

Chapter 4

DEMOLITION WORK

4.1 PRELIMINARY PROCEDURE

4.1.1 General

The safety provisions specified in this chapter shall apply to demolition and dismantling of all types of buildings and structures in addition to the safety requirements mentioned in Chapter 3.

4.1.2 Planning

Before commencing the demolition work, a detailed survey and study shall be made of the structure to be demolished and the structures in its surroundings. This shall include the manner in which the various parts of the building to be demolished are supported and how far the demolition will affect the safety of the surrounding structures. Planning for demolition and safety of adjoining structures shall be made accordingly.

The sequence of operations shall be planned by an Engineer-in-charge recognized by the Authority as having experience in demolition work of similar magnitude. No deviation from the approved plan shall be permitted without the approval of the Engineer-in-charge. Before the commencement of each stage of demolition, the foreman shall brief the workmen in detail regarding the safety aspects to be kept in view.

Demolition of buildings and structures shall be carried out under supervision of qualified Engineer and with prior notification to the AUTHORITY as prescribed by the latter.

The Authority may require the permittee to submit the plans and a schedule of demolition. Neighbors and public shall be notified of the intended demolition through newspaper or other media. The extent, duration and time of the demolition shall be clearly specified in the notice.

4.1.3 Protection of Adjoining Property

A written notice shall be delivered to the owner of each potentially affected plot, building or structure at least a week in advance of the commencement of work. The notice shall request written permission to enter the plot, building or structure prior to the commencement of work and as and when required during the work to inspect and preserve them from damage.

Owner of the structure to be demolished or dismantled shall under all circumstances preserve and protect the adjoining lot, building or structure from damage or injury. This shall be done at his own expense.

In case damage to the adjoining property is imminent, the demolition operation shall be stopped forthwith and shall not be restarted until the necessary measures to prevent such damage have been taken. All waste materials and debris from the demolition shall be removed immediately.

If the owner of the property to be demolished is denied entry to an adjoining structure, he shall immediately notify the Authority in writing of such denial. In this situation, the Authority may hold the adjoining property owner fully responsible for any damage to his property.

4.1.4 Precautions prior to Demolition

Demolition of any building shall not commence until the required pedestrian protection structures in accordance with 4.1.5 have been built. Building or structure damaged by fire, flood, explosion or earthquake, shall be protected from collapse by way of bracing, shoring etc. before demolition is commenced.

Permission shall be secured from the Authority for using explosives. General public and owners of the adjoining properties shall be notified beforehand of such use. All precautions as required by Sec 2.2.5.3 and Sec 4.3 shall have to be ensured before, during and after the use of the explosives.

Danger signs shall be posted round the property; this shall conform to the relevant sections of Part 10. All entrances shall be barricaded or manned. At least two independent exits shall be provided at night; warning lights shall be placed above all barricades during the night and dark hours. Even when work is not in progress, watchmen shall be provided to prevent unauthorized entry of the public in the danger zone.

4.1.5 Protection of Public

Safe distances shall be clearly marked and prominent signs posted. Every sidewalk and road adjacent to the site shall be either closed or protected. All public roads shall be kept open and unobstructed at all times unless unavoidable circumstances arise.

If a covered walk is not necessary in the opinion of the Engineer-in-charge he shall issue a permit to block off part of the sidewalk and have a temporary walk provided. Pedestrians shall be provided with diversion roads or alternate protection as specified in Sec 1.7 and Table 7.4.1.

All utility lines shall be disconnected upon the approval of the concerned Authorities. Temporary service connection for the demolition work shall be taken separately. See Sec 3.3.9 and 3.3.12 for other requirements.

Workmen shall be provided with all necessary safety appliances as specified in the following sections and in Chapter 3 prior to the start of work. Safety precautions for fire shall be provided.

The site shall be thoroughly cleaned of combustible materials and debris before commencement of demolition.

4.1.6 Sidewalk Shed and Canopies

A toe board at least 1 m high above the roof of the shed shall be provided on the outside edge and ends of the sidewalk shed. Such boards may be vertical or inclined outward at no more than

45° angle with the vertical. The side of the shed adjacent to the building shall be completely blocked by planking/sheeting.

