

Demolition Practices – an Review of Recent Local Project Cases (Demolition within Urban Environment)

by
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Demolition work is one of the most dangerous operations in construction.

Reasons/causes:

- Easy to cause injury to human workers due to the difficulty of accessing into or working inside a building which is under demolition.
- Falling of smaller objects or debris from the demolishing building.
- Falling of partially demolished structure.
- Collapse of unstable structure due to original structure being disturbed.
- Employing inappropriate methods to demolish

Reasons/causes (continued):

- Collapse of heavy demolition equipment due to inadequate support of the partially demolished structure.
- Collapse of the partially demolished structure due to the accommodation of large amount of uncleared debris.
- Congested site environment that easily cause damages to human workers, or to the third parties and their properties that are situated nearby the demolition site.



Difficult
access for
workers
entering into
a building
under
demolition



Further examples
of difficult access
in demolition jobs



Partially demolished structure
is hazardous and may easily
collapse and create accident



Heavy machinery used in demolition may have risk of collapse due to insufficient support.



Accommodation of too much debris during demolition can impose intolerable loading to the disturbed structure





Typical congesting neighbourhood condition for demolishing small buildings within urban environment



Why demolition is needed?

What kind of projects need demolition?

1. Building redevelopment where existing buildings need to be removed.
2. Building alteration projects in which a number of the existing elements need to be removed, altered or re-layout. (esp. for large scale work like a shopping mall)
3. Building works in which new and old facilities needed to be broken through for temporary or permanent access. (e.g. a new pedestrian subway cutting into a basement)
4. Other civil engineering works

Building Department has imposed very strict control to any form of demolition works by the use of approval & consent procedure

1. Authorized person (AP) should be appointed to submit application for approval of the demolition, which includes an appraisal report with a method statement proposed for the demolition.
2. Building Department will approve the work subject to the satisfying of all precautionary measures pursuant to the Building (Demolition works) Regulations, as well as the provision of hoarding and covered walkways or any other safety arrangement to satisfy the on-site conditions as required.

3. After approval is obtained, another 2-stage consent procedure are still required before starting the actual demolition.
4. Stage 1 is to obtain the consent for carrying out all precautionary/temporary works which include the installation of the hoardings, covered walkways, scaffolding, catch fans, dust screens and shoring etc.
5. In case the provisions in Stage 1 is completed and to the satisfaction of the Building Department, Stage 2 of consent for the actual demolition can be applied. Demolition can be started only with the successful obtaining of the consent.

Appraisal report as part of the submission documentations. In the report, the following information should be included:

1. Structural survey of the building to be demolished
2. Photographic record of the site and its adjacent buildings, slopes and retaining structures.
3. The overall height of the structure above ground level and the proximity to adjoining buildings.
4. Information on the type of building, its structural support system, the principal materials of its construction, the degree of deterioration and the effect of demolition etc.

Demolition Plan

Another required documentation to be submitted to BD for approval is the Demolition Plan, which include the following information:

- a) A set of drawings showing :
 - the location of the building to be demolished
 - other existing structures and facilities in vicinity
- b) Proposed methods of demolition.
- c) Proposed shoring and precautionary measures for adjacent buildings
- d) Proposed shoring and protection for the building to be demolished

Demolition Plan

- e) Proposed methods of handling and disposing of the demolished materials
- f) Proposed sequence of carrying out work.
- g) Detail of equipment used, with methods of raising, lowering or supporting the equipment.
- h) Structural calculation to justify the proposal
- i) Proposed arrangements for site supervision

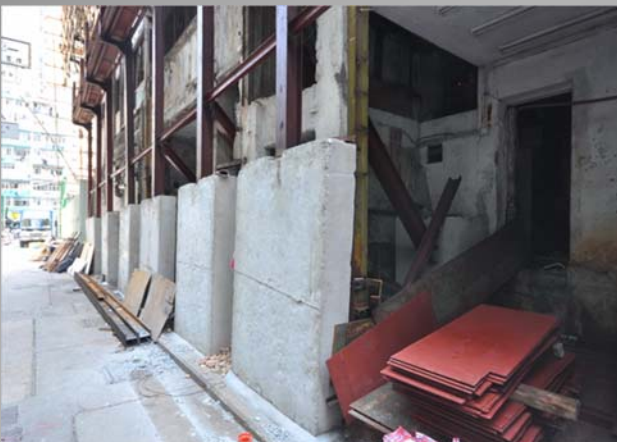


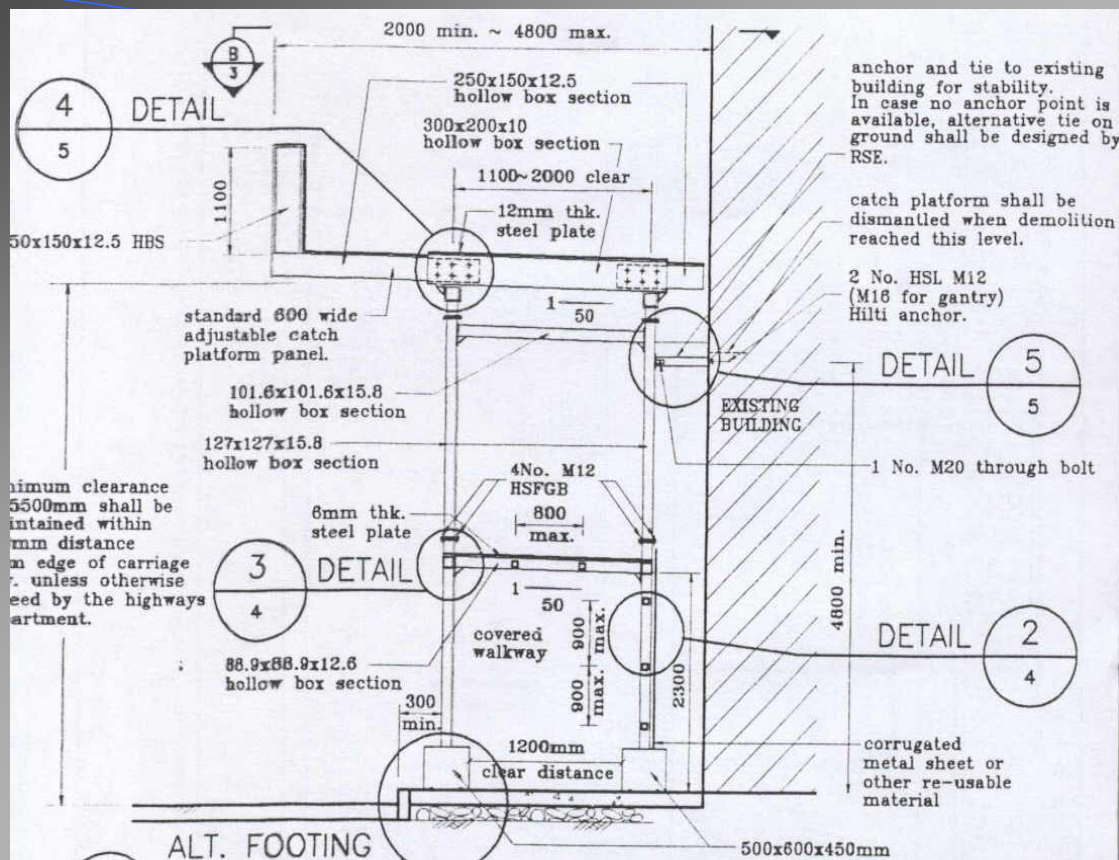
Typical dust screen and fans provision to protect building and minimize disturbance to public during demolition



