

**STANDARD
FOR
DEMOLITION**

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1. SCOPE

This Standard gives recommendations for various aspects of demolition work. It includes basic considerations and recommended methods of demolition of different types of structure; provides a basis for a logical approach to safe procedures and offers advice on safety precautions and statutory requirements.

2. REFERENCES

In this Standard the following standards and publications are referred to and to the extent specified, form a part of this Standard:

BSI (BRITISH STANDARDS INSTITUTION)

BS 6187: 1982	"Code of Practice for Demolition"
BS 5228: Parts 1 and 2: 1984	"Noise Control on Construction and Open Sites"
BS 5973: 1981	"Code of Practice for Access and Working Scaffolds and Special Scaffold Structures in Steel"
BS 8004: 1986	"Code of Practice for Foundations"
BS 5744: 1979	"Code of Practice for Safe Use of Cranes"
CP 3010: 1972	"Code of Practice for Safe use of Cranes" (Mobile Cranes, Tower Cranes and Derrick Cranes)
BS 5607: 1988	"Code of Practice for Safe Use of Explosives in the Construction Industry"

IPS (IRANIAN PETROLEUM STANDARDS)

E-SF-400	"Industrial Stairs, Ladders-Platforms and Scaffolds"
E-SF-900	"Noise and Vibration Control"

IRANIAN PUBLIC LAWS AND PROVISIONS

"Safeguarding Regulations for Construction Worksites", No. 69826, Dated 7-10-72 (28-12-1993)

3. DEFINITIONS & TERMINOLOGY

For definitions and terminology used particularly for demolition refer to Clause 3 of BS 6187:1982.

4. UNITS

This Standard is based on International System of Units (SI), except where otherwise specified.

5. PRELIMINARY PROCEDURES

5.1 Survey

5.1.1 General

Before any works of demolition are started, a detailed survey and examination of the building or structure and its curtilage should be made, and recorded and kept available for inspection. Photographs should be taken where necessary. Special care should be taken when entering and surveying buildings affected by fire or blast damage.

The relationship and condition of the adjoining property and other properties that may be affected by the demolition should also be considered.

The possible effect of ground or structural tremors caused by falling rubble may need to be considered when work is carried out in the vicinity of hospitals and other buildings containing equipment sensitive to shock and vibration.

The possible modifying effects of the local ground structure and geological strata on the dispersion of such tremors should also be borne in mind.

If there are any benchmarks on the building to be demolished, the National Cartographic Center should be informed, in order that it may take appropriate action.

5.1.2 Features of the structure

5.1.2.1 General

During the survey, particular attention should be given to the nature of the construction of the building or structure, especially to those components or services detailed in Clauses 4.1.2.2 to 4.1.2.9 of BS 6187:1982.

Also, the building or structure should be examined and, if necessary, tests be carried out, to determine its condition and whether constituent materials have deteriorated in strength, which could result in instability arising during particular demolition process. Structural elements hidden by cladding, suspended ceilings, etc. should be examined.

5.1.3 Mains and services

Some or all of the following mains and services, as appropriate, should be diverted, cut off, removed, or plugged before work commences, in order to make the site safe from foreseeable dangers:

- a)** electricity (underground cables, overhead lines and former consumers supply equipment);
- b)** gas mains or similar piped supply;
- c)** other fuel lines;
- d)** water;
- e)** hydraulic pressure mains;
- f)** drainage;
- g)** district heating mains;
- h)** telecommunication cables;
- j)** radio and television relay lines;
- k)** other underground or overhead works, e.g. transport installations or road underpasses.

Suitable arrangements should be made in advance for this. The demolition contractor, when actually commencing demolition, should verify that the services, particularly gas and electricity mains, have been rendered safe.

5.1.4 Wastes and previous uses

During the survey a careful examination of the whole site, including basements, cellars, vaults and other voids and dumps of materials and rubbish, should be made to establish whether there are any drums containing flammable materials or toxic chemicals, gas cylinders, domestic aerosol sprays and similar items that could be hazardous if they were involved in a fire.

5.2 Trees

Trees or other plants should not be removed or cut without instructions. Trees and other plants that are to be retained should be listed, numbered and a description recorded in the contract documents, and positioned on a drawing.

Trees to be retained should be protected from damage to branches and trunk by a suitable fence at least 1 m from the trunk of the tree.

Fires should not be lit close to vegetation. A minimum distance of 3 m outside the furthest spread of foliage is preferable.

Trees to be retained should not be used to assist demolition operations on site in any way. Heavy vehicles should be kept well clear of trees to avoid damage to branches, and to roots by compaction of the soil.

If excavation has to be carried out within the spread of foliage care should be taken to avoid damage to roots. Comprehensive guidance on precautions to take when working in proximity to trees is given in BS 5837.

5.3 Materials

Any materials required for the demolition works should be the best of their respective kinds for the work required. Materials arising from the works should be removed as they accrue and not stored, disposed of or used again on the site, except with the approval of the building owner.

