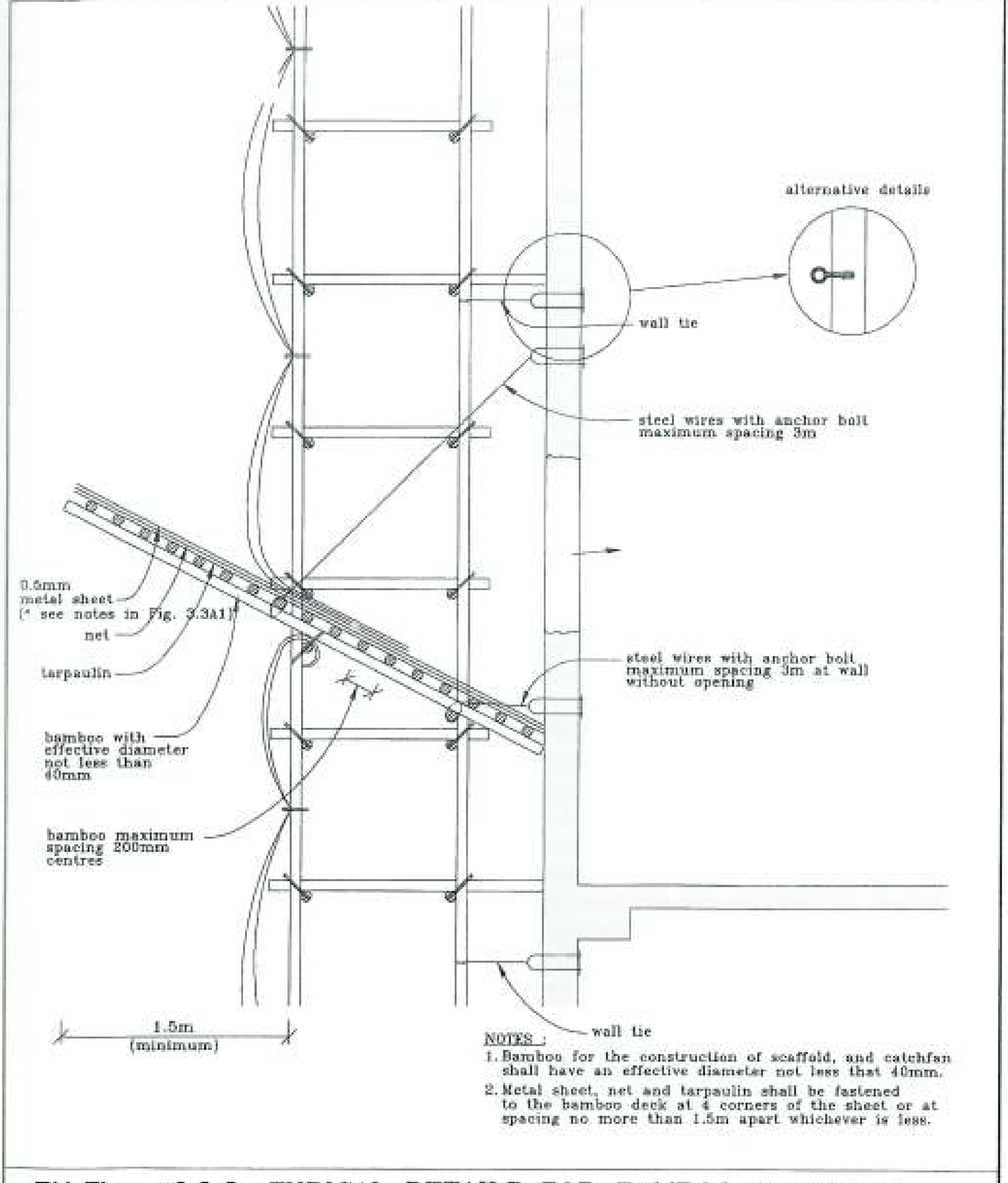
3.4.3 Steel Catchfan

Consideration should be given to prevent falling objects when openings are to be punched or cored through the external wall, particularly abutting the boundary line, for the installation of the cantilever steel sections. Bamboo scaffolding may need to be erected as a temporary protection measure for the erection of the steel platform.



NOTES :
1. Bamboo for the construction of scaffold, and catchfan shall have an effective diameter not less that 40mm.
2. Metal sheet, net and tarpaulin shall be fastened to the bamboo deck at 4 corners of the sheet or at spacing no more than 1.5m apart whichever is less.

EH-Figure 3.3-1 TYPICAL DETAILS FOR BAMBOO CATCHFAN AND SCREEN COVER



EH-Figure 3.3-2 TYPICAL DETAILS FOR BAMBOO CATCHFAN

3.5 Temporary Supports

3.5.1 General

(A) Requirements

Demolition work by hand-held breakers may not require propping of the roof floor if the floor is structurally sound and not supporting any loading more than its designed load. This would be the situation where there is no building structure above the roof floor, and at the time of demolition, the debris would fall directly onto the floor below.

The dead weight of a roof floor is, in general, heavier than a typical floor due to the waterproofing and heat- insulation layers on top of the structural slab. When designing the propping system for the other lower floors, give consideration to the excess debris loading created by the roof floor demolition. Please also refer to notes in clause 3.10.4 below. However, this may not be the case for industrial buildings, which usually have high live loads on typical floor slabs (e.g., warehouse, container terminal building, etc.).

If a structure is capable of resisting the residue debris loading from the floor above during demolition, props may not be required for the manual method of demolition. However, props may be required along the perimeter of the building to take up and resist the impact load caused by the falling impact of the perimeter wall panel during its demolition.

For demolition work by mechanical plants, the possible accumulated debris loading from the demolition of the floor above should be considered in the design calculations of the propping system. Apart from the bulk volume of concrete debris formed from beams and slabs, including screeding, the amount of debris generated from columns, external walls and partition walls, either in brick or concrete with plaster finishes, should be considered. In some cases, the bulk volume of debris could accumulate to 600mm high or more with voids between the demolished debris.

To work out the allowable height of the debris for the design, a reduction factor of 0.7 may be used for the bulk density of the debris to allow for a 30% void. However, debris should be removed as frequently and as soon as possible to avoid overloading the floor. When working out the propping system with the designed accumulated debris load, the superimposed load due to the mechanical plant sitting on the debris should also be considered. This would occur when the mechanical plant descends to the floor below after completing demolition of the majority floor area. For a large floor area where more than one mechanical plant is used, a smaller-sized mechanical plant could operate in conjunction with other bigger machines. The smaller mechanical plant could first descend to the floor below and clear away the debris to make room for the bigger machine to descend and without sitting on top of the debris. In this case, the calculated load of the debris and the smaller-sized mechanical plant may be considered in the design of the propping system. However, in addition to the specifications stated in the drawings, on-site supervision is necessary to ensure that the design assumptions are adhered to.

The Code states that "Temporary supports shall not be removed until its supporting loads are completely removed."

The meaning of "its supporting load" in the above clause should not be misinterpreted. The propping system is designed to support extra loading generated from demolition activities, such as load from the demolished debris or the operation of the mechanical plant sitting on the floor. Where there is no extra loading imposed on the floor panels to be demolished (area where there is no excess debris on top or the access of mechanical plants), the props under the floor panels to be demolished should be removed so that the floor can be demolished in a proper manner.

The props are meant to support excess loading generated by the activity of demolition and not meant to support the beam and slab structural elements themselves (i.e., beams or slabs during the process of demolition if they were not overloaded and where they are self-supporting as part of the structural system). The props immediately under the structure elements would be damaged and could not be re-used if they were not removed locally during the process of demolition. There are, however, certain situations, such as the demolition of a large span beam, in which part of the beam would need to be supported by propping during the time of its demolition. In such cases, the props would be arranged in locations under the beam so that sections of the beam can be demolished in a way that also minimizes damage to the props underneath. The use of a mechanical hydraulic crusher for demolishing a large span beam by its biting and crushing actions would reduce the possible impact load induced to the beam compared to the use of a mechanical hydraulic breaker.

(B) Cantilevered Structures

This refers to all the structural elements supported by cantilever elements such as beam and / or slab.

Anchorage or holding down load of the cantilevered structure:

This refers to the support of the cantilever elements which could be in the form of an anchorage such as column and/or beam, or other holding down loads, which could be in a form contributing to form part or all of the supporting system for the cantilever element.

The Code requires special attention to be given to the demolition of **external cantilevered structures facing public streets**, which have a height more than 4m above ground and offset from the site boundary at a distance less than one half of the height of the building to be demolished because such demolition may affect the safety of the public. In demolishing these external cantilevered structures, the area under them shall be protected by temporary platforms designed to resist both the anticipated demolition and construction loading, unless the cantilevered structures are demolished by cut-and-lift or other similar techniques.

Cantilevered structures may be in the form as described in the following paragraph. The AP and RSE should, however, distinguish between **external cantilevered structures facing public streets** and other types of cantilevered structures.

1. Cantilevered Slabs
   When preparing the Demolition Plan design, the engineer should distinguish between a cantilevered slab and a slab spanning between cantilevered beams, or perimeter beams which are supported by the cantilevered beams.

   a. A slab projecting from the face of the building, designed as a canopy over public pavement at the mezzanine or first-floor level of a building, usually has a span in the 1.0m to 2.0m range. The canopy is generally accessible for maintenance and cleaning purposes only. The edge of the cantilever generally only has an upstand curb.

b. A slab projecting from the face of the building, designed as a corridor for public circulation, usually has a span in the 1.2m to 1.8m range. The edge of the cantilever generally has an upstand parapet wall. This design is generally found in early public housing buildings or early post-war buildings.

2. Cantilevered Beams

Cantilevered beams are common along the perimeter in most buildings. The edge of a building is generally designed and constructed with curtain wall/fascia, window with parapet or external wall. This arrangement is also found in post-war domestic buildings built with peripheral, large open balconies projecting over public pavements and later covered up with an external wall as an UBW.

The span of cantilevered beams may vary from 1.5m to 4.0m.

a. Flat slab structures with end bay designed as cantilevers.

For the demolition of **external cantilevered structures facing public streets**, careful attention must be given to assess the possible impact load arising from the demolition process to lower floors, particularly for floor-to-floor heights in excess of 4m. The perimeter wall must be demolished first with all debris being cleared away before any demolition of the cantilevered structure can proceed. The impact load on the floor due to the demolition of external wall on the floor must not be overlooked. For external wall of excessive height, it may be more appropriate to demolish the wall in two or more lifts. In such a case, provision of staging scaffolding may be required in the front, on the same floor where the external wall is to be demolished.

The stability of the platform erected under cantilevered structures and the loading imposed onto the floors below must be included in the demolition design.

(C) Catch Platform

A design justification should be provided if the catch platform provided on top of the covered walkway is to also serve as the temporary platform to support the debris created by the demolition of the cantilevered structural elements. It should be noted that the Code is very specific in stating that catchfans shall be used only as precautionary measures; therefore the design justification should show that the demolition work has now progressed to a stage in which the hazards which require these precautionary measures, and the debris load, will not co-exist. For the comfort of people using the covered walkway, measures should also be taken to reduce the noise of concrete debris.

(D) Adjacent Building

Please refer to the Code.

(E) In complete Demolition Projects

Please refer to the Code.

3.5.2 Materials and Types

(A) Materials

Please refer to the Code.

(B) Pre-manufactured System

The supervising engineer should ensure that the pre-manufactured components being used are capable of sustaining the design capacity.

Verifying that pre-manufactured components are in compliance with the manufacturer's specifications by carrying out laboratory testing to determine their ultimate capacity is recommended. Please also refer to notes on factor of safety of props in clause 3.5.5 below.

(C) Existing Structure

Please refer to the Code.

(D) Used Timber

Please refer to the Code.

(E) Used Structural Steel

Please refer to the Code.

3.5.3 Loads

(A) Gravity Loads

Please refer to the Code.

(B) Lateral Loads

With engineering justification, existing or remaining structures may be considered able to contribute to withstanding the lateral loads stipulated in sub-clause 3.5.1 and 3.5.2. The engineer should specify and check the minimum number of bays to remain at the time before the forming of an access ramp for the descent of the mechanical plant to lower floors. The remaining structure, in conjunction with the propping system, should be checked and capable of withstanding the lateral load generated during the movement of the mechanical plants. In such a case, the remaining structure should only be demolished by the mechanical plants after they have descended to the lower floor. Refer also to notes for clause 3.5.5 below.

(C) Design-Consideration for Temporary Support

Please refer to the Code.

3.5.4 Structural Analysis and Design

Depending on the structural condition of the building to be demolished, it is suggested that the engineers may, at their discretion, allow an increase of 25% of the structural capacity of the structural elements under temporary loading conditions.

3.5.5 Temporary Propping System

For the case of buildings less than eight storeys high and in poor and/or dilapidated condition, with uncertain structural performance and response to the demolition method adopted, providing full propping from top floor to ground floor is recommended.

However, this may be based on engineering judgment and checking. Some buildings, such as factories or warehouses, may have been designed for heavy live loads. In this case, the number of storeys required to be propped during demolition may be fewer than eight storeys.

The propping arrangement as shown in Table 3.4 of the Code is for reference purposes. Structural justification should be provided for the propping where required.

There are various propping systems being used for demolition. These systems are very similar to false work systems used in building construction. The most common systems used are adjustable telescopic steel props, individual tower frames braced in groups and scaffolding tubes and fitting systems with bracings.

The capacity of a prop would be subject to the arrangement of the bracing and its effective length, plus the condition of the prop. Carrying out a loading test of the propping system to check and justify its specified capacity is recommended. Please refer to BS5975 – Code of Practice for Falsework.

For a propping system supporting a floor with a high floor-to-floor height, such as the hallway of a shopping mall or theatre, one could refer to Section 6.4.4 of BS5975 – Code of Practice for Falsework for details on lateral stability and bracing of a propping system. One could also refer to Section 6.6 of BS5975 – Code of Practice for Falsework , which discusses the design considerations of using a propping system with independent towers in groups or using scaffolding tubes and fittings.

Props used in the market are generally of the following types:

1. **Adjustable telescopic steel props**

   These are generally used for floor heights of less than 3.3m. For higher floor heights, the efficiency of the prop strength is much reduced due to the increased slenderness. Due to the height limitation of adjustable telescopic steel props, bracing to the steel props should be simple for the purposes of the application. This type of prop is generally placed at 1.2m centre-to-centre. There is often over-provision of bracing in both the X and Y directions horizontally, plus vertical cross bracing to the top and bottom of every single prop diagonally. It is actually important to check that the props are being properly tightened and fixed during their erection and throughout the period of demolition. The over-provision of bracing makes erection and dismantling of the props impractical.

   Steel bracings, either in the form of a tube or an angle, are generally provided in the horizontal X and Y directions at mid-height, or the weaker section of the prop. The weaker section of the adjustable telescopic steel prop generally occurs where the top and bottom tube sections connect near the pin. When properly performed, bracing stabilizes the prop from buckling and thus increases the load bearing capacity of the prop. When steel tube (generally 48mm in diameter, 2mm thick) is used for bracing, a clamping device is used to lock the tube against the prop. When steel angle (generally 30 x 30mm, 2.5 to 3 mm thick) is used, the connection is achieved by welding the angle to the surface of the tube.

   Providing only vertical diagonal bracings to the top and bottom of the two props next to each other would fix the positions of the props at the top and bottom only. This method of bracing is not effective when considering individual props under loading. For best effectiveness, the mid-height of the length of a prop should be the point for bracing. However, vertical cross-bracing may be provided to a group of props, say 4 to 6 within a typical structural bay between column grids. This arrangement is recommended for perimeter bays where an external wall is to be demolished. The impact from the falling down of a wall during demolition generally causes a momentary vibration to the structure and propping system underneath.

   Vertical diagonal bracing provided for a full bay would minimize the disturbance of the propping system of adjacent bays when the props of a particular bay are being removed immediately before the demolition of that bay. Vertical diagonal bracing may also be required in those cases where at the time immediately before the descent of the mechanical excavators to a lower floor, the remaining part of the structure of the building and the propping system are meant to be integrated and acting together to resist the minimum lateral load (3% of vertical load) plus the traction load of the mechanical excavators. Refer also to related notes for clause 3.5.3 above and 3.5.5 below.

Reference should be made to:

- BS5975 – Code of Practice for Falsework
- BS EN 1065 – Adjustable Telescopic Steel Props – Product Specifications, Design and Assessment by Calculations and Tests
- Section 3.9.6 of BS5975 – Code of Practice for Falsework is repeated here as follows:-

"Steel props should comply with the requirements of BS 4074 – Specification for Steel Trench Struts (now replaced by BS EN 1065 – Adjustable Telescopic Steel Props – Product Specifications, Design and Assessment by Calculations and Tests), in which the construction and sizes of adjustable steel props are specified. A prop comprises telescopic tubular section with top and bottom plates 150mm (100 mm in BS EN 1065). The transfer of load between the two parts is by an adjustable collar and a pin. The pin is of high tensile steel, and should only be replaced with one of the appropriate type."

An extract from BS EN 1065 appears as Table 2 below listing the nominal characteristic strength for class A, B, C, D and E props at various lengths of extension, without any bracing.

4 Classification - (extracted from Page 8 of EN 1065:1998)
An adjustable telescopic steel prop shall be classified according to its nominal characteristic strength Ry.k and its maximum length / max given in Table 2 below.

For classes A, B and C props the nominal characteristic strength given in Table 2 shall apply to the maximum extension length. For classes D and E props the nominal characteristic strength given in Table 2 shall apply to all possible extension lengths.

Table 2 – Classification

Class	Length at maximum extension /max m	Nominal characteristic strength (see clause 8) Ry.k kN
A 25	2,50	20,4
A 30	3,00	17,0
A 35	3,50	14,6
A 40	4,00	12,8
B 25	2,50	27,2
B 30	3,00	22,7
B 35	3,50	19,4
B 40	4,00	17,0
B 45	4,50	15,1
B 50	5,00	13,6
B 55	5,50	12,4
C 25	2,50	40,8
C 30	3,00	34,0
C 35	3,50	29,1
C 40	4,00	25,5
C 45	4,50	22,7
C 50	5,00	20,4
C 55	5,50	18,6
D 25	2,50	34,0
D 30	3,00	
D 35	3,50	
D 40	4,00	
D 45	4,50	
D 50	5,00	
D 55	5,50	
E 25	2,50	51,0
E 30	3,00	
E 35	3,50	
E 40	4,00	
E 45	4,50	
E 50	5,00	
E 55	5,50	

BS EN 1065 Section 9 recommends a method for verifying the actual characteristic strength of a prop by calculation or by tests at the manufacturer's discretion. The method is reprinted below.

BS EN 1065 Table 5 – Verification steps

	Property		Verification method	
1.1	Actual characteristic strength		Determined by calculation in accordance with 9.2	
1.2			Determined by testing in accordance with 9.3	
2.1	Pin and its support	Pin: Strength	Prop conforms to 7.3.5	Determine the shear resistance by calculation in accordance with 9.4.2
2.2			Prop does not conform to 7.3.5	Test in accordance with 10.3
2.3		Inner tube: Pin bearing capacity	Determine by calculation in accordance with 9.4.2	
3.1	Unintentional disengagement		Test according to 10.4	

The verification of BS EN 1065 is based on the condition of a single prop without any bracing. In demolition works, bracings are generally provided for tubular props in the X and Y directions horizontally within the mid-section portion, to achieve a reduced effective length and provide an integrated system of group of props.

Tubular props braced may be formed in groups of 4, 9, 16, 25, 36, 49 or more. When providing horizontal bracings to the props in groups, give consideration to access during the period of erection and demolition. Ideally, a group of props should be provided to a full bay between column grids or beam grid in a way such that as demolition proceeds, the props under the area to be demolished can be removed without disturbing the other structural bays where an excavator might be sitting on the floor carrying out demolition work.

Annex C of BS5975 describes the initial testing, quality control and inspection of falsework equipment. It is reprinted below:

Annex C

Initial testing, quality control and inspection of falsework equipment

C.1 Introduction

Many falsework equipments in use are of a proprietary design that has been purchased or hired. Detailed information, such as that provided by the supplier, is of great importance in inspecting such equipment if the inspection is to be carried out by those not fully experienced in its use.

C.2 Tests on falsework equipment

Very often, technical information relating to the performance of such material has been compiled from tests carried out during the development of the equipment. It is desirable that test procedures for similar systems or components should be standardized in such a way as to make the critical properties comparable. Work has commenced on the production of suitable test procedures (BS 5507-1 - Methods of Test for Falsework Equipment. Floor Centres) for certain items of equipment and where they exist should be used by suppliers in compiling the necessary design data. If no standard test procedure exists the following points should be considered when establishing a test method.

a) The test should, as near as is practicable, simulate the conditions and manner in which the equipment is used on site.

b) Test methods and conditions should be easily repeatable and should be as simple as possible.

c) Testing should be carried out or supervised by an independent test house using suitable test machinery and recording equipment.

d) The test report should show:

1) descriptions of components to be tested with drawings of items and relevant dimensions;

2) the arrangement of an item or system to be tested, with details of test rig, loading points, etc.;

3) a description of the test method or reference to a standard test procedure;

4) tabulation of test results, with test measurements;

5) a summary of the test and conclusions;

6) tensile or compression test results of samples cut from the tested items together with the strength range of the material from which the tested items will be made.

C.3 Prototype and initial testing

Where the strength of a manufactured component cannot be ascertained by applying design criteria recommended in this Code, testing should be carried out at the prototype stage of development in order to obtain results, including ultimate behavior, on which design data for the component or system can be based.

Because of the variability in the sizes and forms of falsework equipment, BS 5507 does not attempt to provide any data on test procedures. The reader should refer to recognized methods of test and assessment for further information when the testing of equipment is required, including the BS5507 series of standards.

C.4 Quality control of manufacture

Good quality control and inspection during manufacture should generally make further destructive testing unnecessary, although it may be advisable to carry out check tests at further intervals.

Where necessary, test certificates should be obtained to ensure the raw material supplied for manufacture is in accordance with requirements. Where any doubt may exist, sampling and testing of material supplies should be undertaken.

For the demolition of a floor by a mechanical hydraulic breaker/crusher, give consideration to the design of the propping system for lateral stability as a whole when acting together with the floor structural system. Please refer also to related notes for lateral loads in clauses 3.5.3 and 3.5.5.1 above. The worst case would be a single or double bay of column grids being left after most parts of a floor have been completely demolished and the breaker/crusher is ready to descend to a lower floor. If the floor structural system is not strong enough to resist the minimum of 3% of the total vertical loads, or a minimum of 1.5kN per metre length of the supported structure, whichever is greater, the propping system, together with the existing structure, should be checked as an integrated system to resist the lateral load. In some cases, diagonal bracing, together with fixing of the propping system to the columns, may be considered as a whole for these particular bays. If the leftover system were not strong enough to take up the lateral force, the number of bays to be left intact before the descending of the machine to a lower floor may have to be increased to achieve the requirements. Alternatively, the propping system could be integrated with the structural floor system by the provision of end fixity of the horizontal bracings to the vertical surface of the columns by fixing plates and bolts. Diagonal bracing may also be provided to increase the overall stability of the propping system together with the building structure to achieve the overall 3% stability resistance requirement.

If acting only as a bracing to the prop, 1.0% of the prop capacity may be adopted as the strength for fixing by tack-welding of steel angles or couplers for steel tubes to the prop.

Providing bracing (may be in the form of vertical diagonal directions) in addition to the horizontal bracings along the perimeter bay of props of the building where external walls are to be demolished is recommended. This would strengthen the integrity of the propping system to resist the impact force caused by the falling of the wall panel onto the floor at the moment of wall demolition. The props underneath the floor should be checked for damage after each wall has been demolished. Re-prop if the props have loosened or replace with new props if they have been damaged.

2. **Tubular Module Frame System with Adjustable Base Jacks.**

The following European Standards may also be referred to:

EN12810-1 (2003)	Façade scaffolds made of prefabricated components - Part 1: Product specifications
EN12810-2 (2003)	Façade scaffolds made of prefabricated components – Part 2: Particular methods of structural design
EN12811-1 (2003)	Temporary works equipment - Part 1: Scaffolds – performance requirements and general design
EN12811-2 (2004)	Temporary works equipment - Part 2: Information on materials
EN12811-3 (2002)	Temporary works equipment - Part 3: Load testing
BS 5975: 1996	Code of Practice for Falsework
BS EN12812 (2004)	Falsework - Performance requirements and general design (BS 5975: 1996 exists in parallel with this standard and provides recommendations on the design of falsework using permissible stress methods and on procedures for the successful management of work on site, including the appointment of a falsework coordinator)

Bracings are generally provided in horizontal X and Y directions at modular nodal joints. The height of the frame system can be formed by a combination of modules of various increments. The horizontal spacing between the vertical props is formed by tubular bracings in modules of various-lengthed increments, attached to the nodal joints to form a frame system.

In some systems, apart from horizontal bracings, diagonal bracings are also provided to the nodal points to increase their stability stiffness for higher floor heights.

There are various Tubular Module Frame Systems in the market, with manufacturers from UK, Europe, Japan, Korea, USA, etc. Systems are also produced in PRC, generally as imitations or modifications of the systems from overseas.

Tubular Module Frame Systems are more suitable for use for floor-to-ceiling heights exceeding 3.5m.

The top and bottom of the frames formed are also mounted with adjustable screwing shoes to make up the required height of the frame.

The conditions mentioned in paragraph '1' above are also applicable to the Tubular Module Frame System.

3. **Scaffold Frame System with 1219mm (4'- 0") Grid Generally**
Please refer also to the European Standard as mentioned in paragraph '2' above.

The scaffold frame system is formed by the connection of two-legged single-plane frames connected to each other by vertical cross-bracings at pre-fixed nodal points. The frames are manufactured in various height modules to suit various height requirements. The frames are stacked on top of one another to form the required height of the propping system. The top and bottom of the frames are also mounted with adjustable screwing shoes to make up the required height of the frame.

