



## Demolition Techniques and its safety measures

Sarath Kumar M (construction Engineering And Management),  
Department of Civil Engineering, Meenakshi Sundararajan Engineering College

Mohammed Sirajuddeen I (Construction Engineering And Management),  
Department of Civil Engineering,  
Meenakshi Sundararajan Engineering College

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**Abstract.** We know every structure is designed for a life period. The existence of the structure after the service life period is very dangerous to its occupants and surrounding buildings. The building act usually contains provisions that enable local authorities to control demolition works for the protection of public safety and to ensure adjoining premises and the site are made good on completion of the demolition. A notice of conditions is issued that require certain works to be undertaken to achieve these aims. Demolition of a building means tearing down or falling down of a building with the help of equipment's or explosives. This report deals with how a demolition work is to be performed safely and also elaborates different steps involved before and during the execution of a demolition process. The various steps involved before the demolition process includes surveying, removal of hazardous materials, and preparation of demolition plan, stability report and the precautionary safety measures to be taken. The main equipment's used for these demolition activities are sledge hammer, excavators, bulldozers, wrecking balls etc. and main explosives used are dynamites and RDX. When explosive are used for the demolition, it is known as Implosion.

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**Keywords** – Demolition, dismantling, building, collapse, precautions.

### I. INTRODUCTION

Demolition is the process of destroying down or dismantling or collapsing down of large buildings after its useful life period. The process of demolition is carried out with the help of some equipment or other methods with legal procedure followed by the consent of the local authority. We know that every structure is designed for a specific life period generally 100 years. The existence of the structure after the service life period is over is very dangerous to its occupants and surrounding buildings. The purpose of demolition is to prevent the accidental collapse of any part of the building and to ensure safety of workers, public and neighbouring properties.

Prior to carrying out any building demolition, detailed building appraisal by means of surveys and appropriate assessments shall be required which shall include a building survey and a structure survey. Increased concern for environmental protection has led governments to introduce legislation to encourage the use of construction demolished waste after recycling it. Demolition sites are the sources of large amounts of solid waste, which today is being used as mere landfill. On the other hand, building practices are such that reusable materials also become mixed with rubble, stone and soil, reducing their value and making recycling difficult or uneconomical. A building waste recycling as aggregates is a modern approach for preventing environmental pollution through reducing the stocks of waste. The reuse of building waste is a relatively new issue for the world despite the existing considerable quantity of building waste. Demolition work is one of the most important operations in construction engineering field. If demolition activity is not done carefully it may result into severe consequences. The various causes of consequences of demolition of buildings are as follows -

- i. Injury to human workers due to the difficulty of accessing into or working inside a building which is under demolition.
- ii. Falling of smaller objects or debris from the demolishing building.
- iii. Falling of partially demolished structure.
- iv. Collapse of unstable structure due to original structure being disturbed.
- v. Employing inappropriate methods to demolish.
- vi. Collapse of heavy demolition equipment due to inadequate support of the partially demolished structure.
- vii. Collapse of the partially demolished structure due to the accommodation of large amount of unclear debris.
- viii. Congested site environment that easily cause damages to human workers or to the third parties that are situated nearby the demolition site.
- ix. Difficult access for workers entering into a building under demolition
- x. Heavy machinery used in demolition may have risk of collapse due to insufficient support.

To avoid these consequences from demolition work, it is necessary to understand complete process of demolition of building



## LITERATURE REVIEWS

**Title - Demolition of Structures Using Implosion Technology**

**Author -M.tech Student, Dept of Civil Engineering, TIST, Kochi, Kerala, India.**

**Co-author-Associate Professor, Dept Civil Engineering, TIST, Kochi, Kerala, India**

**Content** -In order to demolish a building safely, blasters must map out each element of the implosion ahead of time. The first step is to examine architectural blueprints of the building, if they can be located, to determine how the building is put together.

**Conclusion-** Demolition method applied in a structure depends upon various factors such as site condition, type of structures, age of building, height of building and economy and most important its location with presence of its surrounding with its structural stability. Controlled demolition of building is necessary to ensure safety of both the workers and the surroundings so as to cause least amount of injuries and accidents. Building implosion is the strategic placing of explosive materials and timing of its detonation so that a structure collapses on itself in a matter of seconds, minimizing the physical damage to its immediate surroundings.

## II. DEMOLITION OF BUILDINGS

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. Demolition methods can vary depending on the area where it will be held on, time available, the building material, the purpose of the demolition and the way that debris is going to be disposed. Times saving methods are more expensive than the slower ones.