The responsibility of the demolition contractor in regard to clearing all refuse, debris etc. from the site and for the provision and use of the necessary tip should be emphasized. No refuse or waste should be allowed to enter public sewers and water courses. The means of disposal of explosive or flammable substances, toxic wastes, lead, asbestos, and radioactive substances should be in accordance with the appropriate regulations.

5.4 Scaffolding and Shoring

5.4.1 Scaffolding

5.4.1.1 General

Any scaffolding required should be designed and erected in accordance with the recommendations given in IPS-E-SF-400 and should be provided by a competent scaffolder.

5.4.2 Shores and shoring

When required, shores and shoring should be designed and erected in accordance with the recommendations given in Clause 9.7 of BS 8004: 1986, particularly:

- a) All shoring should be so positioned as to leave clear the space needed for the work of demolition and all subsequent building operations be so designed that part may be safely removed without affecting the whole.
- b) The removal of portion of a building during demolition usually results in making other parts unsafe, and it is therefore necessary to make a careful survey before commencing work as stated in Clause 5.1.

- c) All shores should be adequately anchored and capable of resisting transverse movements.
- d) For types and location of shoring refer to Clause 9.7.7 of BS 8004: 1986.

5.5 Administrative Aspects

5.5.1 Statutory requirements

As with other forms of building activity, demolition work is subject to the controlling influences of a large number of national and local legal requirements. Attention is therefore directed to these Acts, Byelaws, Regulations and other statutory requirements. Work should be carried out in accordance with, and the equipment in use should comply with "Safeguarding Regulations for Construction Worksites", No. 69826, dated 7/10/72 (28/2/93) of Iranian Public Law and Provisions.

5.5.2 Supervision

The demolition contractor is required by law to appoint a competent person, experienced or trained in the type of operation being performed at that particular time, to supervise and control the work on site.

Where two or more demolition contractors take part in work on the same site each should appoint a competent person to supervise the work. To ensure the safety of the whole works these foremen should collaborate in the planning and execution of the work. This does not prevent the joint appointment of one person by two or more demolition contractors. It is in the interest of the building owner that he arrange for supervision and coordination of the work on site.

5.5.3 Sequence of demolition operations

Before the commencement of work on any particular phase a program should be drawn up in which the proposed sequence and the method of operations is clearly indicated.

Where demolition is to be carried out in areas of severe exposure, careful consideration should be given to the possibility of sudden and severe climatic changes that might affect the work.

6. PROTECTIVE PRECAUTIONS

6.1 General

Demolition is a hazardous operation and, at all times, the methods, materials and equipment used should accord with the need to safeguard life and property. It is essential that precautions be taken both before and during actual demolition. For the purposes of this Standard, such precautions may be categorized under the following three headings:

- a) Those precautions that are specifically aimed at safeguarding personnel engaged on the site of the works;
- b) those precautions that are necessary for the safety and convenience of persons not connected with the demolition, including members of the public;
- c) those precautions that are necessary for the protection of property likely to be affected by the demolition works.

In addition to these general precautionary measures, there are various specific precautions associated with the particular method or methods of demolition being employed and the structure or structural element being demolished.

Attention is drawn to the recommendations given in BS 5228 concerning the control of noise on demolition sites.

For safety of personnel and third parties on site refer to Clauses 5.2 and 5.3 of BS 6187: 1982.

6.2 Protection of Property

6.2.1 General

The original survey should have indicated whether it is necessary for permanent support or weatherproofing or both to protect the adjoining buildings. Where required, temporary support and protection from the weather, debris and dust should be effected to adjoining buildings.

When foundations are being grabbed out, or when buildings are being reduced to new levels adjacent to existing buildings not being demolished, care should be taken to ensure that the support to the remaining foundations, structure or land is not disturbed.

After basements and cellars have been cleared, soakaways should generally be provided. Precautions may need to be taken to prevent water penetration to adjoining buildings. Where a watertight basement has been built in ground having a high standing water table level, the basement should be filled with material to prevent flotation.

6.2.2 Vibration and concussion

Special care should be taken when demolishing buildings or tall chimneys to ensure that no undue vibration or concussion is caused that could result in damage to other properties, underground services or drains, or damage to adjacent property by flying debris.

For details of general vibration considerations refer to IPS-E-SF-900 "Noise and Vibration Control".

7. METHODS OF DEMOLITION (see Table 1)

7.1 General

This clause describes the various methods of demolition in use, together with the appropriate precautionary measures that should be taken. While described separately in this clause, it is common for several methods to be used in combination or at different parts of the demolition site. In such cases the precautions relevant to all the methods in use should be taken.

7.2 Hand Demolition

7.2.1 Hand demolition involves the progressive demolition of a structure by operatives using hand-held tools; lifting appliances may be used for lifting and lowering members once they are released.