Because the system is formed by pinned joints stacked on each other and with the cross-bracing connected to two frames by pinned joints, it must be used with due care. With excessive floor-to-ceiling height, linking up each of the four-legged frame modules to the other modules by horizontal bracings to form a group of modules is recommended. Vertical cross-bracing is required for excessive heights, such as the demolition of a cinema hall, to increase the stability of the system. The system should be braced effectively to avoid side-sway during the demolition process if the propping system has an excessive height-to-width ratio.

Factor of Safety for Props
For temporary works, EN12811-1 specifies a single load factor of 1.5 and a material factor of 1.1.

Annex B - BS5975
Table B2 of BS5975 also shows the permissible axial compressive stress and load to be used for as new tubes and used tubes at various effective length and slenderness ratio. The reduction factor for used tube is approximately 0.9.

BS5975 also states that where the strength of a manufactured component cannot be ascertained by applying the design criteria recommended, it should be either determined by applying a minimum factor of safety against collapse of 2.0 when tested in a condition described in its section 7, or the actual site conditions likely to apply, or in a condition equivalent to the worst acceptable condition described in its Section 3.9.4. An appreciably larger factor of safety will be more appropriate for materials that have a wider scatter of strengths.

3.5.6 Erection and Dismantling

On-site control of the adequacy of propping installations and compliance with the approved plans are crucial during the course of demolition. The following are some recommended practices:

- Maintain proper inspection routes on the floors with propping.
- Use horizontal ties at mid-height and about 1.8m high along emergency access routes; or use steel scaffolding frame systems which provide convenient and safe access.
- Have supervisory staff endorse removal schedule before workers remove propping.
- Set up system of access control of on-site personnel for building under demolition after obtaining consent for demolition.

3.6 Protection of Properties

3.6.1 General

Please refer to the Code.

3.6.2 Party Walls and External Walls

For two abutting buildings without party wall, prior to demolition, investigate and determine if an external wall once existed in the adjacent building. The adjoining owner may have to carry out remedial work to reinstate a missing external wall if one had been present.

3.6.3 Foundation Support

Please refer to the Code.

3.7 Protection of Traffic

3.7.1 Adjacent Traffic

In some cases, temporary closure of part of a lane may be required for the demolition of pre-war or immediately post-war buildings where columns had been constructed along and at the edge of the pavement. The hoarding may have to be constructed directly under the portion of the building overhead along the pavement. It is possible to close part of the street and to construct the hoarding on the street if the width of the street permits this kind of arrangement.

3.7.2 Traffic Impact Assessment

To accomplish the above, carry out a Traffic Impact Assessment (TIA) at an early stage to avoid delay.

Individual activities such as the hoisting of mechanical plant or construction of hoarding would also require a TIA to conform to the requirements of the Transport Department and the police. A noise permit from the EPD would also be required if the activity is being carried out beyond permitted working hours.

3.7.3 Site Access

Please refer to the Code.

3.8 Special Safety Considerations

In preparing precautionary safety measures, do not overlook the issue of the safety of debris disposal. There is generally a lot of left-over rubbish and loose furniture, fixtures and decoration, wooden partitions, overhead air conditioning ducts with insulation, ceiling boarding, piping and electrical cables, etc. These have to be removed and disposed of in such manner as to allow asbestos abatement and erection of props to be carried out accordingly. For multistorey buildings, such as ones with more than 12 storeys, it is often the case that at the same time that a building is being handed over to a contractor, the developer cuts off all services such as electricity, water and lift for account management reasons. By doing this, management is creating a hazard for contractor, who has to face the risk of fire outbreak before it can reinstate the function of these services in order to maintain the safety of the building. For electricity supply, a temporary generator may be installed but its operation beyond permitted hours would require a noise permit from EPD. Application for water supply can take as long as three months, which would make the site incapable of spraying down dust generated and fighting fire using the existing fire-fighting system for an unnecessarily long period of time. The ability to use the lifts would assist and enable the efficient disposal of unwanted materials and debris from the site, thus avoiding the accumulation of inflammable materials in the building, and facilitate the delivery of materials to the site.

3.8.1 Training and Communication

The site conditions of a demolition project change as work progresses. As good practice, carrying out a daily, pre-work risk assessment (PWRA) of each trade in the morning briefing or tool box before work starts, so that each worker is aware of his/her daily duties and scope of work, is recommended.

Apart from (A) to (H) as described in the Code, items should also include the following as far as practicable:
- Prop or steel scaffolding erection and dismantling
- Bamboo scaffolding work
- Tower crane, crane lorry and mobile crane operation, if applicable
- Demolition method and procedure

Method statement for and risk assessment of each type of work should also be prepared beforehand with briefing to site personnel and workers.
Providing daily safety briefing/meeting to demolition workers to enhance their safety awareness both before the start of and during the works, in addition to regular site safety inspections and meetings, is recommended.

3.8.2 Equipment Maintenance
Please refer to the Code.

3.8.3 Electrical Safety
Please refer to the Code.

3.8.4 Fire
The Fire Services Department (FSD)'s guidelines on the provision of firefighting systems on a construction site shall be followed.

Make a plan with method statement and risk assessment, particularly for the removal of combustible materials such as timber fixtures and partitions, pipe duct with insulation and any leftover inflammable materials including chemicals. Also address fire hazards created by hot works and smoking.

3.8.5 Occupational Heath

Please refer to the Code.

3.8.6 Emergency Exit Requirements in Demolition Sites

Providing daily safety briefing/meeting to demolition workers before the start of work to maintain their safety concept and vigilance is recommended. Workers should be briefed of any changes to the emergency exit route caused by the demolition progress.

Incorporate emergency-lighting system and fire extinguishers into the exit route.

3.8.7 Vibration

Vibration limits specified in the relevant regulations would not generally be exceeded in demolition work. However, in sensitive areas such as MTR protection zones, old buildings and designated antiquities sites, it is good practice to measure vibration for monitoring and record purposes.

For demolition work using mechanical plants, the movement, impact or crushing of the machine would generate minor vibrations to the structure. As mentioned above, records of vibratory monitoring during the course of demolition are helpful, particularly for the demolition of a building abutting another building with continuity of the structural system or building abutting another older building with party walls.

3.9 Environmental Precautions

3.9.1 Air Pollution

Air pollution on a demolition site are caused in a number of ways: dust and fumes (due to acetylene-flame cutting or welding) generated during the process of removal of fixtures, piping and air conditioning ducts at the safety precautionary measures stage; dust and fumes generated during demolition by breakers or crushers; discharge of concrete debris through refuse chutes; and transportation of debris onto lorry trucks. The most practical way of dust control is a well-planned strategy of using water sprays, including jets and propulsion boosted by electrical appliances.

The control of fumes generated by mechanical machines such as air compressors, generators, lorry trucks and mechanical plants would only be possible through the regular and effective maintenance and replacement of the equipment being used on site. Fumes generated from flame-cutting and welding require appropriately-arranged exhausts with blowers to divert and discharge the fumes, as well as close attendance and monitoring.

3.9.2 Noise

Please refer to the Code.

3.9.3 Water

Please refer to the Code.

3.9.4 Hazardous Materials

Please refer also to clause 2.3.

3.10 Debris and Waste Handling

3.10.1 Chutes

In general, designer should pay attention to the structural members adjacent to the chute, especially cantilevered slabs.

Plastic chutes are generally used for small scale of demolition activity, such as alteration and addition work or single unit of building, with small quantity of debris generated for disposal.

(A) Lift Shaft

When using lift shaft for hoisting materials and disposing of waste materials, a site management system should be implemented to avoid the risk of accident of people falling at height and injury due to falling objects at height. Keep close communication between supervisory personnel at the top and bottom of the refuse chute direct and simple.

All door openings must be properly and securely blocked to prevent against the possible escape of debris generated by the discharge of the concrete debris dropped from above. Thin lift shaft walls should be checked for their structural adequacy to resist impact forces and their integrity after being repeatedly impacted by small to large pieces of broken concrete debris during the period of demolition. The discharge outlets must be regularly cleared to avoid excessive accumulation of debris in the shaft, which may cause blockage.

The condition of the door openings should be checked and monitored frequently against damage.

(B) Light Well

Light well are generally enclosed with external walls, with window openings at typical floors and door openings at ground level. Where used as debris chute, the same considerations for a lift shaft should be adopted.

For light well not being fully enclosed, the exposed side should be properly designed to suit the site conditions and structural requirements.

(C) Opening on Floor

A suitable position should be chosen without affecting the structural integrity. Openings are generally formed with a size of 900mm x 900mm or larger with structural justification by the removal of floor slabs bounded by beams and/or structural walls.

The openings at each floor must be enclosed with robust material such as steel to resist the impact, rebounding and frictional forces generated from the falling concrete debris. When designing the enclosure system, take into consideration of the speed of the falling debris based on the height of the building.

Consideration on safety issue similar to the use of a lift shaft should be adopted.

(D) Exterior Chutes

Exterior chutes should be properly designed and used with close monitoring and inspection for damage against risk of bursting out of debris during disposal. The location of the chute should be chosen such that there would be no risk of falling objects from height endangering the personnel on site and the public.

3.10.2 Debris Recycling

Please refer to the Code and the requirements for recycling for individual projects. The concept of HKBeam Plus is becoming common and has been adopted by some developers in private sector construction.

In this respect, the stakeholder should budget extra funding for the project, unless the resale value of the materials is sufficient to offset the extra time and resources required to sort them out.

3.10.3 Dust Minimization

Please refer to the Code and the latest legislation of EPD.

3.10.4 Debris Accumulation

Give consideration to the floor immediately below the roof for the extra debris load from roof tiles, thermal insulation and screed laid to fall. The engineer should correctly assess the possible height of debris loading when checking the existing structure and working out the arrangement of props. Please refer also to notes for clause 3.5.1(A) above. Due to the transient nature of debris loading and movement of mechanical plants, increasing the structural capacity of the existing structure by 25% could be considered, subject to the engineer's inspection and the structural condition of the building to be demolished.

Debris accumulation on the floors should be justified by engineering calculations. As mentioned earlier, a void ratio of 30% may be allowed for the density of concrete debris. This should be incorporated in the propping design.

In preparing the Demolition Plan, the engineer should estimate the anticipated weight and thus the average height of debris that may be generated on the floor below after the demolition of a partial or entire floor. If mechanical plants are used for demolition, the weight of the mechanical plants sitting on the debris should also be included such that the debris can be removed practically by the mechanical plants after the demolition of the floor. In this situation, there would be an allowance for the momentary increase of debris height if there is no machine sitting on top of the debris.

In practice, any assumption of height of debris of less than 300mm would be impractical. It is, however, advisable to post a written reminder to remove debris exceeding the design height as soon as possible and when safe to do so.

Knowing the location of the refuse chute and choice of mechanical plant would facilitate the haulage of debris and reduce debris accumulation.

Debris must not accumulate against the hoarding or external wall.

3.10.5 Debris Disposal and Management System

Please refer to the Code.

3.10.6 Debris Loading

(A) A structural transfer system may have to be incorporated for supporting the props from the floors above, particularly at the ground floor level where extra space and headroom are to be provided for the ingress and egress of lorry trucks for the delivery of materials, disposal of concrete debris, etc.

3.10.7 Waste Management

Please refer also to PNAP ADV-19.

Since the implementation of the Construction Waste Disposal Charging Scheme from January 2006, transaction records of construction waste disposed of at Government Wastes Disposal Facilities can be obtained on the Internet for a period of 14 days. It is advisable for the project administrator to check the transaction records frequently to prevent any illegal dumping.

3.11 Inspection and Maintenance

(A) Frequency

Please refer to the Code.

(B) Unsafe condition

It is very important to check whether the structural arrangement on site matches that shown in the Demolition Plan. On some occasions, the Demolition Plan was prepared by engineers before they had access to the existing building. The appraisal report of the structure was based on existing drawings before confirmation by inspection. Sometimes the existing structure may have been covered up by decoration and finishes, which prevent a thorough inspection of changes, either legal or illegal, to be made, or, earlier occupants may not have made records of the building during its life time.

(C) Scaffolding

Please refer to the Code.

3.12 Post-Demolition Precautions

Please refer to the Code.

4. METHODS OF DEMOLITION

4.1 General

The typical methods of demolition used in Hong Kong are introduced below:

Method of demolition in Hong Kong

	type of nuisance	noise	dust	vibration	potential complication in statutory submission	rough cost index*	remarks
A	**Use of hydraulic mechanical breakers:** Hydraulic breakers would generate a low frequency of impact noise with a noise level of about 105 to 120 dB next to the machine. This method is the cheapest way of demolition but annoying to the public.	high	high	high	no	100	common practice

This method of demolition is the most common one in Hong Kong. Depending on the type and usage of the building to be demolished, hydraulic mechanical breakers of various sizes, from 3 to 23 tons (with a full tank), are being used. The breakers generate a high, powerful energy output and produce a high noise level. For residential buildings and depending on their structural condition, using a machine of more than 15.5 tons (with a full tank) is not recommended. When adopting the upper limit, use breakers with extreme care and close supervision. For industrial and office buildings with a higher live loading capacity, heavier machines may be used with close supervision. However, regardless of the type of building, using any machine with a weight of more than 23 tons (with a full tank) for demolition works is not recommended unless the machine is sitting on solid ground.

Note:- *
An index of 100 is used as the basic relative cost of using a hydraulic breaker for demolition. The cost of other methods of demolition are compared against the hydraulic breaker based on this index.

Method of demolition in Hong Kong

	type of nuisance	noise	dust	vibration	potential complication in statutory submission	rough cost index	remarks
B	**Use of hydraulic mechanical crushers:** This machine is becoming common in Hong Kong and generally specified for ASD and Housing Authority projects. The crusher generates a low frequency noise with a noise level of about 85 to 100 dB next to the machine. This method is more expensive compared to A above.	low	high	moderate	no	115	becoming common practice

Public sector projects generally specify crushers for demolition works. Depending on the type and usage of the building to be demolished, hydraulic mechanical crushers of various sizes, from 7 to 23 tons (with a full tank), are being used. Demolition works carried out by the use of crushers generate a lower noise level, and thus less disturbance to adjacent neighbors. For demolition, a machine equipped with crusher with a total weight of less than 7 tons would not be able to generate the required horse power to drive the crusher efficiently.

A crusher is normally equipped with a mini-cutter, which provides a secondary function of cutting reinforcement during the process of demolition. This helps to reduce, to a certain extent, the use of acetylene and oxygen flame-cutting. Mechanical hydraulic machines equipped with crushers for demolition works are now widely used in other countries.

A hydraulic machine, when equipped with a cutter, can be used for the demolition of steel structures. Unlike concrete, steel structures have a higher degree of flexibility and ductility. With a good understanding of its structural design and behaviour, a steel structure can be demolished smoothly and efficiently within a shorter period as compared with the traditional method of acetylene-oxygen flame-cutting and hoisting.

Method of demolition in Hong Kong

	type of nuisance	noise	dust	vibration	potential complication in statutory submission	rough cost index	remarks
C	**Use of pneumatic hand-held jack hammers:** This equipment is applicable to old residential buildings in poor condition or buildings with restricted room for the maneuvering of a hydraulic mechanic breaker / crusher. Hand-held breakers have a high frequency of noise impact and are generally very disturbing to surrounding neighbors. The noise level generated next to the machine is about 100 to 120 dB. This manual method of demolition is expensive.	high	high	moderate	no	200	common practice

This method of demolition is quite common in Hong Kong. It is generally used for the demolition of old and partially deteriorated residential buildings. Compared to methods A and B, the use of jack hammers will be much more expensive because of the additional manpower resources required to carry out the works. It would also take a longer time for the demolition works because of the limited power of jack hammers to break up concrete. This means a longer period of noise, dust and vibration disturbance to the neighbourhood.

Unless there is no other more viable choice, the use of jack hammers for demolition should be avoided. The manual demolition of a perimeter wall by jack hammer is a high-risk activity because of the required increase in manpower and because there is no machine to assist.

Despite the above shortcomings, design engineers often propose this manual method of demolition with full props for all floors to BD and other authorities in order to obtain easy, first-time approval.

Method of demolition in Hong Kong

	type of nuisance	noise	dust	vibration	potential complication in statutory submission	rough cost index	remarks
D	**Use of saw cutting machine, mini breaker and crusher** Concrete is cut by either chain wiring or circular disc system into small pieces and lifted away for disposal. This method generates less noise at the demolition site. However when the disc is cutting through steel reinforcement, it may generate a high frequency noise. This method is the most expensive compared to A, B and C above.	moderate	low	low	yes	300	common practice in small-scale works

This method of demolition is widely used in indoor alterations and addition works (A & A) to reduce nuisance. Technology nowadays has made saw cutting quite a powerful means of demolition. However, for outdoor demolition, saw cutting is much more expensive compared to the other methods of demolition. It also has the disadvantage of requiring and discharging large amounts of waste water, which needs to be monitored and collected to avoid flooding, leaking, or causing other damage to facilities. In addition to saw cutting, the market also has other small tools with various ways of splitting or breaking up concrete elements, which work in conjunction with saw cutting. There are also mini-breakers or crushers weighing 0.5 to 1.0 ton available in the market, some with remote control, for small, indoor, concrete-breaking jobs. This type of machine can be used on its own or in conjunction with saw cutting and other hand tools for indoor demolition.

Saw cutting is also used in the demolition of bridge works, where the cut-and-lift method is applied.

Method of demolition in Hong Kong

	type of nuisance	noise	dust	vibration	potential complication in statutory submission	rough cost index	remarks
E	**Use of hydraulic mechanical high reach demolition rig (HRDR) equipped with crusher, nibbler or cutter** An HRDR is designed to sit and operate on the ground. It requires room outside the to-be-demolished building for maneuvering. One advantage of an HRDR is that its operation requires minimum human resources during demolition. It is ideal for demolition of structures and buildings which are isolated or with three sides exposed.	moderate	high	low	yes	150	limited application Less cautionary work & shorter period of demolition Needs high degree of planning & supervision

This method of demolition is quite common in Hong Kong. It is generally used for the demolition of old and partially deteriorated residential buildings. Compared to methods A and B, the use of jack hammers will be much more expensive because of the additional manpower resources required to carry out the works. It would also take a longer time for the demolition works because of the limited power of jack hammers to break up concrete. This means a longer period of noise, dust and vibration disturbance to the neighbourhood.

Unless there is no other more viable choice, the use of jack hammers for demolition should be avoided. The manual demolition of a perimeter wall by jack hammer is a high-risk activity because of the required increase in manpower and because there is no machine to assist.

Despite the above shortcomings, design engineers often propose this manual method of demolition with full props for all floors to BD and other authorities in order to obtain easy, first-time approval.

4.2 Top Down - Manual Method

4.2.1 General

Checking the condition of the rope or wire each time before use is recommended.

As the top down manual method involves workers working at heights with heavy tools, paying particular attention and vigilance at all times to maintain all safety protection measures. Where required, the provision of temporary supports and working platforms should take into account the structural conditions of buildings, particularly those showing signs of deterioration. If using this method, props supporting the structure should not be removed until the structure is completely demolished.

Referring to Section 17.2.1 of BS6187 – Code of Practice for Demolition, risk assessments will usually demonstrate that using remote demolition techniques (e.g., machines) would be more appropriate. However, from a practical point of view, this ideal approach may not be suitable for all day-to-day demolition activities. This suggests that at the time of planning a demolition project, the engineer should plan to use minimum human resources for carrying out the work to reduce the risk of human injury.

Instead of manual method, small-scale plants, such as a bobcat with a weight of 1.5 to 2.0 tonnes, is an alternative for clearing debris. The engineer should check the propping arrangements to ensure that they are adequate to support the maneuvering of small-scale plants.

From the points of view of safety, environment, cost and time, adopt the manual method for demolition work is not recommended unless it is unavoidable due to site restraints and the building layout. The use of mechanical crushers in demolition is becoming more common and popular based on safety and environmental considerations.

4.2.2 Demolition Sequence

(A) This implies that for the demolition of a typical floor, all cantilever structures, canopies, verandahs and features shall first be demolished prior to demolition of main building and its internal structures on that floor. If the demolition activity of a typical floor would affect any cantilever structure, etc. of the floor below, then the cantilever structure, etc. of the floor below shall also be demolished first. Only in very specific cases, in order to avoid misunderstanding, would it be required that all cantilever structures, etc. of the whole building be demolished prior to the commencement of demolition work. If such a case arises, the engineer must specify in the drawings that the particular cantilever structures, etc. shall be demolished prior to the demolition of the other members of the building.

(E) This refers to internal non-load-bearing walls and load-bearing walls. For external wall construction, the non-load-bearing walls are often constructed in reinforced concrete and cast integral with the external columns and load-bearing walls. Wherever conditions permit, it would be more appropriate that they are demolished together with an acceptable width.

(F) This refers to internal columns and load-bearing walls. For external wall construction, the non-load-bearing walls are often constructed in reinforced concrete and cast integral with the external columns and load-bearing walls. In such a case, it may be more appropriate for the external beam to be demolished together with the columns and non-load-bearing walls in one piece with an acceptable width.

In small buildings, after demolition by hand-held machines down to the second-floor level, if planned with a proper sequence of demolition and debris removal cycle, the building, with just the second and first floors remaining, may be demolished with a machine mounted with a crusher sitting on the ground level. In this case, only a work out portion of the second floor and floor slab need be demolished by the manual method to create room for operation of the machine.

4.2.3 Cantilevered Structures and Balconies

Pay attention to the inspection frequency requirements stipulated in Table 9.1 of Code of Practice for Site Supervision 2005; cantilevered structures over or abutting a street are generally regarded as complex structures requiring more stringent supervision during demolition. EH-Figures 4.1 and 4.2 show alternative suggestions for the demolition of cantilevered structures and balconies.

4.2.4 Exterior Walls, Beams and Columns

Exterior walls, beams and columns are generally demolished by the cut-and-pull down method. The cutting of vertical slots through walls should be minimized to reduce the risk of spilling and consequently, the falling of excessive debris down through the edge of the building. However, the engineer should also judge the width of the wall panel or frame to be demolished to ensure operational safety.

(A) Brick In-fill Wall

Fatal accidents have occurred during the removal of building fixtures and partition walls. Record drawings of layout and details are often not available or inaccurate. During removal of a brick wall, the verticality of the brick wall and signs of local disintegration should be checked constantly and precautionary measures taken to avoid sudden collapse. Provide full-time supervision by a technically competent person.

(B) Exterior Beam

Figures 4.3 and 4.4 of the Code show that tie wires are used to secure the beam before demolition. This is for demolishing a beam with the **manual** method. In practice, the reinforcement of the beam may serve the same purpose to keep the beam under control when lowering. But anchorage of the reinforcement at the supports should be verified first. EH-Figures 4.3 and 4.4 show the alternative suggestions for the demolition of cantilevered structures and balconies.

(C) Exterior Column

EH-Figure 4.5 shows an alternative suggestion for the demolition of cantilevered structures and balconies.

(D) Exterior Reinforced Concrete Frame

(1) For manual demolition, depending on the height of the column and the span of the external beam, the frame may be demolished as a single bay of two columns with the linking external beam. In this case, the demolition of the frames must be supervised and carried out by experienced, competent personnel.

(E) Reinforced Concrete Wall

(1) Load Bearing Wall

Load bearing reinforced concrete wall is generally of thickness greater than 125mm. For wall height of less than 3.5m, the width of the wall panel may be increased to 3m at the discretion of the engineer.

EH-Figure 4.6 shows an alternative suggestion for the demolition of load-bearing reinforced concrete wall.

(2) Non-Load Bearing Wall

Felling of non-load bearing reinforced concrete wall separately from integral heavy cross beams over the wall, by manual method of demolition, is quite uncommon and impractical. The engineer should avoid the use of manual method for demolition if heavy reinforced beams exist in a building structure.

For external non-load bearing brick wall constructed under heavy cross beams, it may be necessary to demolish the brick wall first to avoid the danger of collapse of the brick wall during the demolition of the heavy cross beams. The engineer should assess this possibility in the design with consideration of the panel width, height and thickness of the brick wall.

4.2.5 Floor Slabs

(C) Flat Slab

It is important that the sequence of demolition of flat slab is clearly stated in the method statement of demolition. Exterior panels with cantilever must be treated with care to ensure that the concept of "cantilever portion to be demolished first" is not being wrongly applied to the column strip along the perimeter of the building.

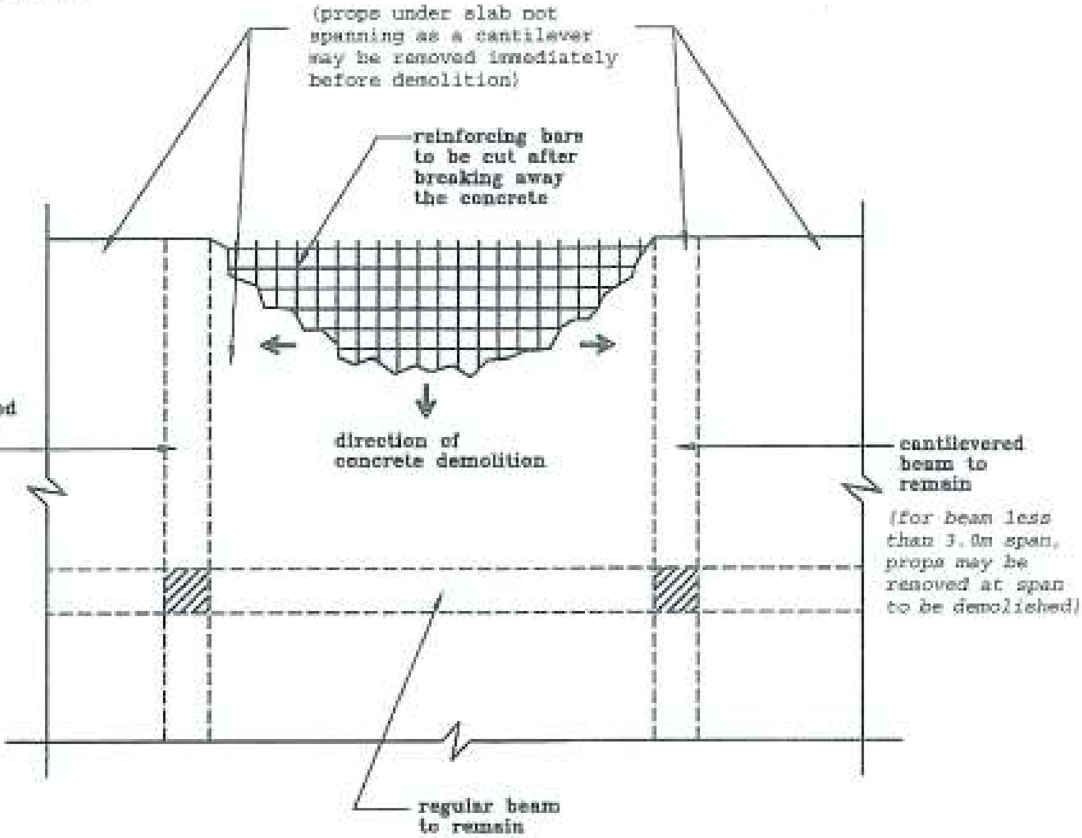
4.2.6 Interior Beams

EH-Figures 4.9 and 4.10 show some suggested alternative details for demolition of internal beams by manual method.