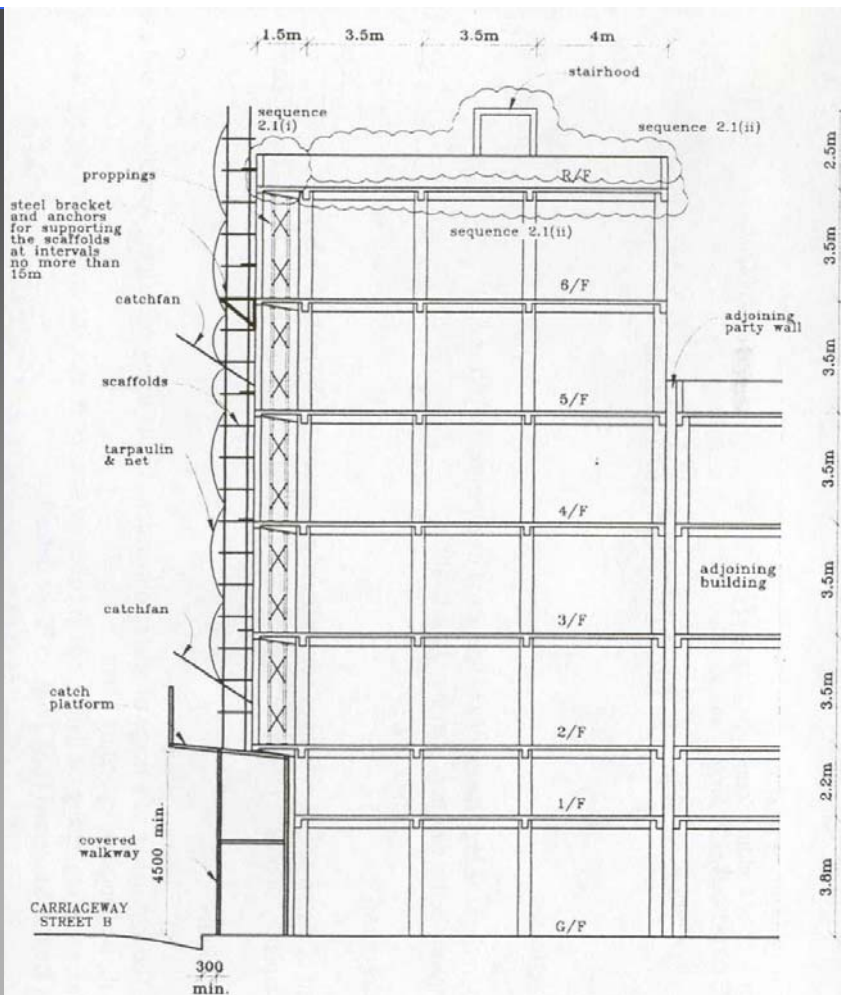


Provision of Hoarding as a protection to public



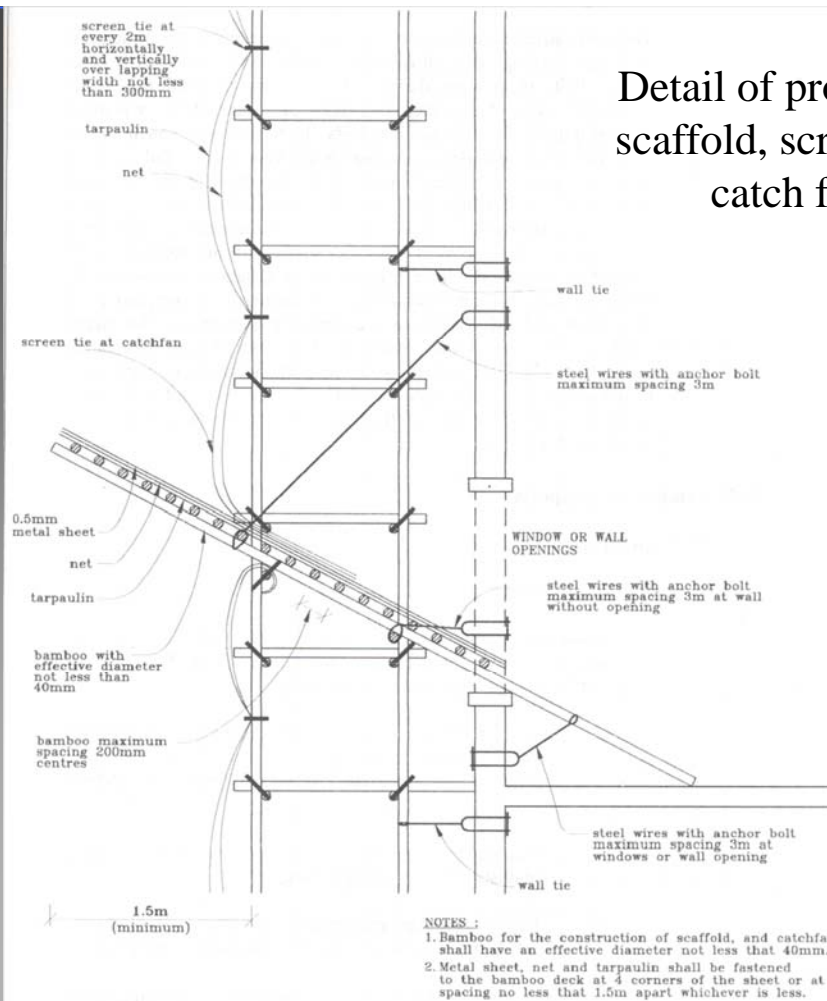


Provision of Hoarding as a protection to public



Provision of Fence and screen to prevent falling of debris and getting out of dust

Detail of protection scaffold, screen and catch fan



Shaft for falling of debris

Common ways to get rid of the demolished debris – to control the falling of the debris into a pre-determined vertical shaft formed on the floor slabs



Debris shaft formed by opening temporarily cut on floor slab



Debris collection area at ground floor under the debris shaft



Temporary props erected to support heavy equipment





Erection of shoring to support affected structure

- a) Basement demolition (left)
- b) A nearby retaining wall (right)



Typical sectioning/
sequencing arrangement of
work during demolition –
demolish from exterior
inward





Typical sectioning/
sequencing arrangement of
work during demolition –
demolish from one side to
the other side of building



Typical layout
arrangement in small and
medium sized building
under demolition





Typical layout
arrangement in
small and medium
sized building
under demolition

Protection measures to public during demolition process

The following concerns related to the protection and safety of general public or their properties should be provided in the demolition process

1. Overall structure of the adjacent buildings (stability).
2. Party walls and external walls of adjacent buildings (sealing and waterproofing)
3. Foundations of other buildings which may be affected.
4. Public roadway and traffic.

What works or preparation needed to be carried out before demolition

1. Terminate, disconnect or cut off all existing services (gas, water, electricity, drainage etc.)
2. Remove all other building elements or fixtures that are not appropriate to be done by usual demolition equipments. (sometimes also for recycling or regulation requirement for C&D waste reasons)
3. Carry out all required precautionary measures before demolition.
4. Carry out temporary propping and support to facilitate the demolition process.
5. Form access for workers and equipments to carry out the demolition.



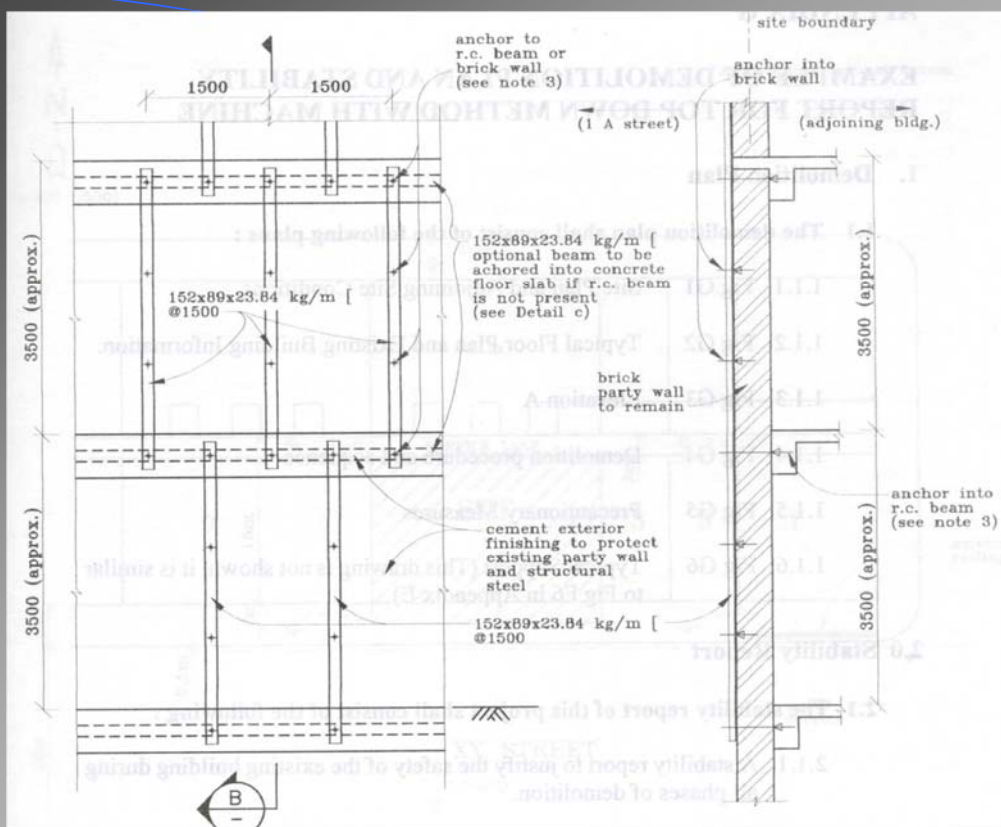
Site needs to be prepared/set-up before demolition can be carried out



Site needs to be prepared/set-up before demolition can be carried out



Site needs to be prepared/set-up before demolition can be carried out



Strengthening of party wall of adjoining building after demolition
(by the use of stiffening frame)



Stiffening frame to strengthen an exposed party wall

Strengthening of party wall of adjoining building after demolition



Timber raking shore as a temporary support to adjacent building

Shoring support to adjoining building after demolition

Method of demolition

General Concerns

The choice of choosing a demolition method depends on a number of factors such as the project conditions, site constraints, sensitivity of the neighbourhood and availability of equipment etc.

In general, top-down methods are applicable for most sites, particularly for those situated in busy urban areas. Other mechanical methods applied from the outside of a building may be suitable for projects that have sufficient clear spaces.

Method of demolition

General Concerns (continue)

For structural projections such as balconies, canopies and verandahs extending beyond the building lines, demolition by hand held tools or the cut and lift process may be a safe solution.

Each site has its specific features and conditions. The method, including detail procedures, shall be designed to accommodate the specific project requirements. In general, demolition should be done in the reverse order of construction.

Method of demolition

Demolition by human operatives –

This method particularly suitable for use in smaller site with congested space where larger machine cannot be employed.

In this case, human operatives are used in the demolition process using simple electrically or pneumatically powered tools such as picks, hammers, wire cutters, welding cutters or hand driven hydraulic jacks etc. to carry out the demolition of individual elements.



Typical demolition arrangement done by human operatives

Typical demolition
arrangement done by
human operatives



Slab with the sides
disconnected ready
for dismantle



Typical demolition
arrangement done
by human
operatives

Worker breaking
down larger piece of
structure which was
demolished by
pulling/pushing
method.





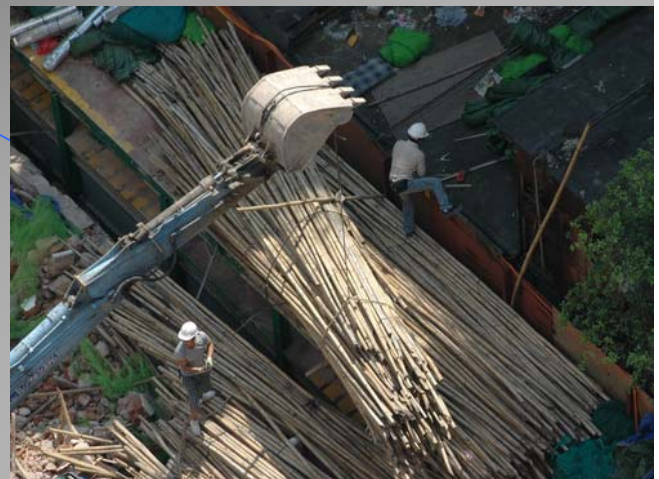
A number of
works where
human
operative is
unavoidable



A number of works inside
demolition site where human
operative is unavoidable



Working condition
and behaviour of
human operatives



Method of demolition

Deliberate collapse method –

Demolition by deliberate collapse consists of systematic removal, or weakening of the key structural elements to induce the collapse of the structure.