7.2.2 Where work cannot be done safely from a part of a building or structure, working platform in accordance with IPS-E-SF-420 made from standard scaffolding or special purpose scaffolding should be used. Other means of support such as specially designed working platforms or a suitable skip suspended from a crane or an aerial platform, or, in some instances, ladders, may also be used.

7.2.3 Buildings and other structures should generally be demolished in the reverse order to that of their construction. The order of demolition for buildings should be progressive, storey by storey, having regard to the type of construction.

7.2.4 On all sites debris should be allowed to fall freely to the ground internally or externally only where the horizontal distance from the point of fall to a public highway, or adjoining property, is not less than 6 m, or half the height from which the debris is dropped, whichever is the greater. In other cases, chutes or skips should be used.

Where debris from walls, etc. above first floor level is to be dropped to the ground or basement level within a building, sufficient openings, clear of joists or beams, should be formed in the floors to enable the debris to fall without deflec-

tion. If it is proposed to remove one or more joists to allow the free passage of debris, care should be taken that such action will not jeopardize the stability of the surrounding structure.

Precautions should be taken against flying or falling debris by sealing off all openings in walls adjacent to the area of fall. To prevent excessive lateral pressure, care should always be taken to avoid a building-up of fallen debris against walls in the lowest storeys. This is of particular importance in confined spaces such as lift and tall chimneys. When material is being dropped, a look-out man should be posted to ensure safety generally.

7.2.5 Steel structural members and reinforced concrete structural members should be lowered to the ground or be cut into lengths appropriate to the weight and size of member before being allowed to fall.

Where possible, a crane and lifting gear should be used to support beams and columns whilst they are being cut and lowered to the ground. In framed structures of precast concrete or steelwork, similar support should be given to members while joints are being severed.

7.2.6 When only a portion of a structure is to be demolished, the stability of the part to remain should be checked.

7.3 Mechanical Demolition by Pusher Arm

7.3.1 Mechanical demolition by pusher arm involves the progressive demolition of a wall using a machine fitted with a pusher arm exerting horizontal thrust.

7.3.2 The pusher arm should be used only when the equipment is on firm level ground. It should not be overloaded and should generally be used from outside and not from inside the building. No person should be within that distance of the building where debris is liable to fly. The pusher arm should be made of steel. Pusher arms of other materials should not be used.

The cab of the appliance should be robust enough to withstand impact from flying debris and the cab windows should be of shatter-proof glass.

7.3.3 Where this method is adopted for demolition of attached buildings, the structure to be demolished should first be detached by hand demolition. The clear space in which the equipment is to operate should be a minimum of 6 m.

The plant should be used only in accordance with the manufacturer's recommendations; on no account should the point where the pusher arm is applied to a wall being demolished be more than 600 mm below the top of the wall. The plant should not be worked from a roadway without the permission of the Local Authority.

7.4 Mechanical Demolition by Deliberate Collapse

7.4.1 Mechanical demolition by deliberate collapse involves the removal of key structural members causing complete collapse of the whole or part of the building or structure being demolished.

7.4.2 Expert engineering advice should be sought before this method is used; it should be employed only on detached, isolated, reasonably level sites and where the whole structure is to be demolished. There should be sufficient space to enable equipment and personnel to be removed to a safe distance.

Sections of a structure should not be pulled down by deliberate collapse in separate operations if instability of the remaining structure may result, causing a possible hazard to personnel on the site.

7.5 Mechanical Demolition by Demolition Ball

7.5.1 Mechanical demolition by demolition ball involves the progressive demolition of the building by the swinging of a weight suspended from a lifting appliance.

7.5.2 Three techniques may be used:

- a) Vertical drop;
- b) swinging in line with the jib;
- c) slewing jib.

The operator should be experienced and skilled in the use of the equipment and techniques of demolition and there should be a high standard of inspection and maintenance. For further information about demolition by demolition ball refer to Clause 6.5 of BS 6187: 1982.

7.6 Demolition by Explosives

7.6.1 Reference should be made to the recommendations given in BS 5607 when explosives are to be used for demolition. A specialist experienced in the controlled application of explosives for the purpose of carrying out the demolition of civilian structures should be consulted before deciding whether explosives are to be used for demolition. Account should be taken of the type of structure and its situation. An explosives specialist or specialist firm or company should be employed, experienced in this type of work and holding the necessary licence from the police to purchase explosives. Before blasting operations commence, the police should be informed and their assistance sought to keep people and livestock away from the area.

Use of explosive inside fenced areas of Oil Industries' facilities is generally prohibited.

7.6.2 Utilities require special consideration, and the proximity of underground and overground services should be carefully considered before blasting operations are carried out. Consultations should be carried out with the necessary authorities who are responsible for concealed underground works (e.g. pipes, cables. etc.)

The explosives specialist should decide the charges to be used and their placing. Adequate storage accommodation should be provided.

Precautions should be taken to protect other property from shock and vibration, and flying debris should be controlled by means of blast mats or other baffles.