4.2.7 Interior Columns

Please refer to the Code.

Depending on the floor to floor height, temporary platform may be required under the beam / slab to be demolished such that the impact created by the falling of the concrete debris during demolition would not jeopardise the stability and integrity of the structure below. If no platform is provided, the structural floor / floors propped below should be checked to resist the effect of the impact load when the floor to floor height became substantial, say exceeding 3.0m. Alternatively, means of shock absorbent material such as sand, or polystyrene may be placed on the floor below for protection and minimizing the effect of impact.



PLAN

Note: 1. Prior to demolition of the floor slab, perimeter wall above floor level must be demolished, and all the debris on the floor shall be cleared away.

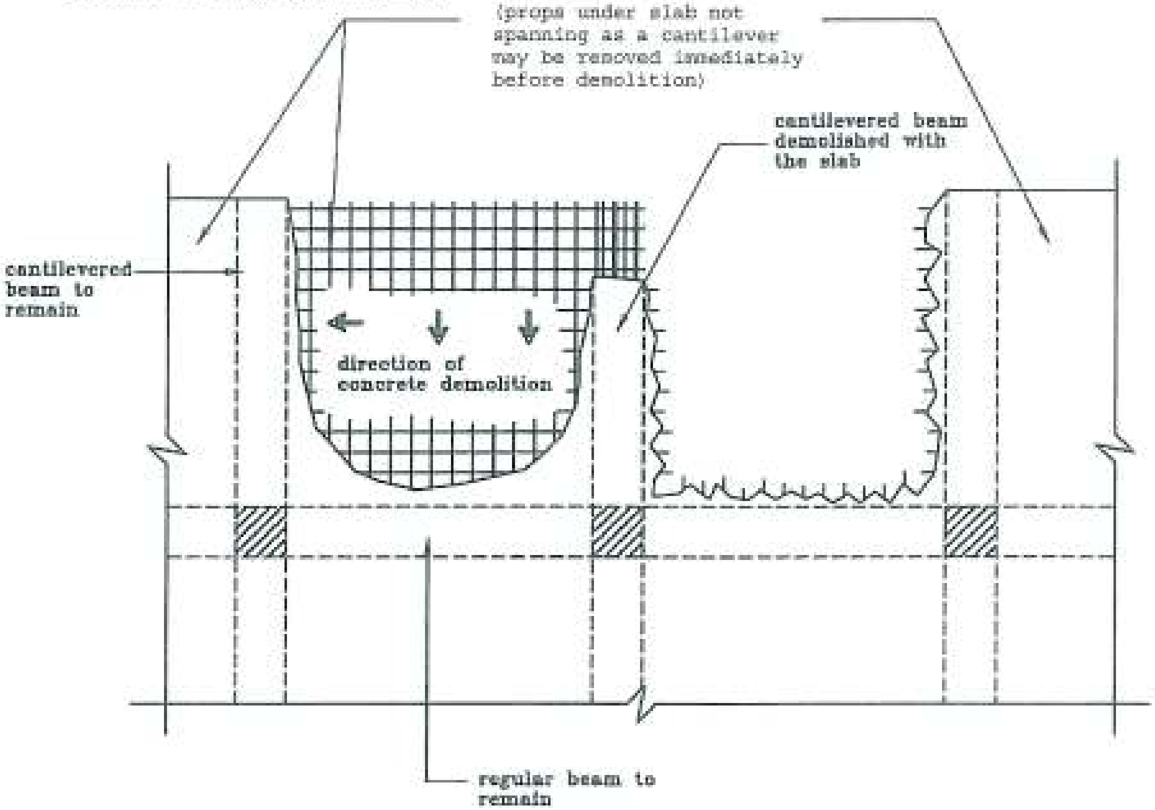
2. Depending on the floor to floor height of the cantilever structure (repeating floor to floor), the platform immediately under may be omitted. The design of the propping system should however include the effect due to the impact of the falling debris.

3. Depending on the span of the beam, in general less than 3.0m, after demolishing the slab panels adjacent to the beams, the beams may be demolished with the props under being removed.

EH-FIGURE 4.1 DEMOLITION OF CANTILEVERED REINFORCED CONCRETE SLAB (MANUAL METHOD)

By hand held jack hammer or pneumatic hammer.

Depending on the floor to floor height, temporary platform may be required under the beam / slab to be demolished such that the impact created by the falling of the concrete debris during demolition would not jeopardise the stability and integrity of the structure below. If no platform is provided, the structural floor / floors propped below should be checked to resist the effect of the impact load when the floor to floor height became substantial, say exceeding 3.0m.



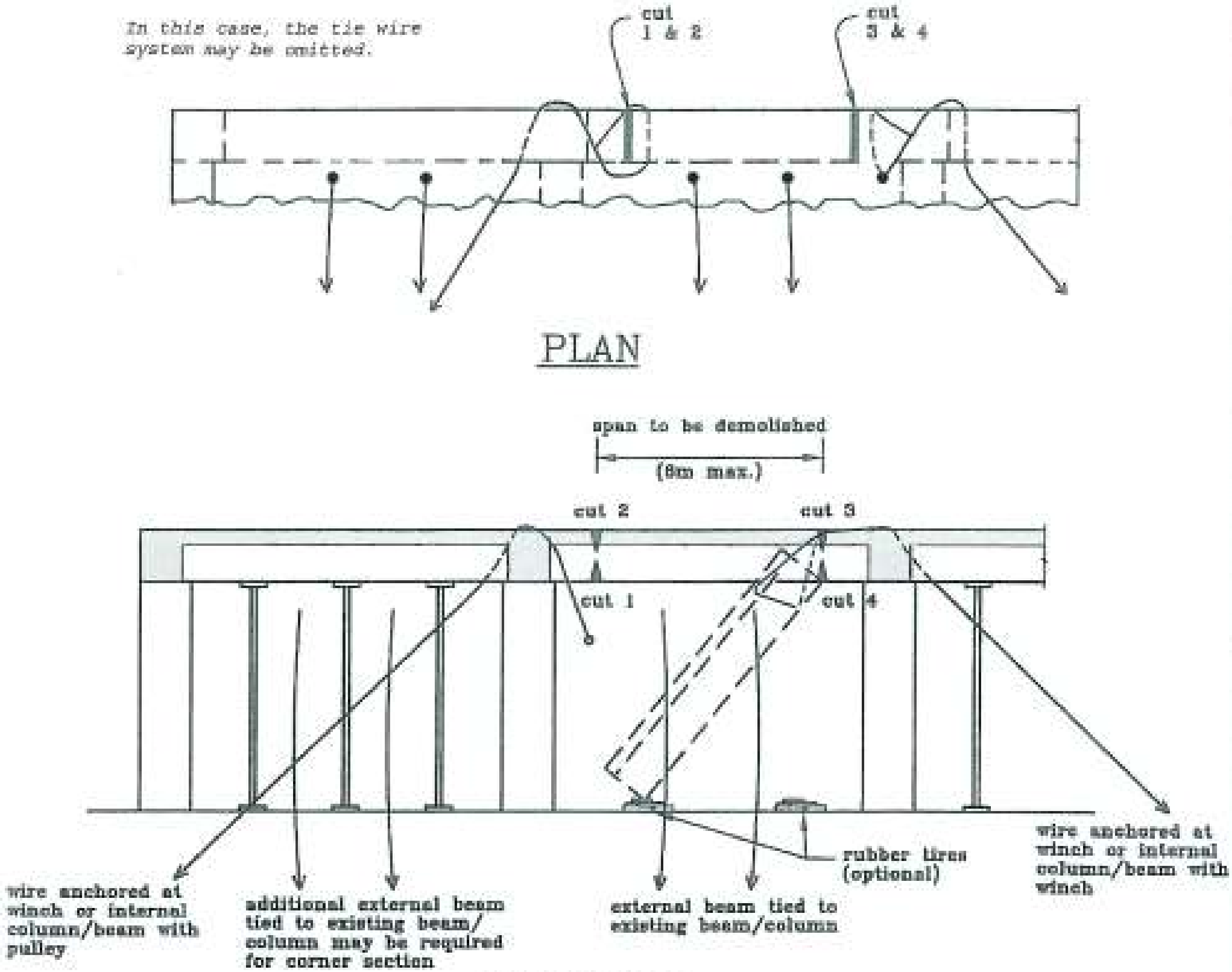
PLAN

Note: 1. Prior to demolition of the floor slab, perimeter wall above floor level must be demolished, and all the debris on the floor shall be cleared away.
2. Depending on the floor to floor height of the cantilever structure (repeating floor to floor), the platform immediately under may be omitted. The design of the propping system should however include the effect due to the impact of the falling debris.
3. Depending on the span of the beam, in general less than 3.0m, after demolishing the slab panels adjacent to the beams, the beams may be demolished with the props under being removed.

EH-FIGURE 4.2 DEMOLITION OF CANTILEVERED REINFORCED CONCRETE SLAB AND BEAM (MANUAL METHOD)

By hand held jack hammer or pneumatic hammer.

Note: External beam may also be demolished by hand-held breaker bit by bit into pieces and allow the debris to fall free to the floor below.

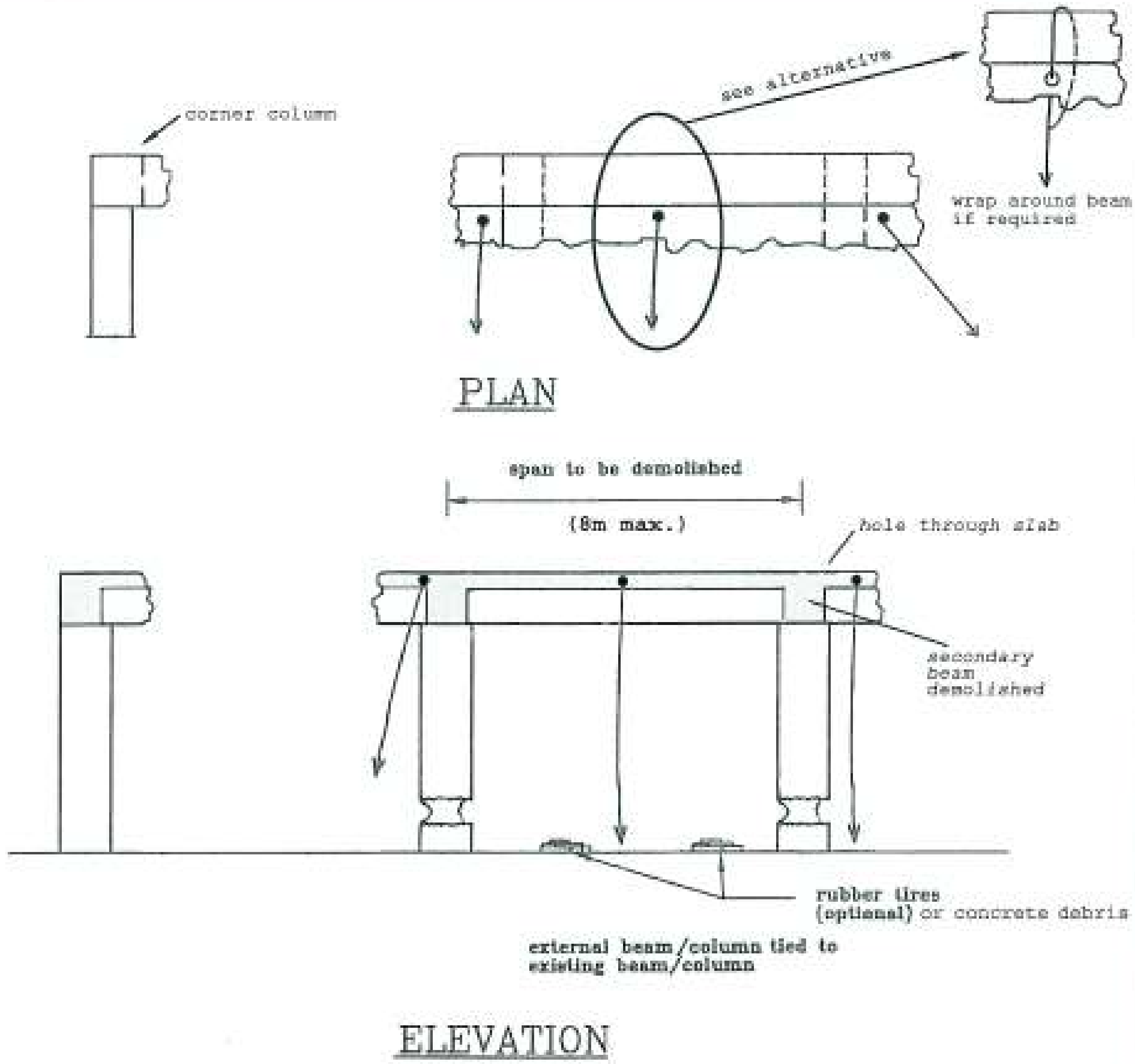


1. *Check if beam can span between supports with only loading due to its self weight when there is no infill wall under. Provide props to all spans if the beam cannot support its self weight with consideration of structural integrity when the adjacent span of beam has been demolished.*
2. Tie the span of beam to be demolished. (details of the connection may refer to figure 4.4)
3. Remove props at span to be demolished.
4. Expose all reinforcement.
5. Cut reinforcement at cut 1, cut 2, and cut 3.
6. Lower the end at cut 1 & cut 2.
7. Cut reinforcement at cut 4.
8. Lower the beam.

Note : The tie wire is indicative. If there are permanent anchors or lifting machines available tie wire arrangements may be simplified to suit.

EH-Figure 4.3-1 DEMOLITION OF EXTERNAL BEAM WITHOUT INFILL PERIMETER CONCRETE WALL / BRICK WALL (MANUAL METHOD)

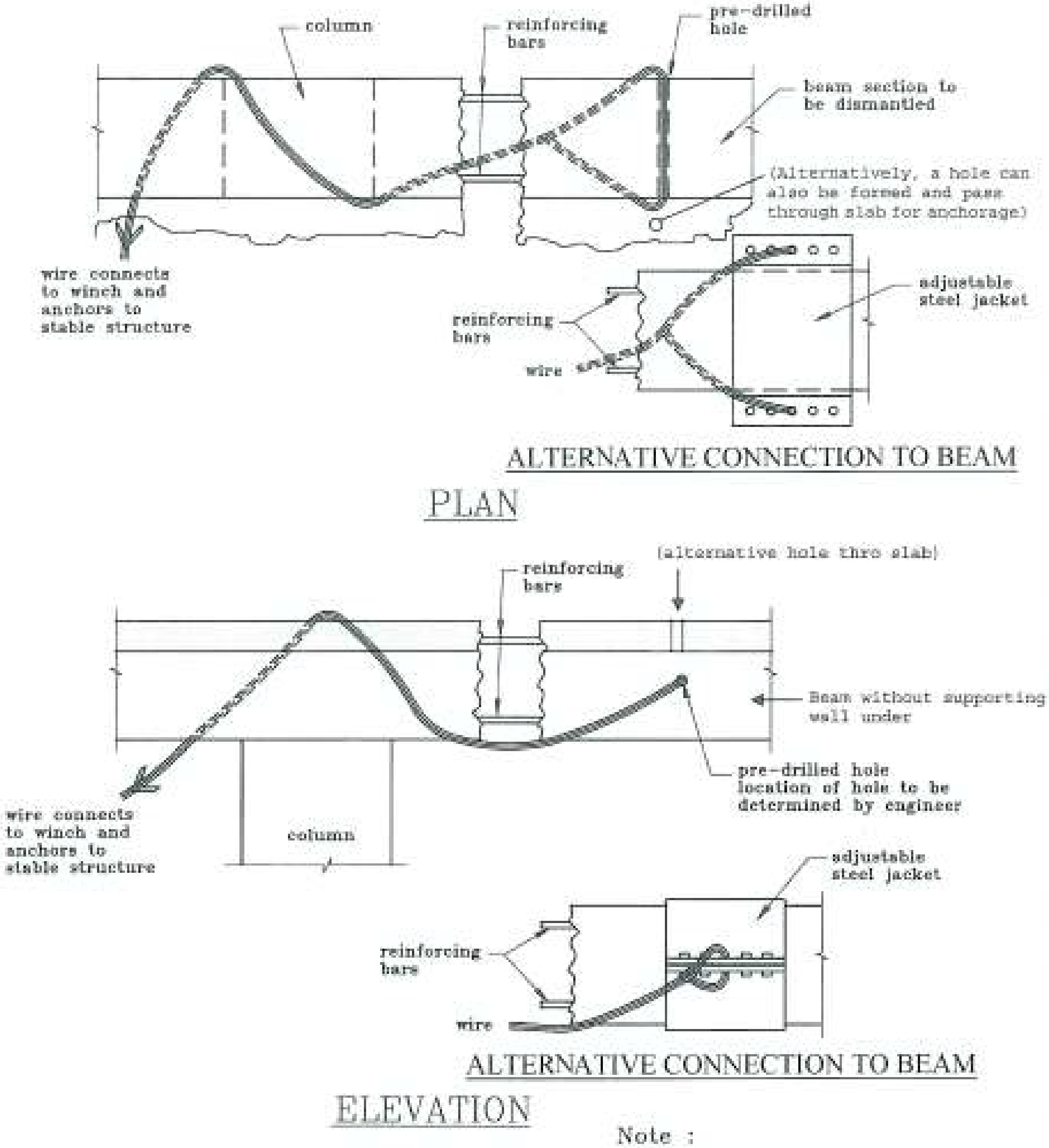
By hand held jack hammer or pneumatic hammer.



In some cases, the external beam may be demolished together with two adjacent columns. Refer to figure 4.5 for column demolition.

EH-FIGURE 4.3-2 DEMOLITION OF EXTERNAL BEAM WITHOUT INFILL PERIMETER CONCRETE WALL / BRICK WALL (MANUAL METHOD)

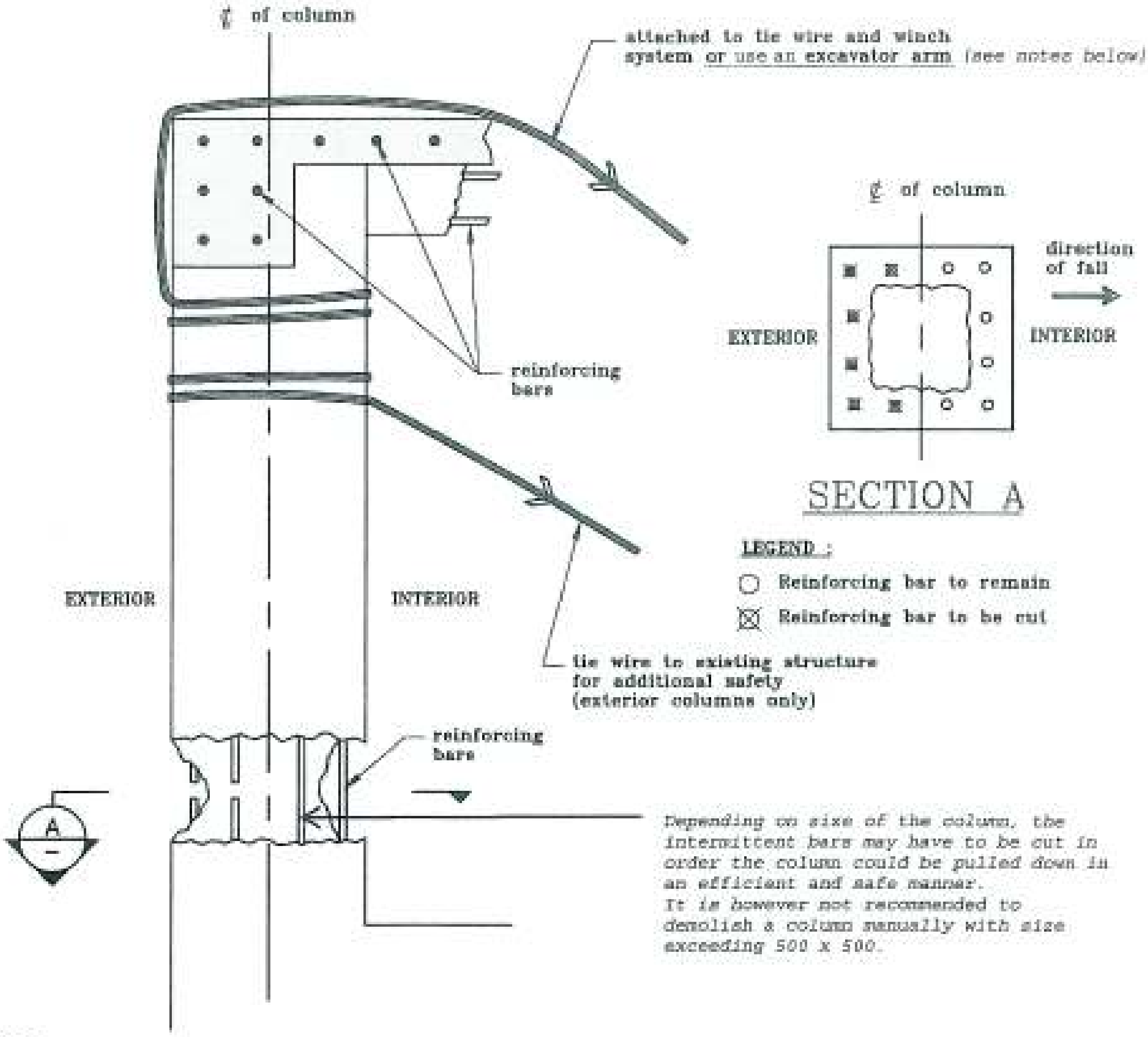
By hand held jack hammer or pneumatic hammer.



Note :
The tie wire arrangement is for illustration purpose. It may be simplified to suit depending on the availability of structural anchor.

EH-FIGURE 4.4 DETAILS FOR SECURING EXTERNAL BEAMS BEFORE DISMANTLING (MANUAL METHOD)

By hand held jack hammer or pneumatic hammer.



NOTES :

1. Secure the column by wire & winch to existing structure or excavator arm.

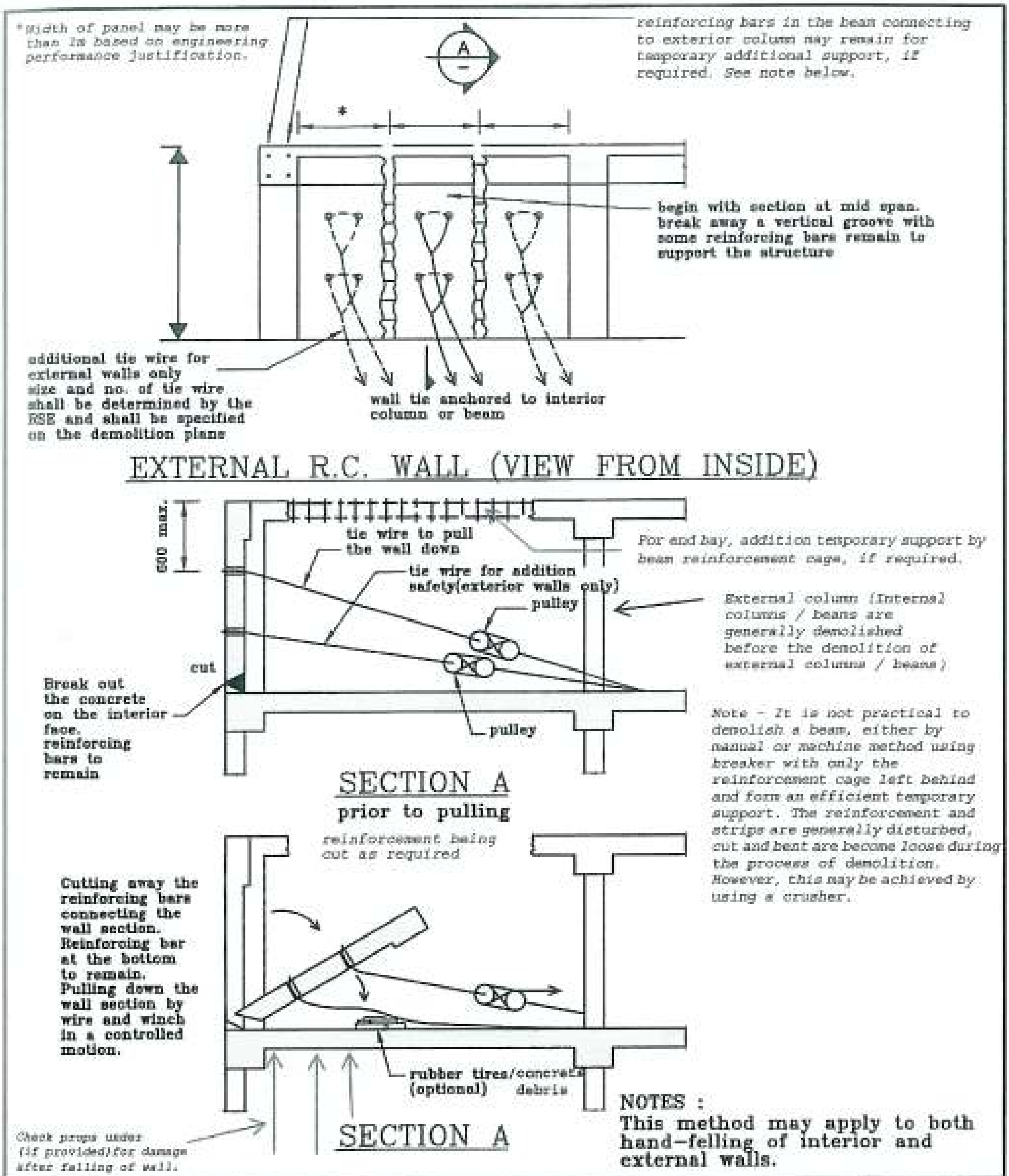
1A. *With the presence of an excavator the column may be pulled down directly by the excavators arm without the tie wire.*

2. Pre-weakening at the bottom of column
   i) Break away the concrete to expose the reinforcing bars.
   ii) cut the reinforcing bars at the exterior half of the column. Cutting shall be performed immediately prior to pulling.