However, when applying this method, several precautions should be observed, such as:

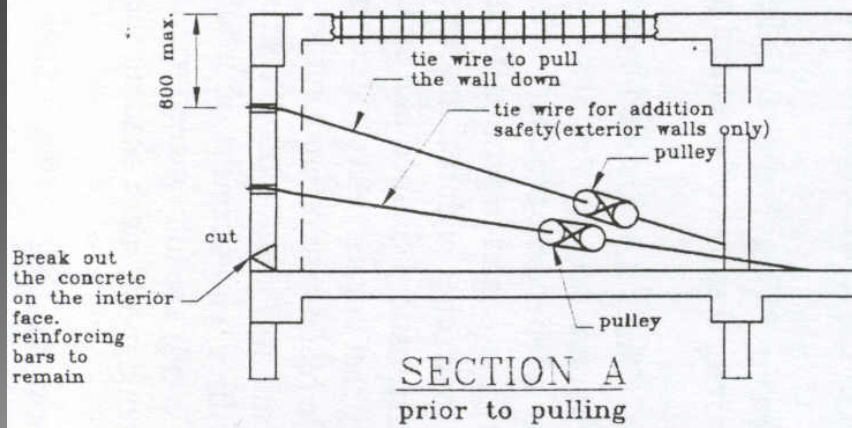
- Sufficient distance of collapse should be provided
- Collapse procedure should be carefully designed so that there is no pre-mature collapse or collapse out of the anticipated area.
- Control height of building structure to be collapsed

Method of demolition

Using of applied pulling/pushing forces

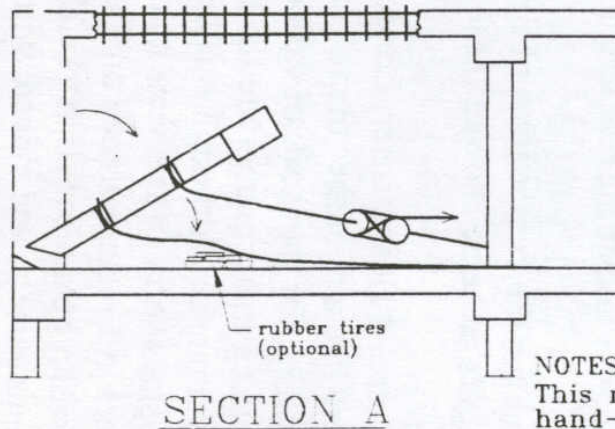
Connecting structural members are disconnected first allowing part of the remaining structure to be dragged down by the use of some pulling/pushing equipments such as powered jack, winching machine, pulley systems, pushing arms, powered blocks or from the pull/push of a hydraulic excavator.

However, a firm base in the demolishing building is required such as basing on an undisturbed core wall or a strong column section for the applying of the pulling/pushing force.

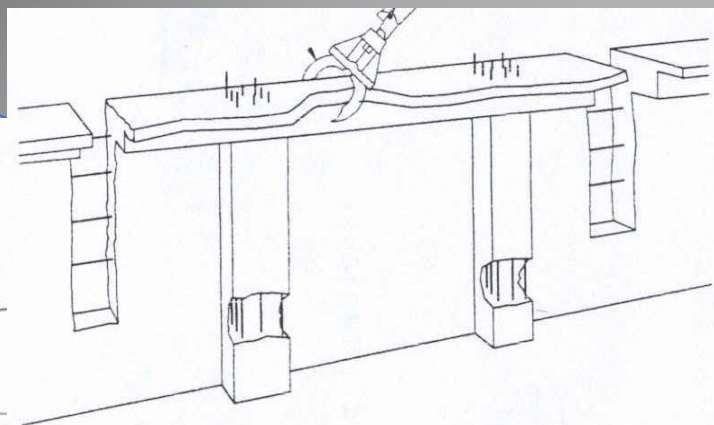
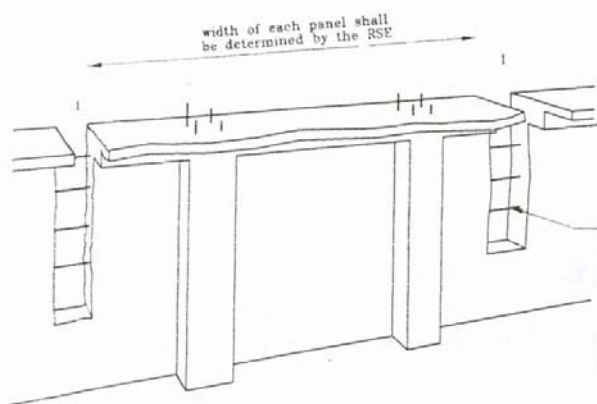


Demolition of an external wall by pull-down method using pulley

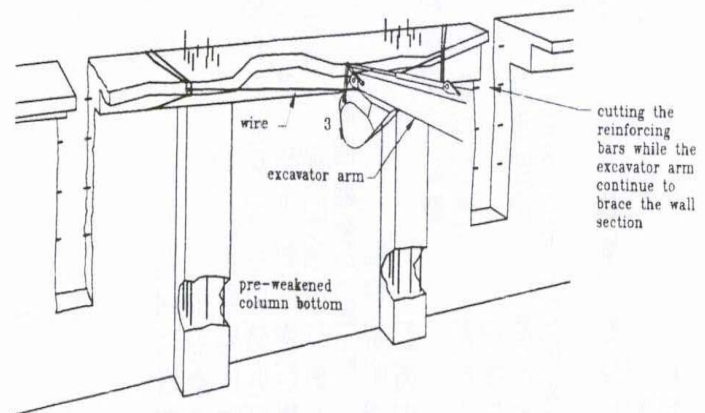
Cutting away the reinforcing bars connecting the wall section. Reinforcing bar at the bottom to remain. Pulling down the wall section by wire and winch in a controlled motion.



NOTES :
This method may apply to both hand-felling of interior and external walls.



Demolition of an external wall by pull-down method using excavator arm





Disconnected external wall ready to be pulled down by an applied force

Demolition done by applying a pulling force to a portion of structure

Remain fragments from pulled-down structure to be removed afterward



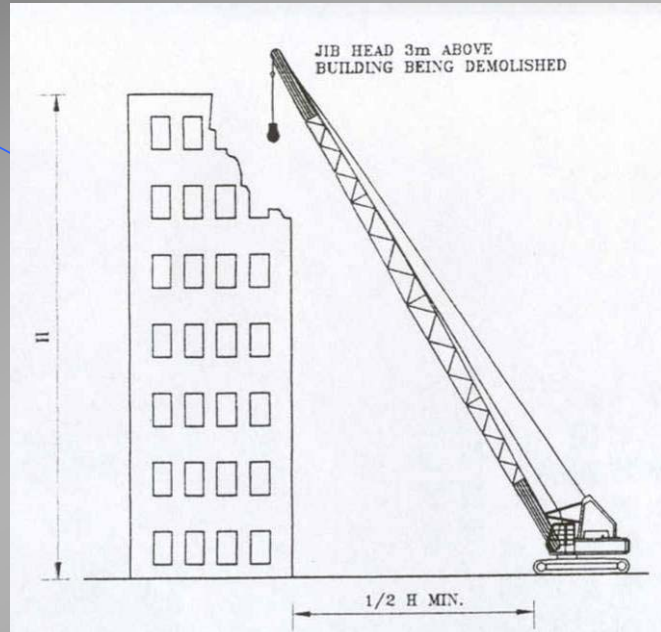
Method of demolition

Using of wrecking ball -

The use of wrecking ball method requires a crane equipped with a steel ball. The destruction of the building is caused by the impact energy of the steel ball suspended from a crawler crane.

The wrecking ball can be operated outside or inside a building. In case the process is operated inside a building, sufficient clearance from the building interior should be made first (by having the interior portion of the building demolished)

This method also demands experienced operators in order to handle the wrecking ball and control the demolition sequence in a safe manner.



Vertical drop of
wrecking ball

Swing action of
wrecking ball

Method of demolition

Use of powered plant or demolition machine -

The principle of demolition by machine is typically the same as the top-down manual method, except that most of the demolition begins with the lifting of the mechanical plant on to the building top floor.

Powered plant such as crawler mounted breaking hammer are used in the demolition process and excavating machines with bucket are used in the removal or handling of the demolished materials. However, due to the weight of these machines, they should be properly supported such as by the use of steel props no matter in still or in operating condition.

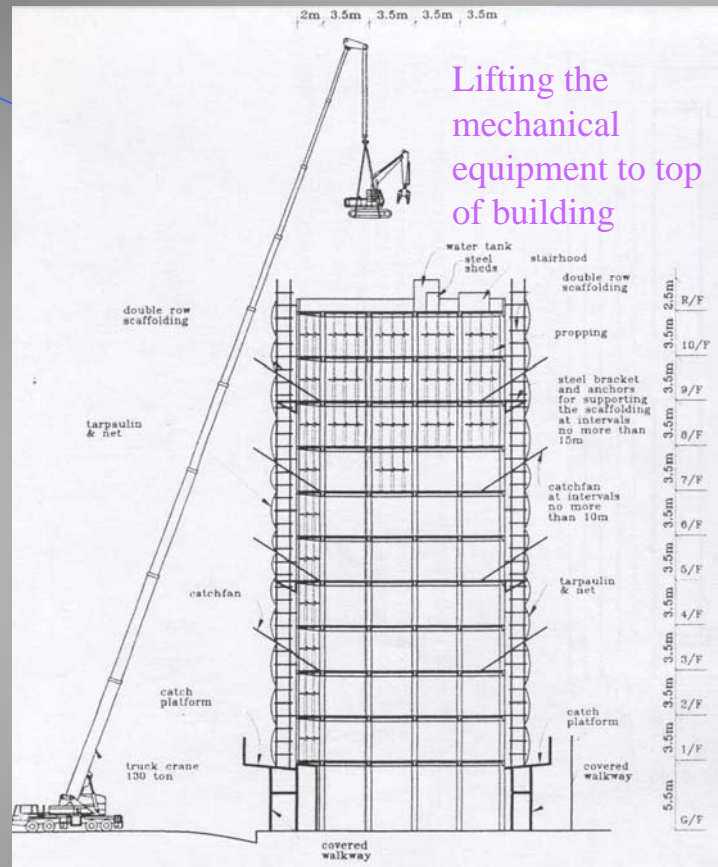
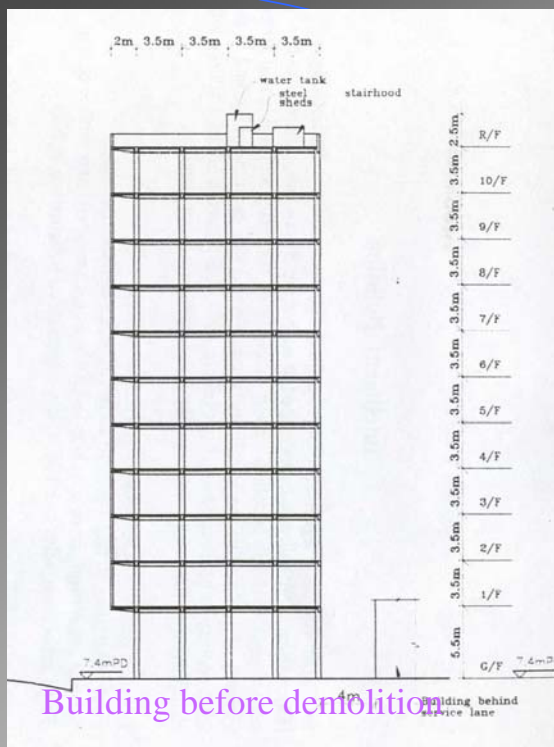


Demolition by the help of mechanical plant –
pneumatic breaker and bucketed excavator