In the event of a misfire the area should remain cleared until the explosives specialist has dealt with the situation. If, after blasting operations, a misfired charge is found during the subsequent removal of debris, the area should be cleared and entrance restricted until the explosives specialist has rendered the misfire safe.

Under certain circumstances electrical and radio-transmitting installations can cause detonation of electrical detonators without physical contact; electrical storms may have the same effect.

7.6.3 Demolition by explosives should be supervised by personnel experienced in the controlled application of explosives.

7.6.4 Where site conditions preclude the use of explosives, a form of bursting may be a suitable alternative (see Clause 6.8.6 of BS 6187: 1982).

7.7 Other Methods of Demolition

For other forms of mechanical, thermal or percussive demolition refer to clause 6.8 of BS 6187: 1982.

8. TYPICAL METHODS OF DEMOLITION (see Table 1)

8.1 Small and Medium Dwellings (Not Exceeding 10 m in Height)

Generally, before any major demolition process is commenced, the pitched roof construction should be taken down to wall plate level by hand methods.

TABLE 1 - GUIDE TO TYPICAL METHODS OF DEMOLITION (See Note 1)

TYPE OF STRUCTURE	TYPE OF CONSTRUCTION	METHOD OF DEMOLITION			
		Detached Building Isolated Site *	Detached Building Confined Site *	Attached Building Isolated Site *	Attached Building Confined Site *
Small and medium two-storey buildings (see 8.1)	Loadbearing walls	ABCDM	ABDM	ABDM	ADM
Large buildings three storeys and over (see 8.2)	Loadbearing walls	ABDM	ABDM	ABDM	AD
	Loadbearing walls with wrought iron and cast iron members	ABDM	AM	AM	AM
Frame structures (see 8.3)	Structural steel	ACM	AM	AM	AM
	In situ reinforced concrete	ADM	ADM	ADM	AM
Chimneys (see 8.4)	Composite (structural steel and reinforced concrete)	ADM	ADM	ADM	AM
	Timber	ABCDM	ABDM	ABDM	ABDM
	Steel	AC	A	A	A
Pylons and masts (see 8.5)	In situ and precast reinforced concrete	AD	A	AD	A
		AC	A	A	A
Petroleum tanks (underground)	See 8.6				
Above ground storage tanks	See 8.7				
Chemical works and similar establishments	See 8.8				

Notes:

1) This table is a general guide to the methods of demolition usually adopted in particular circumstances. In addition, subject to local restraints, explosives may be used by experienced personnel in many of the circumstances listed (see 7.6). This table should be read in conjunction with the main text. The indication of a particular method does not necessarily preclude the use of another method, or the use of several methods in combination (see 7.1).

2) Legend:

- A** denotes hand demolition (see 7.2)
- B** denotes mechanical demolition by pusher arm (see 7.3)
- C** denotes mechanical demolition by deliberate collapse (see 7.4)
- D** denotes mechanical demolition by demolition ball (see 7.5)
- M** denotes demolition by other mechanical means excluding wire pulling (see 7.7)

* For definitions see clause 3 of BS 6187: 1982.

8.2 Large Buildings with Loadbearing Walls (Three Storeys and Over)

8.2.1 General

Large buildings with loadbearing walls (three storeys and over) may sometimes incorporate wrought iron or cast iron structural framed members. Before any demolition is commenced, it is essential to determine whether metal members

are included and to identify the type of metal used in construction. Frequently metals used in columns are different from those used in beams.

Normally explosives would not be employed in the demolition of this type of construction unless it is proposed to demolish the building as a whole.

8.2.2 Roof trusses

If a building has a pitched roof, the roof structure should be removed to wall plate level by hand methods. Enough purlins and bracing should be retained to ensure stability of the remaining roof trusses while each individual truss is removed progressively.

Temporary bracing should be added where necessary to maintain stability. The end frame opposite to the end where dismantling is commenced, or a convenient intermediate frame, should be independently and securely guyed in both directions before work starts.

On no account should the bottom tie of roof trusses be cut until the principal rafters are prevented from moving outwards.

8.2.3 Filler joists

When breaking out the concrete or brickwork between filler joist floors, the operative should be supported on a safe working platform independent of the bay of floor being removed.

8.2.4 Floors

Heavy baulks of timber and steel beams should be supported before the extremities are cut and should then be lowered to a safe working place.

8.2.5 Jack arches

Where tie rods are present, they should not be cut until after the arch or series of arches in the floor have been removed. Particular care should be exercised and full examination of this type of structure undertaken before demolition is commenced.

The floor should be demolished in strips parallel to the span of the arch rings (at right angles to the beams supporting the arches).

8.2.6 Reinforced concrete and patent floor slabs

Before demolition is commenced, a small trial hole should be cut in order to ascertain the direction of the main reinforcement. The floor should be demolished in strips parallel to the main reinforcement.