3. Pulling down the column in a controlled motion.

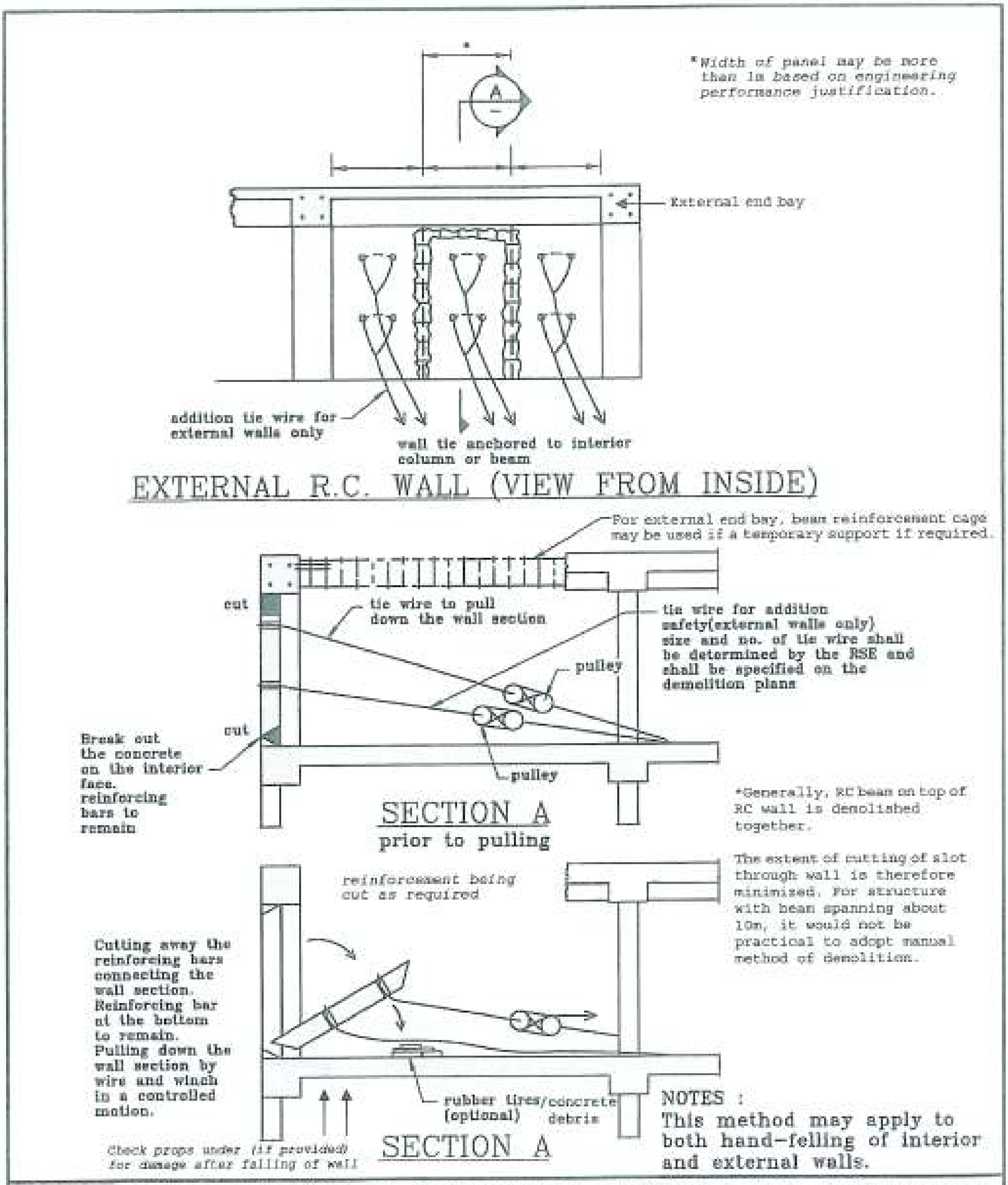
EH-FIGURE 4.5 PRE-WEAKENING AND DISMANTLING OF COLUMN (MANUAL METHOD)

By hand held jack hammer or pneumatic hammer.



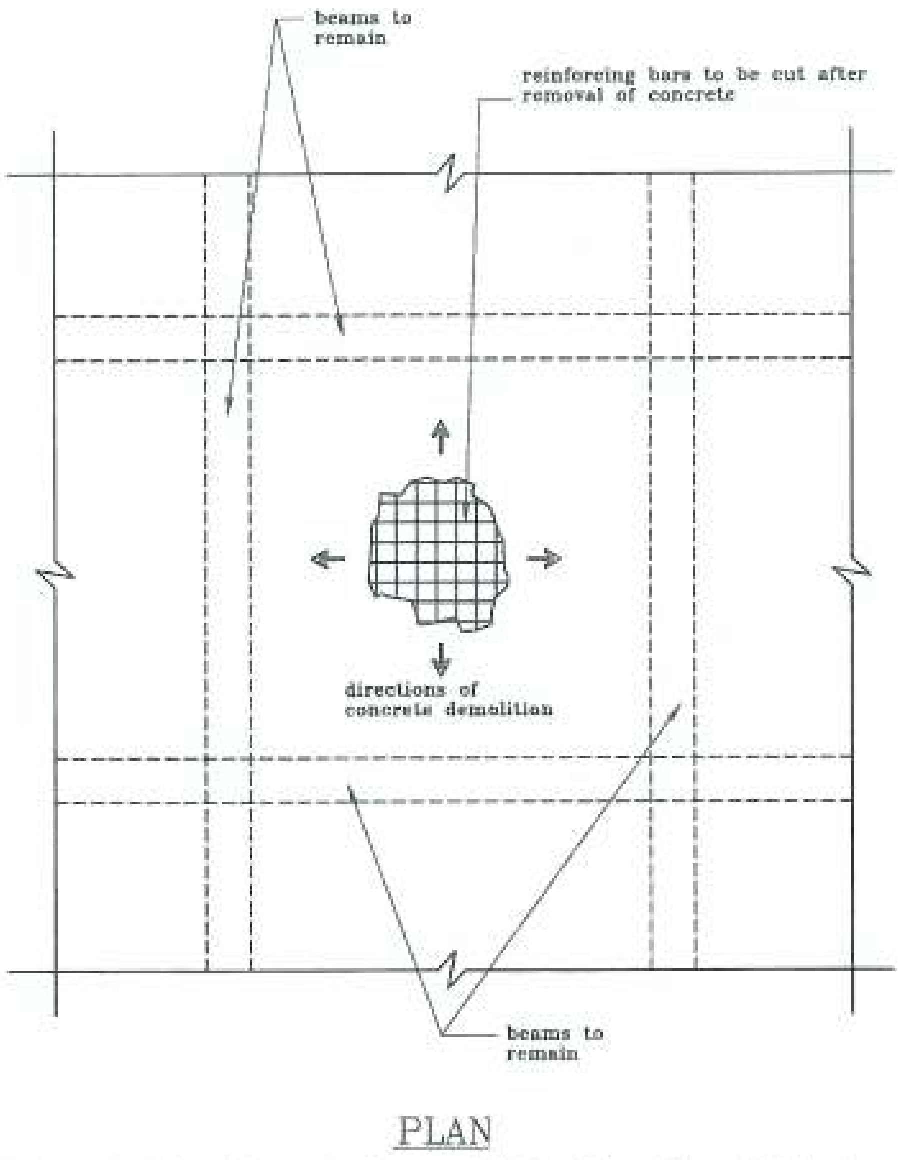
EH-FIGURE 4.6 FELLING OF A REINFORCED CONCRETE WALL (MANUAL METHOD)

By hand held jack hammer or pneumatic hammer.



EH-FIGURE 4.7 FELLING OF REINFORCED CONCRETE WALL SEPARATELY FROM THE CROSS BEAM (MANUAL METHOD)

By hand held jack hammer or pneumatic hammer.

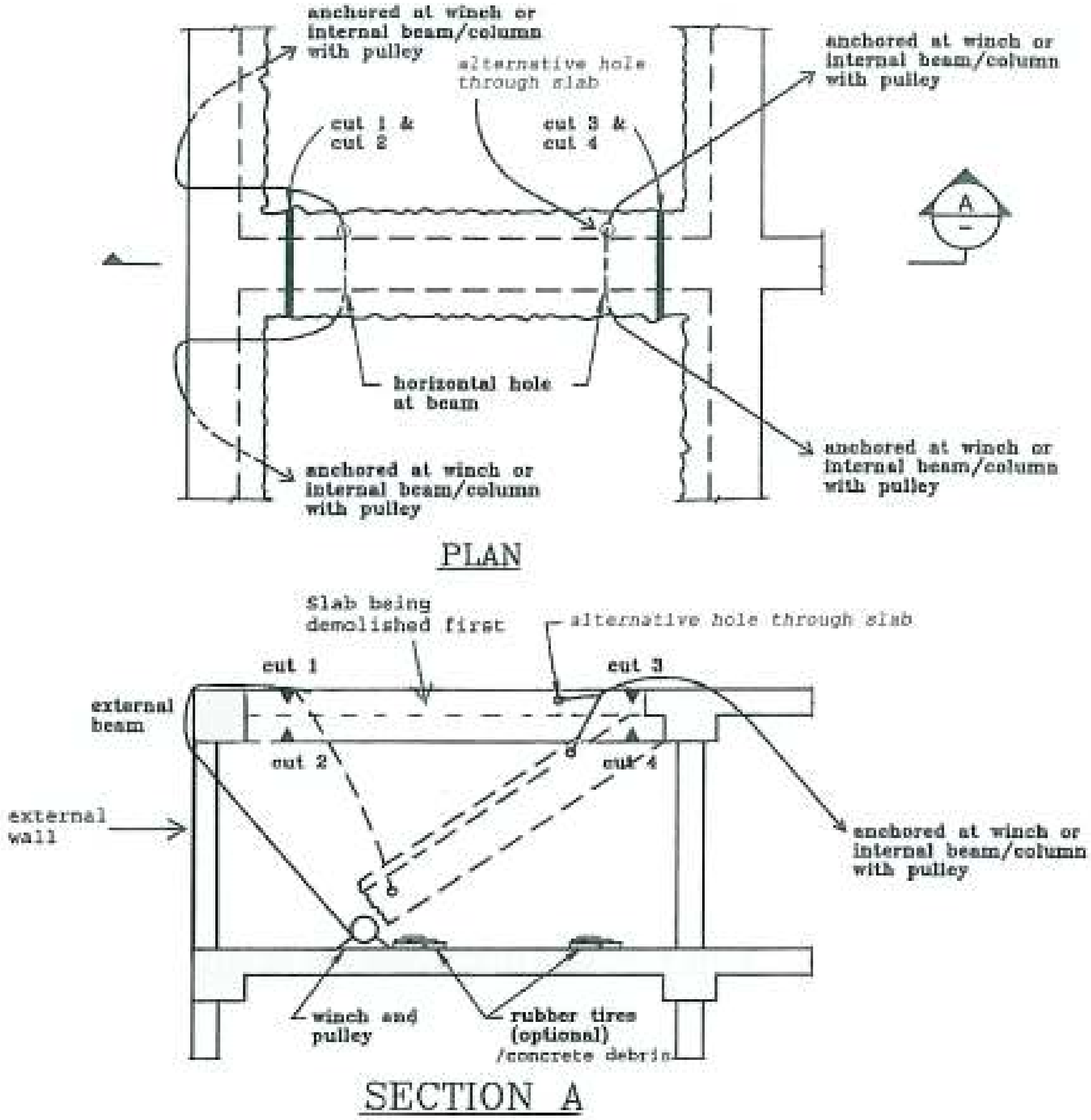


For the demolition of reinforced concrete frames with RC columns / beam / slabs by manual method, in general it is not necessary to prop the floor to be demolished. The floor is subjected to its self weight and finishes, plus operating live load during the demolition. However, the floor below, which will be supporting the concrete debris generated, should be checked for its capacity and propped to support the debris load, as required.

EH-FIGURE 4.8 DEMOLITION OF TWO WAY SLAB (MANUAL METHOD)

By hand held jack hammer or pneumatic hammer.

Note: Beam may also be demolished by hand-held breaker bit by bit into pieces and fall free to the floor below.

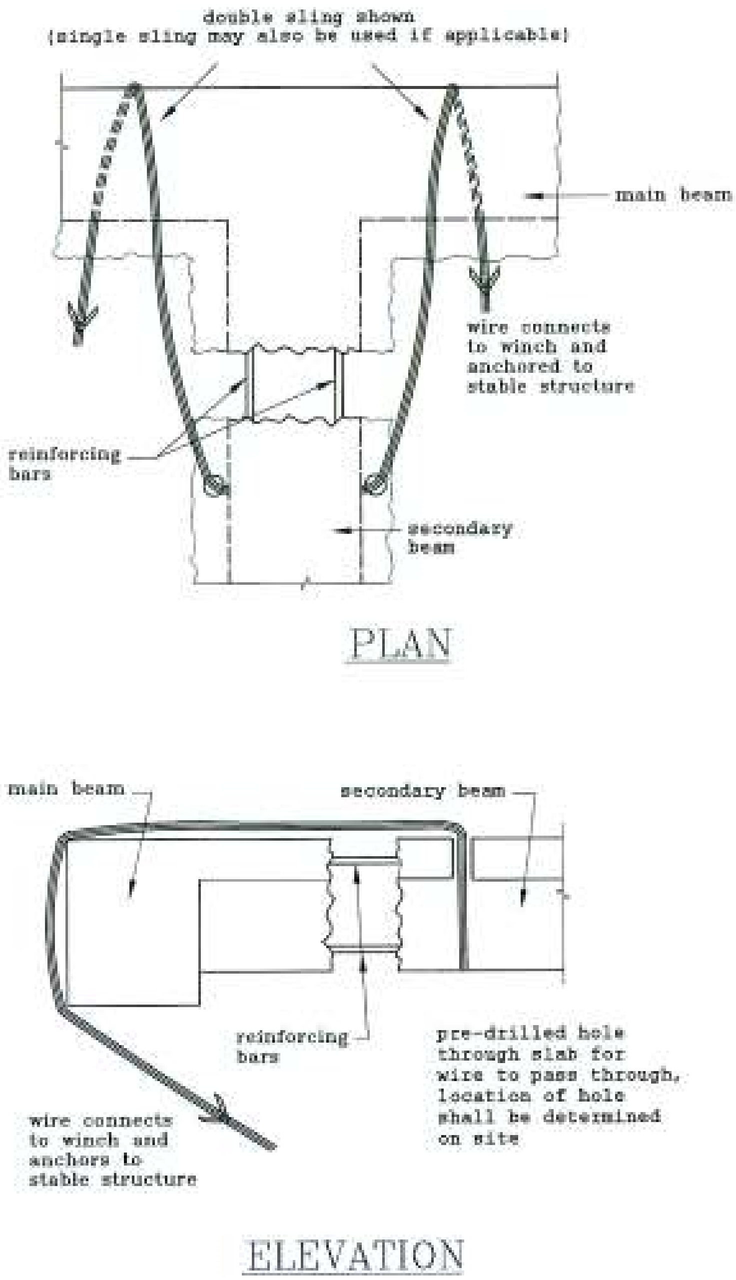


1. Ensure no load on the beam.
2. Tie the beam to be demolished.
   (refer to figure 4.10 for details of connection)
3. Expose reinforcement at both ends of the beam.
4. Cut reinforcement at positions cut 1, cut 2, and cut 3.
5. Lower the beam at external end.
6. Cut reinforcement at cut 4 and lower the beam completely.

Note : The tie wires are indicative. If there are permanent anchors or lifting machines available, tie wire arrangements may be simplified to suit.

EH-FIGURE 4.9 DEMOLITION OF SECONDARY BEAM (MANUAL METHOD)

By hand held jack hammer or pneumatic hammer.



Note :
The wire arrangement is for illustration purpose. It may be simplified to suit depending on the availability of structural anchor.

EH-FIGURE 4.10 DETAILS FOR SECURING SECONDARY BEAMS BEFORE DISMANTLING (MANUAL METHOD)

By hand held jack hammer or pneumatic hammer.

4.3 Top Down – Mechanical Method

4.3.1 General

The details shown in the Code refer generally to the method of demolition by hydraulic breakers and crushers. Some of the details shown are applicable to the use of a hydraulic breaker but not necessarily to the use of a hydraulic crusher.

The use of a hydraulic crusher for demolition work has become more popular for environmental reasons. Depending on the type and condition of hydraulic plant and the crusher attachment being used, the background noise level produced by a hydraulic crusher for demolition can be controlled within a range of 85 to 95 db. This noise level would be reduced even more at a distance.

The use of a hydraulic crusher for the demolition of beam, slab, column and wall is different in concept from the use of a hydraulic breaker. A hydraulic crusher is more versatile compared to a hydraulic breaker. The former can efficiently demolish a beam or slab panel from the same floor level or from a floor level below. When demolishing a typical floor, a hydraulic crusher would start demolishing the slab and beam panel at the same floor level with props under the machine. As soon as space allows for it, the machine can descend to the lower floor and start clearing a part of the debris generated through the refuse chute. At the same time, workers can start removing the props for each bay, making the beam/slab panels ready for demolition by the hydraulic crusher from the floor below. This kind of work flow improves safety during demolition because it avoids the situation whereby workers are approaching a floor immediately above which a machine is operating.

In general, with this work flow, the hydraulic crusher can start demolishing a beam at mid-span and work inward or outward and remove the slab panel immediately. The hydraulic crusher would then repeat the action of biting and crushing the remaining parts of the beam and slab accordingly, with the beam and slab reinforcement cut in stages by the cutting action of the crusher.

The concrete of the slab and beam could be crushed completely and allowed to fall freely to the floor below. The lowering of a beam by cutting slots at each end of the beam is therefore not required.

(A) Supports for Machines

The 2m edge distance is an arbitrary practical design figure. It is suggested for extreme cases due to site constraints; the engineer may specify a marginally smaller dimension if additional safety precautionary measures are taken.

(B) Lifting of Machinery

Where tower cranes are engaged for demolition work, refer to the Code of Practice for Safe Use of Tower Cranes (hereafter referred as CoP), issued by the Commissioner for Labour under section 7A of the Factories and Industrial Undertakings Ordinance (Cap. 59). CoP provides practical guidance to the industry as to how tower cranes may be used safely and properly with a view to assist duty holders in preventing accidents. This CoP has special legal status. Failure to observe any guidance contained in the CoP may be taken by a court, in criminal proceedings, as a relevant factor in determining whether or not a person has breached any of the provisions of the regulations to which the guidance relates.

4.3.2 Demolition Sequence

(D) An excavator equipped with a crusher would perform more efficiently under this condition.

EH-Figures 4.11-1, 2 and 3 show suggested alternative details to Figure 4.11.

4.3.3 Cantilevered Canopies and Balconies

Propping is designed to transfer loading from plants and debris during the demolition process. If site conditions permit, EH-Figures 4.12 - 1, 2 and 3 show some suggested alternative details for demolition of cantilevered suspended floor slabs by mobile machines.

Hoisting facilities are generally limited on a demolition site. An excavator equipped with hoisting hooks should be operated by a licensed operator who is authorized to carry out both demolition and hoisting work. The hoisting hook of an excavator should be tested and certified by a qualified registered professional engineer prior to use. As an alternative, a tower crane, if available, may be used for lifting.

In case there is no platform provided, one must consider the impact load caused by free-falling debris generated from the floor slab / beam being demolished to either the top of the temporary platform or the floor below.

Debris must not accumulate against the hoarding or external wall.

4.3.4 Exterior Walls, Beams and Columns

(A) Brick in-fill Wall

Fatal accidents have occurred during the demolition of brick-in-fill walls by the manual method.

These fatal accidents were mainly caused by the unexpected, free falling of the brick-in-fill wall during demolition. Considering both the public's and workers' safety during preparation of the method statement is recommended.

For working overhead, a temporary steel platform should be provided for demolition of the wall from top to bottom. Demolishing the foot of a brick-in-fill wall and letting it fall freely should be strictly prohibited.

Suggested details by excavator are shown in EH-Figure 4.14-4.

(B) Exterior Column

With the use of a mechanical plant, exterior columns are generally demolished in the form of a frame with the columns being linked together by beam or wall. Depending on the number of machines employed, the height of the columns and the span of the linking beam, the frames may be demolished in a group of either one bay, or, two and three bays.

A single exterior column, particularly a column of flat slab construction, must be demolished with care. The use of a chain-and-block system to tie the column during pull-down to ensure stability is recommended.

(C) Exterior Reinforced Concrete Frame

Suggested alternative details by excavator are shown in EH-Figure 4.13.

For mechanical demolition, the frame may be demolished in either one bay, or, two and three bays between adjacent columns, depending on the available number of mechanical plants for carrying out the support and pull-down operation during demolition. The felling of the frames must be supervised and carried out by experienced, competent personnel and operators.

(D) Exterior Concrete Wall

With the presence of columns, exterior concrete walls are generally demolished together with the columns. The columns would provide a rigid frame for demolition.

Suggested alternative details by excavator are shown in EH-Figure 4.13.

4.3.5 Floor Slabs

For internal one-way slab, the outer beam may be demolished first, followed immediately by the slab. This is generally the case when the slab is being demolished by a crusher, either sitting on the same level as the slab or one floor below. In such a case, a temporary situation would exist where the slab is momentarily spanning and supported on three sides with only self-weight loading.

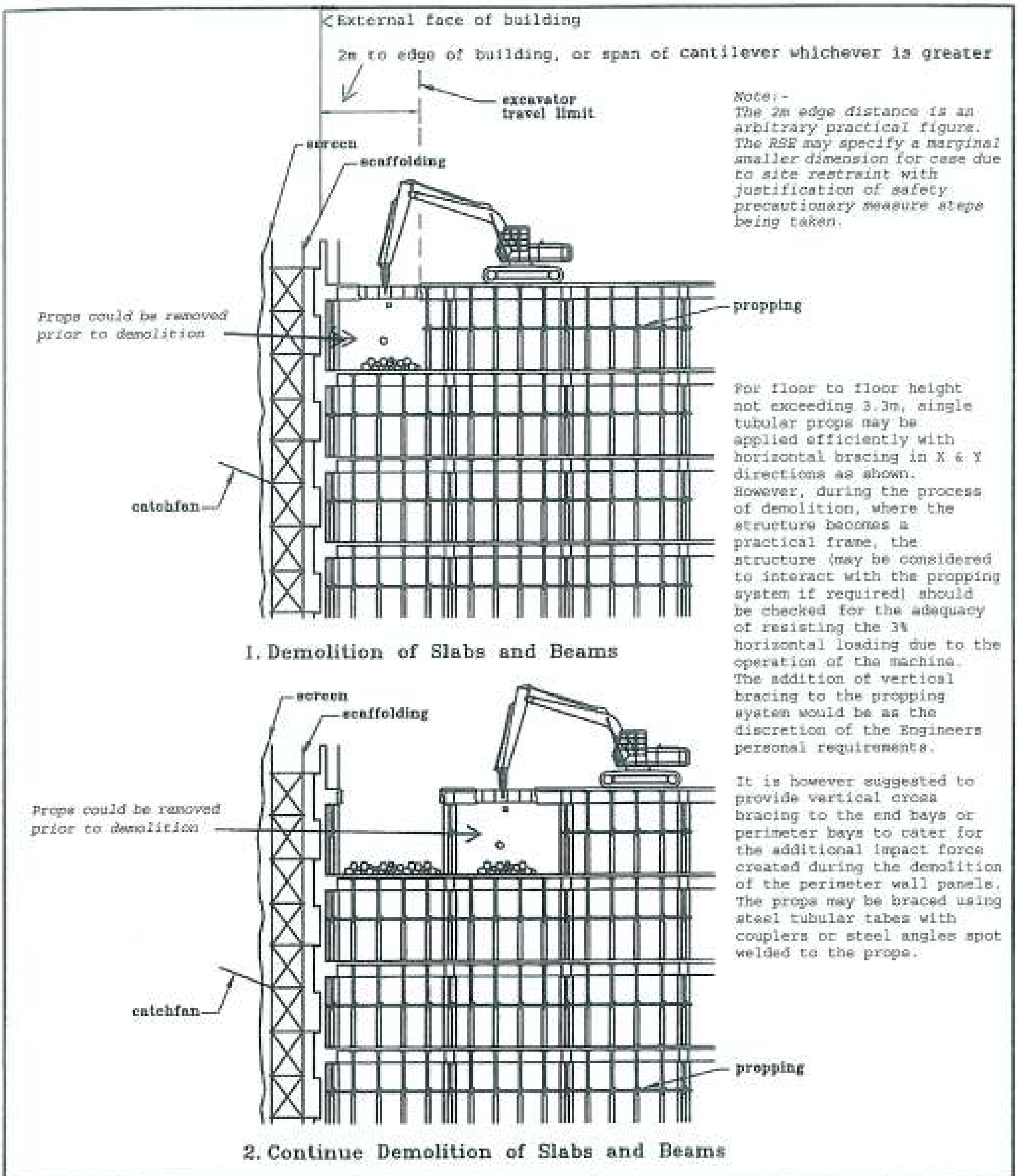
A similar situation may occur for two-way slabs and flat slabs. The engineer should, however, consider every individual case separately after taking into account temporary local yielding conditions and ensure that all debris on the floor is cleared prior to commencement of demolition work.