### 2.1. Pre-planning of demolition activity

The different steps before the start of a demolition process are -

#### 2.1.1. Surveying of Site

Study of different parameters with different views of the structure and its surroundings with structural point of view is carried in surveying. The two types of surveying which are mainly conducted are building surveying and structural surveying.

#### 2.2.2. Removal of hazardous materials

Before starting demolition of building hazardous materials if any, such as asbestos containing materials, petroleum contamination and radioactive contamination, etc exist in the building are removed. Further investigation and removal of such hazardous material or contamination by experts shall be done.



### **2.2.3. Preparation of plan for demolition work**

Demolition Plan and strategy is prepared which includes the following -

- a. The building location to be demolished.
- b. Topography of the site with its ground level contours and sections of the slopes and ground supported by the building where appropriate in detailed.
- c. Details of ground removal and/or backfilling.

### **2.2.4. Required stability report**

The Stability Report shall include the following parts -

- a. A report on the stability of the building to be demolished during all stages of demolition.
- b. In the case when powered mechanical plants or equipment are used, structural calculations for all temporary supports and bracings.
- c. A report on the stability of neighbouring buildings, adjoining properties.

## **III. METHODS OF DEMOLITION**

The demolition sequence will depend on things like the type of construction, location, and demolition methods selected. Buildings and structures should generally be demolished in reverse order to their construction, that is, by „sequential demolition“. The different methods of demolition are as below –

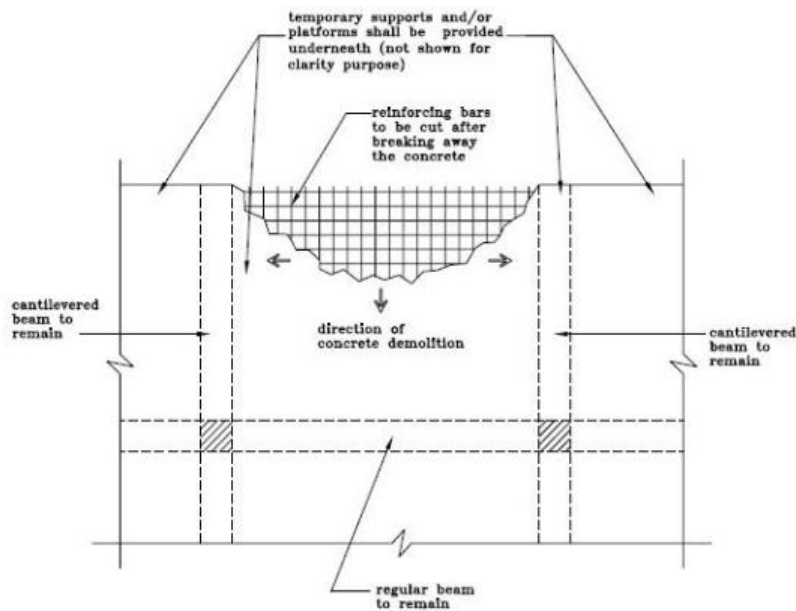
### **3.1. Demolition of building by Top Down- Manual Method**

Manual methods are carried out top down, proceeding, in general, from the roof to ground. The particular sequence of demolition may vary, depending on site conditions and structural elements to be demolished.

#### **3.1.1. Demolition of Cantilevered Structures and Balconies**

Cantilevered structures, balconies and canopies may project out of the building over the pedestrian footpath or in some cases over a portion of the traffic lane. Figure 1. Illustrates the demolition of cantilevered slab. The general sequence of dismantling cantilevered slabs and beams are described in the following –

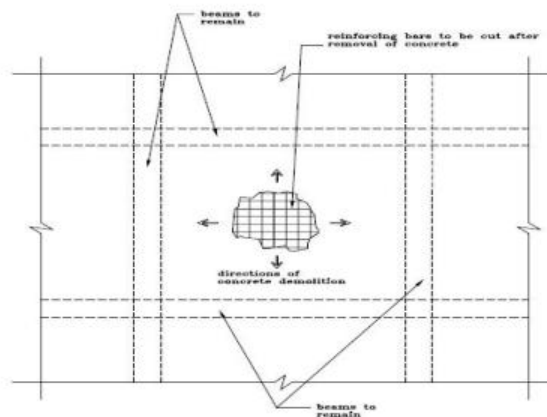
- i. The exterior wall shall be demolished first.
- ii. Any structure or dead load supported by the cantilevered system shall be removed prior to demolishing the cantilevered slabs and beams.
- iii. The concrete shall be broken down gradually starting from the exterior edge of the cantilevered floor, working inwards and toward its supporting beams.