The roof of sidewalk sheds shall be capable of sustaining a load of 7 kPa. Impact of falling debris shall be considered in designing and constructing the shed. Maximum load on the roof of the shed shall be maintained below 12 kPa.

The flooring of the sidewalk shed shall consist of closely laid planks with a minimum thickness of 50 mm made watertight. Only in exceptional cases, temporary storage on the sidewalk shed may be permitted; in such situation, the roof of the shed shall be designed for sustaining 14 kPa.

Entrances to the building shall be protected by canopies extending at least 2.5 m from the building facade. Such overhead protection shall be at least 600 mm wider than the entrance, and 2.5 m in height.

4.2 PRECAUTIONS DURING DEMOLITION

4.2.1 General

The owner shall provide protection against all damages or loss of life and property during demolition. Constant supervision shall be provided during a demolition work by a competent and experienced engineer.

The demolition site shall be provided with natural and artificial lighting and ventilation.

All existing features required during demolition operations shall be well protected with substantial covering to the entire satisfaction of the rules and regulations of the undertakings or they shall be temporarily relocated.

For a building or structure more than 8 m or two stories high, all windows and exterior wall openings that are within 6 m of floor opening used for the passage of debris from floors above, shall be solidly boarded. Openings in floors below the level of demolition, not used for removal of materials or debris, shall be barricaded or covered by planks.

4.2.2 Sequence of Demolition Operation

The demolition shall proceed in descending order and storey by storey. All work in the upper floor shall be completed and approved by the engineer prior to disturbing any supporting member on the lower floor.

Demolition of the structure in sections may be permitted in exceptional cases only if necessary precautions are ensured. The demolition work shall proceed within such a way that:

it causes the least damage and nuisance to the adjoining building and the members of the public, and it satisfies all safety requirements to avoid any accidents.

Table 7.4.1: Type of Protection Required for Pedestrians near a Demolition Site

| Horizontal Distance from inside of the Sidewalk to the Structure | Height* to Horizontal Distance Ratio | Type of Minimum Protection Required |
|---|---|--|
| Less than 3m | 6:1 or more | Type A |
| | 4:1 to 6:1 | Type B |
| | 3:1 to 4:1 | Type C |
| | 2:1 to 3:1 | Type D |
| | up to 2:1 | Type E |
| Over 3 m to less than 4.5 m | 10:1 or more | Type A |
| | 6:1 to 10:1 | Type B |
| | 4:1 to 6:1 | Type C |
| | 3:1 to 4:1 | Type D |
| | up to 3:1 | Type E |
| Over 4.5 to less than 7.5 m | 15:1 or more | Type A |
| | 10:1 to 15:1 | Type B |
| | 6:1 to 10:1 | Type C |
| | 4:1 to 6:1 | Type D |
| | up to 4:1 | Type E |
| Over 7.5 m to less than 12 m | 15:1 or more | Type B |
| | 10:1 to 15:1 | Type C |
| | 6:1 to 10:1 | Type D |
| | up to 6:1 | Type E |
| 12 m and more | 10:1 or more | Type D |
| | up to 10:1 | Type E |

Type A: Total blockade of the road;

Type B: Temporary diversion over the entire length of the footpath adjacent to the structure;

Type C: A sidewalk shed for the entire length, in accordance with Sec 4.1.6;

Type D: A fence of tightly seated 25 mm planks, minimum height 2.5m;

Type E: A railing at least 1.5m high with mid rail and cross bracing.

* Height of the building or portion thereof to be demolished

4.2.3 Wall

Walls shall be removed part by part in reasonably level courses. No wall or any part of the structure shall be left in a condition that may collapse or be toppled by wind, vibration etc.

Fall of the demolished wall in large chunks, which endangers the adjoining property or exceeds the safe load capacity of the floor below, shall be avoided. Debris shall be removed at frequent intervals to avoid piling up and overloading of any structural member.

Platforms shall be provided for demolition of walls less than one and half brick thick. Lateral bracing shall be provided for sections of walls having a height more than 22 times its thickness, or otherwise considered unsound. No workman shall stand on any wall to remove materials; staging or scaffold shall be provided at a maximum of 3.5 m below the top of the wall.