4.3.6 Interior Beams

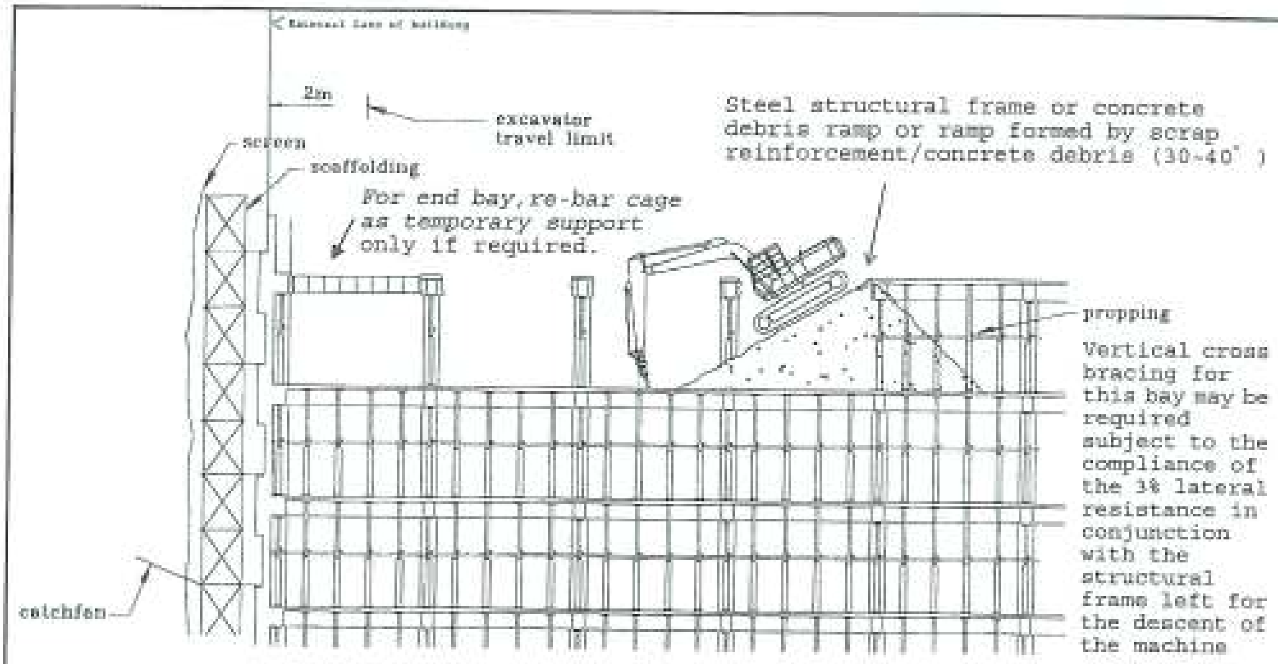
For large-span beams, the supported slab panels adjacent to the beams should be demolished first. The demolition of the beam would generally start from the mid span. The engineer should check if all the props under the beam should be left in place during the demolition. Sometimes it may be necessary to keep the props either under the mid span or the 1/4-end span of the beam during demolition. In this case, the engineer must also check if the beam element itself is stable and able to support its own weight under a temporary, partially-supported condition during demolition. For demolition by crusher, the reinforcement cage left at the mid span during the demolition may provide extra rigidity for the demolition of the remaining beam portions.

4.3.7 Interior Columns

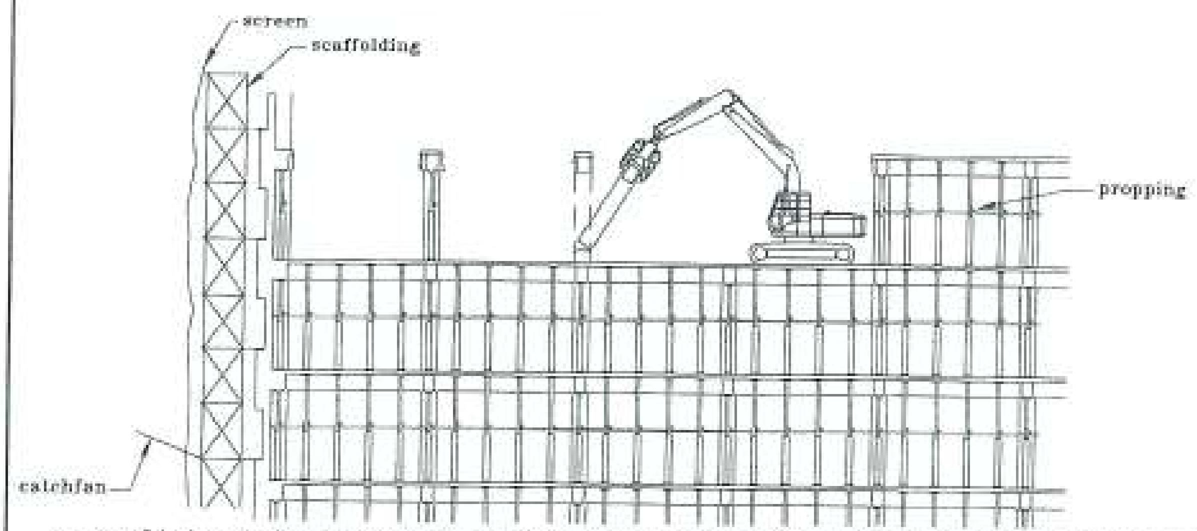
Please refer to the Code.



EH-Figure 4.11-1 TYPICAL SEQUENCE OF TOP DOWN METHOD WITH MECHANICAL EQUIPMENT (SHEET 1 of 3)



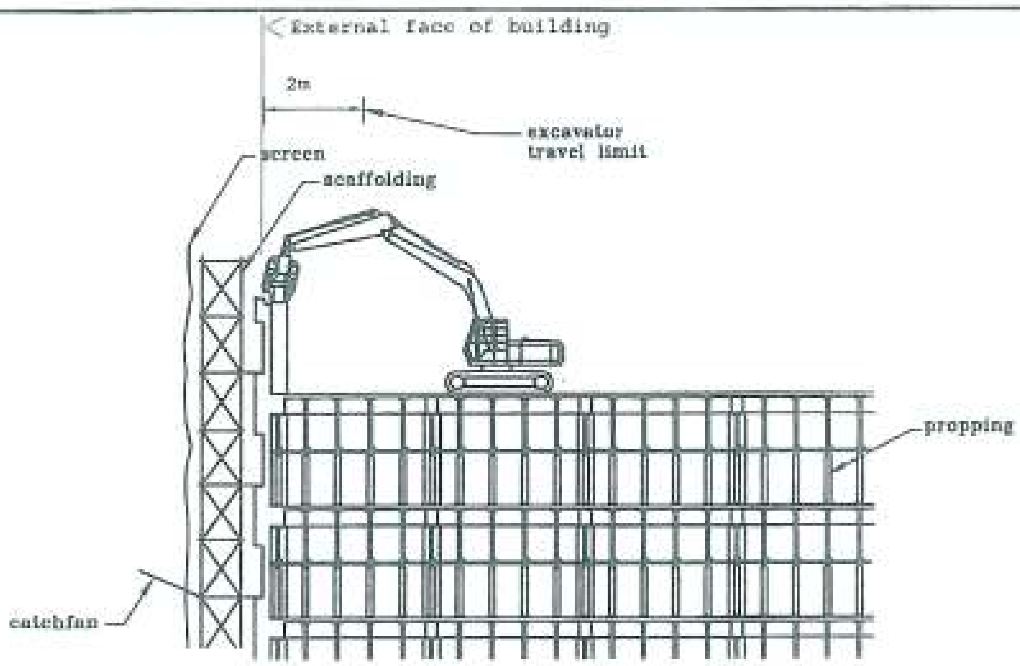
3. An access ramp of steel structural frame or formed by concrete debris /scrap steel metal to allow machine to climb down to the next floor below.



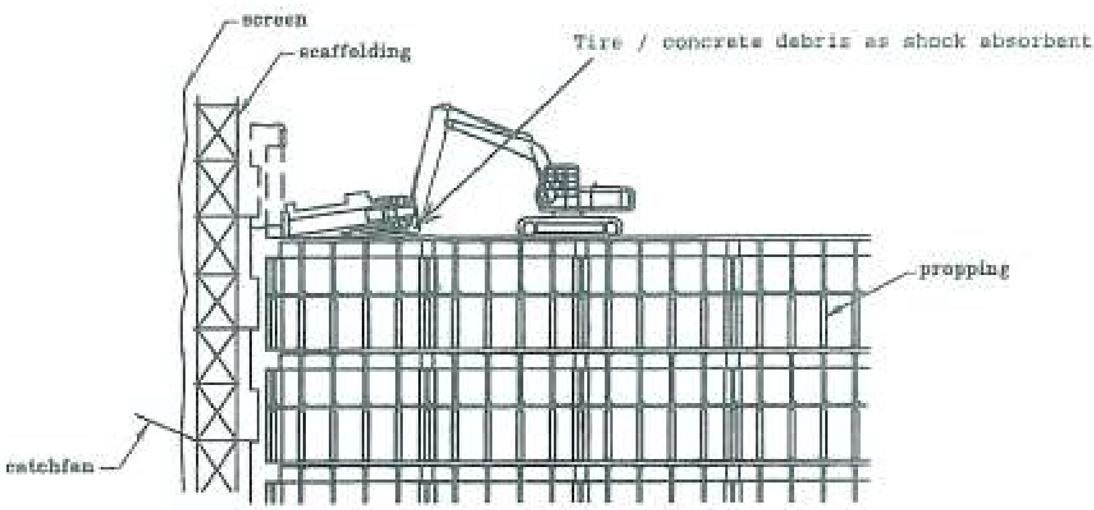
4. Demolition of interior columns are generally carried out first in order to create access and working room for exterior wall demolition. Demolish internal columns by first pre-weakening the bottom, then dismantled by machine in fully controlled motion.

The machine may be in the form of a breaker excavator or crusher and descend to the floor below via the access ramp, or other means of lifting facility such as a tower crane or mobile crane. Priority arrangement should be made to clear away the debris accumulated on the floor to avoid overloading. Afterwards, the machine can also start demolishing the floor above from the floor below.

EH-Figure 4.11-2 TYPICAL SEQUENCE OF TOP DOWN METHOD WITH MECHANICAL EQUIPMENT (SHEET 2 of 3)



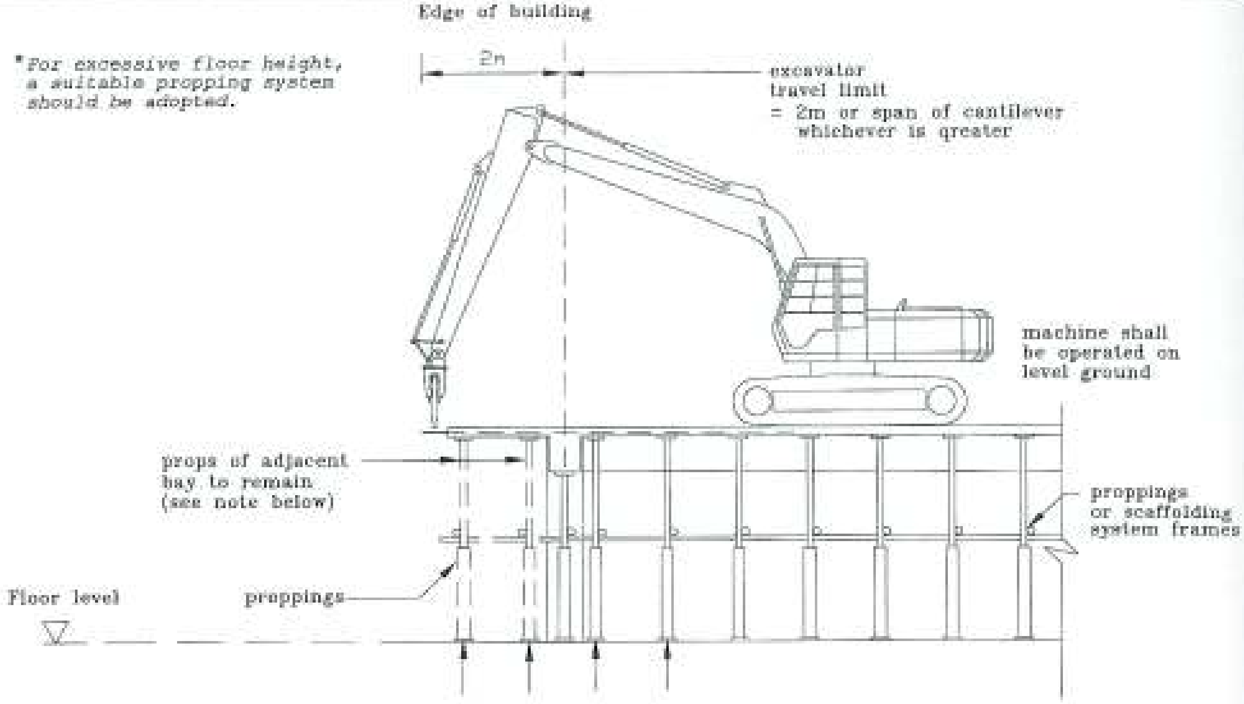
5. Cutting the exterior wall in sections and pre-weakening of columns. (see EM-Figure 4.14-2 & -3) Cutting should be careful to minimise debris falling outside.



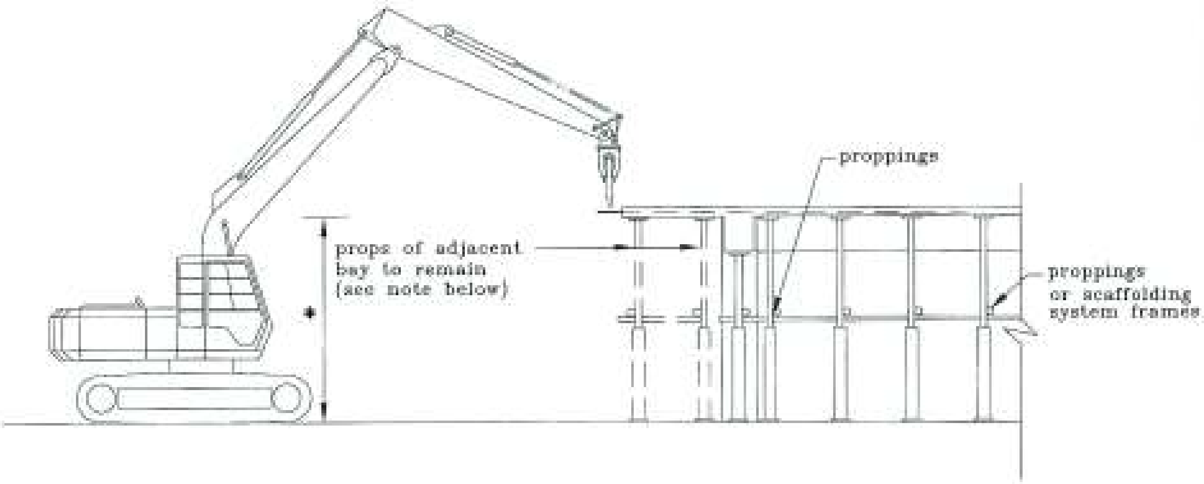
6. Machine should be used to brace the wall section while cutting the reinforcing bars connecting the wall section. The wall section shall be pulled down in a controlled motion.

(Provide extra cross bracing to the row of props against impact force generated during the wall being pulled down. Check if props are damaged afterwards.)

EH-Figure 4.11-3 TYPICAL SEQUENCE OF TOP DOWN METHOD WITH MECHANICAL EQUIPMENT (SHEET 3 of 3)



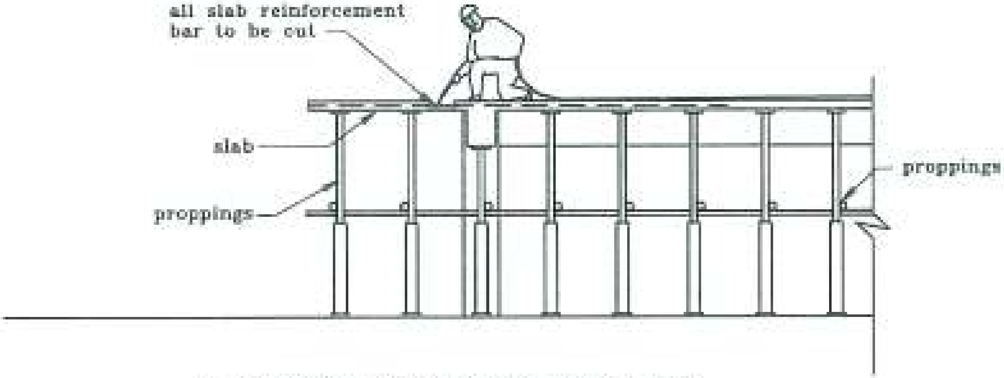
CASE 1A. MACHINE MOUNTED ON SUSPENDED FLOOR



CASE 2A. MACHINE MOUNTED ON GROUND

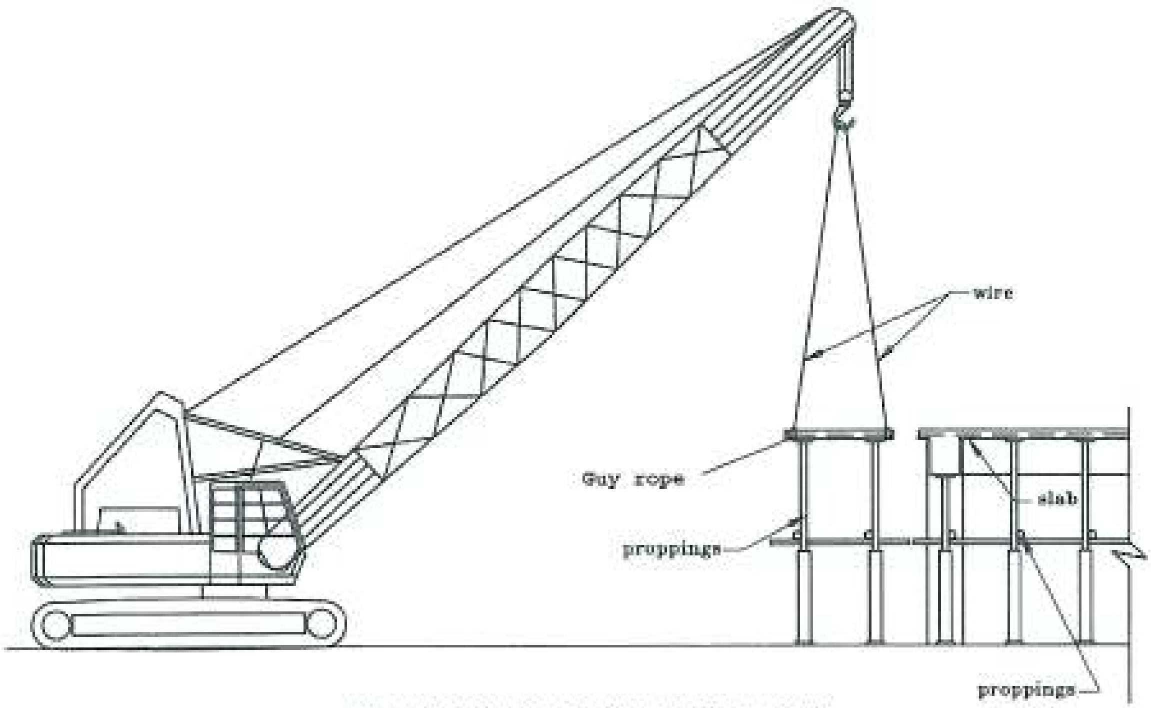
Note: Proppings or scaffolding system frame under bay to be demolished may only be removed after all debris above has been cleared away. For slab spanning between cantilever beams, prop under slab may be removed, with props under cantilever beam to remain. Props of internal bay may be removed after completion of cantilever demolition.

EH-Figure 4.12-1 DEMOLITION OF CANTILEVERED SLAB BY MOBILE MACHINE (CONVENTIONAL METHOD)(SHEET 1 OF 2)



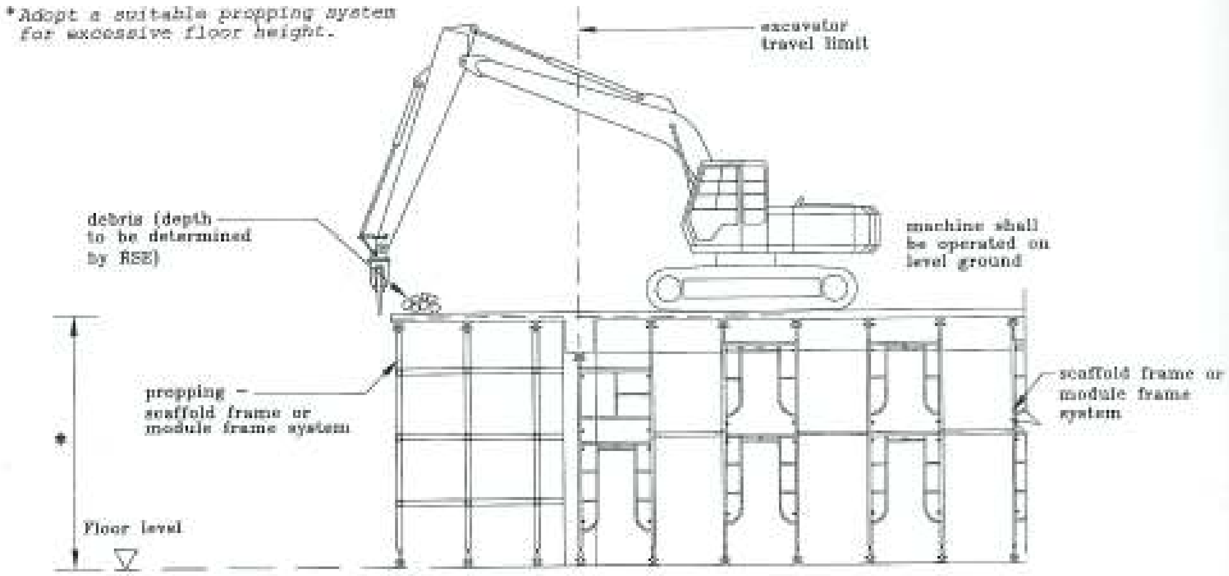
A. CUTTING OF CANTILEVERED SLAB

After cutting, the slab panel becomes a free body supported on the propping system under.
The propping system under must be stable and able to take up the vertical load plus any sway movement due to the cutting of the slab panel.

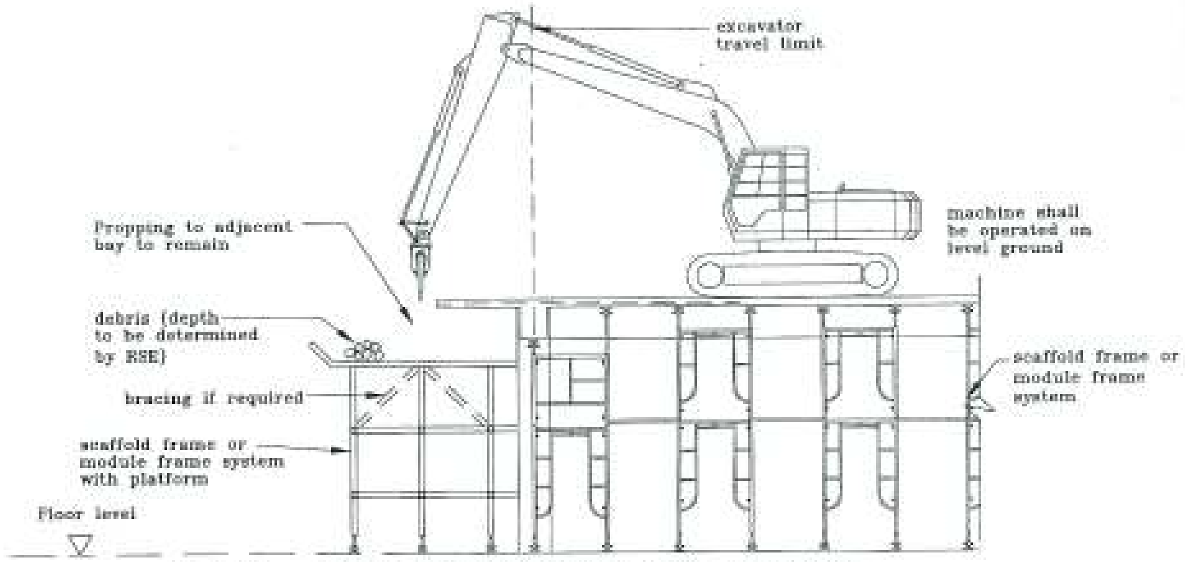


B. LIFTING OF CANTILEVERED SLAB

EH-Figure 4.12-2 DEMOLITION OF CANTILEVERED SLAB BY MOBILE MACHINE (CUT AND LIFT METHOD)(SHEET 2 OF 2)



STAGE 1 1. Clear all debris



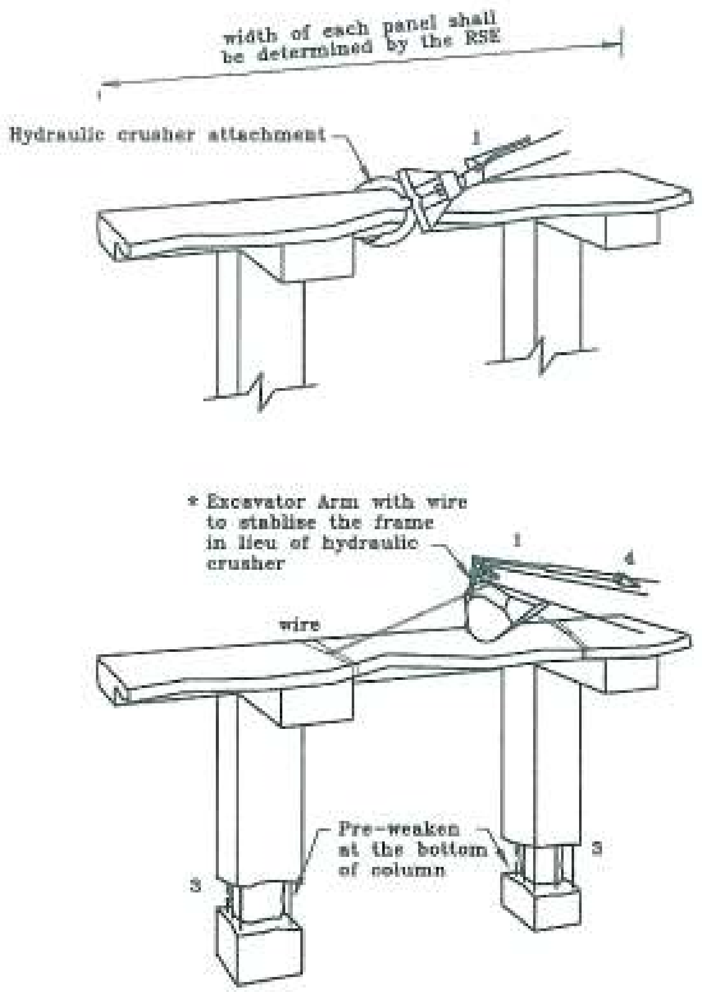
STAGE 2 1. Remove top layer of props to and erect platform for the bay to be demolished

2. Demolish the cantilever slab

<u>MACHINE MOUNTED ON SUSPENDED FLOOR</u>

Note: Temporary platform may be required for excessive floor to floor height In such a case, the platform provided under should be designed to support the loading generated and checked for its structural stability adequacy.