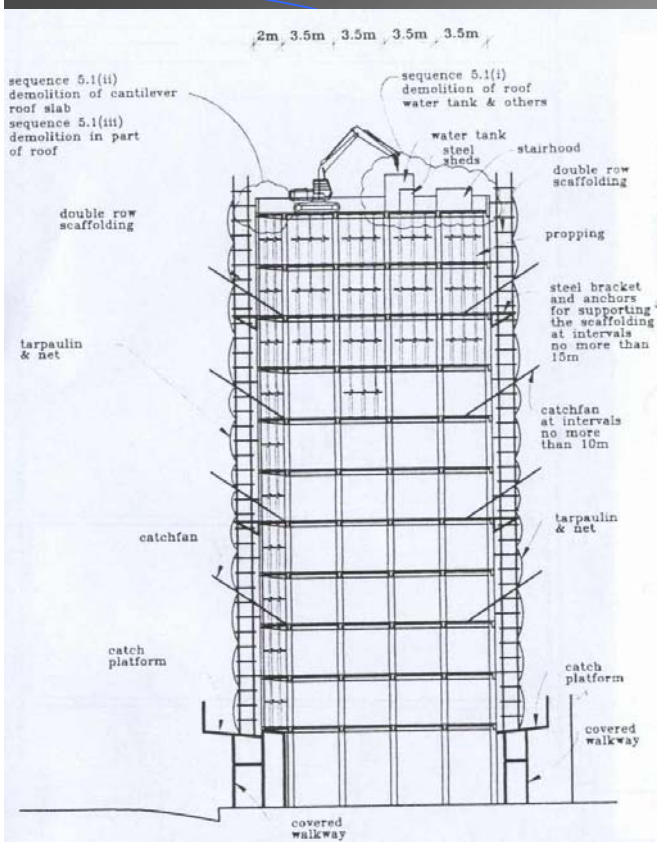


Close-up view of the
pneumatic breaking machine

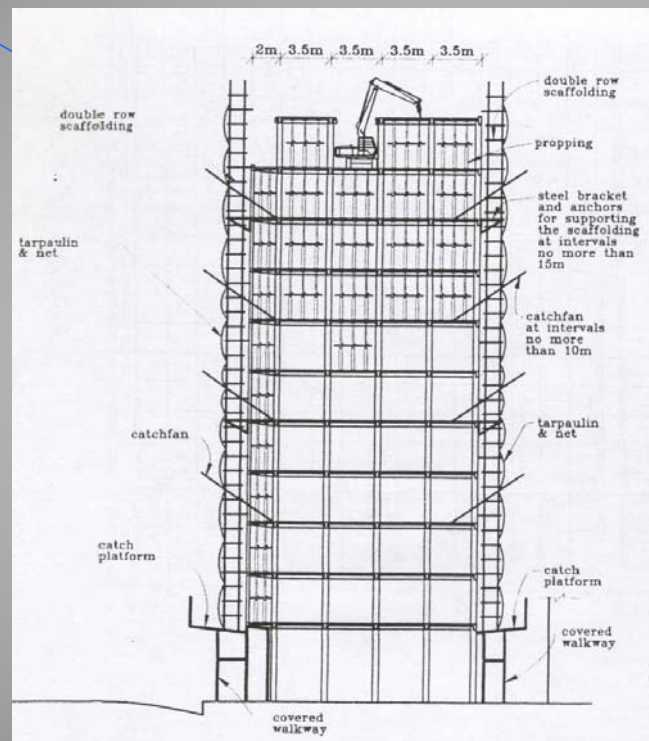




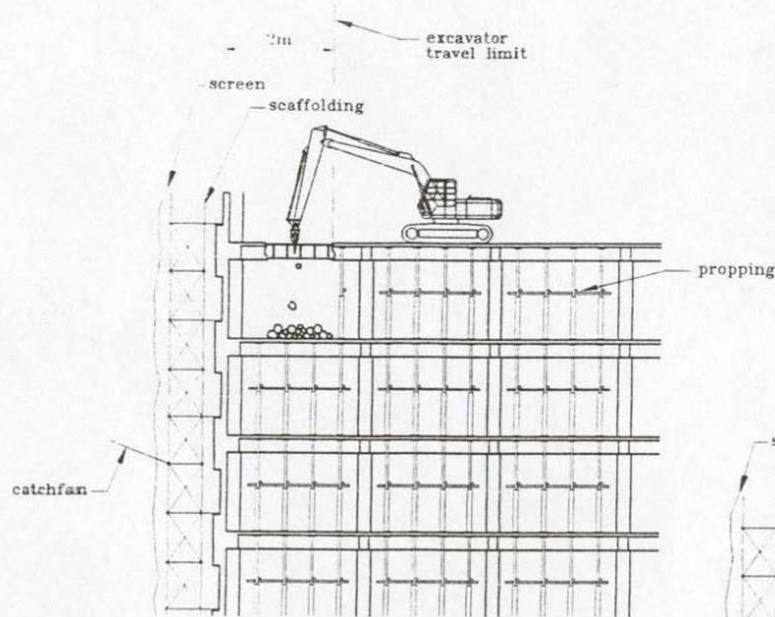
Demolition using top-down method using machines



excavating/breaking machine should be properly propped

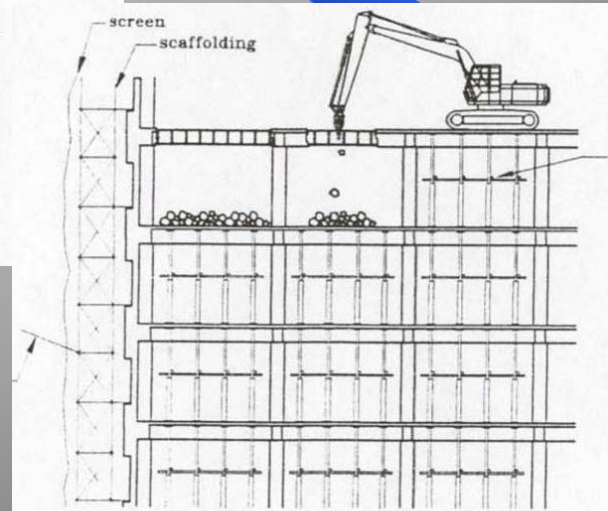


Demolition using top-down method using machines

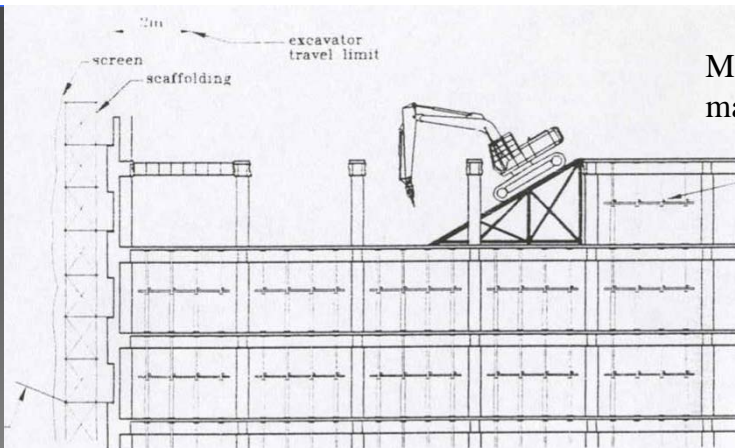


1. Demolition of Slabs and Beams

Demolition using top-down method using machines – typical floor cycle and machine movement



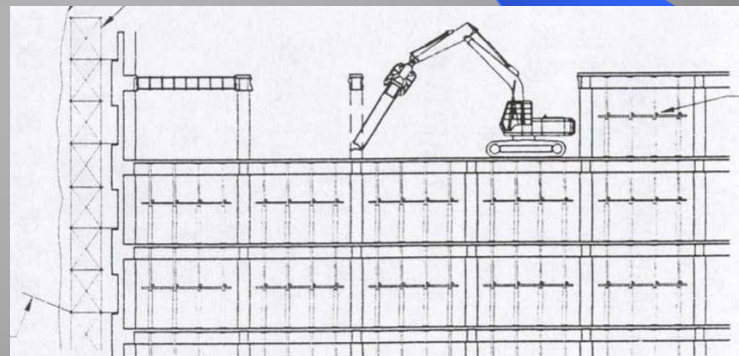
2. Continue Demolition of Slabs and Beams



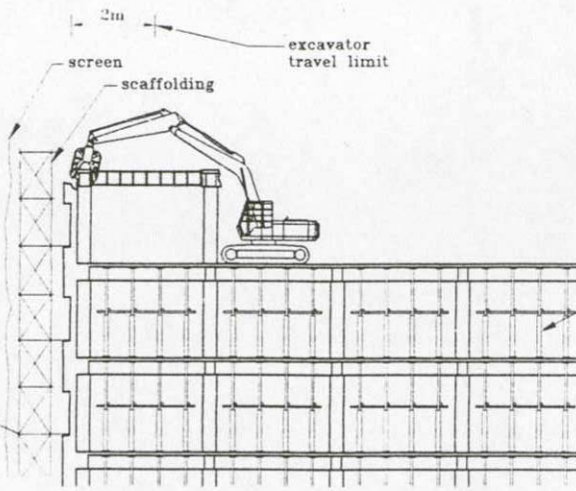
3. An access ramp of steel structural frame to allow machine to climb down to the next floor below.

Moving down of the breaking machine to the lower floor

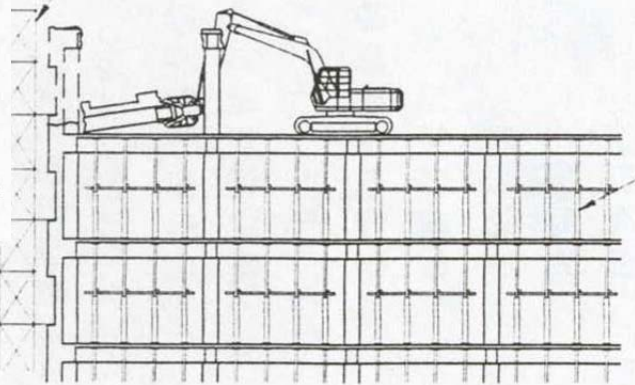
Demolition using top-down method using machines – typical floor cycle and machine movement



4. Demolition of interior column may be needed to create access and working room for exterior wall demolition. Demolish column by first pre-weakening the bottom, then dismantled by machine in fully controlled motion.