8.3 Framed Structures

8.3.1 Structural steel

8.3.1.1 The principle of design and the method of construction should be determined. The sequence of demolition should be so arranged that the remaining structure is stable; where necessary, temporary bracing should be added.

8.3.1.2 Demolition should be commenced by removing partitions and external non-loadbearing cladding. It should be noted that in some buildings the frame may rely on the panel walls for stability.

As demolition proceeds temporary supports and guys should be provided to control the fall of cut members and to support any unrestrained remaining members.

8.3.2 In situ reinforced concrete

8.3.2.1 Before demolition is commenced, the nature and condition of the concrete, the condition and position of reinforcement, and the possibility of lack of continuity of reinforcement should be ascertained.

Attention should be paid to the principles of the structural design to determine which parts of the structure depend on each other to maintain overall stability.

8.3.2.2 Demolition should be commenced by removing partitions and external non-loadbearing cladding. It should be noted that in some buildings the frame may rely on the panel walls for stability. Where hand demolition methods are to be used, the following procedures should be used:

a) Beams

For beams, suitable support should be provided for the beam. The concrete should then be removed from both ends by pneumatic drill and the reinforcement exposed. The reinforcement should be cut in such a way as to allow the beam to be lowered under control to the floor (see Fig. 1a).

b) Columns

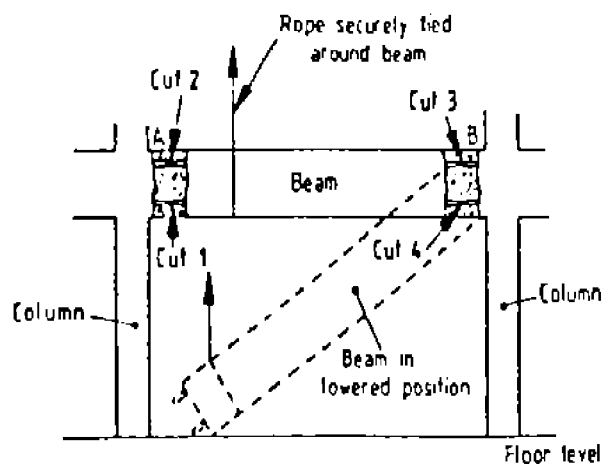
For columns, the reinforcement should be exposed at the base after restraining wire guy ropes have been placed round the member at the top. The reinforcement should then be cut in such a way as to allow the column to be pulled down to the floor under control (see Fig. 1b for sequence of operations).

c) Reinforced concrete walls

Reinforced concrete walls should normally be cut into strips and demolished as for columns (see Fig. 1c), although in some cases it may be acceptable to cut a wall into rectangular portion of a size convenient to lift and transport whole from site.

d) Suspended floors and roofs

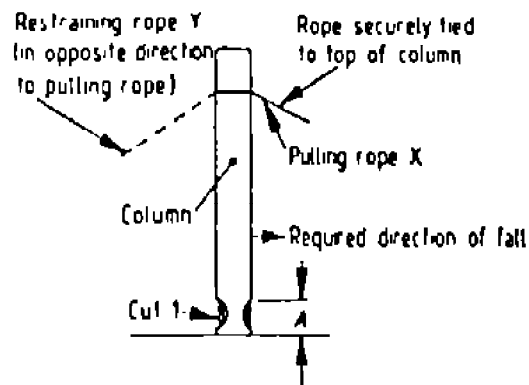
Before suspended floors and roofs are demolished, the type of construction should be ascertained (see Fig. 1d). In solid single span slabs, the direction of the main reinforcement should be determined; the slab should then be cut into strips parallel to the main reinforcement and demolished strip by strip. This method of demolition may not be suitable for slabs spanning in two directions, and a modified technique, taking account of the type of support provided, may need to be developed. Similarly, where ribbed construction has been used, the principle of design and the method of construction should be determined before demolition is commenced. Care should be taken not to cut the ribs inadvertently.



Sequence of operations

- (1) Ensure all loads, other than self weight, are removed from beam.
- (2) Secure rope to end of beam.
- (3) Expose reinforcement at ends A and B.
- (4) Cut reinforcement at positions 1, 2 and 3 respectively.
- (5) Lower beam to floor.
- (6) Refix rope to end B, cut at position 4 and lower beam to floor.

