

Study of the causes of deterioration and new methods of demolition of concrete and metal structures

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Abstract

Demolition of buildings, as the first stage of construction has numerous effects on the urban environment and citizens, hence, is of great importance. Demolition of the building can cause damage to individuals and public and private assets, and endanger human health associated with the project, and damage to the environment and neighbors. However, there are sporadic cases in the regulations and journal of basic specifications in construction works and regulations to protect construction sites, but these cases more consider protection and safety during the work and there is no talk of plan, details and how demolition of building methods. In this study, new methods of demolition of concrete and metal structures will be analyzed. The results show that given that Iran's major cities are about the middle-aged, and there is the need to rebuild, so demolition of building should be discussed in detail.

Keywords: deterioration, new methods, demolition of structures

Introduction

At the beginning of the demolition* of a building to rebuild, life and welfare of citizens is affected. Statistics indicate that, by demolition operations, the financial damages are imposed to adjacent buildings or surrounding buildings are destroyed and these events are sometimes associated with loss of life, disturbing statistics available show that the issue should be discussed with a more professional look. Considering the above, demolition operations should be done as quite professional, and with scientific perspective and reviewing the situation, the most appropriate method for demolition of building must be selected, more importantly, the safety issue of the demolition operations is very important. With proper planning and implementation of the demolition operations in a variety of ways for a variety of steel structures and their parts, we obtain the following objectives:

1. Minimum damage to persons and property
2. Protection of the health and safety of the workplace forces
3. Reducing environmental pollutions

Articles of the protection regulations of the construction sites

Article 198: demolition should start from the top class and terminates to the lowest floor of the building, except in specific cases, demolition is done at one time and using explosives in the foundation, and as remote complying with all the relevant safety precautions and regulations and obtaining the necessary permits, or is done by dragging with the cable and overturn, or through tapping by weight *fluctuations*.

Article 202: the demolition of parts of the building which leads to sudden demolition and loss of other parts of the building should be avoided.

Article 192: before demolition begins, all parts of the building which must be destroyed should be inspected closely and if there is danger and loss, precautionary measures must be taken such as the installation of piles, shield and retaining temporary columns to contain it.

Preliminary operations before demolition, Building damage assessment before demolition

Before starting work permits for building demolition operations, engineering analysis must be done by a competent person to determine the conditions of floors, walls, frameworks and structures and the possibility of deterioration of some parts of the building with any previous plan. Adjacent buildings must be checked, because it is possible that people are living in them. The employer must have a license or written authorization for the operations of demolition, then, to inspect a building and its surroundings, the necessary measures must be done in order to determine potential problems that may arise during demolition and preparing to reports on the proposed methods for demolition.

* **Demolition** is the tearing-down of buildings and other structures. Demolition contrasts with deconstruction, which involves taking a building apart while carefully preserving valuable elements for re-use.

For small buildings, such as houses, that are only two or three stories high, demolition is a rather simple process. The building is pulled down either manually or mechanically using large hydraulic equipment: elevated work platforms, cranes, excavators or bulldozers. Larger buildings may require the use of a wrecking ball, a heavy weight on a cable that is swung by a crane into the side of the buildings. Wrecking balls are especially effective against masonry, but are less easily controlled and often less efficient than other methods. Newer methods may use rotational hydraulic shears and silenced rock-breakers attached to excavators to cut or break through wood, steel, and concrete. The use of shears is especially common when flame cutting would be dangerous.

Demolition is defined as the isolation wards, destroy any building or structure or any part thereof, using the pre-planned and controlled procedures. Before carrying out any demolition, building assessment in detail is necessary by suitable investigating and assessing. In general, the assessment should include assessment and evaluation of structure with pictures and videos taken for the future. Based on these assessments, a demolition plan must be reviewed with a report and structural calculations to assess the sustainability of buildings destroyed and all buildings, structures, streets, land and relevant services.

Preventive measures before demolition

Fencing and implementation of the cloister

The main goal of fencing and implementation of the cloister is to provide public protection during the construction or demolition of buildings. In general, fencing separates demolition workshop area from the public environment and will prevent unauthorized access and transmission. Cloister with a protective pad provides more protection pedestrian crossing against falling debris

Scaffolding[†]