**Figure 1. Demolition of cantilevered RCC slab (Manual method)**

## 1.2. Demolition of Floor Slabs

Reinforced concrete floor slab shall be demolished by gradually breaking away the concrete. The reinforcement shall remain and be cut off after the concrete is broken away.

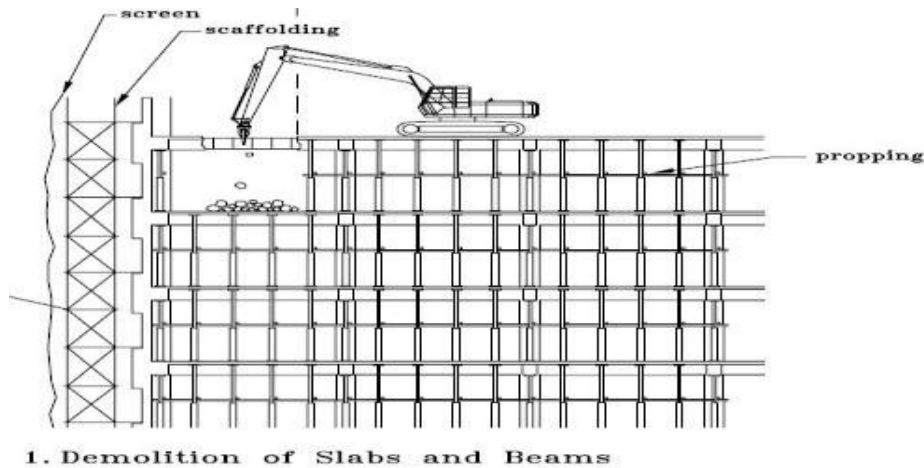




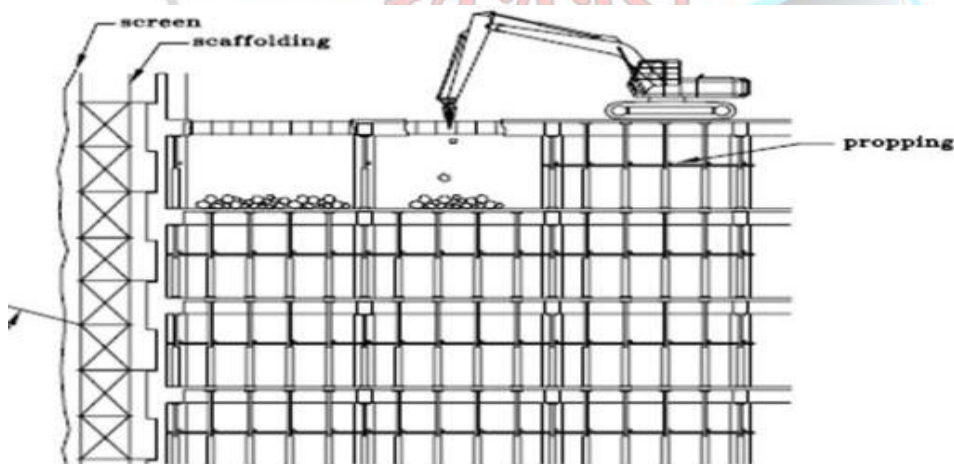
**Figure 2. Demolition of slab**

### Demolition of building by Top Down- by Machines

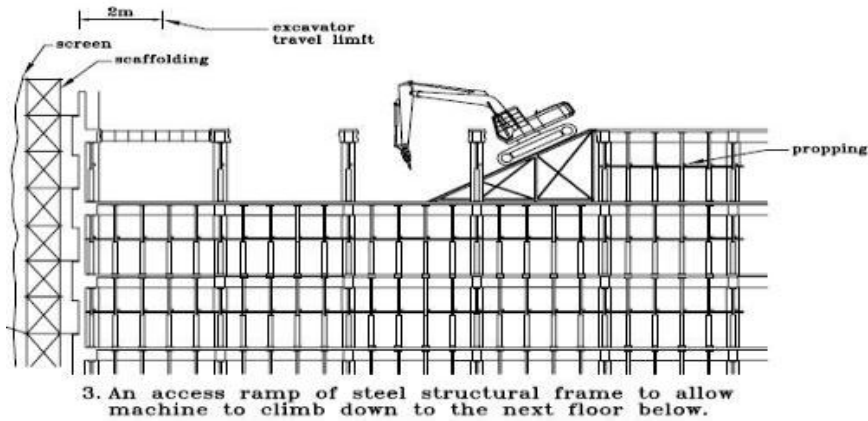
The sequence of demolition by machine is typically the same as the top down manual method, except that most the demolition is done by mechanical plant. The demolition begins with the lifting of the mechanical plant on to the building top floor. When rope or tie wire is used for pulling, the workers shall be protected or stay away from the area within reach of the rope or tie wire. The concrete shall be broken away first before the cutting of reinforcement. Alternatively the reinforced concrete slab may be cut by saw cutting. Demolition sequence would be as shown in following figures.