At the end of each day's work, all walls shall be left stable to avoid any danger of getting overturned. Foundation walls which serve as retaining walls shall not be demolished until the adjoining structure has been underpinned or braced and the earth removed.

4.2.4 Floor

Support/centering shall be provided prior to removal of masonry or concrete floor. Planks of sufficient strength shall be used in shuttering. No person shall be allowed to work in an area underneath a floor being removed; such areas shall be barricaded.

The total area of a hole cut in any intermediate floor for dropping debris shall not exceed 25% of that floor's area. No barricades or rails for guarding the floor hole shall be removed until the storey immediately above has been demolished down to the floor line and all debris cleared from the floor.

In cutting holes in a floor which spans in one direction, at first, a maximum 300 mm wide slit shall be cut along the entire length of the slab; the slit shall be increased gradually thereafter.

Planks of sufficient width, not less than 50 mm thick, 250 mm wide and 2 m long shall be provided at spacing not greater than 400 mm for the workmen to work. These shall be so spaced as to firmly support the workmen against any floor collapse.

4.2.5 Special Elements

4.2.5.1 Catch Platform

Catch platform shall be provided during demolition of exterior walls of structures more than 20 m in height. These shall be constructed and maintained not more than three storeys below the storey from which exterior wall is being demolished.

Catch platform shall not be used for storage or dumping of materials. These shall be capable of sustaining a minimum live load of 7 kPa. The out-riggers shall not be placed more than 3 m apart.

Additional requirements of Sec 1.4.3 and Sec 4.1.6 shall also be followed.

4.2.5.2 Stairs, Passageways and Ladders

Make-shift stairs with railings, passageways, and ladders shall be left in place as long as possible, and maintained in a safe condition. They shall not be removed from their position unless instructed by the foreman. See also Sec 3.5.3 and Sec 3.13.1 for additional requirements.

4.2.5.3 Roof Trusses and Steel Structures

Structural frame of a pitched roof shall be removed to wall plate level by hand methods. Sufficient purlins and bracing shall be retained to ensure stability of the remaining roof truss while each individual truss is removed progressively. The bottom tie of roof trusses shall not be cut until the principal rafters are secured against making outward movement.

Temporary bracing shall be provided, where necessary, to maintain stability. All trusses except the one being dismantled shall be independently and securely guyed in both directions before work starts.

Hoisting gear suitable for the loads to be lifted shall be provided. A truss or a part thereof shall not be put on a floor; it may be allowed to rest only temporarily on the floor below if it can be ensured that the floor is capable of taking the load.

The steel frame may be left in place during demolition of masonry work. All steel beams/girders shall be cleared of all loose materials as the demolition of masonry work progresses downward provided it is still strong enough to stand as an independent structure.

4.2.5.4 Heavy Floor Beam

Heavy timber and steel beams shall be supported before cutting at the extremities. Beams shall be lowered gently and kept in a distant place without obstructing any passageway.

4.2.5.5 Jack Arch

Arches shall be demolished by standing on scaffolding clear of the arch. Tie rods between main supporting beams shall not be cut until the arch or series of arches have been removed. The floor shall be demolished in strips parallel to the span of the arch rings at right angles to the main floor beam.

4.2.5.6 Brick Arch

Abutments shall not be removed before the dead load of the spandrel wall and the arch rings are removed. A single span arch can be demolished by hand cutting narrow segments progressively from each springing parallel to the span of the arch until its width has been reduced to a minimum.

The remainder of the arch can then be collapsed.

The crown may be demolished by the demolition ball method progressively from edges to the centre. Explosives may be used for a complete collapse of the structure by inserting charges into bore holes drilled in both the arch and the abutments.

In multi-span arches, lateral restraint shall be provided at the springing level before individual arches are removed. Demolition procedures as for single span may then be applied. Special temporary support shall be provided in the case of skew bridges.

No partial demolition leaving unstable portion standing shall be allowed. Where debris cannot be allowed to fall to the ground, centering capable of carrying load of the debris shall be designed and provided accordingly.

4.2.5.7 Cast-in-Situ RC

Before commencing demolition, the nature and condition of concrete and position of reinforcement and the possibility of lack of continuity of reinforcement shall be ascertained.

Demolition of cast-in-situ RC members shall start by removing partitions and external non load bearing cladding and other decorative features.