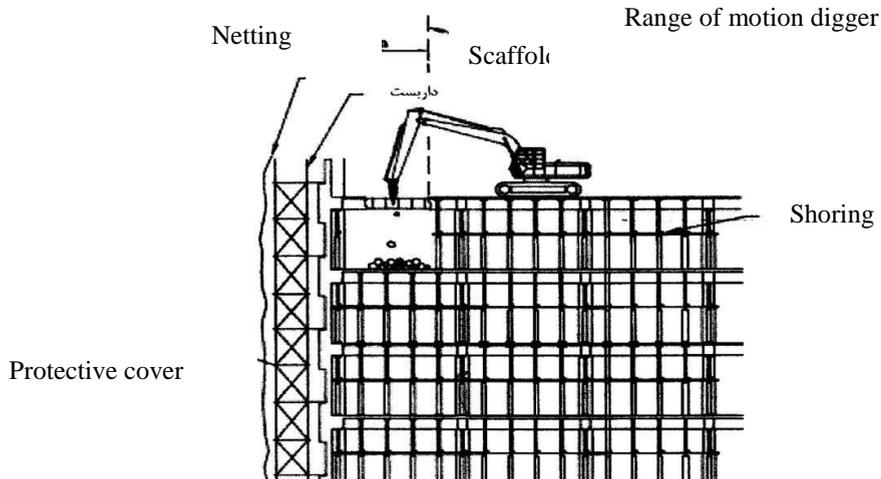
Metal scaffolds should be used in demolition projects. Metal scaffolding is acceptable, while is complying with safety regulations of construction sites and regulations for scaffold safety. Scaffolding supports must have sufficient resistance to vertical and lateral loads on the scaffold, including protective coatings, platforms, etc. work.

[†] **Scaffolding**, also called **scaffold** or **staging**, is a temporary structure used to support a work crew and materials to aid in the construction, maintenance and repair of buildings, bridges and all other man made structures. Scaffolding is also used in adapted forms for formwork and shoring, grandstand seating, concert stages, access/viewing towers, exhibition stands, ski ramps, half pipes and art projects.

There are four main types of scaffolding used worldwide today. These are Tube and Coupler (fitting) components, prefabricated modular system scaffold components, H-frame / facade modular system scaffolds, and timber scaffolds. Each type is made from several components which often include:

- A base jack or plate which is a load bearing base for the scaffold.
- The standard which is the upright component with connector joints.
- The ledger (horizontal brace).
- The transom which is a horizontal cross section load bearing component which holds the batten, board or decking unit.
- Brace diagonal and/or cross section bracing component.
- Batten or board decking component used to make the working platform.
- Coupler a fitting used to join components together.
- Scaffold tie used to tie in the scaffold to structures.
- Brackets used to extend the width of working platforms.

Specialized components used to aid in their use as a temporary structure often include heavy duty load bearing transoms, ladders or stairway units for the ingress and egress of the scaffold, beams ladder/unit types used to span obstacles and rubbish chutes used to remove unwanted materials from the scaffold or construction project.



Protective cover

The aim of protective covers design is to take small pieces of construction debris which pass protection nets, and protective covers are not designed in order to collect large pieces of construction debris which should be collected by the protection net.

Protection of traffic

Any obstruction of roads and sidewalks can strongly influence the movement of pedestrians crossing, causing public nuisance. In case of necessity, must be obtained prior authorization from the municipality and the traffic police. Temporary closure of the crossings, in exceptional cases, such as when there is no practical alternative to the destruction of building components such as balcony or front porch of the building, is permitted.

Demolition methods

Selection of demolition method depends on the project conditions, workshop restrictions, sensitivity and neighbors' sensitivity and the availability of equipment. Top-down demolition methods are applicable in most cases, especially, for those buildings are in crowded urban areas.

Other mechanical methods, which are performed outside of the building, are suitable for projects that have open space around their own.

In the case of corbelling, such as balconies, canopies and porch that are ahead of the building line, demolition can be safe solution by hand tools or cutting and lifting process. Methods which use metal balls and explosives should be done cautiously and carefully, and they are can be used when, adequate precautionary measures are scheduled.

Top-down approach (Manual)

Top-down approach is the way that starts from ceiling and continues to earth's surface. There are certain sequences of activities of the mentioned method, which may be different based on workshop situation, and structural components.

The sequence of demolition

The sequence of demolition stages should be determined based on actual conditions of workshop, limitations, building layout, structures layout and its construction. In general, the following shall apply:

All corbelling structures, canopies, porch and parts attached to the exterior walls and structures inside it must be destroyed first of all.

During the demolition of the structure, the floor of all elevator installations rooms and water tanks in height must be destroyed with top-down sequence of the main roof level.

Demolition of the floor slabs should be started from the central crater and continues towards the support beams.

Floor beams must be destroyed as follows:

Cantilevered beams

Then, the secondary beams

Then, the main beams of the building

Columns should be destroyed after the dismantling of the beams above.