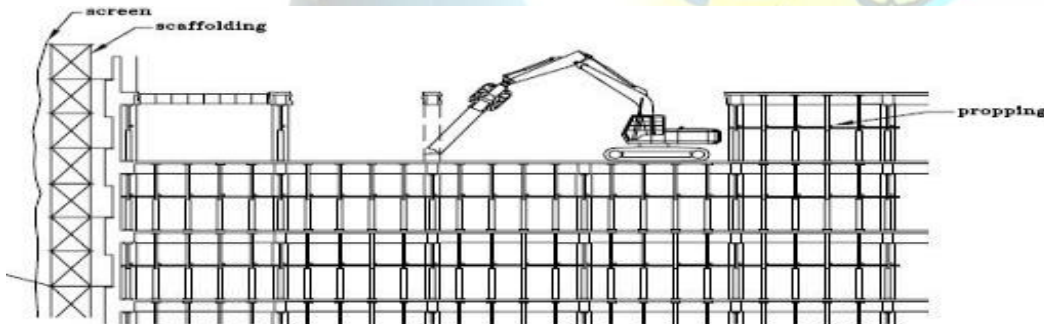
**Figure 3. Demolition of Slabs and Beams**



**Figure 4. Continue Demolition of Slabs and Beams**



*Figure 5. An access ramp to allow machine to climb down to the next floor below*



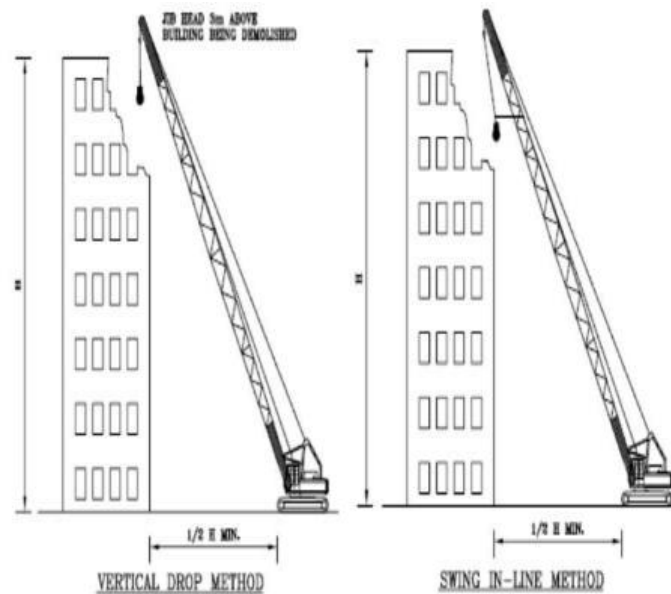
*Figure 6. Demolition of interior column*

### 3.3. Demolition of building by Wrecking Ball

The wrecking ball application consists of a crane equipped with a building is by the impact energy of the steel ball suspended from techniques for the wrecking ball operations include steel ball. The destruction of the crawler crane. Recommended

- i. Vertical Drop - free falling of the wrecking ball onto the structure and
- ii. Swing in line - swinging of the ball in-line with the jib.

Figure 7 illustrates the operation through Wrecking Ball.