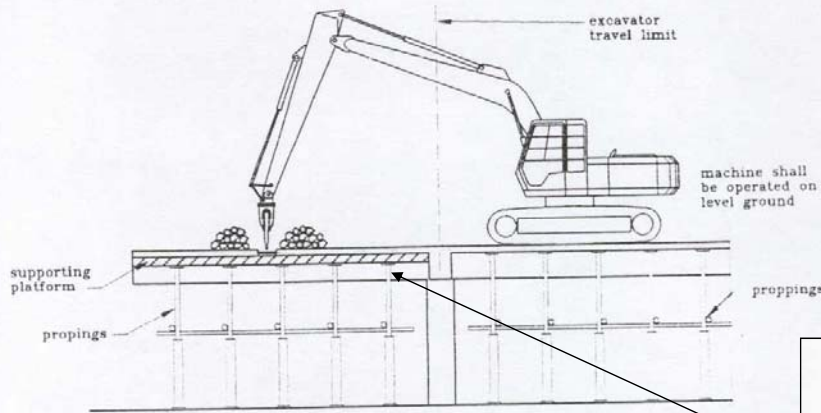


5. Cutting the exterior wall in sections and pre-weakening of columns.(see figure 4.14) Cutting should be careful to minimise debris falling outside.

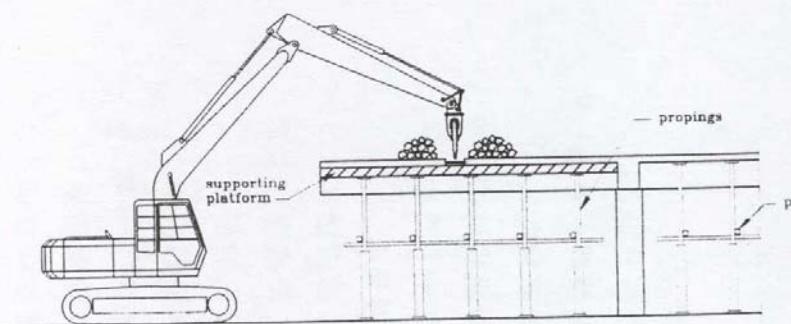


6. Machine should be used to brace the wall section while cutting the reinforcing bars connecting the wall section. The wall section shall be pulled down in a controlled motion.

Demolition using top-down method using machines – typical floor cycle and machine movement

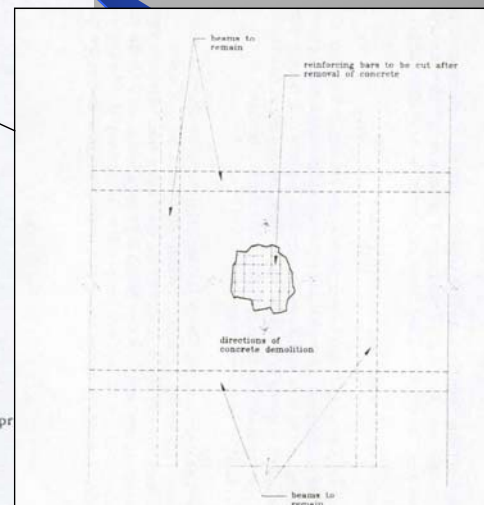


CASE 1. MACHINE MOUNTED ON SUSPENDED FLOOR



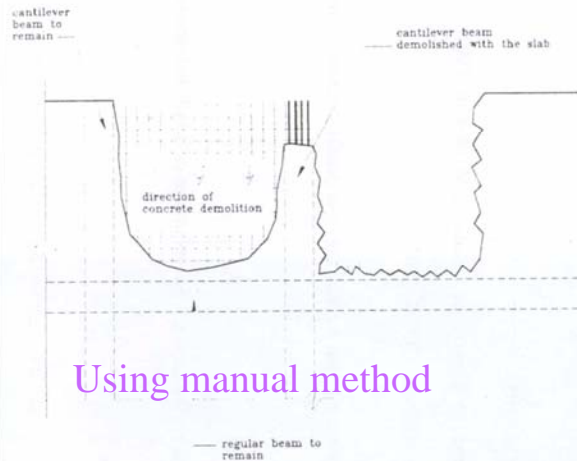
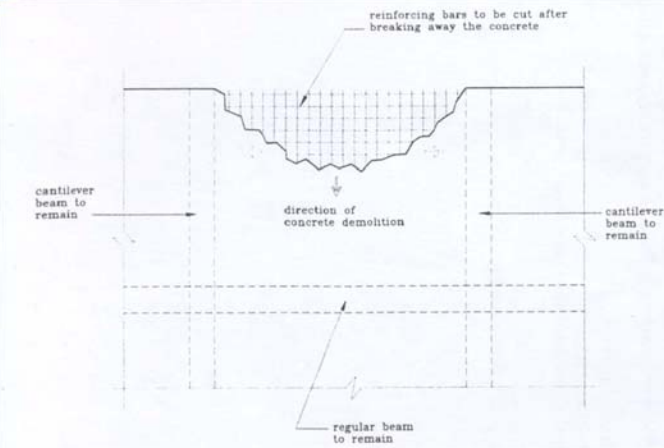
CASE 2. MACHINE MOUNTED ON GROUND

Demolition of 2-way floor slab using mechanical breaker

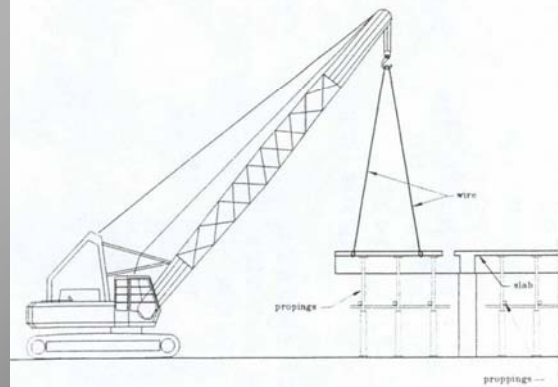
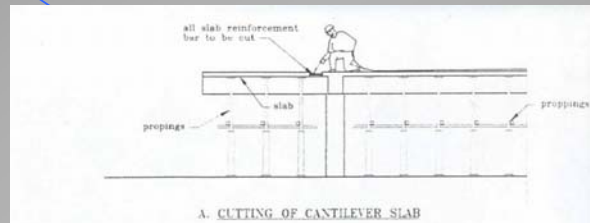


Demolition of floor should be started from the middle

Safe practice – Demolition of cantilever slab

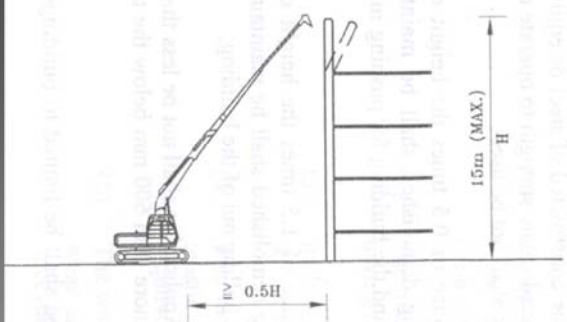


Using manual method

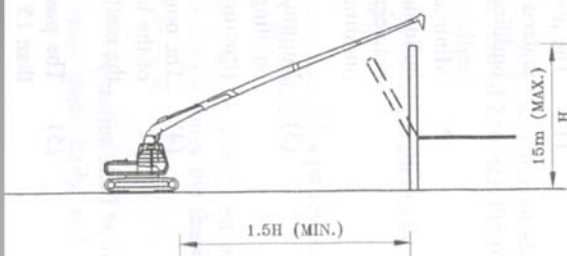


Using cut and remove method

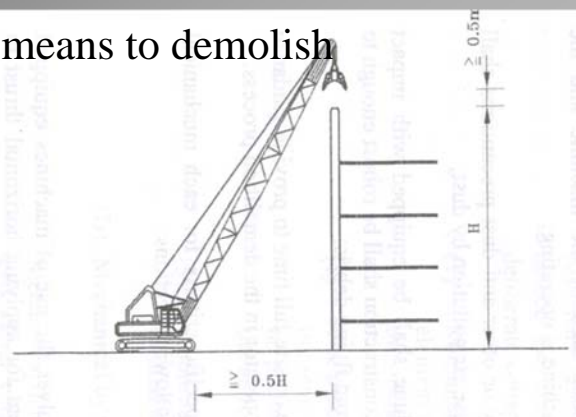
Some more examples of mechanical means to demolish



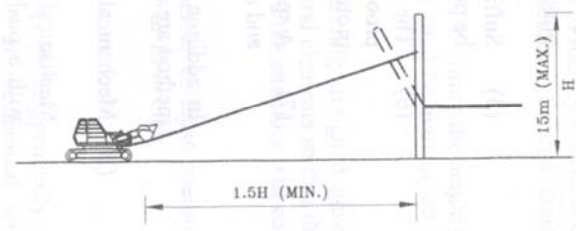
(i) MECHANICAL BY PUSHER ARM - PUSHING IN



(ii) MECHANICAL BY PUSHER ARM - PULLING OUT



(iii) MECHANICAL BY CLAM SHELL



(iv) MECHANICAL BY WIRE ROPING

Method of demolition

Using of hydraulic arm with clamps mounted on excavating machine –

One or more demolition machines similar to normal excavator will be used to perform the demolition work. This machine is mounted with a long hydraulic arm with a crusher or clamp to do the actual breaking. Sufficient working space is an essential criteria in using this method.





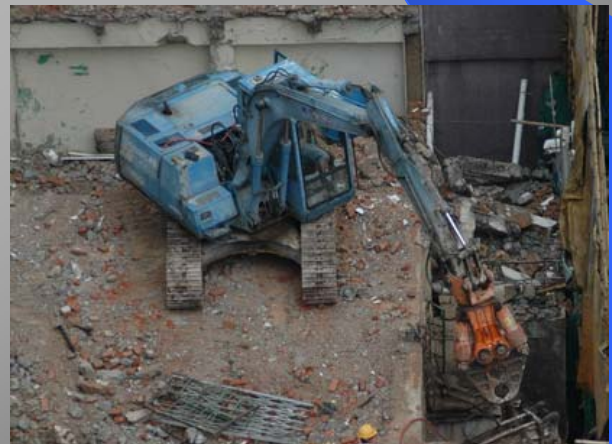
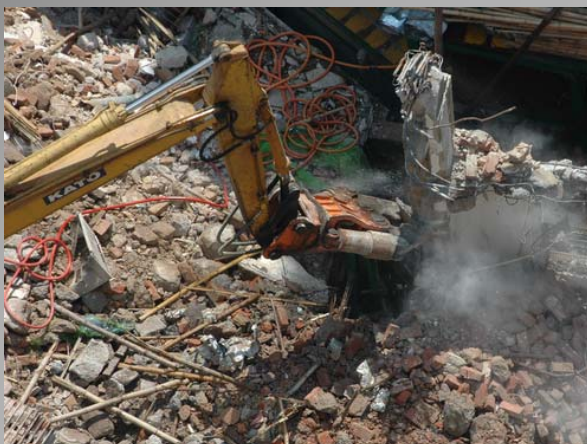
Method of demolition

Using of hydraulic clamp or robotic breaker –

Specially designed breaking/cutting machines, usually track mounted, are used to demolish some smaller structural elements such as thin walls, stairs, slab or parapet etc. when using this kind of equipment, planning for accessing the machines into the working spot is essential.