The corbelling structures and balconies

The corbelling structures, balconies and porch may extend from an upper floor of a building towards the exterior and on the sidewalk, or in some cases on the part of the street.

Temporary support structures, protective platforms or temporary platforms must be placed directly below them as precautions.

Top-down approach (mechanical)

The sequence of demolition steps by machines generally has been applied as a top-down approach, except that most of the demolition operations are done by mechanical equipment. Demolition begins by raising mechanical machinery on the highest floor in the building.

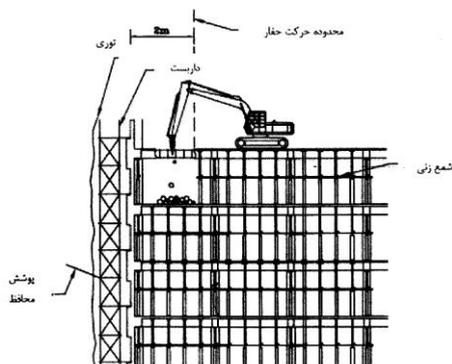
Raising Machines

Mechanical machinery must be placed on top of buildings by cranes and other machinery approved by a licensed structural engineer. Operational area should be blocked while raising machines. If you need to block the interim route, the relevant permissions must be obtained from the police and the municipality before the start of operations.

Machines' supports

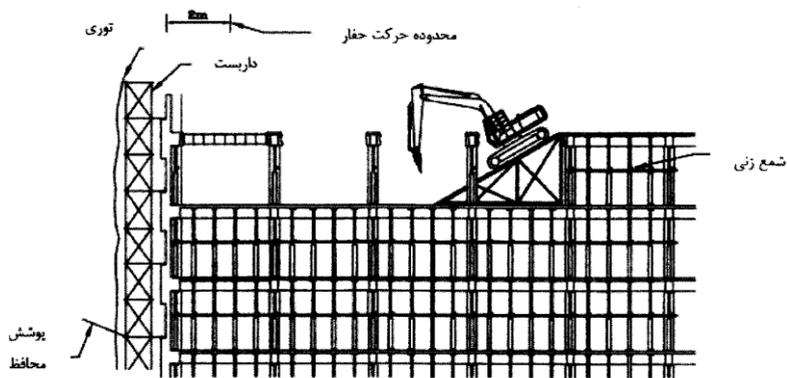
Load applied by the machine to the floor should be investigated. If needed, shoring must be done on the lower floors of the floor which is being destroyed to remain the machines in safe conditions.

Relocation of machinery must be carried out only within the shoring range.



Build a temporary ramp

Machinery should be transferred by the ramp to the lower classes. The slope of the ramp must not more than 1.75 to 1 or the amount recommended by the manufacturer of the machines. As an alternative method, the machines can bring down.



Mechanical machines handling is prohibited in the following areas:

- ❖ Within two meters from the edge of the building
- ❖ Within 1 meter of floor openings
- ❖ *Any cantilevered structures*

The sequence of demolition

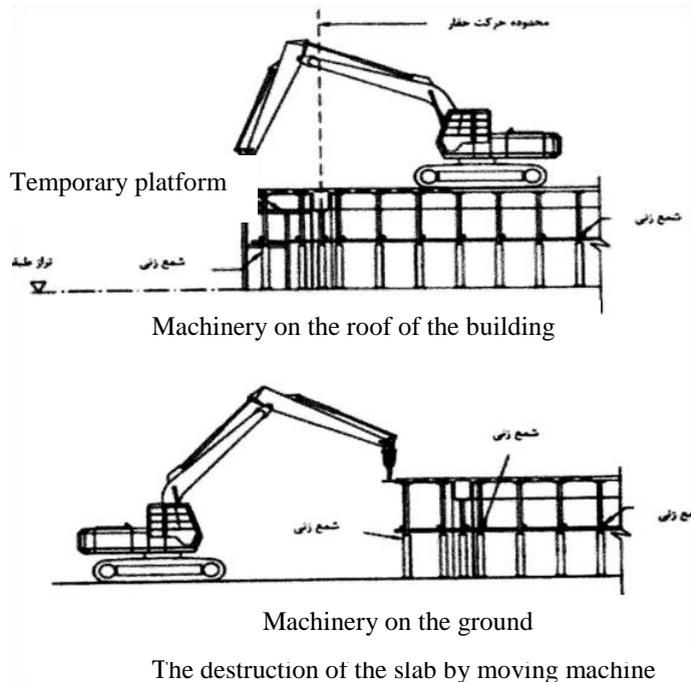
The demolition must be carried out in accordance with the following steps:

- A. All the corbelling slabs and beams such as porch must be destroyed first of all and before demolition of internal classes.
- B. Structural components should generally be destroyed in the following order:
 - ❖ Slab
 - ❖ Then, the secondary beams
 - ❖ Then, the main beams of the building

Wall panels, including beams and columns, should be destroyed gradually and in a controlled manner.