**Figure 7. Operation using Wrecking Ball**

### 3.4. Demolition of building by implosion

Implosion is the strategic placing of explosive material and timing of its detonation so that a structure collapses on itself in a matter of seconds, minimizing the physical damage to its immediate surroundings. [5] proposed a system, this fully automatic vehicle is equipped by micro controller, motor driving mechanism and battery. The power stored in the battery is used to drive the DC motor that causes the movement to AGV. The speed of rotation of DC motor i.e., velocity of AGV is controlled by the microprocessor controller. This is an era of automation where it is broadly defined as replacement of manual effort by mechanical power in all degrees of automation. The operation remains an essential part of the system although with changing demands on physical input as the degree of mechanization is increased. The technique weakens or removes critical supports so that the building can no longer withstand the force of gravity and falls under its own weight. Implosion are discussed in the following -

- i. Pre-weakening of the structure shall be designed to ensure the structural stability before the implosion.
- ii. To minimize the dispersion of building debris into adjoining land after implosion, a trench or bund wall shall be installed outside the building to contain the debris, unless a basement exists.





- iii. A good design will cause the structure to fall towards the centre of the building and/or within the protected area.
- iv. A good design will provide adequate and sufficient time delay to allow only one or two floors of the building debris to fall on ground level at a time in order to limit the magnitude of the impact on the ground.
- v. The design must also identify an exclusion zone to evacuate all residents or inhabitants during the implosion.
- vi. The structural safety of the building to be imploded shall be checked and certified to be sound and safe at all stages prior to implosion.

#### **IV. PROTECTIVE PRECAUTIONS FOR DEMOLITION**

Safety precautions must be taken to safeguard persons working on the site and members of the public who are in the vicinity, as well as to protect property likely to be affected by the demolition.

##### **4.1. Precautions regarding Machinery / Equipment**

The following precautions should be taken regarding machinery/ equipment -

- i. All dismantling equipment should be operated by competent persons with appropriate training.
- ii. These equipment should be used and maintained as recommended by the equipment's manufacturer or supplier.
- iii. Lifting equipment should be thoroughly examined by an authorized examiner at least once every 12 months for those lifting goods or materials or once every 6 months for those lifting personnel.

##### **4.2. Precautions regarding Scaffolding**

The following precautions should be taken regarding scaffolding -

- i. Scaffolds above 4m in height (excluding tower and trestle scaffolds) should be erected, installed, added, altered or dismantled by an approved scaffold contractor.
- ii. Working platforms should be free from debris.
- iii. Every scaffold should have at least one designated access point.
- iv. Care should be taken to prevent damage to scaffolding components from falling debris.



#### **4.3. Precautions regarding Public Safety**

The following precautions should be taken regarding public safety -

- i. The demolition site should be properly barricaded with appropriate warning signs posted.
- ii. No unauthorized entry should be permitted in the demolition site.
- iii. Catch platforms should be provided where exterior walls or roofs are being demolished.
- iv. Movement of machinery from floor to floor should be considered in the demolition procedures.
- v. The use of dismantled debris to form access ramps for machinery may lead to overloading of floors.

#### **4.4. Precautions regarding Worker Safety**

The following precautions should be taken regarding worker safety -

- i. Workers involved in demolition works must be provided with appropriate training and instructions to carry out demolition works safely.
- ii. Supervision is needed to ensure that only those workers who have received training and instructions are authorized to carry out the work.
- iii. All personnel assessing the demolition site must be provided with safety boots and helmets.



- iv. Workers should, when necessary, be provided with appropriate personal protective equipment such as goggles, hearing protection devices, safety harness, gloves, protective clothing, etc.
- v. Appropriate respirators for dust or chemicals should also be provided.

## V. PROBLEMS IN DEMOLITION OF BUILDINGS

The problems which may arise while carrying out the building demolition are as follows -

- i. Accidents due to persons falling from high, unprotected workplaces and through openings.
- ii. Accidents due to persons being struck by falling objects.
- iii. The building collapsing suddenly and unexpectedly may cause death of the workers.
- iv. Insecure materials in or on the structure.
- v. Exposure to dust, chemicals, and noise influence the occupational health.

Demolition of buildings involves various demolition activities which cause influence on the environment which ultimately give rise to pollution.

## VI. CONCLUSION

It is concluded that before carrying out any demolition works, building survey must be done carefully, so that it may not cause any severe damage to the environment, public and adjacent properties around the building which is to be demolished. Any type of building to be demolished, its method depends upon various factors such as site condition, type of structures, age of building, height of building and economy and most important its location with presence of its surrounding with its structural stability. Controlled demolition of building is necessary to ensure safety of both the workers and the surroundings so as to cause least amount of injuries and accidents. Explosive or implosion demolition is the most preferred method for safely and efficiently demolishing the larger structures which requires a very high precision. The procedure of demolishment should be carried out with the aim of minimizing the risks of causing damage to persons and properties of the public, endangering the health and safety of site personnel and damaging the neighbourhood environment.

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