Demolition using
hydraulic clamp or
robotic breaker



Method of demolition

Using saw cut method –

This method is suitable for alteration and additional works where accuracy is important and restriction on noise and vibration is required.

It can be used to cut concrete slab and wall elements into segments or for the forming of openings, breaking into existing structure like a basement, servicing tunnel, flyover, or other part of an inhabited building in the process of alteration or renovation works.

Method of demolition

Using saw cut method (continue) –

Saw cutting can be done using the following methods:

- wire saw cutting
- diamond core stitch drilling
- disc saw



Set-up and mounting of the
saw dis on wall



Demolition using disc saw cutting

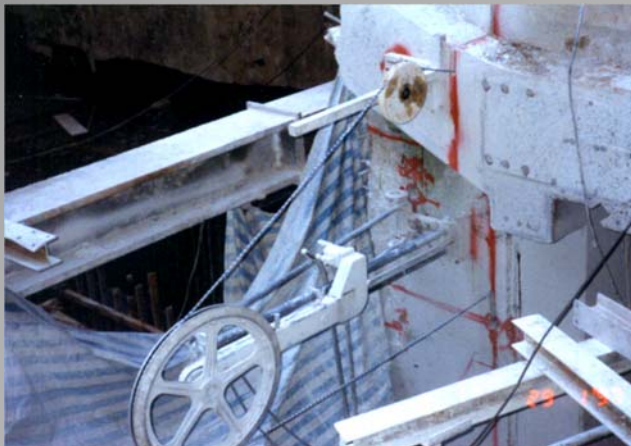


An opening
formed on floor
for the insertion
of a steel prop



Demolition using diamond core

Demolition using wire sawing

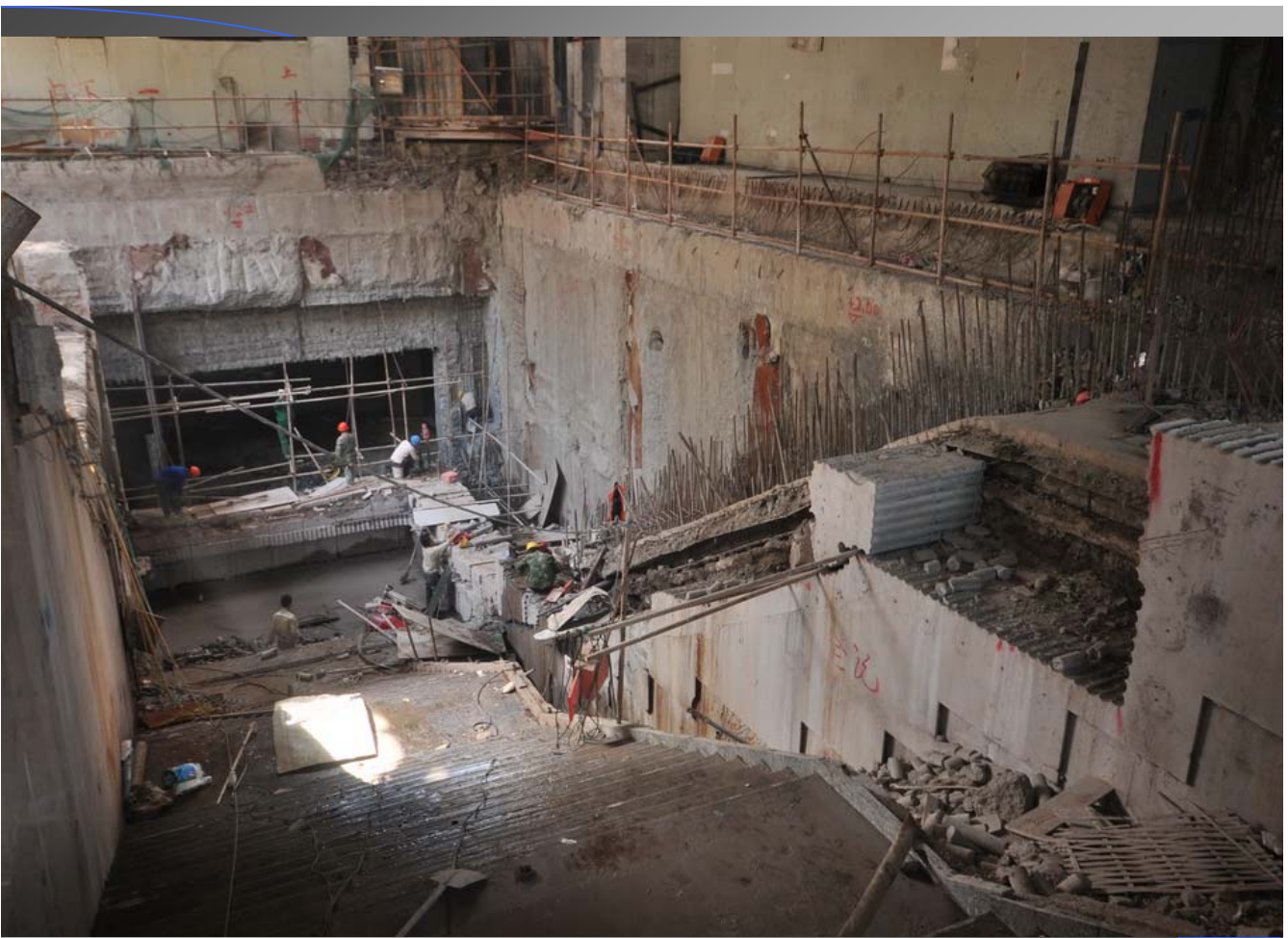




Demolition using saw-cut and boring method for the diversion of a storm water discharge culvert

Demolition using saw-cut to demolish a long section of bridge





Using core and drill method to demolish a pedestrian subway





Method of demolition

Using cut and lifting method –

Cut and lifting involves the initial cutting of the structure into individual pieces or segments, and then lifting the pieces by crane onto the ground for further demolition or hauling away.

Special precaution should be made when applying this method for demolition such as:

- weight of the cut segment may cause extra loading to the remaining structure
- lowering of the segment can be dangerous



Lowering of segment from a footbridge after dismantled by saw-cut

Method of demolition

By implosion (explosive) –

If using this method to demolish a building, contractor should carry out a comprehensive risk and environmental assessment on the effect of implosion on the neighbourhood.

A detail demolition design is also important, which should cover:

- Method to pre-weaken the structure (e.g. demolish some load taking structures)
- Placement of explosive
- Time-delay design to allow the building to collapse under control direction and location
- Case examples <http://www.youtube.com/watch?v=sK50So-yYRU>

Shenzhen Example – to demolish 7 building block average 16-storey tall using explosive to provide land for the HK-Shenzhen border crossing at Huanggang





How to clear and clear away the unfinished structure after the explosion?

Method of demolition

By implosion (continue)

charges of explosive are placed within the fabric of structure and detonated to cause partial or complete collapse. Competent explosive specialist is required when demolition is to be done by using explosive.

There are numerous types of explosives for use for various types of demolition (sometimes including non-explosive agent). Consideration such as the spacing and depth of explosive to be located, the amount of explosive to be used, or the degree of fragmentation required in order to control the boundary of demolition etc., are required throughout the planning and operation process.

Removal of demolished material or debris

Demolition will generate huge amount of debris. The safe and effective removal of such construction remains will be a prime concern in the operation.

In this case, before and during demolition, the following provision should thus be provided:

- Overall debris disposal planning
- Traffic routing for debris handling and vehicular access etc.
- Adequate number of chutes/shaft for debris disposal
- Sorting of non-structural materials such as timber and metal for recycling.

Removal of demolished material & debris

Debris created by demolition is usually collected to one or two pre-arranged shafts in the building and the debris are allowed to fall or drop freely from the shafts, by the push of a bulldozer or alike, down to a safe debris collecting areas for further deposal. Since the accommodation of a certain amount of debris is expected, the areas around the shaft should be properly fenced or propped so that the extra weight of the debris can be taken up.

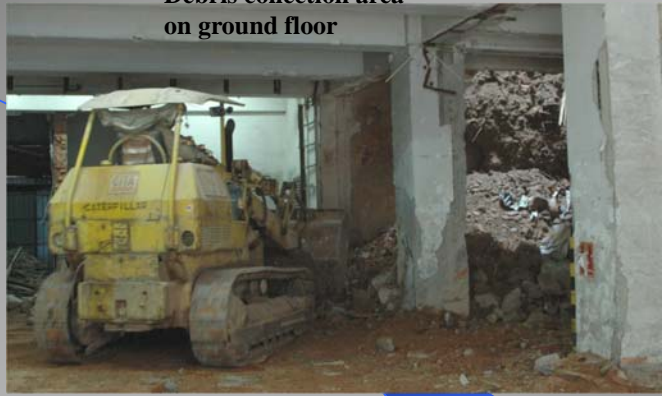
Accommodation of debris is often dangerous for they may impose extra load to the floor or wall (if leaned against onto). Debris should be cleared away the structure at the earliest possible.

For larger demolished materials, such as a section of a beam or column member, they can be hoisted down using steel rope, lifting arms or winch etc.

If the site area is large enough or where situation allows, a section of building may be demolished first. The area vacated can be used for the handling of the debris. In this case, a mobile crane may be employed to lower the debris using a bucket or skip.



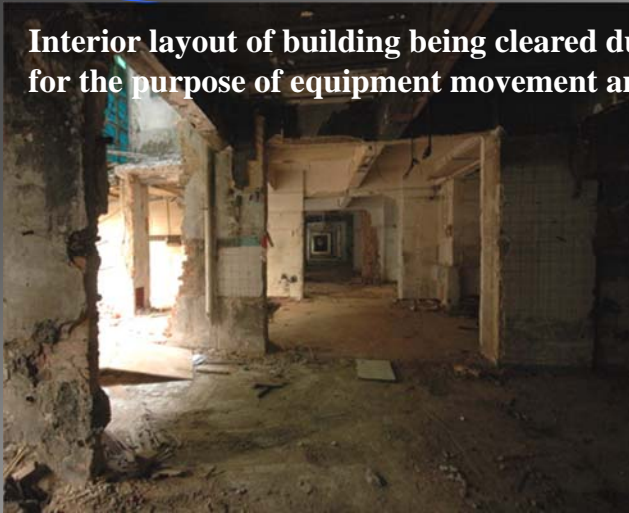
**Debris collection area
on ground floor**



**Rebate, light-well or temporary
floor opening for the falling of
debris onto ground level**



**Interior layout of building being cleared during demolition
for the purpose of equipment movement and debris handling**





Removal of debris in downtown congested site – using small loading vehicle to take debris from site through public roadway to dumper truck



Removal of debris in downtown congested site – using small loading vehicle to put debris directly onto a dumping bucket placing just outside the site exit.