Corbelling porch and balconies

Demolition of porch and balconies, can severely jeopardize public safety, and should be done with caution and great care. Anchor temporary structures, temporary or protection platforms should be placed just under the porch or balcony.



Wrecking ball method[‡]

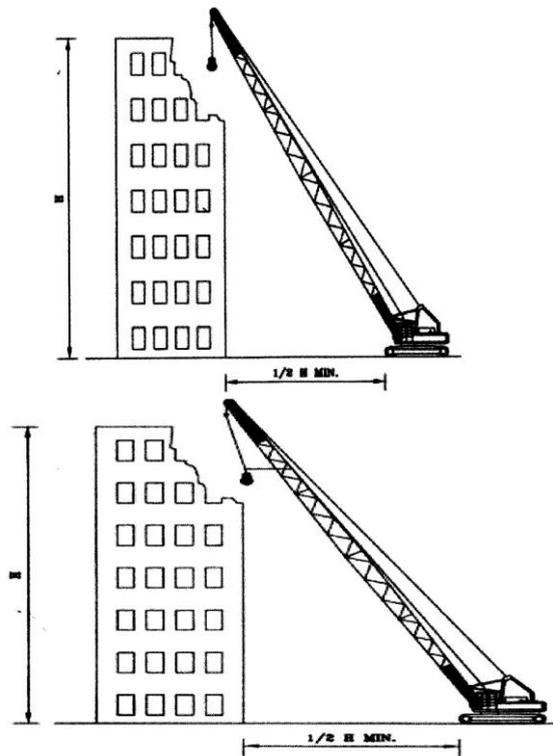
The wrecking ball is formed of a crane with a steel ball. Demolition of building is done by the impact energy of steel balls suspended from a crane tracked. The wrecking ball acts from outside of the building. The procedure is suitable for dilapidated buildings, silos and other industrial facilities. However, the operation requires a lot of free space around the device. Also, operators with high skills and appropriate equipment are needed.

Terms of use

- A. Except for special cases, the demolition of any part of the building should be done from top to bottom.
- B. Suggested techniques for using the wrecking ball include:

[‡] A **wrecking ball** is a heavy steel ball, usually hung from a crane that is used for demolishing large buildings. It was most commonly in use during the 1950s and 1960s. Several wrecking companies claim to have invented the wrecking ball. An early documented use was in the breaking up of the SS *Great Eastern* in 1888-1889, by Henry Bath and Co, at Rock Ferry on the River Mersey.

In 1999, the wrecking ball was described as "one of the most common forms of large-scale coarse demolition." Although the wrecking ball is still the most efficient way to raze a concrete frame structure, its use is decreasing. With the invention of hydraulic excavators and other machinery, the wrecking ball has become less common at demolition sites as its working efficiency is less than that of high reach excavators.



General impact of the free fall of wrecking ball on structures

Blasting method

If you want to blow up a building, specialized contractor which has demolition license must prepare a comprehensive risk assessment report and an environmental assessment report on the blasting effects on workshop's neighbors. In case of a positive outcome for risk assessment, and assessment of environmental impacts, and agreements of relevant authorities, specialized licensed blasting contractor can begun the study of the building structure, and provide a blasting plan. The plan can include initial weakening of the structure, strategy for inserting explosives and delay time, so the building can be destroyed safely. Primary weakening of the structure can include cutting and removing a portion of the shear walls and other structural components, the protection of adjacent property, and residents are also important considerations.

Public concerns

Public concerns to run properly demolition by the blasting, are as follows:

- A. The initial weakening of the structure must be designed in such a way that, you must ensure the stability of the structure prior to the blasting.
- B. To reduce the broadcasting of construction debris near the ground after the blasting, a channel or levee walls must be installed outside the building to accommodate the trash unless there is an enough space in the basement of the building to do it.
- C. Also, an exclusion zone must be determined in the design, and all residents or residents in the area were evacuated during the blasting. Radius of the exclusion zone is generally not less than 2.5 times the height of the building. The effects of noise and dust caused by the blasting must be considered.