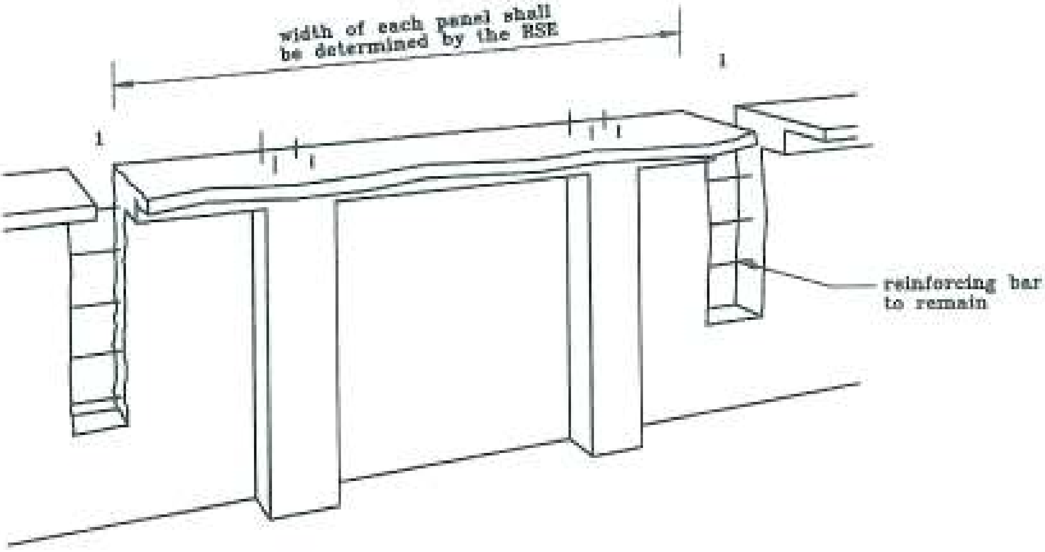
EH-FIGURE 4.12-3 DEMOLITION OF CANTILEVERED SLAB BY MOBILE MACHINE FOR EXCESSIVE FLOOR HEIGHT (FACING STREET)



1. Excavator arm with wire or hydraulic crusher attachment secures the R.C. Frame.
2. The width of the frame section shall be determined by the RSE.
3. Pre-weakening of the concrete column at the bottom by breaking out the concrete cover to expose the reinforcing bars. Only the reinforcing bars at the exterior face, where the columns fall away from, shall be cut. (see Figure 4.5)
4. Excavator arm pulls down the frame in a slow and controlled motion.

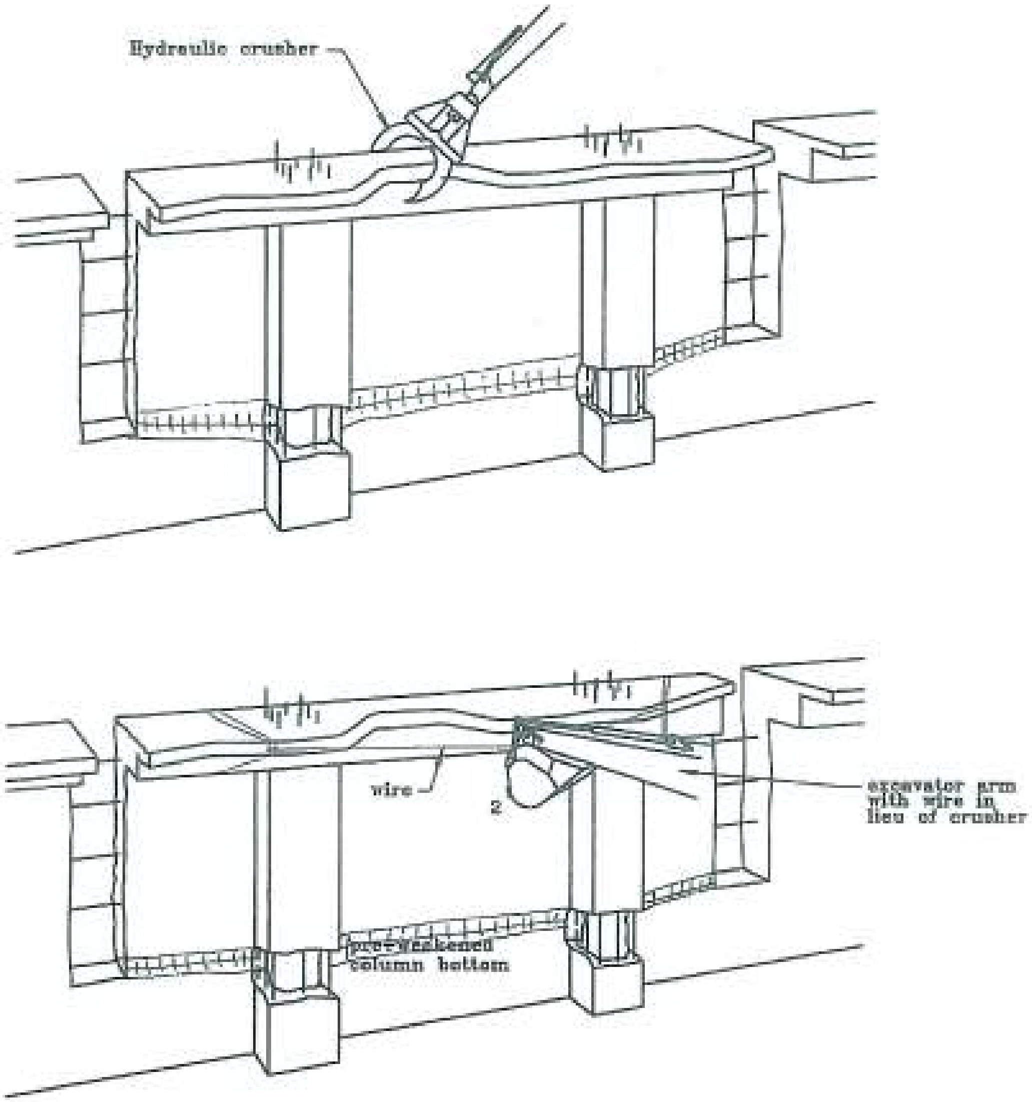
* *Alternatively, the bucket / crusher / breaker of the excavator may be placed directly on the structure for the purpose of stabilization and pull down. Use two or more excavators wherever possible. (see example photo of concrete frame demolition)*

EH-Figure 4.13 DEMOLITION OF REINFORCED CONCRETE FRAME BY EXCAVATOR WITH CABLE



1. Breaking away the concrete along vertical slots to separate the wall section.
   Width of wall section shall be determined by the RSE.
   Reinforcing bars shall be left to stabilise the section.
   Breaking of concrete shall be done cautiously to minimise debris from falling outside the building.

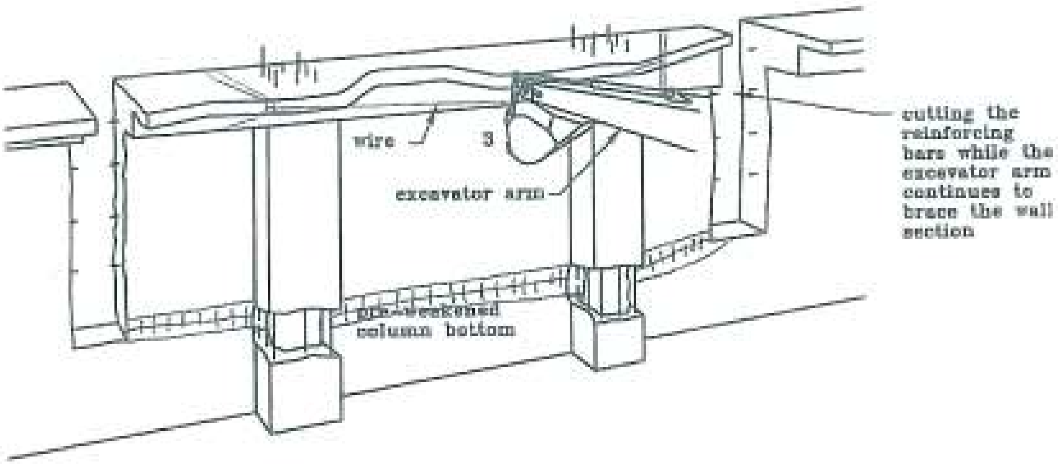
EH-Figure 4.14-1 DEMOLITION OF REINFORCED CONCRETE WALL BY EXCAVATOR (sheet 1 of 3)



2. Excavator arm with wire to brace the wall section while pre-weakening at the bottom of columns. (see Figure 4.5)

* *Alternatively, the bucket / crusher / breaker of the excavator may be placed directly on the structure for the purpose of stabilization and pull down. Use two or more excavators wherever possible.*

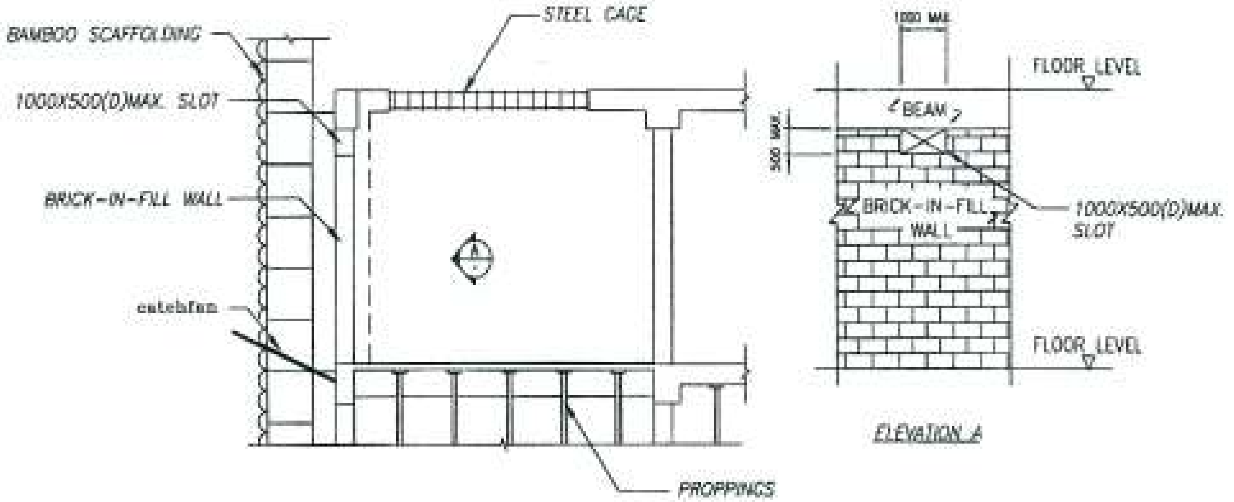
EH-Figure 4.14-2	DEMOLITION OF REINFORCED CONCRETE WALL BY EXCAVATOR (sheet 2 of 3)



3. Machine continues to brace the wall section, while cutting the reinforcing bars.
   Reinforcing bar at the bottom to remain.
   After cutting off reinforcements, excavator arm pulls the wall down in a controlled motion.

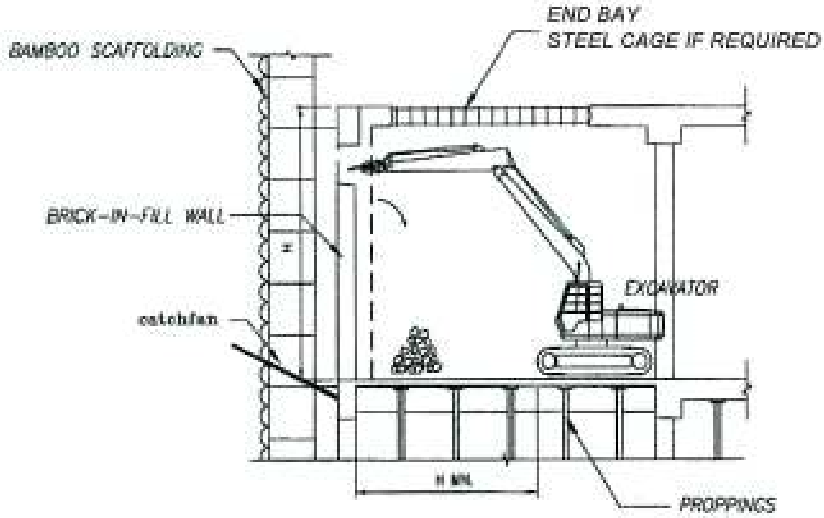
* *Alternatively, the bucket / crusher / breaker of the excavator may be placed directly on the structure for the purpose of stabilization and pull down. Use two or more excavators wherever possible.*

EH-Figure 4.14-3 DEMOLITION OF REINFORCED CONCRETE WALL BY EXCAVATOR (sheet 3 of 3)



STAGE 1

1. PROVIDE EXTRA BAMBOO CATCHFAN AT EACH FLOOR
2. TRIM THE SLOT AT BRICK-IN-FILL WALL



STAGE 2

1. PULL DOWN THE BRICK-IN-FILL WALL GRADUALLY FROM TOP TO BOTTOM

MACHINE MOUNTED ON SUSPENDED FLOOR

EH-FIGURE 4.14-4 ***SUGGESTED ALTERNATIVE METHOD FOR DEMOLITION OF EXTERNAL BRICK-IN-FILL WALL***

4.4 Mechanical Method by Hydraulic Crushers with Long Boom Arm

4.4.1 General

The Code suggests that for environmental reasons, a long boom arm (HRDR - high reach demolition rig) crusher should be used wherever practical because of its ability to operate quietly. However, long boom arm crushers require more space to operate so their use during demolition is limited.

4.4.2 Application Criteria

Figure 4.15 shows a 7-storey building being demolished by a crusher with a long arm boom. Depending on the size of the long arm boom mechanical plant used, a 300-ton machine could have a working height of about 60m for demolition works.

(A) The Code has specified a minimum and safe distance requirement for a mechanical plant to be kept away from the building being demolished. For a 7-storey building with, say, a 3m floor-to-floor height, the crusher would need to be kept away from the building's edge by a minimum distance of 10.5m. For a building depth of, say, 10mand for a machine with a 4m front edge distance to the center of the long boom arm, the long arm boom should have a horizontal reach of at least 25m. The minimum length of the long arm boom required is (212 + 252)1/2 = 32.65m.

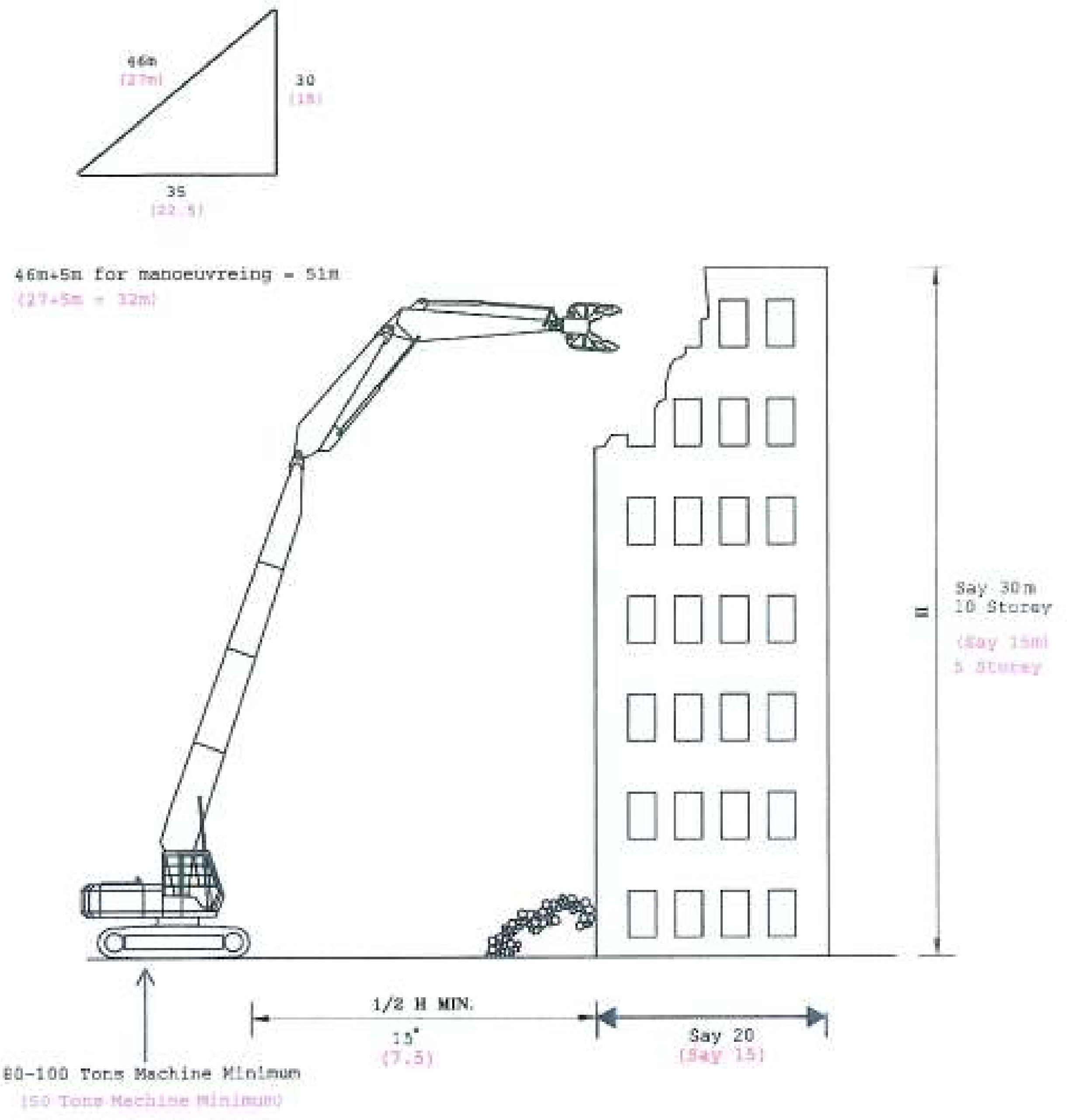
The HRDR machine is specially designed for use in demolition works. Its design concept is to create a demolition environment in which minimum manpower resources is required, thus reducing the risk of injury to workers. The HRDR must be operated by an experienced operator under the strict supervision of an experienced, competent person and engineer. The distance restriction of machine-to-building specified in the Code provides a good safety margin. A lesser margin has been adopted in other countries for HRDR and corresponds to the manner in which a structure will collapse under controlled conditions plus a buffer zone.

(B) Due to the complicated design of the machine, having the mechanical plant inspected, tested, and issued a valid certificate each time prior to use on site is recommended.

(C) Using a long arm boom mechanical plant equipped with a hydraulic crusher is different from the typical methods of demolition shown in the Code. In general, no propping is provided. Scaffolding at the working front is omitted. The building would generally become inaccessible during demolition. The demolition sequence should be planned in such a way that each stage of the building would be demolished using the long arm boom mechanical plant. If access were required, inspecting the conditions of the site and first removing unstable elements with the HRDR is recommended. This type of demolition may require provision of an elevated platform or an equivalent hoisting facility for inspection or other activities. For the demolition of a concrete-frame building, the engineer should plan carefully how concrete debris would be removed from each floor being demolished to avoid accumulation and overloading of the floors below. For the demolition of a steel structure, the crusher/cutter could grip the steel members and lower them in sections or small pieces to the ground. For the demolition of a concrete-frame building, part of the concrete debris would free fall to the ground, and part of the debris would fall to the floor immediately below or other lower floors via floor openings or vertical shafts.

The control of dust with hoses spraying water is required. The hose can be fixed to the arm of the HRDR or held manually.

(D) If the space required for operation of an HRDR is not readily available, the space can be created by splitting the demolition works within a lot into phases, in which case the initial phase would have to be carried out by more conventional mechanical plants. Another possibility is to occupy space outside a lot. For public sector works, approvals can normally be obtained via communication channels set up to involve relevant government departments and the local community. This method of obtaining approval is less established for private sector works. However, given that the use of HRDR may be a more environmentally-friendly solution overall, the AP and RSE can prepare an assessment in this respect, plus a TIA / TTMS referred to in 3.7 of the EH, and seek approval in a manner similar to public sector works.



*Depending on the nature of the building structure, the minimum distance of the machine to the building (1/2 H min.) may be physically reduced with an acceptable margin of safety with a pre-arranged vacated and fenced off area of operation, and controlled collapsed mode under engineering performance base.

EH-Figure 4.15 DEMOLITION BY HYDRAULIC CRUSHER WITH LONG ARM BOOM

4.5 Wrecking Ball

This method is not being used commonly due to generally congested site conditions. During the use of a wrecking ball, the mode and timing of collapse of the building / structure is very difficult to control. Therefore, as a safety precaution, the spatial requirement is much larger than that of the HRDR. If site conditions allow, this method of demolition should be used carefully with a detailed method statement and procedure of operation, including risk assessment.

4.6 Implosion

The implosion method of demolition has been applied only occasionally in Hong Kong. Ample site space is required for using this method of demolition. Specialists are generally engaged for the planning, design and execution of the work and approvalis needed from various authorities. The control of dust generated as a result of the demolition would require careful planning.

4.7 Other Methods

4.7.1 Non Explosive Demolition Agent

4.7.2 Saw Cutting

Sawing operations usually generate noise of higher frequency when cutting through steel rebar, particularly if jamming occurs. Providing a good sound insulation enclosure at the cutting location should be considered. Workers should wear equipment to protect ears during cutting operations.

4.7.3 Cutting-and-Lifting

Prior to cutting, adequate temporary supports or propping should be installed to the element to be removed and its adjacent structures, in addition to tying to the lifting appliances, to avoid sudden jerking to the lifting appliances. Placing wooden panels on top of temporary supports in order to minimize impact and damage during cutting is recommended.

Once a cut-and-lift operation has commenced, for safety control, the whole operation should be completed for a segment or an element without unnecessary stoppage.

When cutting a wall panel, vertical cuts should be made prior to the horizontal cut at the bottom of the wall. For the external wall, in addition to tying to the lifting appliances, the wall should also be tied back internally to the building.

Pay attention to the quality of the structural element when the lifting method is used. A lifting beam or frame to support or contain the cut segment during hoisting may be required instead of tying with a hoisting chain.

A temporary platform should be properly designed by AP & RSE and its construction should be supervised by a Competent Person appointed by Registered Contractor or Specialist Registered Contractor in accordance with PNAP ADV-010.

5. SPECIAL STRUCTURES

5.1 Precast Concrete Structures

5.1.1 General

Failure of connections may result in a catastrophic failure of the structure; therefore, the connection strength and overall stability of the building and the temporary stability of individual members should be checked at all demolition stages. If in doubt, take precautionary measures prior to carrying out demolition works.

5.1.2 Simple Precast Construction

Pay attention to the mechanism of building stability to resist lateral loads (e.g., wind load and soil load). The types of ties to be provided for stability and interaction between precast units shall be clearly identified. If possible, original structural design assumption should be ascertained prior to planning for demolition.

(A) Dismantling

Adequate temporary supports (e.g., propping and bracing) should be provided at all stages of demolition to ensure that the overall and local stability of the structure is maintained at all times.

(B) Existing Lifting Points

When checking design, make reference to Code of Practice for Precast Concrete Construction 2003 to verify the existing lifting points.

(C) Lateral Support During Lifting

The connection details shall be carefully designed. Adequate supports/propping points should be provided to restrain excessive sway movements during lifting.

5.1.3 Continuous Precast Construction

As the structural stability behaviour of a building may differ between its permanent condition and during demolition, give consideration to vertical and lateral stability at all stages of demolition works.

(A) Dismantling

The order of construction shall be indicated to determine the correct demolition sequence. For example, the precast elements which provide lateral stability cannot be demolished prior to removal of other in-situ elements.

Adequate temporary supports (e.g., propping and bracing) should be provided at all stages of demolition to ensure that stability is maintained at all times.

A feasible temporary works scheme with sufficient details, including propping and bracing layout, etc. as well as the sequencing of demolition to show how temporary stability is provided at each demolition stage, should be produced.

5.2 Prestressed Concrete Structures

The engineer should carry out a trial panel to identify the behaviour of prestressed concrete structures prior to commencement of massive demolition. The construction sequence shall be amended if the behaviour does not match the design assumptions stated in the approved demolition plans. Cutting of tendons should be carried out progressively based on the residual, superimposed loads at the time, the capability of the structural member to support its own weight, the extent of proppings, and if the area has been fenced off to eliminate the hazards created during the whole demolition works.

1. The presence of any pre-stressed concrete structures should be identified in the structural survey and the details and record plan made available to the demolition contractor.