Reinforced concrete beams shall be demolished one at a time after the slabs have been removed.

Ties shall be attached to the beam to support the beam when suspended.

The reinforcement near the supports shall first be exposed by drilling with pneumatic drill and removing the concrete. The reinforcement shall then be cut at both supports in such a way as to allow the beam to be lowered to the floor or the ground under control.

RC columns and any other supporting columns of one level shall only be demolished after all other building elements of that level have been completely removed.

The reinforcement in columns shall be exposed at the base after restraining wire guy ropes have been placed round the member at the top. The reinforcement shall then be cut in a way to allow it to be pulled down to the floor or the ground under control.

Reinforced concrete walls shall be cut into strips and demolished in the same way as concrete columns.

4.2.5.8 Precast RC

Supports and joints of precast RC blocks shall be removed and the member lowered to the ground or floor below before demolition is performed. Precautions in the form of providing temporary supports or balancing weights shall be taken to avoid toppling over of prefabricated units or any other part of the structure.

4.2.5.9 Suspended Floor, Roof and Cantilevered Structure

Suspended floor and roof slabs shall be cut into strips parallel to the main reinforcement and demolished strip by strip. For ribbed floors, the principle of design and method of construction shall be considered and procedures determined accordingly.

Ribs and beams shall never be cut at their mid-span and without securing by ties. Cantilevered portions, canopies, cornices, staircases and balconies shall be demolished after providing support to the portion before demolition of the main structure.

4.2.6 Mechanical Demolition

Mechanical demolition shall be restricted to a height of 25 m. When mechanical devices, such as weight ball and power shovels are used in demolition work, the area shall be barricaded up to a minimum distance of one and a half times the height of the wall in addition to the requirements laid out in Table 7.4.1.

While the mechanical device is in operation, no person shall be allowed to enter the building.

Location of the devices shall be such that it is neither hit by falling debris nor it causes any damage to adjacent structure, power line, etc.

4.2.7 Miscellaneous

No demolition work shall be carried out at night, or during storm or heavy rain. If demolition has to be done at night, precautions in the form of red warning signals, sirens, working lights and watchmen shall be provided. Auditory warning devices shall be installed at the demolition site.

Safety devices like industrial safety helmets (BDS 1265, BDS 1266), boots, gloves, goggles made of celluloid lens (BDS 1360), safety belts (BDS 1359) etc. shall be used by the workmen.

First aid box shall be made available at all demolition sites. In fire-risk area, appropriate portable fire fighting appliances shall be kept at hand. See also Sec 3.11.2 and Sec 3.11.3.

4.3 BLASTING OPERATION AND USE OF EXPLOSIVES

4.3.1 General

Before any work involving the use of explosives is started, a detailed survey and examination of the site, buildings or structures and adjoining areas and property shall be made. Due care shall be taken to avoid disruptions or damage to underground wells, tunnels, storage tanks etc.

Proximity of underground and over ground services shall be carefully considered before blasting operations are carried out. Relevant authorities responsible for concealed underground works shall be duly consulted. Special attention shall be paid to the presence of power cables, radio and television transmitting stations sited within 3 km of the site.

Experts shall be consulted before proceeding with any work where sources of danger like flammable gases or liquids, sewage and drainage, unexploded missiles or mines, waste, explosive etc. are likely to be found. Also see Sec 4.1.

4.3.2 Code of Signal

Before any blasting commences on the construction or demolition site, both audible and visual signaling systems giving warning of blasting operations shall be established. These shall be such that they can be clearly heard and seen by site personnel working within the site areas, and also by the general public who may be affected.

Audible warnings shall comprise a series of readily recognizable signals with a distinctive tone. The Code of signals, once established for a particular site, shall not be altered without good reason and adequate warning to personnel.

Visual signs shall comprise clearly painted notices posted on all access roads to the site. Sentries shall be posted at the entries at blasting times with clear instructions; if necessary, they shall warn personnel who failed to hear warning signals or see signs.

4.3.3 Supervision and Responsibility

Only competent persons shall be employed as shot firers. When subcontractors are taking part in the work on same site, the main contractor shall ensure a close liaison and collaboration with other contractors.

All site personnel present during blasting operations shall come under the control of the shotfirer.