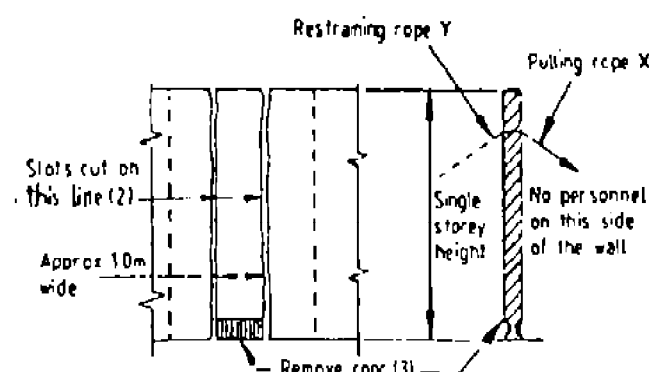
(a) Reinforced concrete beams



Sequence of operations

- (1) Ensure all loads, other than self weight, are removed from column.
- (2) Secure and tension two wire guy ropes to the top of the column. Rope 'X' is to prevent unintentional collapse in the wrong direction and finally for pulling column over. Rope 'Y' is to prevent unintentional collapse in the direction of winch.
- (3) Expose reinforcement on side opposite to required direction of fall. The height of concrete cut, dimension A, should be restricted to a minimum to prevent the possible uncontrolled collapse of the column.
- (4) Cut reinforcement at position (1) on side opposite to required direction of fall.
- (5) With all workers in positions of safety release the anchorage of rope 'Y' and pull the column over with rope 'X'.

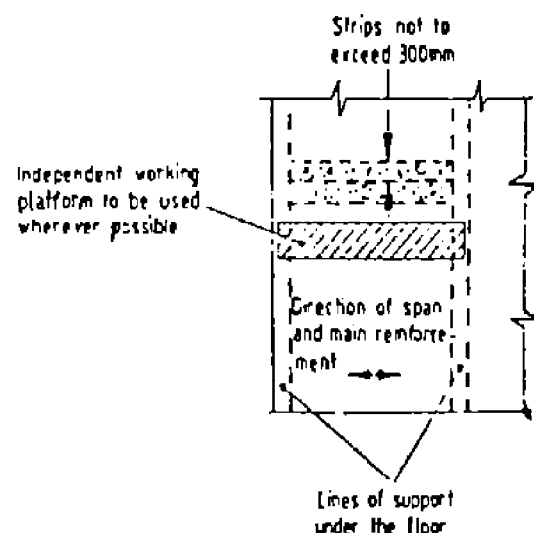
(b) Reinforced concrete columns



Sequence of operations

- (1) Ensure all loads, other than self weight, are removed from wall.
- (2) Cut slots in wall.
- (3) Proceed as for (b).

(c) Reinforced concrete walls



Sequence of operations

Depends of type of floor construction (see B.3.2.2 (d)).

(d) Reinforced concrete floors

HAND DEMOLITION OF IN SITU REINFORCED CONCRETE STRUCTURES

Fig. 1

8.4 Independent Chimneys

8.4.1 General

8.4.1.1 The methods described in 8.4 normally apply only to chimneys of at least 1 m internal base diameter. Demolition should be supervised and carried out by operatives thoroughly experienced in this type of work.

8.4.1.2 If it is proposed to demolish a chimney by hand a careful inspection and survey should be made to determine whether existing ladders, climbing irons and bands are sound. No reliance should be placed on existing painters' pulleys. If the existing ladders, etc. are unsound, the chimney should be laddered by skilled steeplejacks.

The fabric of the chimney should be examined to determine its condition and whether there has been any deterioration in the strength of the materials. Particular care should be taken surveying chimneys in which the structural materials are obscured by cladding. Measurements should be taken to determine whether there is any deviation from the perpendicular.

8.4.1.3 Where a chimney has varying cross sections through its height, or its condition has deteriorated, particular care should be taken where deliberate collapse is used for demolition as it may prove difficult to fell the chimney exactly along the proposed fall line.

8.4.2 Steel chimneys

8.4.2.1 Hand demolition should be carried out from a safe working platform provided by an external or internal scaffold.

The chimney should be taken down from the top; the plate should be cut into manageable sizes and lowered to the ground. Any internal lining should be demolished progressively with the steelwork, and the debris should be allowed to fall to the ground internally and should be cleared as the work proceeds. If the lining is concrete, difficulty may be experienced in burning the plate with it in position and the lining should be removed first. Guys, if any, should be cut systematically as the shaft is lowered, temporary guys having first been fixed at other points, where necessary.

8.4.2.2 Movement of the chimney should be observed. If the chimney is guyed two steel wire ropes should be attached at 45° on plan to each side of the line of fall before felling. The ropes should be made taut and the guys on the far side of the line of fall should be systematically severed.

8.4.2.3 Explosives should be used only by a specialist experienced in such work.

8.4.3 Reinforced concrete chimneys (in situ and precast)

8.4.3.1 Concrete chimneys should be examined to determine whether they are prestressed. If post-tensioned cables have been used, no work should be started until a chartered engineer has been consulted.

8.4.3.2 Hand demolition should be carried out from a safe working platform provided by a scaffold. The chimney should either be taken down in sections from the top in panels of manageable size which should be lowered to the ground, or should be broken up in situ, with the debris being dropped to the ground inside the chimney and cleared as the work proceeds. This latter method may be appropriate when the chimney is fabricated from precast panels of light construction. When the chimney is removed in sections the concrete should be shattered by pneumatic tools to expose the reinforcement and each section should be supported while the reinforcement is cut. The lining should be demolished progressively with the shaft and the debris allowed to fall to the ground internally.

