

Study of safety in demolition of buildings

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Abstract - Every structure is designed for a specific life period, generally 100 years. The existence of the structure after the service life period is very dangerous to its occupants and surrounding buildings. Therefore, it becomes essential to demolish the building. Demolition is the tearing-down of buildings which involves taking a building apart while preserving the valuable elements for re-use. There are various methods of demolition. The building is brought down either manually or mechanically depending upon the method used for demolition of buildings. Equipment's used for demolition work are hammers, rammers, excavators, bulldozers, wrecking ball and the explosives used are dynamites and detonators etc which is generally preferred for tall buildings. The various steps involved before the demolition process includes surveying of the demolition site, removal of hazardous material and safety precautionary measures. The study also includes the precautionary measures regarding machinery or equipment's, scaffolding, public safety and worker safety. Various strategies of demolition waste have been reported in literature for implementing good practices for demolition of buildings.

Key Words: Demolition, Safety, building, dismantling, Scaffolding.

1.INTRODUCTION

In general, demolition can be defined as wrecking or taking out of any load supporting structural element of a building (houses, commercial establishments, and office buildings) or non-building facility (highways, streets, and other non-inhabitable construction projects).

The era of demolition is begun centuries ago. Nowadays, this industry brings a lot of potentials and become highly sophisticated business and also requiring expertise and competent persons. Demolition and construction, two major types of building and structural industry definitely opposite against each other in many conditions and have a lot of different. "It's a popular misconception that demolition is nothing more than knocking down a structure and hauling the debris to a landfill. That assumption is wrong on many counts, especially: First, the process of planning for and completing a demolition project is far more thorough and complex than simple knockdown. Second, demolition contractors are master of recovering valuable materials and minimizing need for disposal. Almost of the structure is salvaged for reuse and recycling then make the cost saved

and bring more profit for the owner. Demolition is very high-risk job, complex and unique required well knowledge and strict regulation and precaution measurement that must be followed to avoid any damage to human life and environment.

2. 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 Techniques for Structure Demolition

Three types of structure demolition.

- I. Progressive Demolition
- ii. Mechanism of Control Demolition
- iii. De construction or Top Down

2.1.1 Progressive Demolition

Progressive demolition is a technique to demolish, wrecking or taking out of any load-supporting structural member part by part before the building completely fall (fully or partially demolish) at the same time considered the structure stability so the building will not collapse simultaneously. It is commonly adapted to high rate of catch area and commonly practices using heavy machinery and equipment's. The heavy machinery or equipment includes large motorized vehicles such as bulldozers with rakes, backhoes, hydraulic excavators, and other similar machinery used for transporting, moving of materials at a demolition site. Cranes equipped with wrecking balls, clamshells, or buckets are also considered heavy machinery.

2.1.2 Mechanism of Control Demolition

Control demolition is a technique to demolish, wrecking or taking out of the main structural member or element before the building completely fall, fully or partially demolish. Equal to progressive demolition; it is commonly adapted to big

catch area condition and usually practiced using explosion/implosion and wire rope pulling methods or any other suitable method.

2.1.3 De construction or Top Down

Deconstruction or Top down method is the technique that proceeds from the roof to ground in a general trend, there are particular sequences of demolition which may vary, depending on site conditions and structural elements to be demolished, It is the process of dismantling a building in order to salvage the structural members for material reuse and recovery and commonly practices by machinery and hand demolition methods, lop down method is applicable for most sites, particularly for those situated in busy urban areas.

3. 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.

3.2 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. The general sequence of dismantling cantilevered slabs and beams are described in the following –

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

3.3 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.

3.4 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 of 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.

3.5 Demolition of building by Wrecking Ball

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

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

3.6 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. 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 –

- Pre-weakening of the structure shall be designed to ensure the structural stability before the implosion.
- 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.
- A good design will cause the structure to fall towards the centre of the building and/or within the protected area.
- 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.
- The design must also identify an exclusion zone to evacuate all residents or inhabitants during the implosion.

- 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.

4. HAZARDS IN DEMOLITION OF BUILDINGS

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

- Accidents due to persons falling from high, unprotected workplaces and through openings.
- Accidents due to persons being struck by falling objects.
- The building collapsing suddenly and unexpectedly may cause death of the workers.
- Insecure materials in or on the structure.
- Exposure to dust, chemicals, and noise influence the occupational health.
- Injury to human workers due to the difficulty of accessing into or working inside a building which is under demolition.
- Falling of smaller objects or debris from the demolishing building.
- Falling of partially demolished structure.
- Collapse of unstable structure due to original structure being disturbed.
- Employing inappropriate methods to demolish.
- Collapse of heavy demolition equipment due to inadequate support of the partially demolished structure.
- Collapse of the partially demolished structure due to the accommodation of large amount of unclear debris.
- Congested site environment that easily cause damages to human workers or to the third parties that are situated nearby the demolition site.
- Difficult access for workers entering into a building under demolition
- 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.

5. 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.

5.1 Precautions regarding Machinery / Equipment

- All dismantling equipment should be operated by competent persons with appropriate training.
- This equipment should be used and maintained as recommended by the equipment's manufacturer or supplier.
- 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.