- D. Emergency plan must be considered to handle emergencies such as burst prematurely and fail to prepare explosives.
- E. A good design makes the structure collapse toward the center of the building or within the protected area.
- F. After the blasting, a blasting expert must review and ensure that there is no unexploded explosive in the workshop. All areas must be exploded until all explosives are used, or must be controlled as safe by a blasting expert, and remain under the control of security.
- G. If possible, non-electric blasting systems must be used to minimize the risk of premature blasting caused by stray electrical currents or electromagnetic waves output or radio frequencies.

Mechanical demolition



Mechanical method by wire rope



Mechanical method by stress-strain manipulator
to outside

Mechanical method by stress-strain manipulator to
inside

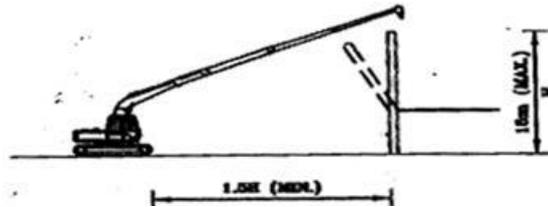
Mechanical demolition generally involves the use of huge machinery with tools to fragment the building from outside it. Conventional mechanical methods include the use of stress Manipulators and wire rope. These methods should only be used in a single building on flat land.

Concerns related to the correct way of mechanical demolition

1. Machines should be used on a flat and stable surface, and have a proper counterweight to prevent the reversal during the operation.
2. Equipment such as transformers and cables should be inspected frequently, and if necessary, they should be repaired or replaced.
3. Sprinkling enough water or other proactive measures should be provided to reduce pollution caused by dust.
4. Impact effects related to structural sections destroyed on the ceiling or floor must be checked, to prevent overload ceiling, vibration and disturbance to adjacent properties and damage to underground utilities.
5. The machine cabin should have Impact-resistant glass, and have sufficient strength to protect the operator against falling debris.

Mechanical method of stress manipulator

This method involves the use of machines equipped with stress manipulator for entering horizontal impacts and demolition of the structural components.



Mechanical method by stress manipulator to inside

Certain circumstances for demolition using this method are as follows:

1. The manipulator must be made of steel or similar material, and has sufficient resistance to the construction work.
2. The minimum safe distance between the machine and the building must be maintained to apply pressure on the building which is equal to half height of building component which demolition operations will be done for it.
3. The point of applying pressure should be lower than two-thirds of the height.
4. The use of this procedure should be limited to buildings with a height of less than 15 meters.

Mechanical methods to collapse buildings as predicted

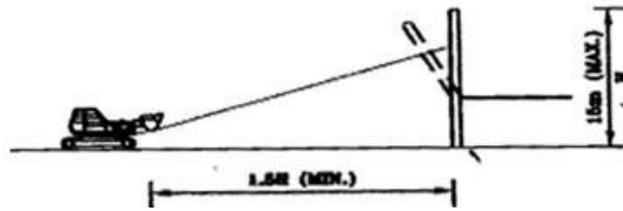
The method generally includes weakening the key structural elements to the collapse of structures.

Specific conditions of application of this method are as follows:

1. The minimum safe distance of 1.5 times the height of a building being demolished should be preserved during the demolition.
2. Instructions should be carefully designed and remove structural components must be designed and implemented carefully to prevent early demolition, and debris must be collapsed on the predicted places.
3. Mechanical methods for demolition of the building as predicted must be limited to buildings with a height of less than 15 meters.

Mechanical method by stretching the wire rope

Mechanical demolition, by stretching the wire rope, generally involves the use of a displacer machine, equipped with a sturdy steel cable, to bring down the structural components.



Mechanical method by wire rope

1. A safe distance to 1.5 times the height of the components being destroyed must be maintained between the machine and the building during the operation.
2. During operation the machine must always move in parallel stretching line.
3. Wire rope or chain must be made of steel with a tensile stress of more than 4 times the theoretical force required for stretching.
4. Any sharp edge of the wire rope should be wrapped around it, should be worn to minimize the possibility of a cut or tear during stretching rope.
5. The lower part of the walls can be weakened accurately and adequately to control the building collapse.
6. Stretching method using the wire rope should be limited to buildings with a height of less than 15 meters.

Conclusion

After reviewing the relevant instructions, guidelines and procedures of the demolition were studied. And then, a comprehensive set of rules that cover all aspects of demolition, was developed. It was said that the law on the one hand must consider the environment and surrounding residents, and on the other hand, should determine the role of the Executive factors associated with demolition. In general, it should be said that the best new methods which is used for demolition include top-down approach (manual and mechanical), building temporary ramps, using the wrecking ball, blasting method and mechanical damage, which minimize human and financial losses by reducing the risks of destruction.

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