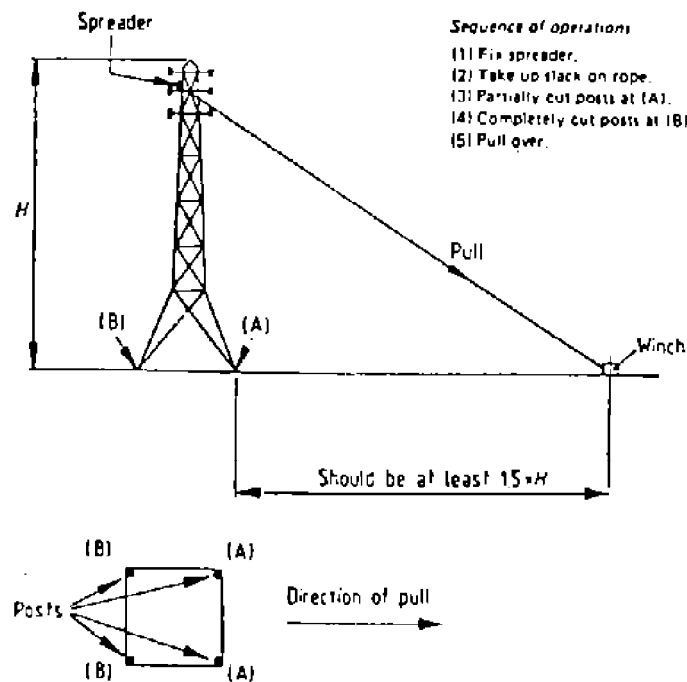
8.4.3.3 Explosives should be used only by a specialist experienced in such work.

8.5 Pylons and Masts

8.5.1 On confined sites, only hand demolition methods should be used. The pylon or mast should be taken down in the reverse order to that in which it was erected.

Before felling, a steel wire rope should be attached to a spreader near the top of the structure and the slack in the rope taken up. The two legs nearest to the direction of fall should be partially severed and then the two legs furthest away should be completely severed. The pylon or mast may be pulled over when all personnel are clear (see Fig. 2).

8.5.2 Explosives should be used only by a specialist experienced in such work.



DEMOLITION OF PYLONS AND MASTS

Fig. 2

8.6 Petroleum Tanks in the Ground

8.6.1 General

Before any work is carried out, the Local Authority of Iranian Petroleum Ministry should be informed (see also 5.1.4).

Before a redundant petroleum tank is to be removed from the ground, the tank should be emptied of fuel, cleaned and rendered inert by one of the following methods:

- a) By filling with water (see 8.6.2);
- b) By filling with inert gas (see 8.6.3).

Where cutting with burning equipment or cutting discs is to be used, great care should be taken to ensure that any risks of fire or explosion due to the previous use of the tank have been eliminated.

In addition to the precautions necessary with the tank, precautions should also be taken with the associated pipework and equipment; tools used to remove pipes and fittings should be of non-ferrous metal to prevent sparking.

Where a tank is being excavated and there is a danger that the surrounding earth may have been contaminated either by leakage from the tank or by spillage, all the following precautions should be taken:

- a) Danger notices should be displayed;
- b) no smoking or naked lights should be permitted in the vicinity;
- c) a copious supply of water should be used to lessen the risk from sparking.

In all these operations, care should be taken to ensure that no petrol is allowed to enter any drainage system or water course.

After excavation, the words 'DANGER PETROL TANK' should be painted in clear and conspicuous letters at each end or on opposite sides of the tank.

8.6.2 Using water as an inhibitor

The petroleum liquid and the ventilating pipe should be removed and the tank should be filled with water until this flows through the ventilating hole(s). The openings should then be sealed, after which excavation may commence.

It should be borne in mind that flammable petroleum spirit may emerge with the flushing water. This should be retained in a suitable vessel, or directed to an interceptor where practicable.

Care should be exercised to ensure that there are no dead pockets into which the water has not penetrated. In compartmented tanks, care should be taken to ensure that all compartments are filled.

When the tank is ready for lifting from the excavation, the water should be removed but any opening should be re-sealed immediately after emptying. It should be borne in mind that this technique does not render tanks suitable for hot work once the water has been partially or completely removed.

8.6.3 Using inert gas as an inhibitor

Nitrogen is recommended for use in purging tanks as it is non-toxic. However, nitrogen is an asphyxiant and this has to be considered when the work is being planned. Whenever gas is used to render an atmosphere inert it is essential to ensure that the atmosphere remains inert. Consequently, frequent monitoring is necessary.

Safety Note:

Pressurized carbon dioxide should not be used for purging, owing to the risk of generating static electricity.

The condition of redundant petrol tanks may be uncertain and, therefore, the atmosphere pressure method should be used. This method involves the nitrogen being passed continuously into the tank at one point, while the air and petroleum vapor being purged leaves at another point.