Portion of the building interior being cleared out for debris handling purposes



Collected metal and other valuable scrape for recycle



Demolition for special structure

The following structure should require very special attention during demolition:

- Precast elements
- Prestressed elements
- Cantilever structure
- High headroom or Large-spanned elements
- Structural elements under special jointing arrangement (e.g. hinged or pin-jointed)
- Composite or steel structure

Demolition for special structure

The following structure should require very special attention during demolition (continue):

- Hanging structures
- Transfer plate and deep beams
- Special floor structures - waffle floor, flat slab
- Arches, trusses or girders structures
- Cladding or curtain wall

Demolition for special structure

The following facilities or buildings should require very special attention during demolition:

- Buildings located in contaminated site
- Buildings used as oil or dangerous goods storage
- Marine structures
- Underground structures (tunnel, basement or foundation)
- Soil retaining structures

Disconnection of utilities services before demolition

The following utilities should be properly sealed or disconnected before the commencement of demolition:

- Electricity and gas
- Gas and water supply
- Vent shaft or any underground access
- Drainage and sewage systems

Majority of these utilities services are located underground and can hardly be seen visually. A detail survey should be done before hand to ensure they are found and disconnected.

Environment concerns in demolition

Demolition is a dirty and dangerous process. In view of ensure such works are done properly without causing any unnecessary interference to general public, the following areas of environmental concern should be noted.

- The proper recycle or disposal of the construction waste
- Treatment of harmful material (e.g. asbestos or contaminated waste)
- Control of dust generation
- Control of noise
- Control of waste water (including rain water carrying large amount of mud running out from site)

Other precautions to be noted

1. Provision of temporary propping support for extra loading (mainly for demolition machines)
2. When handling the debris, continual spraying of water onto the debris can help suppressing the creating of dust.
3. Better work coordination should be maintained to ensure no worker is working inside the building when the debris is being pushed down from the debris shafts.
4. Secure all the partially demolished structures by prop, wire or bracing etc. to ensure the areas are save and will not fall down, at least temporary, and hurt the workers who is working around.

5. When a building is attached to other buildings nearby, the structure to be demolished should first be detached from the adjoining structure by hand demolition techniques.
6. Very special attention should be made to any demolition work that is carried out along the external perimeter of building for the falling of objects may cause great casualty to third party below.
7. Maintain a safe emergency access for manual operators all the time during demolition.
8. Maintain a non-obstructing route for moving of equipment and clearing of debris materials



Normal propping arrangement



Adequate propping support for the machine?



Shoring support
for retaining
structure nearby



Propping
arrangement for
cantilever balcony



Jetting water to the spot
where demolition takes
place

Protect by secure a free
standing external wall
section by steel ropes



Steel rope



Fence off the vertical shaft
for the removal of debris

Maintain a safe access for
worker during demolition





Obstructed route



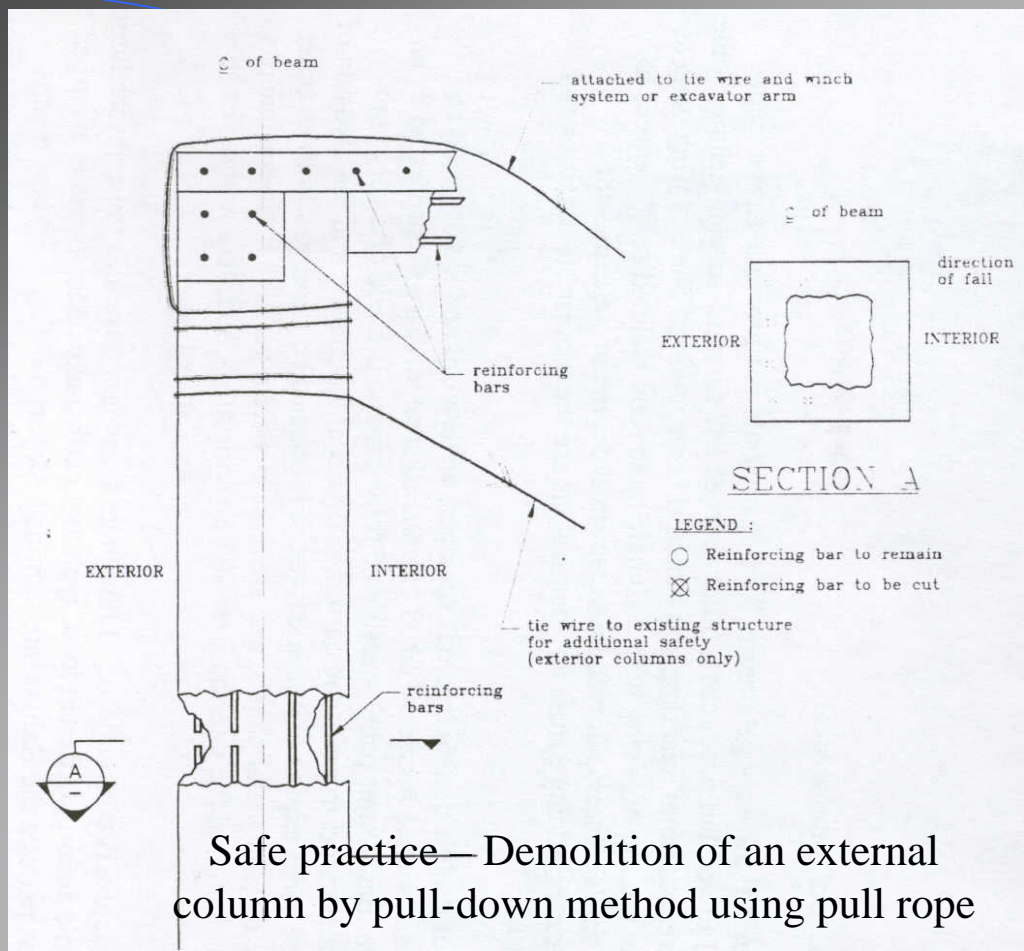
Protect exposed retaining structure after demolition by steel shoring or by remaining building frame of the old structure



Avoid letting a long section of wall free standing without support



Free standing wall without support



Some other very complicated demolition cases

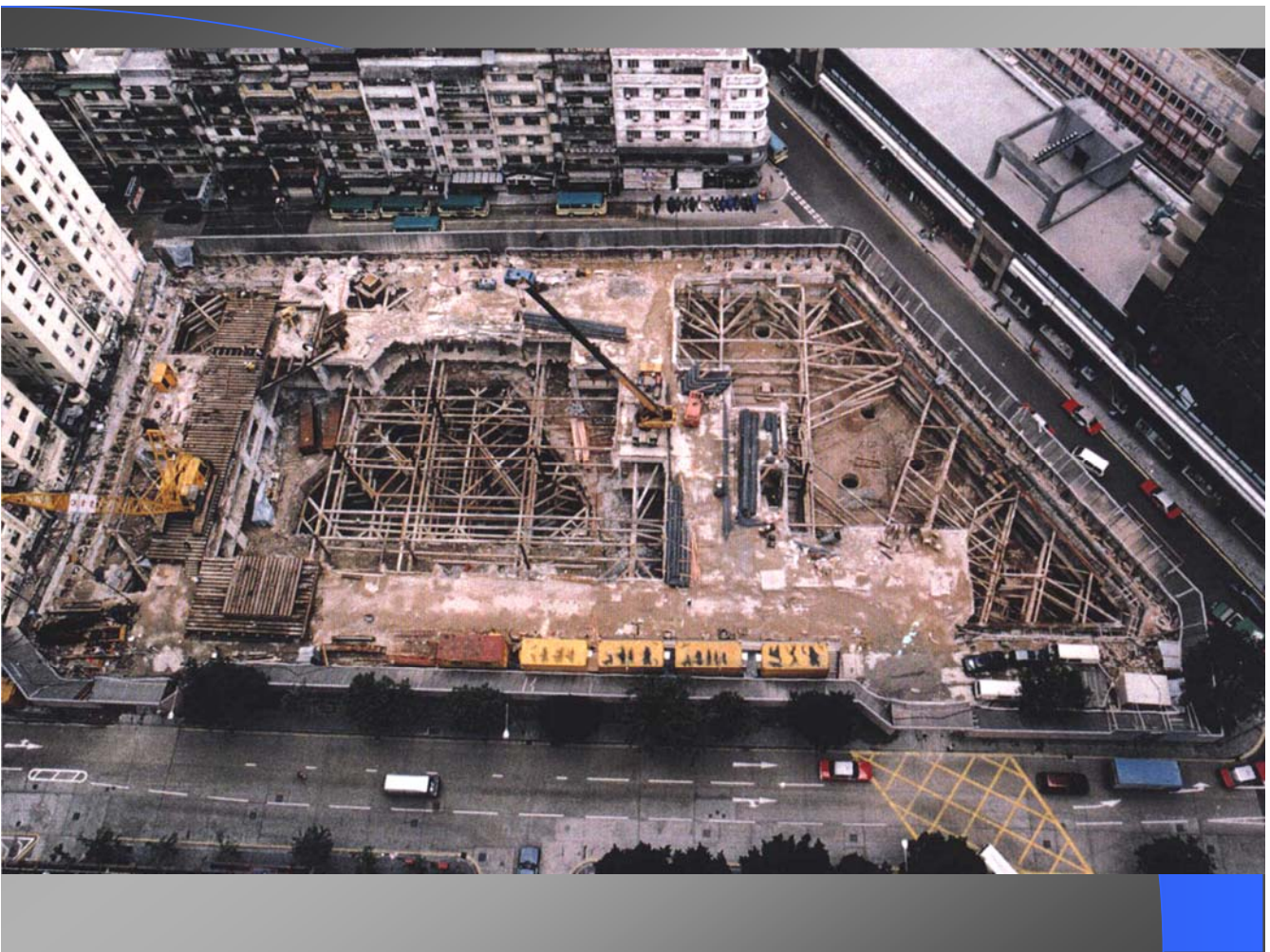
The redevelopment of the Lee Gardens Hotel



Various phases of basement demolition – part of the basement being removed for construction of the pile cap for the future building

Continual stages of the basement demolition with the incorporation of other substructure of the future building