All explosives shall be under the control of the shotfirer.

The handling of explosives on the site shall be restricted to personnel who are required to do so in the discharge of their duties and who are authorized in writing by the engineer. All site personnel shall be warned against maltreatment of explosives and blasting accessories.

4.3.4 Protection of site Personnel and Installations

The contractor shall provide all tools and equipment used in charging and firing blasts. The shotfirer shall inform the engineer the necessity of replacing any item. Shot firing cables shall be examined before use for cuts or abraded insulation.

Circuit testers and exploders shall be handled with care and used and maintained according to the manufacturer's instructions; any malfunction shall immediately be reported and repair shall be carried out only by a competent person.

The area where explosives are to be used shall be defined before the charging of blasts. Vehicles and other mobile equipment shall be prohibited from entering the defined blast area, except as required to deliver or remove explosives.

All personnel shall be instructed as to what places of shelter they are to take up during blasting operations. Mobile plant and equipment shall be moved to a place of shelter and switched off when a blast is to be fired.

After a blast, no personnel shall be allowed to return to the danger area until the shotfirer has conducted a general examination and declared the site safe. The shotfirer shall not return to the blasting site until at least 5 min has elapsed after firing.

Electric detonators shall only be carried in boxes made of non conducting materials, with a lid and catch. The shotfirer shall maintain a check on the number of detonators used against number issued. The boxes shall be kept locked until detonators are needed.

Blasting shall not be carried out in confined spaces without adequate ventilation; positive ventilation at the working face shall be maintained at all times.

No members shall be cut until precautions have been taken to prevent it from swinging freely. All structural steel members shall be lowered from the building and shall not be allowed to drop.

4.3.5 Safety of Third Parties

The safety of persons who reside or work in the vicinity of the site shall be considered. Where necessary, they shall be advised to vacate their homes or offices during blasting operations. In addition to notices giving warning of blasting on all roads and paths approaching the site, sentries shall be posted to maintain surveillance around the site when blasting is in progress.

Blasts shall normally be fired during the hours of daylight. The blasting technique and period shall be chosen so that any annoyance to the general public from noise, ground vibration, dust etc. is reduced to a minimum.

In heavily built-up areas, small-scale short delay blasting techniques employing light charges in small diameter holes shall be adopted. In such situations, short holes shall be carefully placed and charge weights correctly chosen. Sand bags, blasting mats or other screening material of suitable construction shall be placed over the top of each hole.

4.3.6 Use of Explosives

A sketch plan with sufficient duplicate copies shall be prepared for each blast. Before the explosive is deposited at the point of use, a check shall first be made of the depth of each shot hole. The engineer shall be informed of any departure from the planned arrangement.

Exposure to any compressive action or severe effect of a similar kind shall be avoided and grinding, scouring or rubbing actions eliminated. The vigorous use of stemming rods to force explosives into a hole shall be avoided. There shall be adequate clearance to allow easy insertion of the cartridges into the shot holes. The wrapping of the explosive cartridge shall not be removed, nor the cartridge be cut.

Primers shall not be made up in a magazine, or near excessive quantity of explosives, or in excess of immediate use. No attempt shall be made to use fuses, blasting caps, or explosives which have been water soaked. No attempt shall be made to soften hard set explosives by heating or rolling.

A bore hole shall not be loaded with explosives after springing unless it is cool and does not contain any hot metal. Temperature in excess of 65°C is dangerous. A bore hole near another hole loaded with explosives shall not be sprung.

No attempt shall be made to slit, drop, deform or abuse the primer. No metallic device shall be used in tamping. Wooden tamping tools with no exposed metal parts except non sparking metal connectors for jointed poles shall be used.

4.3.7 Blasting Accessories

No person shall attempt to uncoil the wires and open out the short circuited bare leading wires of the electric blasting cap during approach of dust storm, or near sources of large charge of static electricity or near a radio transmitter. Firing circuit shall be kept completely insulated from the ground, other conductors, paths or stray current.

Except at the time and for the purpose of firing the blast, there shall be no electric live wires or cables near electric blasting caps or other explosives. All wire ends to be connected shall be bright and clean. The electric cap wires or leading wires shall be kept short-circuited until ready to fire.