The nitrogen gas should be introduced directly from an industrial gas supplier's road tank vehicle fitted with all the necessary reducing valves and measuring equipment.

The petroleum liquid and the ventilating pipe should be removed and all the openings sealed except those required for the inlet of nitrogen and for the exhaust outlet to the atmosphere. The exhaust outlet should be of sufficient size to prevent build-up of pressure in the tank. The nitrogen should then be introduced and the mixture leaving the tank should be vented to the atmosphere so that the tank remains at atmospheric pressure throughout the entire operation. At the beginning of the purging operation the vented vapor may be flammable.

Precautions should therefore be taken to avoid ignition. If approximately five tank volumes of nitrogen are used, the final oxygen level will be approximately 1%. After completion of the purging, the openings should be sealed and the tank may then be excavated.

8.7 Storage Tanks Above Ground

8.7.1 General

Before commencing demolition of storage tanks constructed above ground level, the contractor should determine their previous use and ensure that risks of fire, explosion and toxicity have been completely eliminated. Precautions similar to those for below ground petrol tanks may need to be taken when dealing with tanks that have been used to store highly flammable liquids or gases above ground.

Before hot work is started on a storage tank the floor of the tank should be flooded or spread with sand to prevent residues being ignited by sparks and hot metal.

8.7.2 Tank roofs

On small tanks, up to approximately 12 m diameter, tank roofs should be removed in one piece by crane. If this is not possible temporary central roof support may be necessary during demolition. On all tanks, when the roof or roof plating is being removed an edge ring should be left to retain the rigidity of the tank walls.

On tanks having fixed roofs supported by steelwork rafters or trusses the roof plating should be removed prior to removing the steelwork spider. The centre plate should be left, as it may form a structural member. The structure supporting the roof may need central support installed prior to cutting. In any event the structure should be cut down in a sequence that removes diametrically opposite half-trusses until a single cross is left for final cutting.

Floating roofs should be landed on the tank floor prior to dismantling. No attempt should be made to demolish roofs whilst they are still supported on their maintenance legs.

8.7.3 Tank shells

On tanks with fixed roofs no attempt should be made to remove the tank shell, apart from access manholes, before the roof has been removed. On tanks with floating roofs the roof should be fully landed before the shell is removed.

The tank shell should be dismantled course by course, the pieces being held and removed by a suitable crane. The practice of making vertical cuts in tank walls and pulling over the plates is not recommended as it is unpredictable and also produces a very unstable partial structure. Partially cut tanks are susceptible to collapse due to wind loading, and guys or other temporary support may be necessary to retain structural integrity.

8.7.4 Tank floors

Tank floors should be cleaned of deposits cut into manageable sizes. The underside of the tank floor should be tested for contamination from leakage that could produce a risk of fire or explosion.

8.8 Chemical Works, Gas Works and Similar Establishments

The demolition or dismantling contractor should make certain that wherever the demolition or dismantling of chemical, gas or similar plant or equipment is to be undertaken a full investigation be made of the previous use of, and the substances contained within, the plant. A competent analyst should always be involved if there is a risk of the presence of flammable, explosive or toxic materials. Advice should be sought from the local inspector of factories before any demolition or removal work is carried out on storage tanks that have contained any explosive or flammable materials.

A very careful inspection should be made of all elements of construction to determine whether there is any deterioration or deformation.

It is strongly recommended that a chemist assist in the examination of the construction in chemical, gas or similar works, so as to determine the nature of any chemical deposits and how they might influence the method of demolition or dismantling.

9. IRANIAN PUBLIC LAWS AND REGULATIONS

9.1 Safeguarding Regulations for Construction

Worksites, No. 69826, dated 7-10-1372 (28/12/1993) (in Farsi).

9.1.1 General

As most of local demolition works will be executed by Iranian Contractors, therefore adherence to the Safeguarding Regulations of Clause 9.1 should be stipulated in contract documents.

The important chapters and sections to be considered are tabulated below:

a) Chapter 1: Demolition

- Section 1: Preliminary activities for demolition;
- Section 2: General requirements for demolition;
- Section 3: Demolition and removal of walls;
- Section 4: Demolition and removal of jack arches.

b) Chapter 3: Scaffoldings

- Section 1: General regulations;
- Section 2: Working areas;
- Section 3: Wooden scaffoldings;
- Section 4: Scaffoldings with steel pipes;
- Section 5: Suspended scaffoldings, hand driven;
- Section 6: Suspended scaffoldings, driven by mechanical means;
- Section 7: Other types of scaffoldings.

c) Chapter 4: Stairs

d) Chapter 5: Storage of materials

e) Chapter 6: Various safety regulations.

9.1.2 Foreign Contractors

When it is required the demolition works be executed by foreign contractors, then it is obligatory for the Owner to supply a translated copy of the regulations mentioned under Clause 9.1 in English language to the foreign contractor(s).