2. It is the responsibility of the demolition contractor to inform all workers on the demolition job site of the presence of pre-stressed concrete members within the structure. The demolition contractor should also instruct workers on the safe work practices which must be followed to safely perform the demolition. Workers should be informed of the hazards of deviating from the prescribed procedures and the importance of following the sequence and method of demolition.

3. Pre-tensioned members usually do not have any end anchors, the wires being embedded or bonded within the length of the member. Simple pre-tensioned beams and slabs of spans up to about 7 meters can be demolished in a manner similar to ordinary, reinforced concrete. Pre-tensioned beams and slabs may be lifted and lowered to the ground as complete units after the removal of any composite concrete covering to the tops and ends of the units. To facilitate breaking-up, the members should be turned on their sides. Lifting from the structure should generally be done from points near the ends of the units or from lifting point positions. The reuse of lifting eyes, if in good condition, is recommended whenever possible. When units are too large to be removed, give consideration to temporary supporting arrangements.

CATEGORIES OF PRE-STRESSED CONSTRUCTION

There are four main categories of pre-stressed members. The category or categories should be determined before attempting demolition, bearing in mind that any pre-stressed structure may contain elements of more than one category.

Category 1
Members are pre-stressed before the application of the superimposed loads and all cables or tendons are fully bonded in the concrete or grouted within ducts.

Category 2
Like Category 1, but the tendons are left ungrouted. This type of construction can sometimes be recognized by the access points that may have been provided for inspection of the cables and anchors. More recently, unbonded tendons have been used in the construction of beams, slabs and other members; these tendons are protected by grease and surrounded by plastic sheathing instead of the usual metal duct.

Category 3
Members are pre-stressed progressively as building construction proceeds and the dead load increases, using bonded tendons as in Category 1.

Category 4
Like Category 3, but using unbonded tendons as in Category 2. Examples of construction using members of Category 3 or 4 are relatively rare. However, they may be found, for instance, in the podium of a tall building or some types of bridges. These structures require particular care in demolition.

Precast Units Stressed Separately from the Main Frames of the Structure, With End Anchors and Grouted and Ungrouted Ducts

Before their demolition, units of this type should be lowered to the ground, if possible. In general, it would be safe to assume that there are ungrouted tendons because grouting is not always 100% effective. After lowering, the units can be turned on their sides with the ends up on blocks after any composite concrete is removed. This may suffice to break the unit and release the pre-stress; if not, erect a sand bag screen, timbers or a blast mat used as a screen around the ends before the start of demolition, taking care to clear the area of any personnel. Bear in mind that the end blocks may be heavily reinforced and difficult to break up.

Monolithic Structures

The tendons or anchorages of structures in which two or more members have been stressed together should be exposed in the presence of an RPE. Erecting temporary supports is usually necessary so that the tendons and the anchorage can be exposed carefully. In such situation, do not make indiscriminate attempts to expose and de-stress the tendons and anchorages.

Progressively Pre-stressed Structures

In the case of progressively pre-stressed structures, it is essential to demolish the structure in strict accordance with the approved method of demolition. The stored energy in this type of structure can be large. In some cases, the inherent properties of the stressed section may delay failure for some time, but the presence of these large pre-stressing forces may cause sudden and complete collapse with little warning.

5.3 Statically Determinate Structures

Dome, shell and simply supported structures are also considered statically determinate structures.

5.4 Composite Structures and Steel Structures

5.4.1 General

The sequencing of demolition shall be carefully studied in order to avoid disproportionate collapse. A steel structure is more versatile and elastic compared with reinforced concrete but with a lesser degree of redundancy. The risk due to buckling, overturning, instability and yielding owing to an incorrect demolition sequence may induce an unexpected event and variations in loads and locked-in stress. This must be carefully studied and assessed. Also in composite structures, the removal of one component, such as the breaking of concrete in a composite slab, requires careful consideration of the reduction in buckling strength in the remaining structure. This includes reduction in buckling strength due to the release of original composite action and removal of restraints against buckling of beams, columns, whole structures etc.

5.4.2 Demolition Method

An adequate demolition method is to be reviewed for each individual building. However, the original structural framing (e.g. bracing of steel structures to provide lateral stability) has to be clearly identified in order to avoid an incorrect demolition sequence. Please also refer to section 4 of this EH for the relevant details.

Demolition of steel members may be carried out by the cut-and-lift manual method with hoisting system such as the use of chain and blocks, derrick, mobile or tower crane. The cutting of steel beams by manual method requires special precautions against the risk of beam falling uncontrollably and possible impact with other structural elements and workers.

Demolition by machine may be carried out by the use of a hydraulic mechanical excavator or HRDR equipped with a steel cutter. The advantage of using a mechanical cutter is that the elastic property and plasticity of steel would allow the cutter to carry out the duty of lowering a cut steel member by slow bending of the steel section using the cut and grip action of the cutter. Where applicable, using machine method to minimize human resources and to lower risk of human injury is recommended.

5.4.3 Shoring of Slender Member

When appropriate, Code of Practice for the Structural Use of Steel 2005 shall be adopted for the stability analysis and buckling check. The effective length of beams and columns may be increased significantly when restraining members are removed and temporary restraints may be required for maintaining stability. Second-order analysis effects, notional force and imperfections to 3% of the span and height should also be considered in design, analysis and buckling checks.

5.5 Cladding Walls

Cladding walls are, in general, facing or architectural decoration fixed to external walls (e.g., aluminium or metal cladding, glazing, polished granite slabs or limestone cladding, marble facing and the like). Claddings are, in general, supported and connected by a system of cast-in anchors, dowels, anchor bolts and screws. Before demolition of cladding, the sequence of support to, and connection between, claddings shall be carefully examined. In case of doubt, open up critical positions for inspection.

5.6 Hanging Structures

5.6.1 General

Hanging structures and associated supporting members must be carefully located in a building and clearly shown in the demolition plans. This is particularly important for the top down demolition method.

5.6.2 Demolition Method

A disaster may occur if the traditional top down method were used for demolishing hanging structures. The procedure and sequence of demolition of hanging structures must be well-planned and clearly shown in the Demolition Plan. Pay special attention to the supporting mechanism of the hanging structures. It is important to train and brief supervising personnel and on-site workers.

If using the top down method in demolishing hanging structures is inevitable, provide adequate temporary supports to the hanged structures as described in Section 3.5 prior to commencement of any demolition works.

5.6.3 Guidelines

1. Hanging structures are hung from other elements suspended at the upper portion of the structures by tension forces. Overstressing particular structural elements or ties may constitute failure or even collapse of the building.

2. The method of, and sequence in, destressing the hanging ties prior to cutting shall be studied and specified in the plans.

3. The stability of main gravity structures and other elements providing lateral stability of the hanging structure shall be carefully protected on site prior to complete release of the hanging ties.

4. Study and consider the stability of main gravity structures for all stages of demolition carefully. Bracing, if any, shall be clearly shown in the plans.

5.7 Oil Storage Facilities

A sample guideline for precautionary measures to be taken before demolition of a fuel oil tank and underground oil interceptor is shown below:

A. Chemical waste shall be cleaned up prior to demolition and all oil storage facilities shall be thoroughly cleaned. Tests should be carried out by specialist agents to ascertain the presence of any accumulated gases which should be extracted and removed. The management of waste and waste water generated from the process must conform to the Waste Disposal Ordinance and the Water Pollution Control Ordinance. The management of any waste which is classifiable as a chemical waste shall be in accordance with the Waste Disposal (Chemical Waster) (General) Regulation. In the case where a license for dangerous goods storage has been previously issued, the licensee should cancel the DG License with the licensing authority, i.e., Fire Services Department. Any risk of fire explosion and exposure to toxicity shall be minimized and confirmed by tests. For works under the category of "EIA Designated Project", they shall be carried out in accordance with the recommendations in EIA Report.

B. Suggested Specific Protective and Precautionary Measures to be carried out:-
   a. The tank shall be emptied of all fuel oil by a specialist contractor prior to commencement of works.
   b. AP shall inform FSD and EPD before commencement of any works on fuel oil tank, preferably before the tank is emptied.
   c. Provide adequate fire extinguishers.
   d. Prepare adequate fuel oil containers (200 litres).
   e. Close or detach all associated valves from inlet pipes and outlet pipes connected to the tank.
   f. Disconnect any power supply and other utilities connected to the tank.
   g. Drain the remaining oil inside the pipes.
   h. Drain pipe from the sump of bund wall (below staircase) to oil interceptor to be capped and backfilled.
   i. Open the manhole door at top of the tank, and then open the other door near the ground.
   j. Use Gas Monitoring Instrument to check whether toxic gases exist inside or not. No fire work or hot works shall be carried out before thoroughly checking and testing whether oil is present inside the tank. Set up a blower at the ground manhole door; ensure there is good ventilation using Gas Monitoring Instrument to check the inside conditions of the tank.
   k. Pump out the waste water by using waste water treatment car during cleaning.
   l. Further test the toxic levels of the tank and for presence of fuel oil and submit reports prepared by independent engineers and client's representative before starting any hot works.

5.8 Marine Structures

5.8.1 General

Marine demolition is the demolition of docks, piers or structures built over water and the removal of piles.

5.8.2 Demolition Method

In addition to the methods used for demolition on land, methods utilizing barges, tug boats and support craft along with specialized heavy equipment may be used for marine demolition. The lifting method is commonly used. This involves less work salvaging the debris.

Sensitive water is the water quality that is sensitive to impact from pollution. The principal legislation for protecting water quality in Hong Kong is the Water Pollution Control Ordinance, which defines Water Control Zones, Water Quality Objectives for each Zone and standards for effluent discharges.

5.9 Underground Structures

5.9.1 General

The adverse effects of demolition works to any building, structure, land, street or service are to be studied. A monitoring plan should be provided if necessary. It may include, but not be limited to, the following: -

1. Monitoring stations (including, but not limited to, settlement check points, tilting and vibration check points) for detailed monitoring of movement and vibration in any building, structure, land, street or underground service should be provided throughout the demolition period. Refer to PNAP APP-24 & APP-131, Schedule Area No. 3 for the trigger levels of a monitoring station. The vibration control can make reference to PNAP APP-137;
2. Piezometers for the detailed monitoring of ground water conditions;
3. Inclinometer for the detailed monitoring of lateral movement of existing retaining structures (e.g., screen wall, pile wall or diaphragm wall);
4. The frequency at which readings will be recorded or taken;
5. The alert, alarm and action levels of the monitoring stations and contingency measures to be taken should be agreed upon with the Building Authority and concerned utility undertakers.

5.9.2 Demolition Method

Refer to Section 4 of the EH for the demolition method of various structural elements. Effects on adjacent structures are to be studied.

5.9.3 Guidelines

(A) Overall Stability

In addition to maintain the stability of the remaining parts of the buildings, the uplifting checking should fulfill the requirements as stated in Clause 1(c) of Paragraph 15 Part III of Building (Construction) Regulations (CAP. 123). Refer also to paragraph 2.5.4 (b) of Code of Practice for Foundations.

(B) Shoring

Assess the movement of adjacent building structures, land, street or services in early design stages in order to determine a suitable demolition method and precautionary measures. The condition of a building's structure shall be verified if the floors or part of the building structure act as propping to the retaining structures.

(C) Dewatering

Dewatering should be avoided during demolition works. In case dewatering is required, the engineer should submit a proposal with Excavation and Lateral Support Works or Foundation Works for Building Authority's approval.

Please also refer to PNAP APP-22 on dewatering.

(D) Existing Foundation

The re-use of existing foundations should be considered in the foundation submission if applicable.

(E) Site Security and Safety

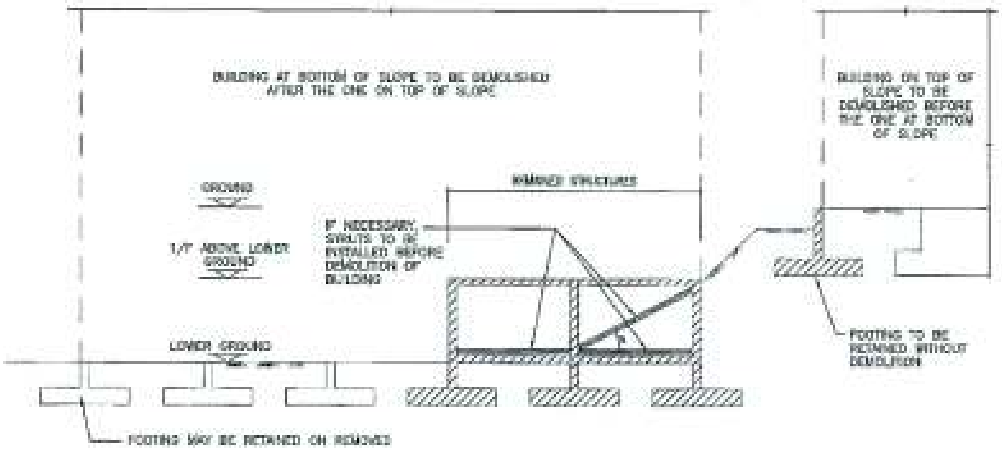
AP/RSE/RSC shall plan and implement suitable site security and safety.

5.10 Structures Supporting Ground or Sitting on Slopes

5.10.1 General

Geotechnical assessment and relevant geotechnical calculations are to be implemented at early design stages. Any relevant recommendations should be incorporated into the suitable demolition method. Relevant geotechnical work and precautionary measures shall be provided if structures to be demolished are supporting ground or sitting on slopes.

There may be cases where parts of buildings or structures need to be retained or additional shoring installed to avoid causing adverse effects to adjacent buildings, structures or slopes. Demolition Plan shall show details with record plan properly maintained for future development reference (refer to Sketch 5A below).



SKETCH 5A – STRUCTURES SITTING ON SLOPES

NOTES :

1. [hatched symbol] – STRUCTURES TO BE RETAINED
2. BUILDING ON TOP OF SLOPE SHOULD BE DEMOLISHED PRIOR TO THE ADJACENT BUILDING AT BOTTOM OF SLOPE

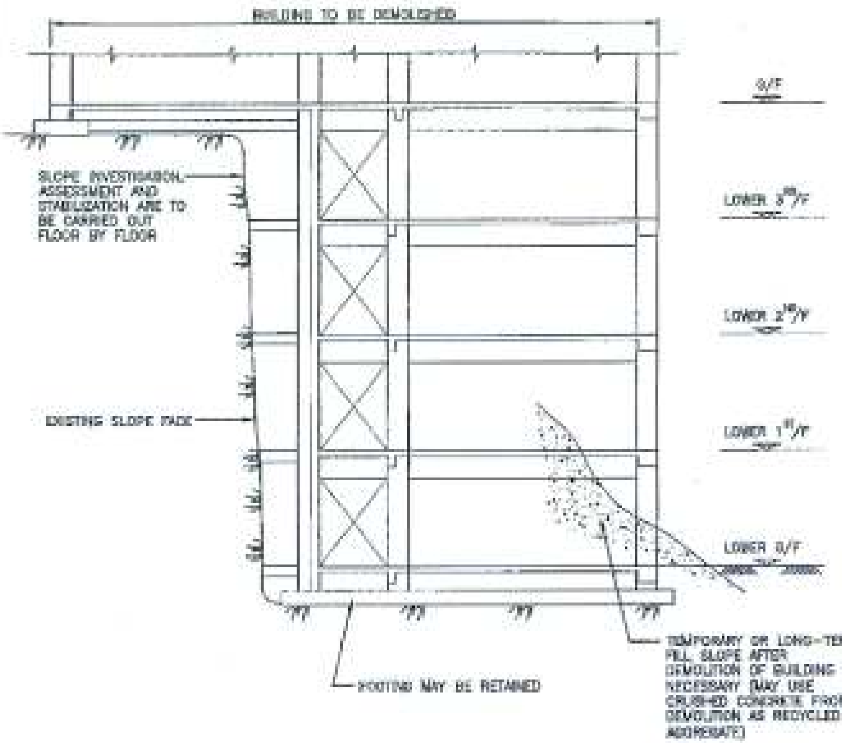
During demolition involving slope stability, provide supervision, including Technical Competent Persons of Registered Geotechnical Engineer (RGE) stream.

5.10.2 Demolition Method

For demolition method, please refer to Section 4 of this EH. Effects on adjacent structures are to be studied.

Demolition sequences affecting slope stability must be explicitly stated in the Demolition Plan. For example, for two linked blocks with one on the crest of slope and the other at the toe of slope serving as retaining structure, the one on the crest would have to be demolished first.

Sometimes, staged demolition is required and needs to be stated clearly in the Demolition Plan. There are cases where a building is attached to a slope and partly used as a retaining structure. Slope stabilization works in stages may be required and the scope of works can only be determined after exposure of the slope floor-by-floor consecutively with the demolition works. Allow adequate time and resources to prioritize works which involve geotechnical assessment, design, approval and execution of slope stabilization works floor-by-floor (refer to Sketch 5B).



SKETCH 5B – BUILDING ABUTS TO SLOPE

(N.T.S.)

DEMOLITION SEQUENCES OF BUILDING ABUTTING SLOPE

1. CONDUCT GEOTECHNICAL ASSESSMENT ON SLOPE STABILITY BASED ON AVAILABLE INFORMATION.
2. DEMOLISH THE BUILDING FROM ROOF DOWN TO ONE FLOOR BELOW THE CREST OF THE SLOPE.
3. CLEAN THE EXPOSED SLOPE FACE AND CONDUCT GEOTECHNICAL INVESTIGATION AND ASSESSMENT.
4. CARRY OUT SLOPE STABILIZATION WORKS FOR THE EXPOSED SLOPE AT THE FLOOR WHERE THE DEMOLITION PAUSES IF NECESSARY.
5. NO DEMOLITION OF THE FLOOR BELOW IS ALLOWED UNTIL THE STABILIZATION WORKS ARE COMPLETED TO THE SATISFACTION OF ENGINEER.
6. DEMOLISH ANOTHER FLOOR DOWNWARDS.
7. REPEAT STEPS 3 TO 6 UNTIL THE COMPLETION OF DEMOLITION OF THE SUPERSTRUCTURES.
8. CONDUCT OVERALL GEOTECHNICAL ASSESSMENT ON THE EXPOSED SLOPE AND CARRY OUT TEMPORARY OR LONG-TERM STABILIZATION WORKS IF NECESSARY.

5.10.3 Guidelines

(A) Buttress/Shoring for Building Supporting Ground

In addition to maintain the stability of the remaining parts of a building supporting ground, the stability of associated geotechnical features shall not be adversely affected by the demolition and shall also be maintained.

(B) Retaining Wall System

If temporary or permanent support to stabilize the retaining wall or any geotechnical features is required, site formation or temporary excavation and a lateral support plan should also be prepared for the demolition works.

(C) On-grade Floor Slab

If the existing on-grade floor slab is demolished, adequate temporary surface protection and surface drainage system on the exposed ground surface during and after the demolition works should be provided in order to prevent and protect against rainfall infiltration, which may affect the slopes.

(D) Surcharge on Slope and Retaining Wall

In case having a surcharge on top of slopes, such as the construction of hoarding and/or a temporary platform, etc. is inevitable, geotechnical assessment should be carried out by a Registered Geotechnical Engineer. The allowable surcharge should be stated in the Demolition Plan.

(E) Drainage

Please refer to the Code.

5.11 Demolition of Precast Concrete Building by Cut-and-Lift

5.11.1 General

Prevention of progressive collapse of precast building during demolition is of paramount importance. Design of demolition method should not rely solely on as-built records, instead, comprehensive pre-demolition structural investigation should be carried out to ascertain the condition and formation of the precast joints.

5.11.2 Demolition Method

Demolition of precast building by cut-and-lift method employing tower crane or mobile crane is effective and environmental friendly. Safety provisions and measures to maintain the structural stiffness and to assure the overall stability of the precast building as well as individual precast panels through-out the demolition process should be rigorously devised.

(A) Investigation at Planning Stage

Engineer should carry out comprehensive structural investigation, and as far as possible include open-up inspection to ascertain the location, condition and formation of the precast joints. Fabrication of a structural model based on the findings of the investigation would facilitate the design of the demolition method and corresponding safety measures. Carrying out of structural analysis to check the stability of the building against the lateral wind load, dynamic effect and accidental impact load at staged demolition is recommended.

(B) Removal of Non-structural Elements

All non-structural elements and household debris such as partition walls and fixtures should be removed prior to dismantling the precast panels. This would eliminate the risk of falling of objects during the cut-and-lift process.

(C) Tower Crane

The tower crane employed for cut-and-lift demolition method should as far as possible be a standalone type. If mounting of the tower crane to the precast building could not be avoided, the engineer should check and ensure that the existing building could withstand the lateral sway and dynamic effects induced by the tower crane during its operation. Additional temporary support shall be provided to the building to sustain such external forces induced. Special care should also be taken on lowering and dismantling of the tower crane.

(D) Temporary Support System

Adequate temporary supports (e.g. propping and bracing) should be provided at all stages of demolition to ensure that overall stability of the building and local stability of the precast panels are maintained at all times. Prime consideration should be given when designing the temporary support system to prevent potential progressive collapse of the precast building.

(E) Trial Demolition

Engineer should require the carrying out of trial panels or floor to test the proposed demolition method prior to granting consent for commencement of mass demolition. All demolition details and sequence should be reviewed and refined if the construction details of the precast panels do not match with the design assumptions stated in the approved demolition plan.

(F) Demolition Sequence

The sequence of removing the precast panels should tie-in with the structural analysis at staged demolition and be indicated clearly in the demolition plan. In general, the sequence should best be the reverse order of the construction sequence when the precast building was built. During mass demolition, all procedures in particular the removal sequence and safety measures must be in strict compliance with the approved demolition plan.

(G) Safety Measures

The cut-and-lift demolition method would in general involve considerable number of workers on working floor for coring lifting holes, exposing grouted joints, cutting rebars, jacking up precast panels and installing slings to the panels for hoisting etc. Safety measures in particular erection of rigid barriers at building edges and wearing of safety belts by workers should be strictly enforced to prevent workers from falling at height.

6. SITE SUPERVISION AND INSPECTION

6.1 General

Specified sequence and procedures of the demolition works should be strictly followed (for example in accordance with the approved plans). As operational conditions of demolition activities change and vary from time to time, close site supervision by qualified and experienced personnel is very important. This would reduce the risk of misunderstanding and improper management of the specified sequence and procedures by plant operators and workers.

It is necessary to provide proper training and regular briefing to the demolition team. For example, the AP, the RSE and the RSC should hold daily briefings and weekly training workshops for plant operators and workers. This would improve the communication channels and reduce the risk of injury or accident due to misunderstanding.

For large-scale demolition works, demolition works involving complex or special structures, or demolition works involving the use of special equipment or machineries, the entire process of work should be closely supervised by experienced personnel of the AP, the RSE and the RSC.

6.2 Resident Supervision of Demolition of Complex Structures

For complex structures as described in the Code, apart from exercising the supervision by the RSC as required by the Code, it would be beneficial to the demolition process for the AP and the RSE to provide full-time site supervision by having independent, experienced and qualified personnel full-time on site.

APPENDIX

APPENDIX A
DEMOLITION CHECKLIST

For the general checklist, please refer to the Code.

1.2 Project Site and Building Structures To Be Demolished

- Examine site and position gantry for a workable and efficient ingress and egress for site transport.
- Identify if UBW were present and verify condition of UBW, including existence of asbestos.
- Identify and verify any trees present and make provisions for protection where necessary.

1.5 Testing and Removal of Hazardous Materials

- Identify if underground asbestos pipes were present.
- Identify if radioactive installations, such as smoke detectors, were present.
- Identify if unused or disregarded chemical waste and high pressure toxic or non-toxic gas cylinders were present.

2. During Demolition

- For sites with basements, provide effective de-watering system with monitoring during demolition work.
- Provide surface drainage system to prevent against flooding if required.

APPENDIX B
DEMOLITION PLAN CHECKLIST

For the general checklist, please refer to the Code.

5. Precautionary Measures

- Use and test fire retardant tarpaulin sheets for scaffolding and catch fans.
- Provide de-watering system for basements.

7. Special Safety Considerations

- Provide fire-fighting equipment and emergency-exit lighting.
- Provide proper packaging, labelling and storage for radioactive products.

APPENDIX C
PRESTRESSED CONCRETE AND GUIDELINES FOR IDENTIFICATION

For the general guidelines, please refer to the Code.

APPENDIX

APPENDIX D
REGULATIONS RELATING TO DEMOLITION PROJECTS

For the general related regulations, please refer to the Code.
The AP/RSE/RSC should take note of and refer to the latest amendment of the regulations.

3. Building demolition is also subject to the following legislation and subsidiary documents administered by the Labour Department:
   (xxiv) Code of Practice for Safe Use of Tower Crane under section 7A of the Factories and Industrial Undertakings Ordinance (Cap. 59);

4. In the design of hoarding, covered walkways, temporary works and possible modifications to the existing building structure, the following documents may also be relevant:
   (ix) Guidelines on the Design and Construction of Scaffolds issued by Buildings Department

   The following European Standard may also be used as a reference for propping:-
   (x) BS EN 1065 - Adjustable Telescopic Steel Props;
   (xi) EN 12810-1 - Façade Scaffolds Made of Prefabricated Components;

   Part 1: Product Specifications;
   (xii) EN 12810-2 - Façade Scaffolds Made of Prefabricated Components;

   Part 2: Particular Methods of Structural Design;
   (xiii) EN 12811-1 - Temporary Works Equipment - Part 1: Scaffolds – Performance Requirements and General Design;
   (xiv) EN 12811-2 - Temporary Works Equipment - Part 2: Information on Materials;
   (xvi) EN 12811-3 - Temporary Works Equipment - Part 3: Load Testing;
   (xvii) BS EN12812- Falsework - Performance Requirements and General Design (BS 5975: 1996 exists in parallel with this standard and provides recommendations on the design of falsework using permissible stress methods and on procedures for the successful management of work on site, including the appointment of a falsework coordinator.)

   The following may also be used as a reference for debris and waste handling:-
   (xviii) Public Cleaning and Prevention of Nuisances By-Law (Cap 132);
   (xx) Public Health and Municipal Services Ordinance (Cap 132);
   (xxi) Land (Miscellaneous) Ordinance;
   (xxii) Dumping at Sea Ordinance;
   (xxiii) Works Bureau Technical Circulars on debris and waste.