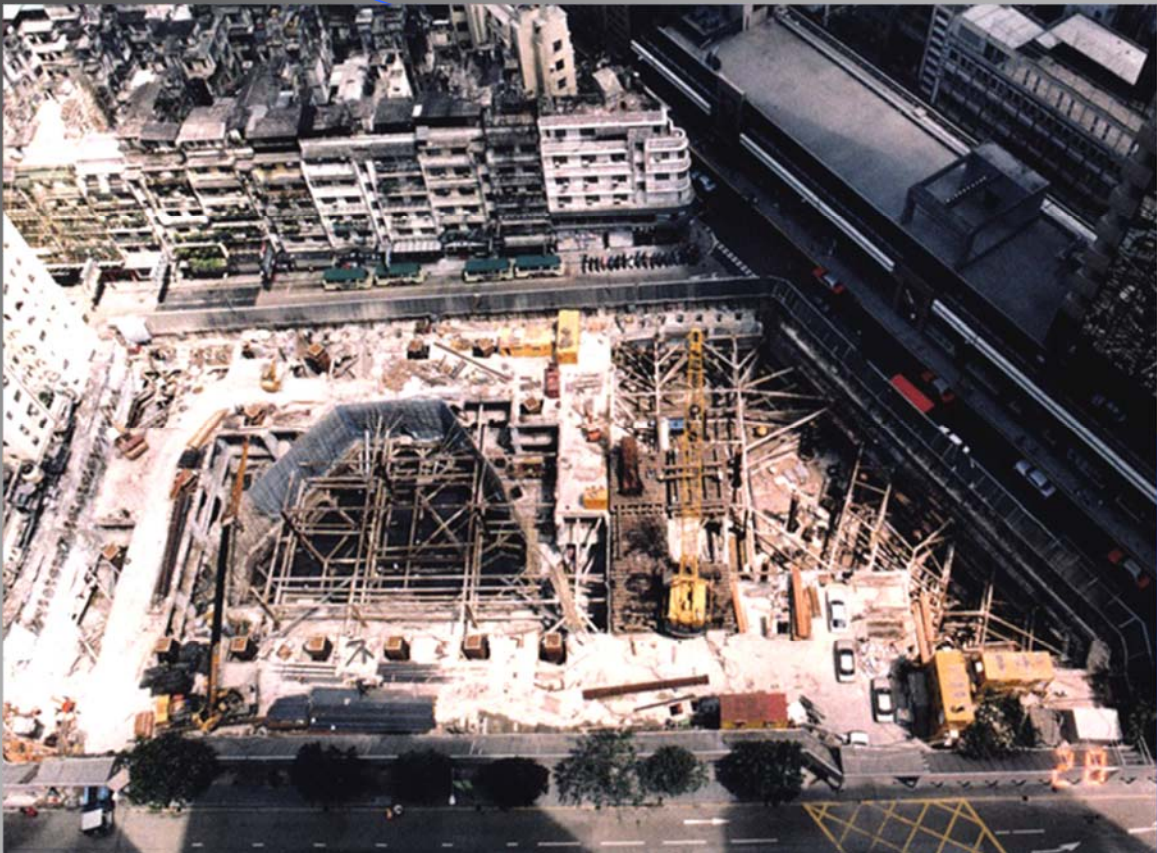


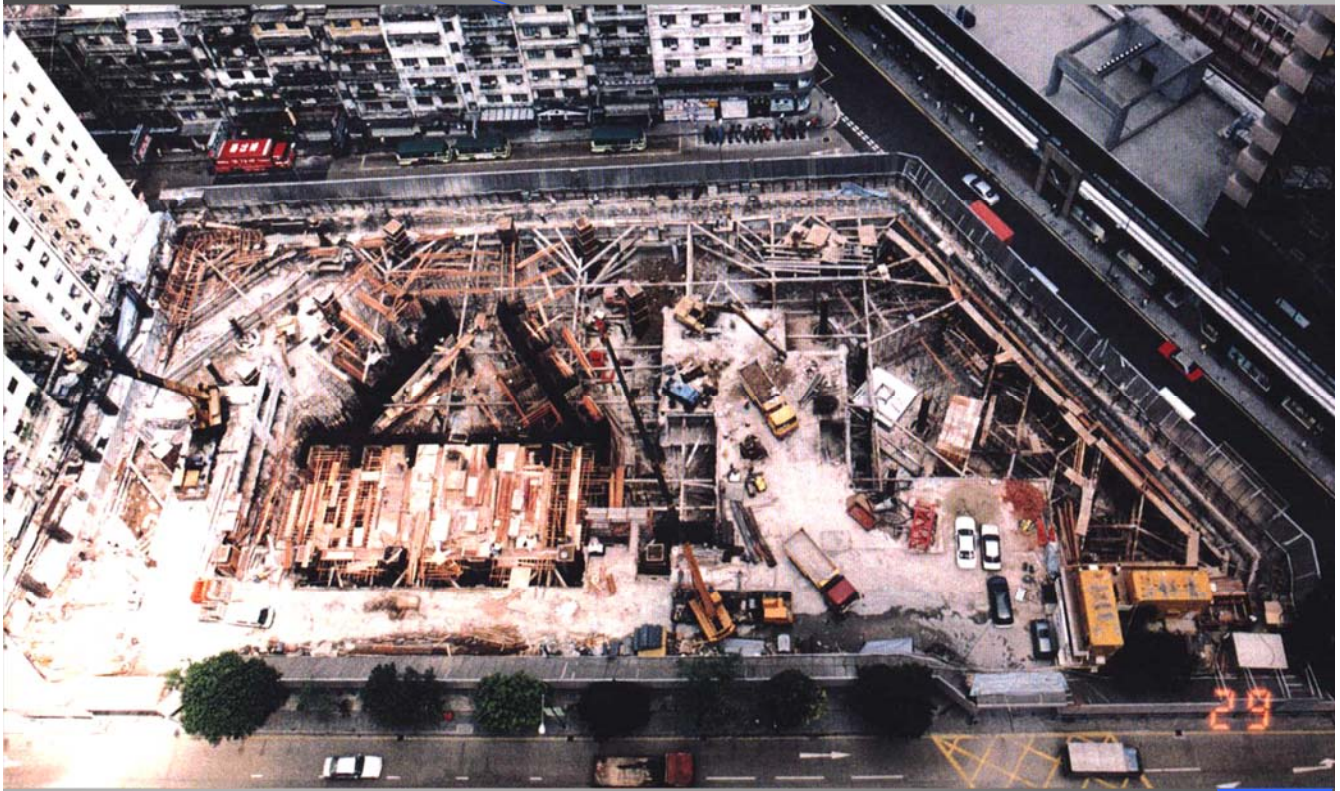


The redevelopment of the Lee Gardens Hotel (building with an existing basement)



The demolition of the basement structure working at the same time with the construction of the future building





The redevelopment of the Hilton Hotel

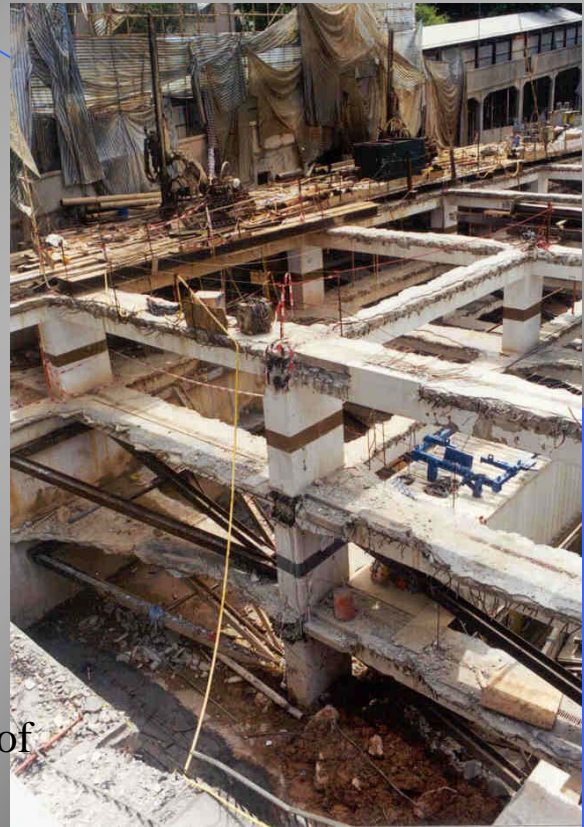


Demolition of the basement structure of the previous Hilton Hotel – the lower basement was backfilled to maintain stability of the disrupted basement structure before the commencement of the new basement

The redevelopment of the Hilton Hotel



Demolition of the basement structure of the previous Garden Road Carpark



The Millennium City in Kwun Tong

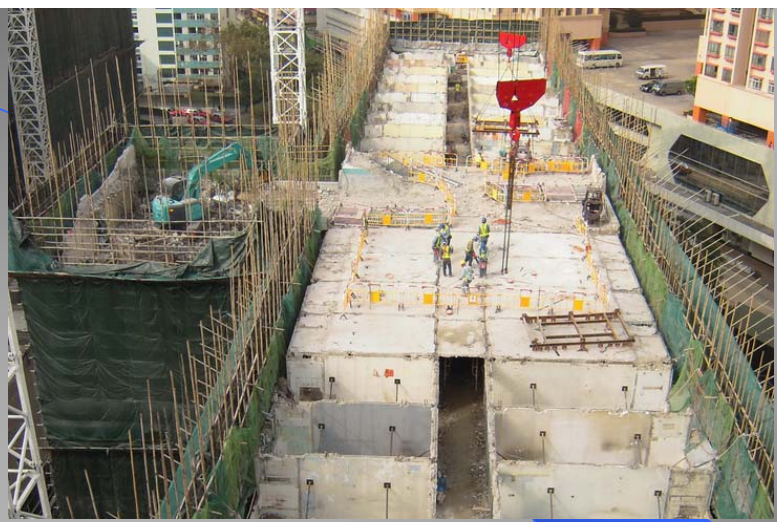


Demolition of the basement working at the same time with the building foundation



Demolition of building constructed using precast method –
Ngau Tau Kok Lower Estate





Concerns when demolishing a basement

Basement is a soil retaining structure. If demolished not in a proper manner, the basement and the surrounding may collapse and cause serious damage both inside and outside the basement boundary. The following concerns should be taken when doing the demolition work:

- Careful planning of work is important (usual to demolish in smaller section and in coordinated phases)
- Proper shoring should be provided to the basement during demolition

Concerns when demolishing a basement (continue)

- Because the upper structure has been remove, the basement (and the soil below) may have uplifting problem.
- There may have ground water problem.
- Existence of old foundation structure (usually required to be removed)
- Accessibility into basement (and removal of debris) is difficult.