All electric blasting caps shall be tested both singly and when connected to a circuit. Electrical blasting caps made by more than one manufacturer or electric blasting caps of different design or function, even if made by the same manufacturer, shall not be used in the same circuit. These shall not be fired by less than the minimum current specified by the manufacturer.

Where energy for blasting is taken from power circuits, the voltage shall not exceed 220 V. A safety switch, the same type as the blasting switch, shall be installed between the blasting switch and the firing circuit and lead lines at a distance not exceeding 1800 mm from the blasting switch.

Both safety switch and blasting switch shall be locked in the open position immediately after firing the shot. Key to the switches shall remain with the shotfirer at all times. Blasting shall be carried out using suitable exploder with 25% excess capacity.

Rubber covered or other adequately insulated copper wires shall be used for firing lines; sufficient firing line shall be provided. Single conductor lead lines shall be used. All holes loaded on a shift shall be fired on the same shift.

In very cold weather, the safety fuse shall be slightly warmed before using. Short fuse shall not be used. The length of a fuse shall be at least 1200 mm and the maximum burning rate 600 mm/min.

A fuse shall not be cut until the blasting cap is ready. The fuse shall be cut squarely across about 50mm with a clean and sharp blade to ensure a dry end.

The fuse shall not be twisted after it has been seated lightly against the cap charge. Blasting caps shall not be crimped except by a cap crimper designed for the purpose. The cap shall be squarely crimped to the face.

The fuse shall be lighted with a fuse lighter designed for the purpose. It shall not be lighted until sufficient stemming has been placed over the explosives. The explosives shall not be held in hands when lighting the fuse.

In case of firing with safety fuse, the number of loud reports shall be counted; in the event of misfire, no person shall be allowed to the blasting site for at least 30 minutes. An inspection for remaining of un-detonated explosives shall be made; all misfired shot holes shall be marked.

If the misfire is due to faulty wiring or connection, the defect shall be remedied and the shot fired.

The stemming shall be floated out by using hose water until the hole has been opened to within 600 mm of the charge; the water shall be siphoned out thereafter and a new charge placed or, a new hole drilled 600 mm away from the old bore and parallel to it and about 300 mm less in depth and the new hole charged and duly fired.

4.4 LOWERING, REMOVAL AND DISPOSAL OF MATERIALS

4.4.1 General

No material shall be dropped or thrown on the ground or outside the exterior walls. They shall be lowered either in containers or by ropes, tackles, properly designed wood or metal chutes etc.

When the removal of any material causes an excessive amount of dust, it shall be wet before lowering or dropping, if feasible. Tag lines shall be used on all materials being lowered or hoisted up and a standard signal system shall be used and the workmen instructed on the signals. No person shall be permitted to ride the load line.

4.4.2 Use of Chutes

Chutes, if provided, shall be at the centre of the building. It shall have an angle of more than 45° with the horizontal, and shall be entirely closed on all sides except at the opening for receiving the material. The chute opening shall be kept locked. The top opening of chute shall be protected with guard rails.

Debris may be dropped through holes in the floor, if absolutely necessary. Precautions shall be taken to avoid overloading of the floor with debris. The debris dropping area shall be protected by rails.

4.4.3 Removal of Debris

Temporary stacking of demolished materials at the site shall be done in a manner ensuring fire prevention and orderly removal. Debris shall be removed from the site as soon as possible. Materials like glass, nails, etc. shall not be strewn about. Standard precautions to prevent fire from debris shall be taken.

4.4.4 Disposal of Materials

Demolished materials shall be disposed off according to their salvage value. Materials, which can be re-used, shall be salvaged and re-used with the approval of the owner.

Rubbish having no salvage value shall be removed from the site and disposed off according to the local statutory rules and regulations. Rubbish of combustible materials shall be disposed off immediately. All such operations shall have the approval of the owner.

4.4.5 Regularization of Plots

If there is no immediate construction planned on the plot vacant after demolition, it shall be filled, graded and maintained in conformity to the established street grades at curb level. The plot shall be maintained free from the accumulation of rubbish and water, and all other unsafe and hazardous conditions.

Provisions shall be made to prevent damage to any foundation on the premises or on the adjoining property. All previous service connections shall be capped.