5.2 Precautions regarding Scaffolding

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

5.3 Precautions regarding Public Safety

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

5.4 Precautions regarding Worker Safety

- Workers involved in demolition works must be provided with appropriate training and instructions to carry out demolition works safely.
- Supervision is needed to ensure that only those workers who have received training and instructions are authorized to carry out the work.
- All personnel assessing the demolition site must be provided with safety boots and helmets.
- Workers should, when necessary, be provided with appropriate personal protective equipment such as

goggles, hearing protection devices, safety harness, gloves, protective clothing, etc.

- Appropriate respirators for dust or chemicals should also be provided.

6. SAFETY MEASURES

6.1 Training and Communication

Demolition workers, including plant or equipment operators, shall go through proper job safety training and be aware of the potential hazards by attending training sessions as well as on-the-job training.

6.2 Equipment Maintenance

All equipment shall be examined before use. They shall be properly tested, stored and maintained. The equipment shall be inspected daily and results of the inspection shall be recorded. A detailed safety instruction shall be provided to cater for specific situations of the project, if necessary.

6.3 Electrical Safety

A properly connected power source from a local electric utility supplier or a mobile electricity generator shall be utilized in demolition sites. The safety requirements given in the Factories and Industrial Undertakings (Electricity) Regulations shall be adhered to.

6.4 Fire

All flammable goods shall be removed from site unless they are necessary for the works involved. Any remaining flammable goods shall be stored in proper storage facilities. All furniture, timber, doors, etc. shall be removed before any welding work is performed. Firefighting appliances shall be provided and maintained in working conditions. The Construction Site (Safety) Regulations require the contractor to maintain in good condition and free from defects all firefighting appliances provided in such construction site.

6.5 Occupational Health

The health of workers on site shall be properly protected in accordance with the relevant subsidiary regulations of the Factories and Industrial Undertakings Ordinance and the Occupational Safety and Health Ordinance with particular attention to areas such as: Exposure to Dust, Chemical Exposure, Heat Stress and Ventilation, Noise Exposure, Medical and First Aid Facilities, Sanitation and Occupational Diseases.

6.6 Emergency Exit Requirements in Demolition Sites

Emergency exits shall be provided during building demolition. In case of any emergency evacuations, the emergency exit will serve as a lifeline for transportation of injured workers. A minimum of one exit route shall be maintained and designated as the emergency exit at all times during the demolition. Adequate lighting and fire extinguishing equipment shall be provided. Emergency exit shall be properly protected, free of obstruction, and properly marked with exit signs or other indications to clearly show the route. All workers shall be informed about the exit route.

6.7 Vibration

Demolition work will cause vibration to neighbouring buildings or structures to various extents, depending on the method of demolition. The most serious vibration is caused by implosion. The effect of vibration caused by implosion is categorized as follows: -

- Permanent ground distortion produced by blast-induced gas pressures;
- Vibratory settlement of foundation materials;
- Projectile impact (blast fly rock)
- Vibratory cracking from ground vibration or air blast.

6.8 Environmental Precautions

6.8.1 Air Pollution

Concrete breaking, handling of debris and hauling process are main sources of dust from building demolition. Dust mitigation measures complying with the Air Pollution Control (Construction Dust). Regulations shall be adopted to minimize dust emissions. Burning of waste shall not be allowed. Diesel fumes generated by mechanical plant or equipment shall be subject to the control of the Air Pollution Control (Smoke) Regulations.

6.8.2 Noise

Noise pollution arising from the demolition works including, but not limited to, the use of specified powered mechanical equipment (SPME), powered mechanical equipment (PME), such as pneumatic breakers, excavators and generators, etc., scaffolding, erection of temporary works, loading and transportation of debris, etc. affects the workers, and the sensitive receivers in the vicinity of the demolition site. Silent type PME shall be used to reduce noise impact as much as practicable. Demolition activity shall not be performed within the restricted hours as established by Environmental Protection Division (EPD). Currently under the Noise Control Ordinance, noise from the use of SPME and

PME within restricted hours is governed by a Construction Noise Permit (CNP) system.

6.8.3 Water

The discharge of wastewater from demolition sites requires a valid discharge license from the EPD and the application of such a license shall be made under the Water Pollution Control Ordinance (WPCO). Effluent shall be treated to the standards as stipulated in the license before discharge.

6.8.4 Hazardous Materials

If removal of asbestos containing material is needed, an Asbestos Investigation Report (AIR) shall be submitted to EPD. An Asbestos Abatement Plan (AAP) shall be submitted at least 28 days before the asbestos abatement work commences. The asbestos abatement works shall be carried out in accordance with the Air Pollution Control Ordinance (APCO) and the Factories and Industrial Undertakings (Asbestos) Regulations before demolition. Other materials such as LPG cylinders in domestic flats, toxic and corrosive chemicals for industrial undertakings, and any other hazardous materials have to be identified and properly handled and removed prior to the commencement of the demolition of the building. The management of waste must fully comply with the Waste Disposal Ordinance. Additionally, management of waste which is classifiable as a chemical waste must also comply with the Waste Disposal.

7. 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. 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 neighborhood environment.

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