APPENDIX

APPENDIX E
NOTIFICATIONS AND PROCEDURES

For the general checklist, please refer to the Code.

1. **Asbestos Abatement Works**
   The contractor should take into account that EPD's inspectors may require asbestos materials to be removed prior to the removal of other fixtures, including the provision of safety precautionary works such as propping, etc., in the area affected. The contractor may have to erect protective work such as scaffolding with tarpaulin sheets as a protective medium and provide access for the removal of asbestos materials.

   Apart from the removal of asbestos, the contractor should also remove and deactivate hazardous products such as gas cylinders for various functions off-site. Radioactive installations such as smoke detectors should be removed and collected by a specialist acknowledged by the Radiation Board.

2. **Hoarding Permit**
   The Authorized Person should monitor the expiry date of the hoarding permit and renew the permit accordingly. For the erection of the hoarding, road traffic would normally be affected, resulting in the temporary closure of one or part of a road or street lane; the Contractor needs to study the effects on pedestrians and vehicular traffic. A Temporary Traffic Management (TTM) proposal with a Traffic Impact Assessment (TIA) should be submitted to the Transport Department and Police for approval. Upon approval, application shall be made to Road Management Office (RMO) for approval in principle. For final approval and implementation, this would then be followed by an on-site trial run, if required by the Police.

   If construction work affects the pavement, the TTM should also be submitted to the Highways Department for approval.

3. **Excavation Permit**
   The requirements for the application of an Excavation Permit ("EP") may change from time to time due to revisions to the operation system of the Highways Department to match rural requirements.

   Currently, an applicant of an EP would be the landowner with payment. Allow ample time for an EP application as the process may take longer than expected due to other EP applications in the vicinity for road and/or pavement projects by private-sector developers, utility companies and government.

4. **Consent for the Demolition Works**
   Appendix B – Demolition Plan Checklist of the Code requires that a Chinese version of the Demolition Plan be provided. Although it is not a statutory requirement of the Buildings Department, consent for demolition works may not be granted under the authority of the Buildings Department.

   The contractor must ensure that all hazardous materials such as asbestos have been completely removed from the site and that a report of completion is filed with EPD.

   The contractor may commence demolition work after a 7-day notification under the requirements of Form BA10.

APPENDIX

APPENDIX E
NOTIFICATIONS AND PROCEDURES

5. Notification for Commencement
The principal contractor shall give notice to the EPD and Labour Department no less than 7 days prior to the commencement of work onsite.

6. Posting of Information
Please refer to the Code.

7. Demolition Activities within the "Restricted Hours"
Please refer to the Code.

8. Discharge to the Waters of Hong Kong
Please refer to the Code.

9. Notification for Completion
The specified form is Form BA14A.

10. Waste Disposal
Under the Waste Disposal Ordinance (Chapter 354) and Waste Disposal (Charges for Disposal of Construction Waste) Regulation, an application for waste disposal trip ticket chits must be made with EPD using Form 1 no less than 21 days prior to actual waste disposal.

APPENDIX

APPENDIX F
EXAMPLE OF DEMOLITION PLAN AND STABILITY REPORT FOR TOP DOWN MANUAL METHOD

The example shown in the Code is a general guideline and may not be applicable to every case of demolition work. The AP/RSE/RSC should assess the special conditions and requirements of a project to determine whether the Demolition Plan and Stability Report need to be modified. The general requirements of the Code are repeated here as follows:

1. DEMOLITION PLAN

1.1 The Demolition Plan shall consist of the following plans:

- 1.1.1 Fig F.1 Site Plan and Adjoining Site Conditions.
- 1.1.2 Fig F.2 Typical Floor Plan and Existing Building Information.
- 1.1.3 Fig F.3 Elevation A.
- 1.1.4 Fig F.4 Demolition Procedure and Sequence.
- 1.1.5 Fig F.5 Precautionary Measures.
- 1.1.6 Fig F.6 Typical Support at Cantilever.
- 1.1.7 Fig F.7 Typical Detail for Party Wall Strengthening.

1.2 In the case of sloping ground, the following additional plans are required:

- 1.2.1 Plan Showing Adjoining Slopes, Buildings, Structures Utilities That May Be Affected by the Demolition.
- 1.2.2 Sections Showing the Slopes, etc.
- 1.2.3 Supports to Slopes, Buildings, etc. at Each Stage of Demolition.

2. STABILITY REPORT

2.1 The Stability Report of this project shall consist of the following:

- 2.1.1 A Stability Report to Justify the Safety of the Existing Building During All Phases of Demolition.
- 2.1.2 A Structural Check with Calculation on the Support of the Cantilevered Slab Between Gridlines A and B.
- 2.1.3 A Structural Check with Calculation on the Hoarding, Covered Walkway and Catch Platform.
- 2.1.4 A Structural Check with Calculation on the Strengthening of the Party Wall.

2.2 In the case of a sloping site, the Stability Report shall include the following:-

- 2.2.1 Stability Check of the Adjoining Slopes, Buildings, Structures and Utilities Which May Be Affected by the Demolition, with Supporting Calculations.
- 2.2.2 Optional Structural and Geotechnical Checks on Any Remedial Measures to Strengthen the Slope.

Figure F.1-(1 of 2): Please refer to the Code.
Figure F.1-(2 of 2): Please refer to the Code.
Figure F.2-(1 of 2): Please refer to the Code.
Figure F.2-(2 of 2): Please also refer to the Code.

4. Hazardous materials

If other hazardous materials are found in the building, such as toxic or non-toxic gas cylinders, chemicals and radioactive gas smoke detectors, their presence shall be documented and they shall be removed from the site accordingly.

Figure F.3: Please refer to the Code.
Figure F.4-(1 of 4): Please also refer to the Code.

APPENDIX

APPENDIX F
EXAMPLE OF DEMOLITION PLAN AND STABILITY REPORT FOR TOP DOWN MANUAL METHOD

Figure F.4-(1 of 4): Please also refer to the Code.

1.3 (i) Cantilever slab

For multi-storey building with cantilever structural abutting the street, and depending on the floor to floor height, the following should be considered:-

1. No. of storeys of props

   The Code specifies that all cantilever floors are to be propped. For multi-storey building, the engineers may work out the debris loading due to the demolition of the cantilever structure, plus the effect of impact of the falling debris onto the lower floor, and design the number of floors with props required to distribute and support the said loadings.

   When props are provided for short span of cantilever structure, ensure that the props are properly connected and braced to form a stable system.

2. Temporary platform

   In traditional residential and office buildings with floor to floor height not exceeding 4.0 m and at the discretion of the engineer, the provision of a temporary platform may not be required if the cantilever structures are being demolished by hand held breakers. The broken down pieces of debris generated would be in small sizes and the effect of impact to the floor below would be of lesser magnitude. The Code also specifies that cut and lift method may be applied.

   It is however very important that prior to the start of demolition of the cantilever floor, all the debris accumulated on top shall be removed and cleared away.

   If a temporary platform is required to be installed under the cantilever structure to be demolished, the engineer must design the platform to be adequately stable on its own, or being braced to the permanent structure, or integral with tubular frame system with consideration of debris loading generated during the demolition and removal process apart from the construction load.

Figure F.5 (3 of 4): Please also refer to the Code

Notes on Precautionary Measures:-

3. Scaffolds, working platforms, screen and catchfans

   3.2 Bamboo catchfans shall be provided at vertical interval of no more than 10m, measured form top of steel catch platform of hoarding or from ground level if there is no catch platform.

   When props are provided for short span of cantilever structure, ensure that the props are properly connected and braced to form a stable system.

5. Debris Handling

   5.1 Loose furniture, and other fixture including E&M works obstructing the preparation of safety precautionary measure work such as propping erection, scaffolding and asbestos removal works would generally removed. It is not recommended to remove the window and glass unless unavoidable. This would still form a typhoon protection to the building before the erection of scaffolding. Even during the demolition period, the windows would act as protection behind damaged scaffolding, even functioning partially. In this case, windows should be checked for safety and in operation function.

APPENDIX

APPENDIX F
EXAMPLE OF DEMOLITION PLAN AND STABILITY REPORT FOR TOP DOWN MANUAL METHOD

With the latest operation of the HK Beam plus for new building development, recycling and reuse of scrap materials in demolition become a common practice. In such a case, records of materials being removed and sent for recycling are being kept systematically for credit scoring achievement.

5.2 Building debris would be best conveyed through a lift shaft if present. For manual method of demolition, openings formed through slabs of each floor may be in circular form to match the traditional circular plastic chute available in the market. Depending on floor area of building, opening for debris disposal can be bigger than 800mm x 800mm.

5.3 (A) Debris accumulation on the first floor or above shall not be higher than 100mm. The specified '100mm' is for demonstration as an example. The engineer should estimate and work out the actual debris loading generated from the demolished floor and design the number and capacity of props and floors below required to support and distribute the loading. Depending on the type of building, debris generated from the floor slab, beams, walls and columns, plus internal partition walls and external walls might accumulate up to 400 - 600mm high in bulk with voids. For demolition using hand held pneumatic breakers, the floor under demolition may be free of props if the structural of the building is of reasonable condition.

(B) Height of accumulation of debris on ground may also be worked out by the engineer. In some case, stock pile of concrete debris may be necessary in open area. The RSC should ensure that the stock pile of debris would not create a hazard and disturbance to the public health without protection from dust generated. The RSC must also ensure that hoarding or walls are not being surcharged by accumulated debris.

5.5 In the demolition plan, the engineer should consider and study the route for the debris to be conveyed to the ground floor. In most cases, a transfer system for props at 1st floor level to make provision for the access of trucks and bull dozer or bob cat for the removal of the debris at ground level is required. For lift core within shear wall structures, openings may be required to form part of the wall at ground level for the discharge of the debris conveyed from above. There are also cases that part of the structure at 1/F would have to be demolished first to form the required headroom for the passage of vehicles and trucks.

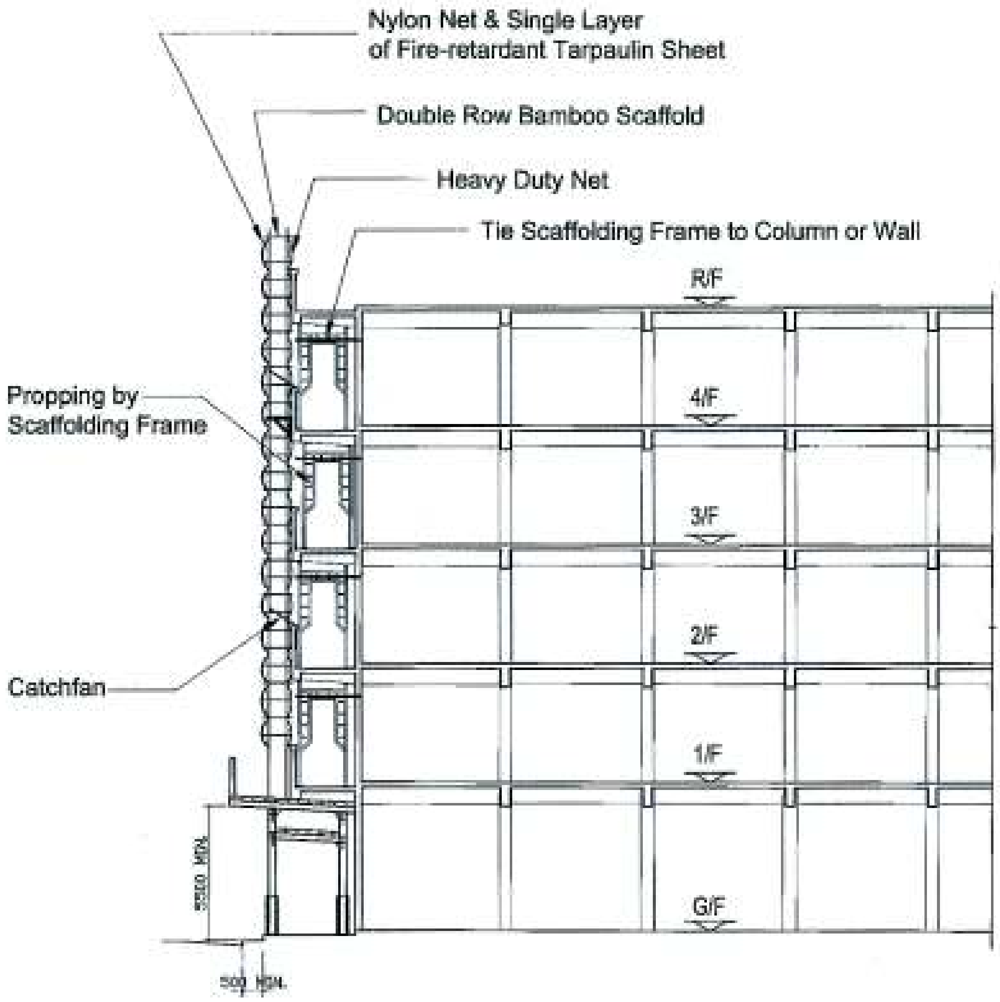
When preparing the demolition plan, ensure that the gantry is not located right in front of a wall, a column or even a transformer room.

APPENDIX

APPENDIX F
EXAMPLE OF DEMOLITION PLAN AND STABILITY REPORT FOR TOP DOWN MANUAL METHOD

Alternatives for Precautionary Measures for Demolition of Cantilevered Beams over Pedestrian Footpath - Sketch A: Fig. F.5-(2 of 4) refers

Appendix F



SKETCH A - ALTERNATIVE PRECAUTIONARY MEASURES
FOR DEMOLITION OF CANTILEVERED BEAMS
OVER PEDESTRIAN FOOTPATH.
(Fig. F5 on Page F13 refers)

APPENDIX

APPENDIX F
EXAMPLE OF DEMOLITION PLAN AND STABILITY REPORT FOR TOP DOWN MANUAL METHOD

a. Temporary Platform –
It increases loading to the cantilevered structure and incurs hazard to workers during erection. Installation of temporary platform is suggested to be waived provided that the floors below demolition are properly propped taking into account the impact load from the falling debris in the temporary work design. Extension or strengthening to the catch platform on top of covered walkway would be a more effective means.

b. Catchfan –
All debris falling out the building is in general caught by the nets and tarpaulin sheet, there should be no debris falling on the catchfan outside the bamboo scaffolding. It is different from the scaffolding used in building site where no tarpaulin sheet is provided. The protruded part of the catchfan from the bamboo scaffolding is suggested to be deleted. It will facilitate the maintenance of the scaffolding in particular in taking precautionary measures for the imminent typhoon.

c. Steel Scaffolding Frames –
It is preferable to prop for provision of convenient and safe access and better stability.

d. Heavy Duty Nylon Net –
To be installed between the bamboo scaffolding and building façade which is effective in catching falling debris.

Notes on Precautionary Measures - Figure F5-(3 of 4)

a. Para. 1 – It is advisable to design on-ground footing for the hoarding to avoid excavation at footpath.

b. Para. 3.3 – Guidelines on the Design & Construction of Bamboo Scaffolds from Buildings Department should also be referred to.

c. Para. 5.3 – Loader / Excavator / Backhoe may be used for picking up the debris, but not bull dozer.

d. Para. 5.3(A) – Depth of debris accumulation should be assessed by RSE adopting a suitable void ratio (e.g., 30% voids).

e. Para. 5.3(C) – Depth of debris accumulation on cantilevered structures should also be assessed by RSE in consideration with the propping system provided. However, debris accumulation should be avoided as far as practical.

APPENDIX

APPENDIX G
EXAMPLE OF DEMOLITION PLAN AND STABILITY REPORT FOR TOP DOWN METHOD BY MACHINES

The example shown in the Code is a general guideline and may not be applicable to every case of demolition work. The AP/RSE/RSC should ascertain and modify as required to meet the special conditions and requirements that may occur in the project. The general requirements from the Code are repeated as following.

1. DEMOLITION PLAN

1.1 The demolition plan shall consist of the following plans:

- 1.1.1 Fig G.1 Site Plan and Adjoining Site Conditions.
- 1.1.2 Fig G.2 Typical Floor Plan and Existing Building Information.
- 1.1.3 Fig G.3 Elevation A
- 1.1.4 Fig G.4 Demolition procedure and sequence
- 1.1.5 Fig G.5 Precautionary Measures
- 1.1.6 Fig G.6 Typical Support (This drawing is not shown, and is similar to Fig F.6 in Appendix F)

2. STABILITY REPORT

2.1 The stability report of this project shall consist of the following:

- 2.1.1 A stability report to justify the safety of the existing building during all phases of demolition.
- 2.1.2 A structural check with calculation on the support of cantilevered slab and beams between gridlines 5 and 6.
- 2.1.3 A structural check with calculation on the support to typical floors catering for the loading due to powered mechanical plants.
- 2.1.4 A structural check with calculation on the temporary ramp design to allow the descending of the machines.
- 2.1.5 A stability report with calculation to justify the safety of lifting of the machine to the roof.
- 2.1.6 A structural check with calculation on its hoarding, covered walkway, and catch platform.

The notes described in Appendix F are also applicable for use in this Appendix.

5. Debris Handling

The notes on the allowable height of for demolition by manual or machine method would both apply.

Refuse chute formed are generally bigger for demolition work by machine. A size of 2.0m x 2.0m is common. Please also refer to Clause 3.10 of Chapter 3 - Precautionary Measures, for the protection required for refuse chute.

When designing the allowable height of debris, the engineer should include the weight of the mechanical hydraulic excavator equipped with breaker or crusher together with the concrete debris. However, at the moment when the machine is not sitting on the concrete debris, there is a surplus safety margin of the allowable height of the debris that a floor can support without the surcharge from the machine.

In the design, the engineer always assumes that the whole floor is fully loaded with the same allowable height of debris. This is generally not the case. Generally debris would be higher at location of partition wall, either structural or non-structural, or larger size of beams and columns.

APPENDIX

APPENDIX G
EXAMPLE OF DEMOLITION PLAN AND STABILITY REPORT FOR TOP DOWN METHOD BY MACHINES

The number of excavators to be allowed for the demolition work is based on the manouvre area available for a typical floor, such that the machine can demolish the floor in an efficient and safe manner. The design is similar to the design concept of a car park, which a uniformly distributed load has been assumed, such that the space occupied by each car would not be placed by another one on top to overload a floor.

6. Special Site Safety

Emergency exit is very important in a demolition site. This is due to the fact that the site conditions are changing everyday with the ongoing demolition activities. Emergency lighting should be installed in the exit route.

Generally during the demolition of a typical floor, the staircase would be blocked momentarily during the period of the staircase demolition. In such a case, an alternative exit route should be provided if possible to ensure exit safety. Prominent notice should be posted with daily briefing of the exit route of the day for the workers.

LIST OF EXAMPLES

Example 1 Telescopic Tubular Props with Horizontal Tubular Bracings by Couplers or Steel Angle Bracing by Welding




Props with horizontal tubular bracing by couplers


Props with horizontal steel angle bracing by welding

LIST OF EXAMPLES

Example 2 Tubular Module Frame System - Demolition of overhead structure at excessive height showing platform under structure


Frame system with platform at top for cantilever demolition


Platform under cantilever structure


Frame system used as external scaffolding and prop to cantilever


Platform integrated with frame system under cantilever


Propping using tubular frame system for demolition of overhead structure


Erecting platform under structure to be demolished


Close-up view of platform under to-be-demolished structure


Debris from demolition being collected by platform

LIST OF EXAMPLES

Example 3 Tubular Module Frame System

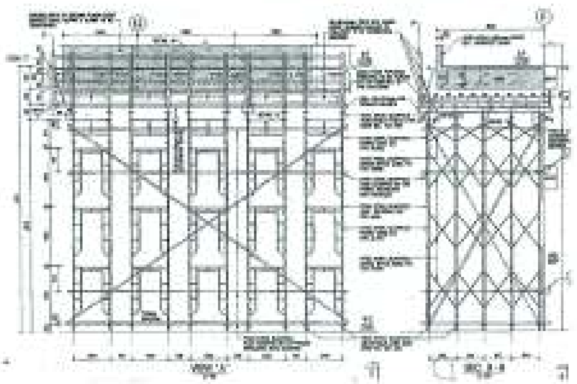
Frame system used as propping for excessive floor height

Frame system used as propping for excessive floor height

Frame system used as propping for excessive height

Frame system used as external scaffolding

Example 4 Scaffold Frame System for Demolition of Structure at Excessive Height



LIST OF EXAMPLES

Example 5 Timber Catch Fans Installed between Scaffolding and Face of Building at Every Three Floors

Example 6 Wall Demolition by Manual Method Using Chain and Block

LIST OF EXAMPLES

Example 7 Cut-and-Lift Wall Demolition by Manual Method Using Mobile Crane





LIST OF EXAMPLES

Example 8 View Showing Tower Crane and Mobile Crane for Hoisting, Bamboo Catch Fans and Fire Retardant Tarpaulin

Lifting by tower crane

Lifting of demolished element by tower crane

Lifting of demolished element by tower crane

Lifting by mobile crane

Lifting of mechanical plant by mobile crane

LIST OF EXAMPLES

Example 9 Demolition of External Column / Beam Frame with Machine

1. Breaking the upper wall / beam

2. Breaking the lower fin / column

3. Two excavators in place

4. One holding the wall with the other breaking

5. Breaking the parapet

6. Cutting outer layer of rebars of column

7. Cutting outer layer of rebars of fins

8. Fire precaution

9. Cutting horizontal rebars

LIST OF EXAMPLES

Example 9 Demolition of External Column / Beam Frame with Machine

10. Two holding the wall while cutting

11. Spraying with water during cutting

12. Two pulling down the wall frame

13. Pulling, wall coming down slowly with column rebar yielding

14. Cutting the inner rebar

15. Breaking the concrete afterwards on ground

LIST OF EXAMPLES

Example 10 Cut-and-Lift Demolition of Precast Buildings using Tower Crane

1. Clearing Non-structural Partition Walls

2. Installing Steel Props and Bracings

3. Exposing Joints of Precast Slab Panels

4. Securing Precast Slab Panel to Lifting Frame

5. Cutting Reinforcement

6. Jacking up Precast Slab Panel

7. Lifting up Precast Slab Panel (1)

8. Lifting up Precast Slab Panel (2)

9. Exposing Joints of Precast Wall Panel

LIST OF EXAMPLES

Example 10 Cut-and-Lift Demolition of Precast Buildings using Tower Crane

10. Securing Precast Wall Panel to Lifting Frame

11. Cutting Reinforcement (1)

12.Cutting Reinforcement (2)

13. Jacking up Precast Wall Panel

14. Lifting up Precast Wall Panel (1)

15. Lifting up Precast Wall Panel (2)

LIST OF EXAMPLES

Example 11 Demolition of Wall by Mechanical Plant in Conjunction with Wires

Example 12 Debris RAMP

1. Ramp formed by concrete debris

2. Machine starting to descend

3. Machine descending

4. Descend almost completed

LIST OF EXAMPLES

Example 13 Demolition of Beam / Slab by Mechanical Crusher

1. Crushing of beam starting at mid span

2. Crushing continues on left side of beam

3. Crushing continues on right side of beam

4. Crushing slab behind beam (slab temporarily supported on 3 sides)

5. Crushing slab behind beam (slab temporarily supported on 3 sides)

6. Crushing internal secondary beam

7. Repeating slab panel demolition

8. Finishing slab panel demolition

LIST OF EXAMPLES

Example 14 Demolition of Internal Beam by Mechanical Crusher

1. Crushing from mid span

2. Crushing continues

3. Crushing continues

4. Exposing beam rebars

5. Crushing continues to other side of beam

6. Crushing continues to other side of beam

7. Crushing continues to other side of beam

8. Crushing completed

LIST OF EXAMPLES

Example 15 Demolition of Internal Column by Mechanical Crusher


1. Crushing starts with surrounding area vacated


2. Crushing continues with water spraying


3. Crushing continues


4. Managing column rebars


5. Splitting column concrete


6. Crushing concrete off at bottom


7. Cutting rebars


8. Crushing remaining concrete


9. Cutting remaining rebar and finishing operation

LIST OF EXAMPLES

Example 16 Demolition of Internal Column by Mechanical Breaker

1. Breaking starts with area vacated

2. Breaking continues with water spraying

3. Exposing column rebars

4. Exposing column rebars

5. Exposing column rebars

6. Pushing down column

7. Column falls down slowly with rebars bending

8. Breaking up remaining concrete

9. Operation completed

LIST OF EXAMPLES

Example 17 Demolition of Internal Beam / Slab by Mechanical Breaker

1. Breaking beam at mid-span

2. Breaking continues

3. Breaking continues

4. Beam breaking completed

5. Breaking up slab behind beam

6. Breaking up of slab continues

7. Breaking of slab continues

8. Breaking beam / slab completed

9. Cleaning away re-bars

LIST OF EXAMPLES

Example 18 Long Span Truss with Propping Remaining under at Mid-span


1. Overview of long span truss


2. Crushing top chord of truss (props remaining in mid-span)


3. Crushing of top chord continues and removing rebars


4. Crushing of diagonal chords


5. Crushing of bottom chords


6. Crushing of bottom chords continues


7. Crushing of bottom chords continues


8. Crushing of bottom chords continues


9. Removing rebars after completion of crushing

LIST OF EXAMPLES

Example 19 Demolition of cantilever structure by HRDR

Spectator Stand – constructed with one-way-span slabs supported on secondary beams spanning between main cantilever girders.

1. Crushing slab panels bay by bay

2. Crashing internal secondary beam

3. Crashing internal slab panel

4. Crashing front portion of main cantilever girder

5. Crushing internal slab panels and secondary beams

6. Crushing remaining main cantilever girder

7. Crushing internal bays completed

8. Demolishing end bay after removal of props

9. Demolition of end bay completed

LIST OF EXAMPLES

Example 19 Demolition of cantilever structure by HRDR

10. Demolishing opposite end bay after removal of props

11. Demolishing end column/wall supporting main cantilever girder

12. Demolishing spectator seating

13. Demolishing spectator seating

14. Clearing debris after seating demolition

15. Finishing off remaining portion

RETAIL PRICE: HK $70